EXPLORING THE RELATIONSHIP BETWEEN ACADEMIC TECHNOLOGY USE, NON-ACADEMIC TECHNOLOGY USE, AND GROSS DOMESTIC PRODUCT ON THE 2009 PROGRAM FOR INTERNATIONAL STUDENT ASSESSMENT (PISA) DIGITAL READING ASSESSMENT

by

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DISSERTATION ABSTRACT

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Title: Exploring the Relationship Between Academic Technology Use, Non-Academic Technology Use, and Gross Domestic Product on the 2009 Program for International Student Assessment (PISA) Digital Reading Assessment

Students' use of technology for the purpose of academic and leisure pursuits is ever increasing. Technology access, and its subsequent use for the many varied forms of digital reading, is particularly timely and relevant for high school aged students that will likely interact with digital reading for years to come. The relationship between academic technology use, non-academic technology use, and students' scores on the 2009 Program for International Student Assessment (PISA) supplemental Digital Reading Assessment (DRA) as they related to gross domestic product (GDP) were explored in this study. Research questions were answered using extant data collected from the DRA and Information Communication Technology (ICT) survey portions of the 2009 PISA. Results indicated that academic and non-academic technology use ICT survey items were moderately correlated, however the academic and non-academic survey items were only weakly correlated to the DRA score. Moreover, the non-academic mean score was significantly higher than the academic mean score survey items. Finally, a regression analysis showed that GDP accounted for 3.28% of the variance; the non-academic survey explained 0.27% of the variance, while the academic technology use survey items only accounted for .05% of variance in the DRA. The relationship between academic and non-academic technology use as well as countries' overall DRA and GDP is further explored in the discussion.

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Buy the Ticket - Take the Ride.

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CHAPTER I

LITERATURE REVIEW

Access to Technology

Increasing a student's digital reading, in both academic and non-academic settings requires access to technology. Research shows that students today are using technology both at home and at school for the purposes of academic support and leisure endeavors (Lenhart, Purcell, Smith & Zickuhr, 2010). There is evidence that students with greater access to digital technology perform at higher levels academically than students who have less access (Thompson & De Bortoli, 2007). For example, Thompson and De Bortoli (2007) noted that students with access to computers at home scored 61 score points higher on the Program for International Student Assessment (PISA) mathematics assessment than those without similar access (average score 514).

Analyses of data from the 2001 PISA indicated a significant relationship between academic achievement and computer access (Bielefeldt, 2005). Globally, particularly those first-world countries including many Organization for Economic Cooperation and Development (OECD) member countries are engaged in a technological arms race led by young people in particular is happening now. As adolescents increasingly access technology as a means of communication and school districts increasingly implement and require such technology, including screens that digitally display text, access to technology has became a prerequisite to school success. Schools must consider increased technology access when asking the professions age-old self-reflecting question, "what's best for kids?"

Access to technology is an academic advantage even after controlling for other sources of variance such as socioeconomic status (SES) and school characteristics. Thompson and De Bortoli (2007) found a significant performance advantage for students with a computer at home, even after adjusting for SES. After controlling for the effects of family background and school characteristics, Fuchs and Woessmann (2004) also found that students who had the Internet at home scored five points higher on the PISA in math and about four points higher in reading. School instructors are increasingly developing a web-presence; commonly post their resources and materials online, and even videotape lessons that are accessible exclusively via various forms of technology. Coupled with these pedagogical changes, school policies are increasingly steering students to the Web as both acceptable notice and communication. Limited or no technology access outside the immediate educational environment can mean a significant delay in student-teacher/student-student communication and other relevant information that would otherwise aid students' academic success.

Recent survey data show that 93% of students aged between 12-17 regularly access technology (Lenhart et al., 2010). Specifically, Lenhart and colleagues (2010) reported that 48% of teenagers have made online purchases, which was a 47% increase from the year 2000. Such a significant increase in digital consumption over a relatively short time period demonstrates a need to explore the use of technology to read text digitally. Increased use of technology requires an increased aptitude toward digital fluency. Those students more proficient in digital fluency may also continue to be more proficient in personal and professional settings when they become adults.

Basic economic measures, including a countries' given GDP can serve as an indicator to the likelihood and to what degree their student population has access to technology. Countries with a higher GDP per capita have generally demonstrated higher achievement (Baker, Goesling, & Letendre, 2002; Heyneman & Loxley, 1983).

Studies have confirmed that SES has an impact on reading achievement. Chiu and McBride-Chang (2006) found that log gross domestic product per capita accounted for the most difference across countries reading scores. Further, Chiu and McBride-Chang (2006) found a positive correlation with individual reading achievement and family SES as well as schoolmates' family SES. With both higher GDP and higher student SES within the wealthier countries, students can expect to access and interact with technology for purpose of increasing their digital fluency.

Digital Fluency

Digital fluency is defined as one's ability to find, evaluate and use information in a digital format and includes the skills necessary to use specialized tools for finding digital information (21st Century Information Fluency, 2001). Specifically, the interaction with a digital display screen for the purposes of processing information requires skills that can be embodied by the term *digital fluency*. Information retrieval from the Internet requires the skills of skimming and scanning large amounts of material and evaluating its creditability immediately (Halpern, 1989; Shetzer & Warschauer, 2000; Warschauer, 1998). Students, particularly those in the 14-18 year-old age range, are among the most digitally fluent in world (Head & Eisenberg, 2010). Increased reliance on digital text in leisure, educational and career-related settings makes exploring the digital fluency skills of 15-year-old students relevant and even urgent. Ebay CEO

John Donahoe partnered with retailers to install digital touch-screen storefronts in New York City (Tibken, 2013). Similarly, digital fluency is becoming an increasingly relevant topic when discussing the anticipated needs of K-12 school students both today and in the future. United States President Barack Obama recently announced the expansion of technology programs that will lead to better technology at 99 percent of schools within the next five years (Calmes & Wyatt, 2013). Further, Lederman (2012) encourages parents to think twice before discouraging their children's interactions with a computer screen, noting that their schoolwork may soon depend on it. Finally, US Education Secretary Duncan called for the nation to move away from printed textbooks in favor of digital ones, predicting that the printed text would be obsolete in the coming years (Lederman, 2012).

The particular skills associated with digital fluency such as comprehending information displayed through a digital screen are applied and honed through technology use. Technology use and familiarity varies across age groups. *Digital natives* are defined as fluent speakers of the digital language of computers, video games and the Internet (Prensky, 2001). Although many 15 year-old students qualify as digital natives, particularly those living in a first world countries, their ability to comprehend digital text has received little attention. The 2009 PISA test developers recognized the increased demand on students to read digital text when they created the Digital Reading Assessment (DRA) in 2009 (OECD, 2012). In conjunction with the DRA, students were given an ICT survey exploring their academic and non-academic technology use. One way in which students today build capacity in the area of digital fluency is specifically through the use of non-academic technology.

Non-Academic Technology Use

Using *technology in non-academic settings* includes using technology for leisure purposes, such as gaming, chatting, and social media; all of which are increasingly common among digital natives (Lenhart et al., 2010; Russell & Holmes, 1996). Non-academic technology use can now be accomplished on computers, tablets, cell phones and MP3 players, which are already in the hands of many 15-year-olds worldwide. For example, Fuchs and Woessmann (2004) conducted a bivariate analysis using 2000 PISA student survey and achievement data and found that students who reported never reading e-mail or visiting webpages for personal interest were approximately six points lower in PISA reading scores, while students who reported reading email and web pages several times a week for leisure showed an advantage of about six points in math and about nine points in reading on the same assessment. Additionally, student performance was positively correlated to the use of computers at home for accessing e-mails and Web pages (Fuchs & Woessmann, 2004).

Leisure use of technology also includes the use of technology for the purpose of playing video games, also known as, gaming. Videogame users, or *gamers*, may be defined as those who use digital entertainment for gameplay (adapted from Tavinor, 2008). The majority of gamers who spend more than 3 hours per week gaming are teenagers (Squire, 2005). Using computers for non-academic/entertainment purposes show more positive academic results especially, in reading ($\beta_1 = .370$ for females and $\beta_1 = .379$ in males, $p < .001$) (Gumus & Altamis, 2011).

Gamers, many of whom are in the age range of those having taken the DRA, use technology for leisure. The gaming industry, with sales totaling $67 billion dollars in

2012, and on pace to reach $82 billion dollars by 2017, is accessed in large part by teenagers (Gaudiosi, 2012). In 2004, nearly as many digital games were sold as there were people in the United States (248 million games sold compared to a population of 293.6 million residents) (Van Eck, 2006).

Gaming is experiencing the same rapid growth that all forms of technology are currently going through. Biagi and Loi (2012) noted that gaming was the only activity for which positive relationships between the PISA test scores and intensity of technology use (both type and frequency) was consistently found. Although evidence of negative relationships relative to general technology use and test scores exist, Punie, Zinnbauer, and Cabrera (2006) believe these findings could be rationalized on the basis that technology use is minimal in the current traditional school curricula. Further, Punie, et al., (2006) contended that the PISA test was based on current traditional schools and the positive findings relative to gaming specifically and test scores are encouraging.

Digital Game Based Learning

While general gaming appears to have some positive correlation to learning, a new field of gaming has emerged, known as digital game based learning (DGBL). Harnessing the idea that digitally displayed games can help students learn, the use of such technology is becoming more commonplace (Coffey, 2008). Gaming, for the intentional purpose of education, is increasingly used as an effective means for teaching a variety of skills, across a wide array of learners (McAndrews, Chadwick, & Mullen, 2005). Government and private entities alike use DGBL in areas such as training pilots in flight simulators without risk to the person or machine (Brooks, 1999). At the classroom level evidence of increased use of DGBL is demonstrated by recent mass production of commercial off-the-shelf (COTS) DGBL's ready made for K-12 classrooms (Van Eck, 2006).

Other examples of DGBL include teaching small children the alphabet, helping kids monitor their diabetes, managing ADD symptoms, teaching tactical skills to the military, financial derivatives to auditors, or CAD software to engineers (Prenski, 2000). Other learning products, now widely available include, *America's Army*, an immensely popular, commercial-quality 3D multiplayer game funded by the Army (for approximately $5 million) and given away free over the Internet and at recruiting offices to promote the United States military (Squire, 2005). Additionally, the United States Home Builders Association recently funded a game to help homeowners, students, and teachers better understand the home construction process (Squire, 2005). The melding of non-academic technology use with that of academics is increasing. Students may choose to use the same device for the purpose of both leisure and academics. While uses of technology for both purposes are increasing, academic technology use has historically been a more familiar tool toward academic success in students.

Academic Technology Use

The OECD (2012) defined academic technology use for the purpose of the ICT survey as computer use at home and at school for the purposes of: completing schoolwork and/or practicing, drilling and communicating with others for the purpose of completing schoolwork. Cuevas, Russell and Irving (2012) conducted a study in which they implemented an independent silent reading (ISR) program across a 5-month semester in an urban public high school and included 145 participants from nine 10th grade literature classes. Cuevas et al. (2012) found that carefully constructed technology-based learning materials could stimulate increased learning of difficult material. Those students who read from digital screens showed a significant increase in reading motivation when compared to the control group (Cuevas et al., 2012). Increased motivation as experienced by the students who read from digital screens is promising and is consistent with the findings of Howard, Elllis and Rasmussen (2004) as well as Liu and Bera (2005). Both studies found that technology could enhance academic motivation in modern students.

Classroom instructors should take heed of the evidence that there are positive indicators associated with increased technology use. Studies have repeatedly demonstrated the benefits of the Internet as a teaching and learning tool (Luan, Fung, Nawawi, and Hong, 2005; Wepner, Valmont, and Thurlow, 2000). Inan and Lowther (2010) examined the factors associated with technology integration in K-12 classrooms finding teachers' beliefs and readiness as well as the availability of computers, technical support, and overall support positively influence teachers' technology integration. Russell, O'Dwyer, Bebell and Tao (2007) found teacher technology use also varies by tenure and longevity in the profession with increases in either variable showing a decrease in technology use. The benefits of technology use for student should be strongly considered and barriers including teacher readiness, limited availability and support should be minimized.

Kolikant (2009) studied the effects of computers and Internet use on student learners whose schools did not use this technology in their classrooms. Kolikant (2009) found that often students knew more about the potential resources of the Internet than their teachers. This may be cause for concern. In the typical student-teacher environment, students' superior knowledge means that educators must get up to speed on the educational potential of technology use or risk becoming the subordinate learner. Given this knowledge it is possible that teachers will remain content experts, yet may be unable to deliver their expertise in a digestible format for today's digital native. Such an idea could be negatively reinforced by students' beliefs that because the method of delivery is out of date the content must be as well. With increased demand for and availability of technology, the ability to read digital text is likely to be an increasingly important skill that 21st Century students AND teachers must possess.

It is clear, digital reading is an important skill for teachers and students to possess. The 2009 PISA test developers recognized the impending need for students to be able to read digital text and in response created the DRA in 2009. In order to measure students' aptitude toward understanding digital information as presented via digital display, PISA test developers developed and gave a subtest known as the DRA to a subset of PISA test takers. Examining students' ability to read digital text relative to other technology uses including academic and non-academic indicators was the focus of this study.

Digital Reading Assessment (DRA)

The DRA was given to a subset of students who took the 2009 PISA assessment. PISA worked in conjunction with the OECD to assess the digital reading ability of students with an average age of 15 years old in 2009 (OECD, 2012). International evaluation studies such as PISA are helpful as a comparison tools between countries, as well as in identifying the current successes and failures of various countries' education systems (Aydin, Erdag & Tas, 2011). Further, Aydin et al. (2011) noted that the results identifying strengths or deficiencies in areas such as digital reading could influence educational policies within countries.

Reading in a digital context requires many of the same reading skills that are needed to read print-based materials (e.g., decoding, fluency, and comprehension), but it also requires the skills assessed in the DRA including: (a) characteristics of text, (b) complexity of navigation, (c) explicitness of task demand, and (d) nature of response (OECD, 2012). The DRA task responses associated with the assessment required students to construct their own answers, as well as answer multiple-choice questions. The latter were typically organized in units based on a written passage or graphic, much like the kind of texts or figures that students might encounter in real life (OECD, 2012).

Exploring Digital Reading and Computer Use

Thompson and De Bortoli (2007) used the 2003 PISA ICT use and familiarity data, including school and home use as it compared to academic performance and found a positive relationship. As Thompson and De Bortoli (2007) noted, the association between computer access and usage and academic performance cannot provide evidence of the impact of computers on learning, since the PISA data did not demonstrate causation. However, data can raise issues for further investigation. Mixed findings for overall effects of technology use were demonstrated in other studies. This was the case in other correlational analyses of large data sets, such as such as Wenglinsky’s (1998) analysis of National Assessment of Educational Progress (NAEP) scores. Biagi and Loi (2012) noted that ICT technology has now reached a sufficiently mature stage, which makes engaging in policy evaluation worthwhile and not one that can wait.

The literature outlined above led to questions regarding the predictive relationship between (a) non-academic technology use and (b) academic technology use and overall academic success by secondary students as measured by the PISA DRA. It can be inferred that students will be required to consume more digital text in the coming years. It is for this reason that exploring whether academic or non-academic technology use helps students comprehend information in a digital format on the DRA portion of the PISA is so critical.

Importantly, digital reading is a key idea in the emerging information society (OECD, 2012). Ayhan et al. (2011) noted that top-five economic growth countries also demonstrated success in PISA reading scores. ICT has changed the way in which student's access and process information and the way in which they communicate with each other (OECD, 2012). An examination of the 2009 DRA dataset allows a more clear understanding of student academic and non-academic technology use as it relates to digital reading proficiency.

The DRA defined for students the necessary content, processes and contexts in which digital reading knowledge and skills are applied (OECD, 2012). My study explored the relationship between (a) academic technology use, (b) non-academic technology use, and (c) students' DRA score. Because the extant PISA data set was used, this study will not aim to prove causation between computer usage and DRA score. However, the results could serve as a basis for future causal research in which technology use and the DRA can be experimentally controlled. Specifically, three questions were explored:

1. What is the relationship between (a) student academic technology use, (b) student non-academic technology use, and (c) student performance on the 2009 PISA Digital Reading Assessment (DRA) and (d) GDP?
2. Is there a significant difference between student (a) academic technology use and their (b) non-academic technology use?
3. Does (a) student non-academic technology use, (b) student academic technology use, or (c) GDP best predict student performance on the 2009 PISA DRA?

CHAPTER II

METHODOLOGY

Extant data from the DRA portion of the 2009 PISA were used to examine the research questions guiding this study in an effort to explore a possible association between students’ academic and non-academic technology use and their performance on digital literacy tasks. PISA, which evaluates quality and efficiency of school systems in 70 countries that, together make up nine-tenths of the world economy (OECD, 2011). A subsample of PISA test takers had one opportunity to take the DRA assessment. The specific (a) settings, (b) participants, (c) sample, and (d) measures will be described in the following sections.

Setting and Participants

Settings. The 2009 DRA was administered to those students (a) with a minimum of six years of formal schooling and (b) between the ages of 15 years 3 months and 16 years 2 months at the time of the assessment (OECD, 2012). No consideration was given to the type of institution in which they were enrolled (e.g., academic or vocational), students’ full-time status, or whether they attended public, private, or foreign schools. The DRA was proctored in a school setting in an attempt to provide students and test administrators with a consistent test environment. The technology requirements associated with the administration of the DRA mandated access to newer technology in order to ensure proper functioning of the assessment. Specifically, DRA participation required a computer manufactured after the year 2001, as well as the appropriate software to operate the DRA assessment.

Participants. Assessing comparable target populations was necessary to ensure reliability of results across countries. To increase the comparability of student performance, PISA test administrators used an age-based definition for its target population (e.g., a definition that is intentionally not tied to the institutional structures of national education systems) (OECD, 2012). OECD (2012) noted that the average DRA test-taker in 2009 was 15 years, 9 months old. OECD (2012) stated that because grade levels are defined differently internationally, the use of a common age range as opposed to common grade level(s) allowed student performance to be compared across countries in a more consistent manner. All participating countries agreed to administer the PISA to as many eligible 15-year-old students as possible. As a result, PISA 2009 achieved a diversity of population that is unprecedented in international surveys of this kind (OECD, 2012). From this sample, PISA test administrators were able to randomly draw a subset of students to take the DRA supplemental assessment (to be described later in this chapter).

Sample

As part of the sampling procedures, the 2009 PISA required a participation rate of at least 80% of students within participating countries (OECD, 2012). While this participation rate had to be met nationally, it was not necessarily met within each individual school. This was done to ensure each participating country provided PISA with a large enough sample to make generalizations about student performance. Schools in countries that did not meet the participation minimum of 80% required additional test sessions. Student participation calculations included original schools, replacement schools, in both the original and follow-up test sessions.

Quality standards, procedures, instruments, and verification mechanisms were developed for PISA that ensured that national samples yielded comparable data and that the results could be compared with confidence (OECD, 2012). Most PISA samples were designed as two-stage stratified samples. The first stage consisted of sampling schools by country in which 15-year-old students could be enrolled. As the schools were sampled, replacement schools were simultaneously identified, in case a sampled school chose not to participate in PISA 2009 (OECD, 2012). Schools were sampled systematically with probabilities of being a selected school proportional to a given school's size as defined by eligible student age enrollment.

The DRA sample was determined using KeyQuest sampling software. KeyQuest software was deigned for PISA to manage data associated with their assessment including the DRA (OECD, 2006). Using the Information and Communications Technology (ICT) survey, given to each DRA test taker, PISA administrators gathered data from the respondents (students) about their use of technology as it applied to academic and non-academic settings.

As the DRA was a supplemental assessment to the 2009 PISA, students were randomly sampled via a second stage called *clusters*. The recommended Target Cluster Size (TCS) for the DRA was 14 students from each participating school. The large TCS was chosen to address inadequate computer resources in some schools that would render some randomly selected students unable to participate.

Measures

The following section outlines the measures used in this study including, the DRA, Academic technology use survey, Non-Academic technology use survey, and

GDP. DRA assessment, preparation, characteristics, scale and test administration are detailed. Additionally, the combined variables constituting academic and non-academic indicators are outlined.

DRA Assessment

The development of the 2009 PISA DRA was coordinated by a consortium of educational research institutions including the supports provided by the OECD Secretariat, and under the guidance of a group of international reading experts (OECD, 2012). A consortium of educational researchers organized the 2009 PISA DRA in collaboration with international reading experts, including those with a research interest in digital reading (OECD, 2012). The material was refined iteratively over the three years leading up to the administration of the assessment in 2009. The development process included several rounds of commentary, piloting, and a formal field trial within participating countries (OECD, 2012).

Content experts reviewed DRA test content over the three years leading up to the administration of the assessment in 2009. The development process further involved a test item review, small-scale piloting, and a formal field trial including samples of 15-year-olds from all participating countries (OECD, 2012). The selection of tasks varied in their emphasis on text processing and navigation, as well as their range of difficulty. The PISA reading expert group recommended the final selection of DRA tasks. DRA test item selection sought to ensure that tasks varied in their emphasis on text processing and navigation, and that they ranged widely in difficulty, allowing for an accurate assessment of all 15-year-old students (OECD, 2012).

The DRA portion of the 2009 PISA assessed students' ability to use digital text to find, navigate, and evaluate digital information (OECD, 2012). Similar to paper-andpencil assessment of reading, digital reading items were arranged in units based around a common stimulus, but the stimulus used in the digital reading assessment comprises digital texts with the structures and features including websites, e-mails, and blogs (OECD, 2012).

DRA test developers created stimuli authored in the *hypermedia* software that included text, graphics, sound, and video (Merrill, Hammon, Vincent, Reynolds, Christiansen, & Tolman, 1996). Dynamic hypermedia is designed to enhance Web users' experience by changing content, positioning Web page elements and styling features such as the ability to change the Web page's color, font, size or content (techopedia.com). A digitally based reading assessment made the presentation of multiple texts a practical possibility, as the use of hypertext allows for unlimited access to texts; and reading in this medium often involves referring to several pages, texts and sources, appearing in different formats (OECD, 2012). Hypermedia created environments with dynamic behavior for 2009 PISA DRA test takers allowing for better assessment of students' ability to read digital text (OECD, 2012).

DRA test characteristics. DRA test developers defined the following four key characteristics associated with task difficulty in digital reading (OECD, 2012). (a) *Characteristics of text* that includes familiarity, complexity, vocabulary and length of passages. (b) *Complexity of navigation* addresses the immediate visibility of information versus increased navigational tasks (e.g., scrolling, visiting multiple sites) for the reader. (c) *Explicitness of task demands* includes how much the reader needs to infer the scope and substance of what is required for the response (e.g., measuring ease of using similar or different terms in the question than that used in the preceding text). Finally, the (d) *nature of response* variable relates to the kind of mental processing that the reader has to undertake to complete the task (e.g., abstract concepts versus concept outlines provided within the assessment).

From the initial sample of PISA test takers, a secondary random sample, called *clusters* were rotated in six forms so that each cluster was paired with the other two and appeared in both first and second position in the pairing. Through the use of logit scale, this design made it possible to construct a single scale of digital reading proficiency, in which each question is associated with a particular point on the scale that indicates its difficulty, and each student's performance is associated with a particular point on the same scale that indicates his or her estimated proficiency. A single continuous scale shows the relationship between the difficulty of questions and the proficiency of students (OECD, 2012). By creating a scale that shows the difficulty of each question, it was possible to locate the level of digital reading literacy that the question represents. By showing the proficiency of each student on the same scale, it is possible to describe the student's level of digital reading literacy (OECD, 2012).

Test administration. Twenty-nine digital reading tasks, yielding thirty-eight maximum score points, were used in PISA 2009. The items were presented to students in six test forms, with each form being composed of two clusters (OECD, 2012). Standardized administration procedures were developed to ensure that students received the same information prior to and during the digital reading assessment. Each student was given a forty-minute DRA assessment, with an additional 10 minutes at the beginning of the testing session for orientation and practice questions to familiarize students with the assessment platform. Test items were selected from a pool of 72 digital reading items that were tested in a field trial conducted in all countries participating in the international option in 2008, one year prior to the actual DRA assessment.

DRA Item formats included selected response or constructed response in either the task area or browser area, in the form of an email message (OECD, 2012). Most of the selected-response items were a variation of standard multiple-choice, exploiting the interactive possibilities of the medium, where students selected an option from a dropdown menu in the browser area (OECD, 2012). In the DRA, the screen had two areas including, a browser area, in which the stimulus is displayed, and a task area, in which the questions are provided organized in units based on a written passage or graphic (see Appendix A) (OECD, 2012). Test designers attempted to mimic the kind of texts or figures that students might encounter in real life. Most test items required students to provide their responses in the *task* area as defined by an open space on the computer screen to input student responses. The multiple-choice item format maximized the interactive possibilities by requiring students to select an answer from a dropdown menu in the browser area (OECD, 2012). Open-constructed response items required more extensive writing as well as explanations or justifications. Responses were given either in a text box in the task area, or, where appropriate, in the browser area in the form of an e-mail message.

Students use technology regularly for professional/educational purposes and well as for those leisurely/non-academic purposes. For the purpose of this study, Academic and non-academic technology responses were taken from the ICT survey and then made into the combined variables, academic technology use and non-academic technology use. These variables were then compared to students' DRA results.

Academic and Non-Academic Technology Use Survey

The 2009 PISA featured an ICT survey component taking test takers approximately 30 minutes to complete. Students completed the survey prior to taking the DRA. All such survey questions were administered to test takers via computer. This survey focused on their background, learning habits, attitudes towards reading, and their involvement and motivation (OECD, 2012). ICT survey questions relating to academic and non-academic indicators were reviewed and selected for the purposes of each group. The survey asked students to respond by relating their level of access, interest, and frequency of use of various ICT related items (e.g., Internet use, computers at home and at school). From student responses, survey questions were combined to create the variables, academic (ACAD) and non-academic technology (NACAD) use (see Appendix B).

ICT survey items.

PISA 2009 categorical items from the context questionnaires were scaled using IRT modeling. Weighted Likelihood estimates (logits) for the latent dimensions were transformed to scales with an OECD average of 0 and a standard deviation of 1 (with equally weighted samples) (OECD, 2012). ICT survey choices included the scale: Never or hardly ever; Once or twice a month; Once or twice a week; Everyday or almost everyday. Higher values on this index indicate more frequent computer use at home for leisure.

Academic and non-academic survey items.

The variables of interest used in this study were taken from the 2009 PISA ICT survey and asked respondents about their technology use prior to assessing their ability to comprehend digital text through the use of the DRA. The purpose of this study was to examine to what extent a relationship between academic and non-academic computer use and DRA score existed. Multiple student-reported technology-use variables were identified and combined into the variables *academic technology use* or *non-academic technology use*.

Five non-academic variables were combined, giving equal weights to each of the following activities that include: Computer use at home for leisure, social interaction/communication with friends, browsing the internet for fun, downloading entertainment and gaming (e.g., both individually and collaboratively). Similarly, five academic activities were combined to form the academic variable for this study. The academic variables included: Computer use at home and school for the purpose of schoolwork, browsing the Internet for the purpose of schoolwork, computer use for practice and drilling and using a computer to complete homework. The multiple indicators were combined either under the variables *academic* of or *non-academic* to form the two predictors for this study.

Cronbach's Alpha for Academic Survey Items

The Cronbach's alpha for the Academic items was .898, which indicated a high level of internal consistency. The inter-item correlations ranged from .511 for IC04Q03 and IC06Q07 to .754 for IC06Q08 and IC06Q07. Importantly, the deletion of any Academic item would have resulted in a lower Cronbach's alpha. Therefore, no survey items were removed from the Academic grouping. See Table 1 for complete Cronbach's alpha statistics for the Academic survey items.

Table 1

Cronbach’s Alpha for Academic Technology Use

Reliability Statistics

Cronbach's Alpha	Cronbach's Alpha Based on Standardized Items	N of Items
.898	.898	5

Item Statistics

	Mean	Std. Deviation	N
IC06Q08	1.961	1.554	106557
IC04Q03	2.732	1.433	106557
IC05Q01	2.612	1.421	106557
IC06Q03	2.496	1.530	106557
IC06Q07	1.780	1.526	106557

Inter-Item Correlation Matrix

	IC06Q08	IC04Q03	IC05Q01	IC06Q03
IC04Q03	.572			
IC05Q01	.620	.722		
IC06Q03	.746	.539	.606	
IC06Q07	.754	.511	.603	.695

Table 1 (continued)

Item-Total Statistics

	Scale Mean if Item Deleted	Scale Variance if Item Deleted	Corrected Item-Total Correlation	Squared Multiple Correlation	Cronbach's Alpha if Item Deleted
IC06Q08	9.619	24.763	.802	.683	.863
IC04Q03	8.848	27.451	.671	.548	.891
IC05Q01	8.968	26.642	.745	.613	.876
IC06Q03	9.085	25.457	.763	.617	.872
IC06Q07	9.800	25.583	.756	.623	.873

Scale Statistics

Mean	Variance	Std. Deviation	N of Items
11.580	39.581	6.2913	5

Cronbach’s Alpha for Non-Academic Survey Items

The Cronbach's alpha for the Non-Academic Survey items was .889, which indicated a high level of internal consistency. The inter-item correlations ranged from .534 for IC04Q07 and IC04Q01 to .734 for IC04Q01 and IC04Q02. Notably, the deletion of any Non-Academic item would have resulted in a lower Cronbach's alpha. Therefore, no survey items were removed from the Non-Academic grouping. See Table 2 for complete Cronbach's alpha statistics for the Non-Academic survey items.

Table 2

Cronbach’s Alpha for Non-Academic Technology Use

Reliability Statistics

Cronbach's Alpha	Cronbach's Alpha Based on Standardized Items	N of Items
.885	.887	5

Item Statistics

	Mean	Std. Deviation	N
IC04Q07	3.047	1.459	106557
IC04Q01	2.414	1.530	106557
IC04Q02	2.194	1.611	106557
IC04Q05	3.323	1.461	106557
IC04Q06	3.436	1.285	106557

Inter-Item Correlation Matrix

	IC04Q07	IC04Q01	IC04Q02	IC04Q05
IC04Q01	.534			
IC04Q02	.566	.734		
IC04Q05	.658	.490	.544	
IC04Q06	.720	.561	.582	.727

Table 2 (continued)

Item-Total Statistics

	Scale Mean if Item Deleted	Scale Variance if Item Deleted	Corrected Item-Total Correlation	Squared Multiple Correlation	Cronbach's Alpha if Item Deleted
IC04Q07	11.368	24.434	.731	.580	.858
IC04Q01	12.001	24.365	.688	.569	.868
IC04Q02	12.221	23.264	.724	.599	.860
IC04Q05	11.091	24.689	.708	.577	.863
IC04Q06	10.978	25.415	.775	.654	.851

Scale Statistics

Mean	Variance	Std. Deviation	N of Items
14.415	37.106	6.092	5

Gross Domestic Product (GDP)

GDP is defined by the OECD (2011) as, an aggregate measure of production equal to the sum of the gross values added of all resident institutional units engaged in production within a given year. The expenditure method is the more common approach to calculating GDP. The formula for calculating GDP is, *exports* minus *imports* and then adding to that total, *consumer spending* plus *investment* plus *government spending* (EconPort, 2006). GDP is considered a significant measure of economic well being by virtue of the variables used and thus the value of a given countries GDP fiscally impacts practically everyone within a given economy.

Analysis

The variables of interest used in this study were taken from the 2009 PISA ICT survey that asked respondents about their technology use prior to assessing their ability to comprehend digital text through the use of the DRA. The purpose of this study was to examine to what extent there is a relationship between academic computer use, non-academic computer use, DRA scores, and GDP. Multiple student-reported technology-use variables were identified and combined into the variables *academic technology use* or *non-academic technology use*.

Statistical analyses explored the relative importance of examining academic and non-academic technology use as it related to reading digital text on the DRA assessment. Specifically, the potential relationship, differences and predictability of student, academic technology use, non-academic technology use, DRA score, and GDP were investigated. After reporting the descriptive statistics for the three measures of interest statistical analysis associated with the three research questions were conducted.

Question One studied the degree to which the variables academic/non-academic technology use and DRA score were related to one another using correlational analysis. Question Two examined whether students' academic technology use scores were significantly different from their non-academic technology use scores. Finally, Question Three evaluated whether academic technology use, non-academic technology use, or GDP best predicted DRA scores using regression analysis.

CHAPTER III

RESULTS

Descriptive statistics are provided for each of the variables used in the analysis prior to answering the research questions. The first research question was investigated by applying correlational coefficients between the three measurement variables. The second research question was analyzed through the use of a *t*-test. The third research question employed the use of regression analysis.

Cases Included and General Description

Table 3 displays the number of cases, cumulative percentages and gross domestic product of the participants in the study.

Table 3

Descriptive Statistics of Participating Countries' Student Count, Average Academic Score, Average Non-Academic Score, DRA Score, and 2009 Gross Domestic Product (GDP)

Country	Count	Academic Survey	Non-Academic Survey	Average DRA Score	GDP (U.S.$)
Australia	14,251	13.69	14.50	537	42,551
Austria	6,590	11.17	14.54	459	45,872
Chile	5,669	12.45	14.13	435	0,120
Denmark	5,924	14.14	15.60	489	56,227
Hong-Kong	4,837	10.90	14.83	515	30,697
Iceland	3,646	10.95	15.17	512	38,039
Ireland	3,937	10.41	13.98	509	50,560
Japan	6,088	8.90	11.41	519	39,473
Korea	4,989	9.03	13.18	568	16,959

Table 3 (continued)

Macau	5,952	10.60	15.35	492	40,860
New Zealand	4,643	12.15	13.84	537	27,474
Norway	4,660	13.42	15.68	500	78,457
Poland	4,917	10.89	14.80	464	11,295
Spain	25,887	11.13	14.36	475	31,679
Sweden	4,567	11.89	15.47	510	43,640
Total	(*N*=106,557)				

Table 4 displays the means, standard deviations, minimum and maximum scores for the (a) Digital Reading Assessment (DRA), (b) Academic technology use, (c) Non-Academic technology use, and the GDP. These descriptive statistics are based on all students who completed the DRA supplemental assessment of the 2009 PISA for the purpose of this study.

Table 4

Descriptive Statistics of Assessment Results

Measure	Mean	Std. Dev.	Minimum	Maximum
DRA	497.90	32.38	435.00	568.00
Academic	11.58	6.29	5.00	45.00
Non-Academic	14.42	6.09	5.00	45.00
GDP	36,802.67	14,660.79	10,120.00	78,457.00
(N= 106,557)				

Research Question One: Connection Amongst Measurement Variables

The first research question was an investigation into the potential relationship(s) between student performance on the (a) DRA, (b) academic technology use, (c) non-academic technology use, and (d) GDP. The strength of the relationship was determined by analyzing the correlational coefficients. The largest correlation, although moderate, occurred between academic technology use and non-academic technology use (r = .693). The two lowest correlations were between (a) DRA scores and non-academic use survey scores (r = -.038) and (b) DRA scores and academic use survey scores (r = .0003). Both of these correlations were best described as very weak/negligible. Additionally, the correlation between DRA and GDP (r = .181), was also very weak/negligible. Table 5 provides the correlational coefficients for the four measures.

Table 5

Correlation Matrix

Variable	DRA	Academic	Non-Academic
Academic	.0003		
Non-Academic	-.038*	.693*	
GDP	.181*	.095*	.055*

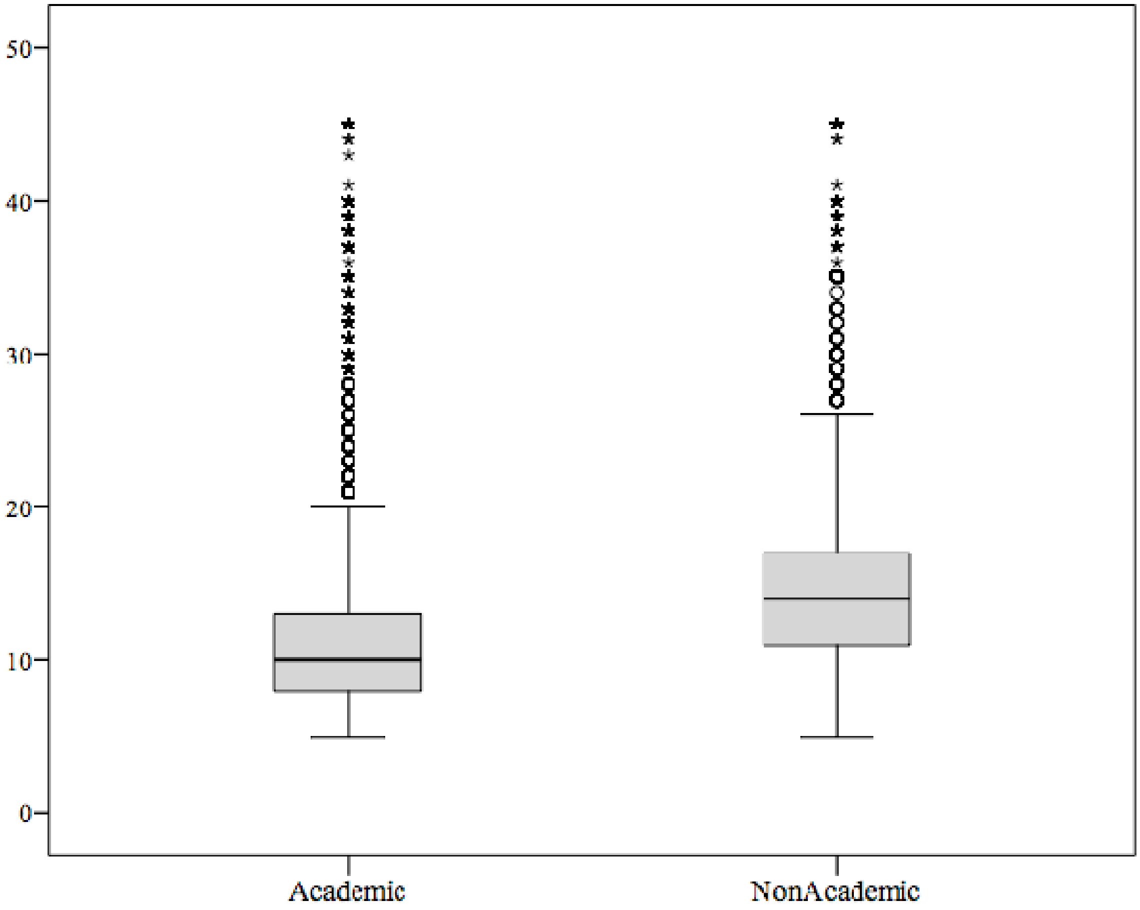
*p<.01

Research Question Two: Verifications of Means

The second analysis explored whether mean academic technology use was significantly different from the mean non-academic technology survey score. Descriptive statistics for academic and non-academic responses are provided in Table 4. The technology for leisure use mean score (M = 14.42) was larger than the mean for the use of technology for academic purposes (*M* = 11.58). The *t*-test, comparing the mean difference between academic and non-academic technology indicated a significant difference favoring non-academic survey scores, *t*(106,556) = (190.691), *p*<.001). The statistically significant difference authenticating the non-academic technology use scores is visually explained in Figure 1.

As a follow-up to the t-test, a Cohen's d effect size calculation for the variables academic and non-academic was applied. Results indicated a mean of 0.46, or a medium effect.

Figure 1: Mean use of technology for the of academic and non-academic purposes



Research Question Three: Predictive Nature of Performance Indicators

The third analysis included three variables: (a) academic technology use, (b) non-academic technology use and (c) GDP. These were used to explore which indicator(s) best predicted students' DRA scores. To analyze the predictive relationship of the non-performance indicators specified above, DRA scores were designated as the dependent variable, while academic technology use, non-academic technology use, and GDP were included as predictor variables. The data indicate that at least one of the three predictor variables could be used to predict (p<.001) DRA score. See Table 6 for the ANOVA statistics.

Table 6

ANOVA

Sum of Squares	*df*	*Mean Square*	*F*	*Sig.*
Regression	3992294.296	1330764.765	1316.147	.000[b]
Residual	107736444.086	106553.000	1011.107	
Total	111728738.380	106556.000		

a. Dependent Variable: DRA Score
b. Predictors: (Constant), Academic technology Use, Non-Academic Technology Use, and GDP

Additionally, the coefficients (adjusted R^2 = .036) indicated that 3.6% of the variance was explained by academic technology use, non-academic technology use, and GDP for students' DRA scores. See Table 7 for the model summary statistics.

Table 7

Model Summary for DRA Score and Predictors, Academic, Non-Academic and GDP

R	R^2	Adjusted R^2	Std. Error of the Estimate	Change Statistics		df1	df2	Sig. F Change
				R^2 Change	F Change			
.189[a]	.036	.036	31.7979	.036	1316.147	3	106553	0.000

Predictors: (Constant), Academic Technology Use, Non-Academic Technology Use, and GDP

The standardized coefficients also indicated that GDP (β = .182) was the most predictive and that the survey items for academic technology use (β = .032) were a better predictor compared to the survey items for non-academic technology use (β = -.071). For more detailed information, see Table 8.

Table 8 also provides further information pertaining to the regression analysis. The semi-partial correlations included in the table reveal that GDP (.181) accounts for more of the unique variance, than either of the other two variables (academic technology use .023 and non-academic technology use -.051). Squaring the semi partial correlational coefficients indicated that GDP accounted for 3.28% of the variance, academic technology use for .05% of variance, and non-academic technology use for only 0.27% of the variance in the DRA Score.

Summary of Results

This study examined the relational and predictive relationships of academic technology use, non-academic technology use, and GDP on DRA scores on the 2009 PISA. Correlational results indicate that academic and non-academic technology use were moderately correlated with each other. However, the academic and non-academic survey items were only weakly correlated to DRA scores. While the non-academic technology use mean score (*M* = 14.42) was significantly higher (*p*<.001) than the academic technology use mean score (*M* = 11.58), the regression analysis showed that GDP accounted for 3.28% of the variance, while non-academic and academic technology use scores explained only 0.27% and .05% of variance in DRA score respectively.

Table 8

Regression Model Results of Academic, Non-Academic Technology Use, GDP on DRA Score 2009 PISA

	Unstandardized Coefficients		Standardized Coefficients	t	Sig.	Correlations		
	B	Std. Error	Beta			Zero-order	Partial	Part
(Constant)	486.597	.342		1424.760	0.000			
Academic	.164	.022	.032	7.612	0.000	.000	.023	.023
NonAcademic	-.375	.022	-.071	-16.891	0.000	-.038	-.052	-.051
GDP	.000	.000	.182	60.251	0.000	.181	.182	.181

Predictors: (Constant), Academic Technology Use, Non-Academic Technology Use (Non-Acad.), and GDP

CHAPTER IV

DISCUSSION

The following sections include, (a) a summary of results, (b) the limitations of this study, (c) significant findings, and (d) suggestions for future research.

Summary of Results

This study examined the relational and predictive relationships of academic and non-academic technology use and GDP on DRA scores on the 2009 PISA. Correlational results indicated that academic and non-academic technology use were moderately correlated with each other. However, the academic and non-academic survey items were not predictive of DRA score. Though, the correlation between DRA and GDP (r = .181) was weak, it was still stronger than the correlation between DRA and academic technology use (r = .0003) or the DRA and non-academic technology use (r = -.038). Moreover, a significant difference ($p<0.00$) was found between the mean scores of the non-academic (M = 14.42) and academic (M = 11.58) survey items including a medium effect size (d=0.46). Finally, a regression analysis showed that GDP accounted for 3.28% of the variance; non-academic technology use explained 0.27% of the variance in the DRA, while the academic technology use only accounted for .05% of variance.

Limitations

Before exploring the practical implications of the study, it is important to acknowledge its limitations. The limitations of this study were largely associated with the instruments and measures used as well as the variation of the populations assessed. Major limitations included internal, external, and construct validity issues.

Internal Validity

Age specificity. This study only included international students between the ages of 15 years 3 months and 16 years 2 months of age at the time of the assessment. The PISA sampling plan was used to decrease potential confounds that could arise when using data across varied age bands. While this approach provided a control, using only one age band reduced the generalizability to other age groups. The results of this study pertaining to the predictive nature of academic technology use, non-academic technology use and the DRA can only be generalized internationally to the 15-16 year old age group. More precisely, these results may only be generalized amongst OECD member countries, or those mirroring the criteria associated with a first-world developed country such as those currently affiliated with OECD.

Standardization. PISA went to great lengths to provide an assessment that could be written, implemented and post-examined with a global lens. During the implementation of the 2009 PISA, including the supplementary ICT survey and DRA assessment, PISA reached agreements with independent international contractors from each participating country to carry out the surveys. PISA created and published specific protocols associated with giving the surveys/assessments and contractors were expected to follow these protocols to the letter.

International contractors were expected to adhere to the administrative rules while proctoring the PISA surveys/assessment with no other oversight from PISA. They were trained in sampling procedures as well as the minimum standards associated with technology (as described in the methods section). Both the ICT and the DRA assessments are computer-based and administered in a group setting, similar to that of current US state testing (e.g., Oregon Assessment of Knowledge and Skills (OAKS), and Smarter Balanced Assessment Consortium (SBAC)). Fidelity requires that the contractors followed all procedures leading up to and including the ICT and DRA assessments. However, PISA did not actually conduct fidelity checks across the globe so fidelity must be presumed.

It should be noted that the PISA, and specifically the DRA and ICT surveys, included assessment data from the 15 countries and over 100,000 students. Presumably, large skews in scores would be present if contractors and/or their designees dismissed any or all of the testing guidelines. This requirement was subject to individual contractor interpretation and execution. Since large skews were not visually present in the data, it can be assumed that standardized administration procedures were followed across countries and sample populations. However, that assumption cannot be verified.

Motivation. Interpreting large, international data sets such as the PISA should take into account student motivation as a potential limitation. Neither the ICT survey nor the DRA assessments were considered as high stakes assessments. Specifically, students taking the ICT and/or DRA assessment were randomly selected to take these two additional survey/assessments beyond the PISA. With such a sampling plan, it is possible that when students were selected for these additional survey/assessments, their level of engagement in the activity may have been diminished. The motivation a student might have for either assessment could be called into question.

In the case of the DRA assessment, the difficulty of the assessment or the challenge of using technology (e.g., computer, mouse, software etc.) as a delivery method could have decreased students' motivation for success. The DRA is used to assess four areas within the general area of digital reading. In addition to text-specific questioning and reasoning, the DRA asked students to navigate and operate the computer as well as type extensive responses in text-boxes. This process requires some experience and/or skill in keyboarding. The lack of such experience and/or skill could result in further decreased motivation.

Scaling. The 2009 PISA ICT survey offered restricted scaling and, thus, limited the statistical findings of this study. With only a 4-point scale, including: (a) rarely/never, (b) once a month, (c) once a week, or (d) everyday, a very wide of a range was covered in four short responses. Practically, students rarely choose the extremes of, *never* or *everyday*, choosing often from the middle two frequency choices, effectively shortening the scale to a 2-point scale. In comparison, GDP offered a much less restrictive scale that provided a range between $10,120.00 to $78,457.00 dollars. Thus, the constrained survey scale restrictively influenced the possible statistical findings in my study.

Interaction of Setting and Testing

The way each country defines a school and students should be considered as a potential external validity limitation. While PISA provides specifics and minimums including the need for DRA testing to occur in a school facility and minimum technology requirements for hardware and software, it does not assure consistency on a practical level within a given country. While the DRA included students from all schools (private schools, public schools, trade schools and children that are home schooled) specifics and weighting was not defined nor were there minimum requirements. This could be considered a marked difference in who was summarized in the data. Additionally, whether or not countries included general education students, accelerated students and/or special needs students in their individual countries' plan to proctor or report the associated results could be a factor in the results.

Finally, minimum technology requirements all but ensured mostly only first-world countries were eligible to be assessed. Specifically, DRA participation required a computer manufactured after the year 2001, as well as the appropriate software to operate the DRA assessment. Conclusions drawn on the results of the PISA study and this one need to be seen through the lens not of all students but rather, those that had adequate access to technology in order to take the 2009 PISA DRA assessment.

Inadequate Preoperational Explication of Constructs

The DRA makes four claims of measurement relative to the test characteristics including: (a) vocabulary, (b) computer navigation, (c) reader inference, and (d) mental processing. Thus, three of the four measures could potentially be assessed in both a digital and non-digital environments (e.g., vocabulary, reader inference and mental processing). This highlights a potential issue of construct validity. Only computer navigation is a distinguishing factor and unique testing characteristic of the DRA. One observed limitation is the inability of the DRA to accurately measure a student's capacity to navigate the test on a computer. Further, students' ability to use a keyboard, particularly in the case of the required typed, short response items had the potential to effect the results.

In reviewing the results of the study, it also seems germane to call into question the validity of the computer navigation portion of the DRA assessment. Specifically, the value assigned to measuring student abilities in the navigational aspects of the DRA reading assessment. The constructs of academic and non-academic technology use as valid measures statistically held up, as demonstrated by the analysis of Chronbach's Alpha. This was not the case when exploring student scores particular to the DRA.

The DRA promised to assess computer skills in addition to those of paper-pencil literacy including: (a) characteristics of text, (b) complexity of navigation, (c) explicitness of task demand, and (d) nature of response (OECD, 2012). DRA test developers required students to interact with specific software (hypermedia), text, graphics, sound, and video as part of the assessment. While these interactions seem substantial and sufficiently differentiated from print reading, it does not appear that the ability to use and interact with the DRA technology requirements affected overall reading scores by country. When we compare countries' overall DRA scores to that of their 2009 PISA print reading scores, we find the same five countries (Australia, Hong Kong, Japan, Korea, and New Zealand) at the top of both the digital and print reading lists (see Appendix C).

It may be that the DRA is a reflection of one's literary ability rather than a reliable measure of computer navigation skills as claimed by PISA. This particular study was based on the idea that academic and non-academic technology use could potentially change or aid a given student's DRA score. We see little evidence of technology use (academic or non-academic) affecting student scores in this study, as the DRA score did not correlate highly to any of the independent variables examined.

Findings

This study explored the concept of digital reading as measured by the 2009 PISA DRA assessment and compared it to students' technology use for academic and non-academic purposes. Academic and non-academic technology use survey items were moderately correlated (*r* = .693). However, neither was highly or even moderately predictive of the DRA. Further, the correlation between DRA and GDP (r =.181) was weak, yet was the strongest in comparison to the DRA and the academic and non-academic technology use items. Students in this sample use technology for leisure more so than academic purposes. Finally, GDP (3.28%) proved to have the greatest on variance as compared to non-academic (0.27%) and academic (.05%). The standard deviation for academic and non-academic variables were minimal as would be expected in such a large sample (*n* =106,557).

The low scores between academic and non-academic computer use with the DRA was surprising. Based on the literature and the push for digital literacy (Lederman, 2012), a much larger connection would be assumed. The pressure and temptation to become infatuated with digital formats is growing. While it is an information delivery mode not to be ignored, the results of this study encourage first teaching fundamental literacy, in any format, before considering the mode or delivery system by which it is taught. As evidenced by the fact that the same countries ranked in the top five for digital and print reading scores, it would appear that mode is less important than the fundamental skill of reading and the DRA was unsuccessful in distinguishing itself as more than merely a reading test.

While the DRA assessment presents itself as at least a somewhat revolutionary new assessment in that it alleges the measurement of digital capabilities, it appears to be hardly distinguishable from a paper-pencil literacy assessment. As all countries finishing in the top five of the standard PISA reading assessment were also ranked in the top five of the PISA DRA (see Appendix C). The PISA DRA assessment asserts that the elements of screen navigation, scrolling, manipulation, and the act of visiting websites is a unique and valuable part of their assessment. While they are unique, at times, unique characteristics can be given undeserved credit or value, even be mistaken as revolutionary. It may be that in retrospect, the 2009 PISA DRA represents an adequate transitional assessment, historically speaking, toward the construct of digital reading, rather than one that accurately measures digital reading capabilities.

Computer Access

Research consistently shows that students with access to computers at home have higher academic achievement and scored higher on PISA reading and math assessments (Bielefeldt, 2005; Fuchs and Woessmann, 2004; Thompson & De Bortoli, 2007). This study explored student use of technology, both for the purpose of leisure and for academic purposes with the potential for use at both home and school. The results of this study showed no strong correlation to a better digital reading score.

While it is possible that computer access may become an increasingly important prerequisite to school success, this claim could not be confirmed by my study. In linking access to success more specific to this study, it should be noted that by virtue of being an OECD member, all given countries were developed first-world and likely had better computer access and the ability to test a non- or limited access country is null.

The digital divide reflects differences among and within countries with regards to technological access and literacy. The OECD (2001) framed the digital divide as "the gap between individuals, households, businesses and geographic areas at different socio-economic levels with regard both to their opportunities to access ICT and to their use of the Internet for wide variety of activities" (p. 5). The results of this study cannot confirm the correlation between access and digital reading capability as every student had at least some access to technology. A certain amount of access to students given by schools is implied in the academic use of technology by virtue of PISA assessment minimums and the first-world status associated with being an OECD member. The desire was to explore further, if the additional access to technology for the purpose of academics or leisure increased the ability to read digital text. It did not appear to do so in this study.

Academic and Leisure Technology Use

Academic use of technology resulted in slightly higher DRA scores, in 15-16 year olds; it appears that using technology in an academic manner may result in better reading ability and/or digital reading ability. The findings of this study confirmed that students in 2009 were using technology for leisure significantly more than for academics, $p < .001$. Some readers may interpret this as evidence that academically centered technology is not a necessity in the school system. Evidence from a more local lens (U.S.) suggests an increased prevalence of digital reading for high stakes assessment. Smarter Balanced Assessment Consortium (SBAC) in Oregon no longer allow for students to print reading passages as in OAKS, without an Individualized Education Plan (IEP). This is a shift from current assessment practices in which students commonly printed materials for ease of display and comprehension. This study makes no claim that technology exposure has a negative academic effect and encourages all educators to keep teaching literacy by any delivery format available. Citing comparison scores between PISA print reading and DRA, the results of this study confer that belief. While one plausible result of this study could be that leisure use of technology improved DRA scores as suggested by Coffey

(2008), Van Eck (2006), and Prenski (2008), my results were contrary. This contradictory finding may be due to the DRA's inability to successfully measure indicators specific to digital reading and distinguish them from the general literacy ability of the student.

Gross Domestic Product (GDP)

The logic that higher GDP may provide the opportunity for more access and thus higher PISA scores did not prove true in this study. GDP was, however, responsible for a small amount of variance. Although GDP proved to be the strongest predictor of the three variables examined, it was still a statistically weak predictor (see Table 5) as it was only responsible for 3.28% variance. Looking at Table 5, it shows that DRA scores do not highly correlate with country GDP as some may be conditioned to predict. In fact, the wealthiest country, Norway, finished with the 9th highest DRA score followed by Demark and Ireland with average DRA scores of 11th, and 8th respectively. The top three DRA scores came from Korea, New Zealand and Australia, which ranked 13th, 12th and 6th respectively in terms of comparative GDP. Increased country wealth increases the likelihood that an individual within that country will have access to a computer, either at school, home or both. But, as is seen in these results, DRA scores do not follow the typical pro-forma where increased exposure and practice to items the DRA attempted to test. Some benefits to exposure and practice may have been minimized if not muted in the summative DRA score.

In considering the role of SES in DRA scores it is asserted that it is a necessary but not sufficient factor in determining or improving the DRA scores of students. It should be noted that, there were inconsistencies and a lack of uniformity in looking at countries' GDP and PISA scores (see Appendix C).

Future Research

Academic/leisure technology use. When considering future steps through the lens of educational policy and practice, it is clear that technology use is becoming more prevalent both in academic and non-academic realms. Expansion of technology programs aimed at education and specifically digital reading is inevitable (Calmes & Wyatt, 2013; Lederman, 2012).

It is important to note that use of technology for leisure is not the only mode necessary to practice hard skills such as reading. This study did not support the idea that exposure to leisurely technology use benefited a students digital literacy skills. Perhaps technology's most natural function is in the leisure realm and its translation as an educational advantage is minimal or null. As students transition toward more digital reading in the classroom, for leisure and high/low stakes assessment including, SBAC and Partnership for Assessment of Readiness for College and Careers (PARCC), it is important that policymakers, educators and all stakeholders consider the fact that fundamental literacy skills are still paramount. The belief that exposure to a given technology device will somehow give a student an advantage cannot confirmed as a result of this study. While DGBL is an exciting, if not promising, method by which learn, this study does not provide evidence that it makes for better readers nor could policy and or investment in this mode be recommended without reservations. Thus, much more research around the influence of leisure computer use on academic outcomes needs to happen.

DGBL. It may seem logical that DGBL should have its place in the training and education world. Many already proven examples of beneficial DGBL include, digital games that teach commercial pilots to fly, loggers to fall trees and soldiers to navigate a warzone for example. In these instances DGBL allows learning to occur in an environment without the associated risks of engaging in dangerous professions. However, most students do not go on to fill these dangerous professions. Thus, future research must investigate whether DGBL can be as effective in less treacherous environments when the inherent benefit is absent and examine how effective is DGBL is at teaching for example an entrepreneur to effectively meet and communicate with potential investors, or a teacher learn to control student behavior in a classroom. Lower DRA scores for leisure technology users (including gamers) as found in this study cannot confirm DGBL as an advantageous learning tool in such instances.

Further DRA research. Despite evidence that digital exposure results in higher digital literacy scores, as provided in the literature review of this study, replicated success could not be confirmed. While this study successfully delineated between academic and non-academic technology use, based on student response in the ICT survey, neither variable could be tied to a higher digital reading score. PISA assessment developers, and more specifically DRA developers should conduct further research in evaluating and improving the DRA's theoretical constructs. The present-day claims regarding the digital assessment demands of the current DRA are in need refinement and confirmation. For example, computer *navigation* and *keyboarding* do not appear to distinguish themselves enough from the essential construct of basic literacy ability. The similar scoring of the top five countries in both the print and digital reading scores best exemplifies this current shortcoming.

Assessing students using more personal devices (e.g., smart phones, tablets or smart watches) rather than those built specifically for business practice or academic use such as those currently in place in schools may be one way to get at students' ability to read digital text in an authentic environment. Further, adding skills that require students to interact with non-social media related content on personal devices for the purpose of literacy comprehension might further isolate the literacy skills associated with digital reading. For example, digital reading could evaluate whether students can successfully navigate a pseudo-online bill pay platform including registration, account linkage, and comprehension about privacy disclaimers using each student's preferred device. This may help provide a more purist digital literacy construct.

As a result of this study that examined 15 countries collectively, opportunities for future research at the individual country level exist, where specificity of more variables within this age-band may be examined. Whereas, more factors associated with internal validity measures can be better insured.

Conclusion

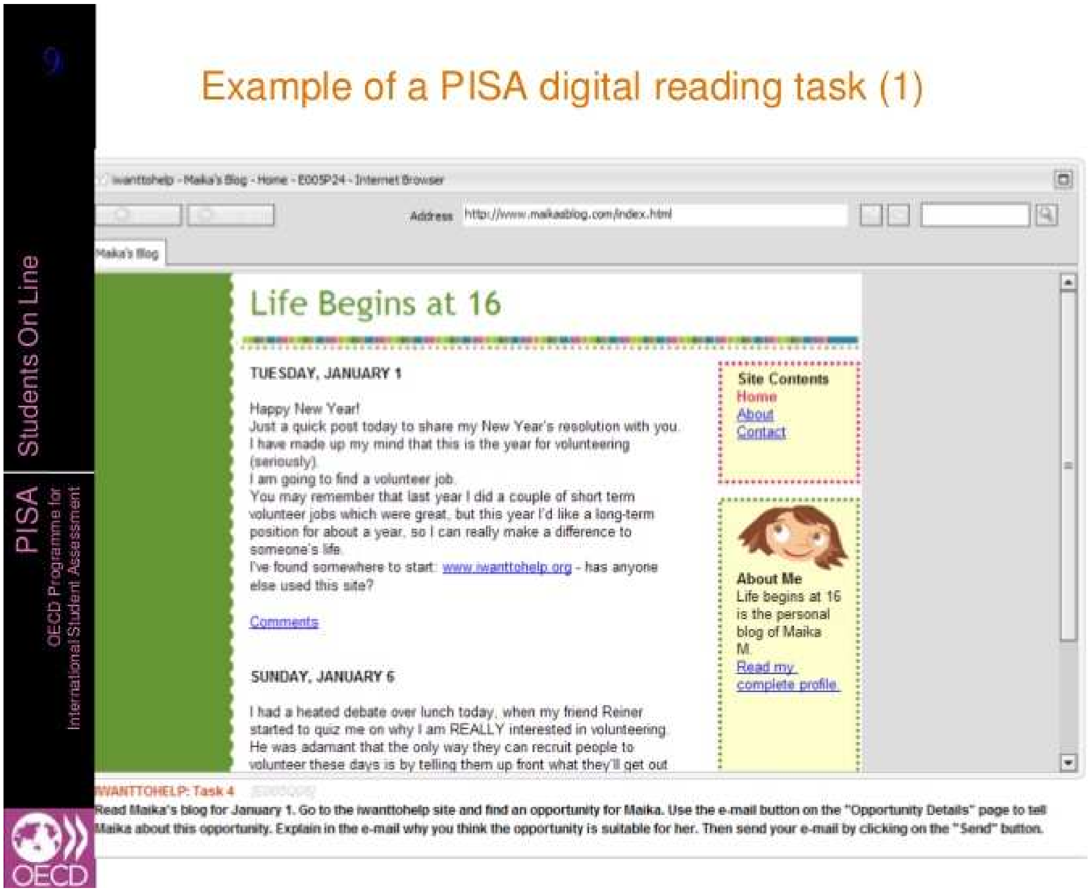
Technology use today is increasingly pervasive. We use it both for leisure and academic/professional purposes. So common is technology that those that are unfamiliar with or dislike technology (either by choice or external circumstance) are considered out of touch, inadaptable, or *Luddites*. Academic and non-academic technology use will likely continue to grow, each directly or indirectly feeding the other. As a result of my study I can recommend non-academic uses of technology only slightly more than academic uses.

Furthermore, I must reemphasize the fundamental need to teach reading by whichever mode available to the classroom teacher. Other studies have supported the findings of this study's conclusion about technologies muted effect (see Wenglinsky's (1998) conclusion on a NAEP dataset). However it should be noted that, large population samples such as these (high powered) portray every minute difference as significant. Potential next steps for a research study in this field would be move toward an effect size measurement of the DRA scores and associated variables. While large sample studies such as the PISA DRA have their limitations, it is still important to consider what can be broadly learned and ultimately applied to the classroom level.

Those educating students in the 15-16 year old age range should consider teaching using both traditional and digital forms. This study cannot conclude that delivering literacy through technology or more traditional print modes is an advantage for students. While it was anticipated that the results of this study could provide concrete conclusions to generalize on a macro level, more localized, country-specific studies with increased internal validity measures may be better able to explore literacy delivery at the micro-level. Literacy both in the print and digital forms exist on a large scale. Whether an absolute digital text environment is where we are headed globally and we simply currently stand in a place of transition remains to be seen. Further assessments that better isolate digital literacy specific skills may be able to better make a distinction between print and digital reading ability. Emphasis on literacy, whether practiced in a digital or non-digital environment, currently translates nearly equally across both mediums.

APPENDIX A

SAMPLE PISA DIGITAL READING TASK



Example of a PISA digital reading task (1)

iwanttohelp - Maika's Blog - Home - E005P24 - Internet Browser

Address http://www.maikasblog.com/index.html

Maika's Blog

Life Begins at 16

TUESDAY, JANUARY 1

Happy New Year!
Just a quick post today to share my New Year's resolution with you.
I have made up my mind that this is the year for volunteering (seriously).
I am going to find a volunteer job.
You may remember that last year I did a couple of short term volunteer jobs which were great, but this year I'd like a long-term position for about a year, so I can really make a difference to someone's life.
I've found somewhere to start: www.iwanttohelp.org - has anyone else used this site?

Comments

SUNDAY, JANUARY 6

I had a heated debate over lunch today, when my friend Reiner started to quiz me on why I am REALLY interested in volunteering. He was adamant that the only way they can recruit people to volunteer these days is by telling them up front what they'll get out

Site Contents
Home
About
Contact

About Me
Life begins at 16 is the personal blog of Maika M.
Read my complete profile

IWANTTOHELP: Task 4

Read Maika's blog for January 1. Go to the iwanttohelp site and find an opportunity for Maika. Use the e-mail button on the "Opportunity Details" page to tell Maika about this opportunity. Explain in the e-mail why you think the opportunity is suitable for her. Then send your e-mail by clicking on the "Send" button.

APPENDIX B

ITEMS IN THE SURVEY USED FOR ACADEMIC AND NON-ACADEMIC VARIABLES

(Response choices – ICT Student Survey)

Academic Technology Use ACAD

Digital reading performance by computer use for practicing and drilling at *school.*

Digital reading performance by browsing the Internet for the purpose of schoolwork at *school.*

Digital reading performance, by computer use at for the purpose of doing individual homework on a school computer at *school*.

Digital reading performance for doing homework on a computer at *home*.

Digital reading performance by browsing the Internet for the purpose of schoolwork at *home*.

NON-Academic Technology Use NACAD

Digital reading performance, by computer use for the purpose of playing one-player games.

Digital reading performance, by computer use for the purpose of playing collaborative online games.

Digital reading performance, by computer use for the purpose of ‘chatting’ online

Digital reading performance, by computer use for the purpose of browsing the Internet for fun.

Digital reading performance, by computer use for the purpose of downloading music, films, games or software from the Internet.

APPENDIX C

COMPARISON OF GDP, PISA PRINT READING AND PISA SCORE (AVG)

Country Rank	**GDP Rank**	**PISA Reading Rank**	**DRA**
Australia	6	5	2*
Austria	4	14	14
Chile	15	15	15
Denmark	2	11	11
Hong Kong	11	2	5
Iceland	9	8	6
Ireland	3	10	8
Japan	8	4	4
Korea	13	1	1
Macau	7	12	10
New Zealand	12	3	2*
Norway	1	6	9
Poland	14	7	13
Spain	10	13	12
Sweden	5	9	7

* - Same average score

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