JRTE | Vol. 45, No. 4, pp. 291–307 | ©2013 ISTE | iste.org/jrte

# Differences in Student Information and Communication Technology Literacy Based on Socio-Economic Status, Ethnicity, and Gender: Evidence of a Digital Divide in Florida Schools

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## Abstract

*This research examines student information and communication technology (ICT) literacy and its relationships to a student's socio-economic status (SES), gender, and ethnicity of middle school students. We recruited 5,990 students from 13 school districts across the state of Florida. Student participants completed the Student Tool for Technology Literacy (ST²L), a performance-based assessment of ICT literacy skills based on the 2008 National Educational Technology Standards for Students (NETS•S). Results show a digital divide between low and high SES, white and non-white, and female and male students on all measures of the ST²L. Specifically, high-SES, white, and female students outperformed their counterparts. The results provide compelling evidence of a digital divide within Florida schools. The article discusses the implications of the findings for practice and future research. (Keywords: digital divide, ICT literacy, technology literacy, SES, ethnicity, gender)*

The term digital divide is polysemous in that it has multiple meanings to multiple people. The term became part of the educator's vocabulary in the mid-1990s (Wilhelm, Carmen, & Reynolds, 2002). It has traditionally been used to describe a social inequity between individuals who have and do not have access to information and communication technology (ICT) (van Dijk, 2006). The digital divide is generally divergent on a number of troubling demographics, such as socio-economic status (SES), ethnicity, and gender. For example, poor and minority families in the United States are less likely to have access to a computer and broadband Internet connection at home and less likely to have the necessary skills and knowledge to meaningfully use these resources (Attewell, 2001; Hesseldahl, 2008).

Although nearly 100% of U.S. public schools now provide Internet access for students, a closer look at the statistics, such as access to instructional computers, reveals that the digital divide still exists. For example, Parsad and Jones (2005) reported that "the ratio of students to instructional computers with Internet access was higher in schools with the highest poverty concentration (percent of students eligible for free or reduced-price lunch) than in schools with the lowest poverty concentration" (p. 7). In addition, "fifty-four percent of schools with the highest poverty concentration had computers with Internet access available to students before school, compared with 82 percent and 80 percent of schools with the two lowest categories of poverty concentration" (Parsad & Jones, 2005 , p. 8).

A study by Hohlfeld, Ritzhaupt, Barron, and Kemker (2008) extended past the examination of access to computers and the Internet in schools by looking at the types of software that students and teachers are using in high- and low-SES schools. Their research provides evidence that high-SES schools had better access to productivity software installed on the machines within their schools. Further, in terms of usage, their results provide compelling evidence that students within low-SES schools are more likely to use drill-and-practice software, whereas students in high-SES schools are more likely to use productivity software for educational purposes. Their work suggests that the digital divide is a multilayered phenomenon.

Another study by Hohlfeld, Ritzhaupt, and Barron (2010b) examined trends in technology and community access for Florida schools from 2003 to 2007. They found evidence of significant differences between high- and low-SES schools and the number of technology tools that were used to communicate with families and the community. In addition, there were clear disparities between high- and low-SES schools, irrespective of school level (e.g., elementary, middle, high), in the types of media that the schools used to communicate. For example, Web sites were more common in high-SES schools than in low-SES schools.

A study of race and gender and their relationship to ICT reveals wide gaps, particularly when looking at Caucasian versus African-American children (Jackson, Zhao, Kolenic, Fitzgerald, Harold, & Von Eye, 2008). In particular, African-American males were less likely to meaningfully use ICT resources when compared to their African-American female counterparts as well as both male and female Caucasians. More important, Jackson, Zhao, Kolenic, Fitzgerald, Harold, and Von Eye (2008) showed a statistically significant relationship between ICT usage and academic performance. Specifically, children who had been using ICT longer had higher grades in school than those who were more recent users of ICT, an effect that they emphasized cannot be attributed to age alone.

Another study, using the Programme for International Student Assessment (PISA) data from 2006, found that "at the individual level, self-reported digital skill is affected by home ICT access, adolescents' SES, gender, and their history of using ICTs" (Zhong, 2011, p. 736). In fact, several studies have shown that boys have better technology skills than girls, perhaps because boys tend to spend more time on home computers. In addition, boys often hold more positive attitudes toward computers (Attewell & Battle, 1999; Hargittai & Shafer, 2006; Imhof, Vollmeyer & Beierlein, 2007: Kuhlemeier & Hemker, 2007).

The research literature on the digital divide has predominantly used survey methodology and focused on student access to ICT in schools and homes. While access is certainly an important component of the digital divide, we now have strong evidence that schools within the United States are providing access to ICT resources in schools (Hohlfeld, Ritzhaupt, Barron, & Kemker, 2008). Further, survey method is limited by participants' honesty. Yet little is known and understood about how students use ICT resources, how well they use these resources, and whether they can use these resources for their own empowerment. This research, in distinction, targets students as the unit of analysis (as oppose to teachers, parents, or schools) and specifically attempts to measure their proficiency with ICT resources, or more specifically, their ICT literacy in relation to the NETS•S.

## Conceptual Framework

The term digital divide has recently expanded beyond physical access to technology to include whether individuals have the necessary ICT skills. Put simply, the digital divide is multilayered and includes several related dimensions of computer access, usage, and skill. As noted by van Dijk (2006), "In terms of physical access, the divide seems to be closing in the most developed countries; concerning digital skills and the use of applications, the divide persists or widens" (p. 221). In 2008, Hohlfeld, Ritzhaupt, Barron, and Kemker outlined the Levels of the Digital Divide in Schools (see Figure 1, p. 294). This framework recognizes three levels of the digital divide within schools and is used as the conceptual framework for this study.

The first level of the digital divide refers to the equitable access to hardware, software, the Internet, and technology support within schools (Hohlfeld et al., 2008). This level, which has been examined extensively in the research literature (Adelman et. al., 2002; Anderson & Becker, 2001; Parsad & Jones, 2005; Becta, 2006; DeBell & Chapman, 2006), is visualized as the base of the triangle and represents the largest percentage of the research. The first level of the digital divide in schools is often described in terms of "student-to-computer ratios, teacher-to-computer ratios, Internet access types, and the number of technical personnel within a school" (Hohlfeld et al., 2008, p. 1650).

The second level of the digital divide addresses how frequently students and teachers are using technology within the classroom and for what purposes they are using technology (Hohlfeld et al., 2008). This level has not

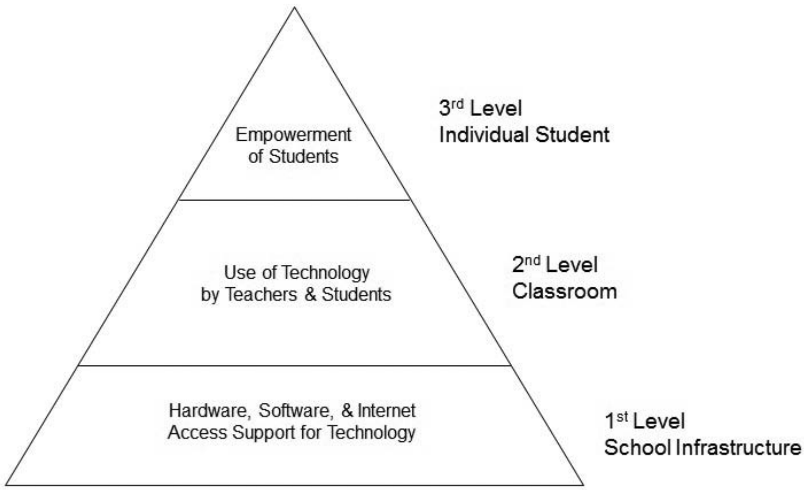


*Figure 1.* Levels of the Digital Divide in Schools (Hohlfeld et al., 2008).

been as extensively researched in the literature, which is why it is visualized as the second layer in the model. However, the research that has been conducted has demonstrated substantial differences in both how teachers and students use technology and how often this occurs (Attewell, 2001; Wayne, Zucker, & Powell, 2002; Wenglinsky, 1998). The second level of the digital divide is contingent upon the minimal requirements of the first level, meaning that the first level is necessary to examine the second-level divide. That is, the technology infrastructure and support system must be in place for teachers and students to meaningfully use information and communication technology in education.

The third level of the digital divide is concerned with whether the student users know how to use ICT for their personal empowerment. Kim and Kim (2001) describe that the "key to bridge the digital divide is not access to or utilization of high-tech information devices or facilities, but whether the user knows how to use them [ICT] for the betterment of their quality of life" (p. 85). As noted by Hohlfeld et al. (2008), the characteristics of the third level of the digital divide may be the most difficult for researchers and educators to address. Researchers must determine which measurements can be used to characterize the third level, and educators must identify meaningful ways to weave technology into the curriculum. The third level has been the least addressed level within the research literature.

We designed this research study to addresses the gap in the research literature by implementing a valid and reliable measurement system to measure middle school student ICT literacy and to examine differences based on SES, gender, and ethnicity. This research adds to what is known in the research literature about student technology literacy and its relationship to these variables. We are attempting to measure the third level of the digital divide as conceived in this conceptual framework.

## Purpose

The purpose of this research study is to examine the third level of the digital divide by assessing student ICT literacy skills in relation to gender, SES, and ethnicity. Specifically, this research uses a valid and reliable measure of ICT literacy, the Student Tools for Technology Literacy ($ST^2L$), which is a performance-based assessment) to gauge a student's ICT literacy. For more information about the $ST^2L$, please visit http://st2l.flinnovates.org.

## Method

### Participants

We recruited a total of 5,990 middle school students from 13 school districts across the state of Florida. Participants were a part of the Florida's Enhancing Education through Technology (EETT) competitive grant program in 2010–2011, which focused on integrating science, technology, engineering, and mathematics (STEM) into the K–12 curriculum. The program had an almost equal distribution of males and females. Approximately 62% of the participants were classified as white, 19% as black, and 12% as Hispanic, and the remaining were classified as Asian or other. Approximately 60% of the participants were on free and reduced lunch programs. Ninety-four percent of the participants spoke English at home with their parents. More than 65% of the participants had been using a computer for more than 5 years.

### Measures

We employed one measurement system in this research study, the $ST^2L$, which is a performance-based assessment designed to measure middle school students' technology literacy across five relevant domains based on the 2008 National Educational Technology Standards for Students (NETS•S): technology operations and concepts, constructing and demonstrating knowledge, communication and collaboration, independent learning, and digital citizenship. The $ST^2L$ included 67 performance-based tasks and 40 selected-response items, for a total of 107 items. The selected-response item types included text-based multiple-choice and true/false items, as well as multiple-choice items with graphics and image map selections (see Figure 2 and Figure 3, p. 296, for examples).

The performance-based items require the examinee to complete tasks in simulated software environments. The $ST^2L$ was pilot tested on $N = 1,513$ eighth grade students (Hohlfeld, Ritzhaupt, & Barron, 2010a?). The purpose of the pilot test was to demonstrate the overall assessment quality by considering item analyses, reliability, and validity. They found the $ST^2L$ to be a sound low-stakes assessment tool. The Appendix (pp. 305–307) provides the indicators for each domain of the $ST^2L$ for validation.

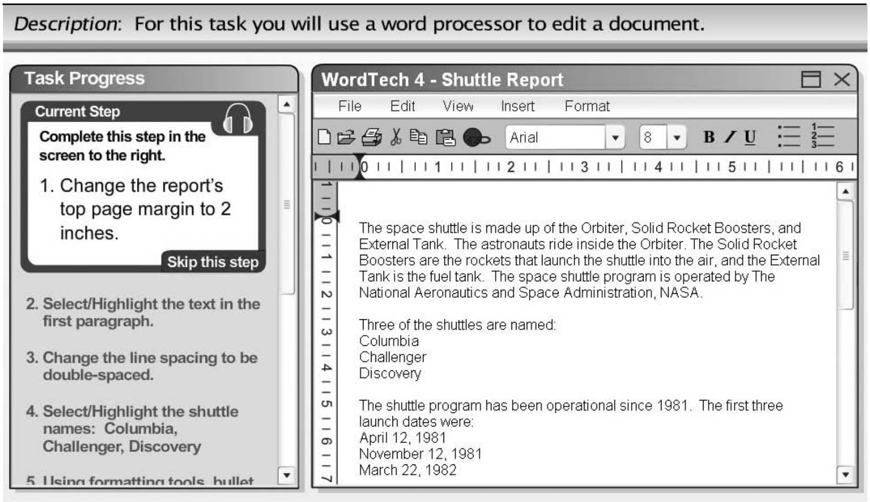


*Figure 2.* Example performance-based task item.

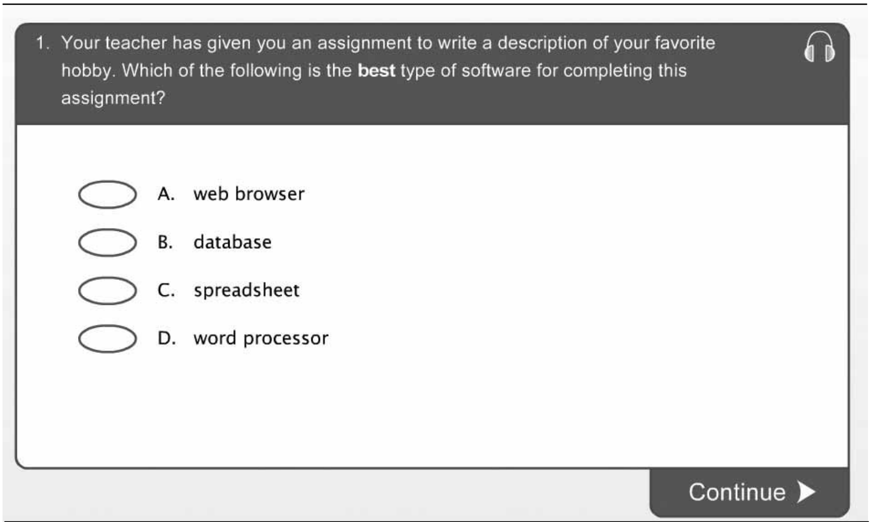


*Figure 3.* Example multiple-selection item.

We estimated reliability using a measure of internal consistency known as Kruder-Richardson 20 (K-R 20), which is used for dichotomously scored items (e.g., right or wrong, yes or no). For an assessment in which subsection scores are reported, it is necessary to estimate reliability of the scores for both the subsections and the entire test. As shown in Table 4, the reliability estimate for scores on the entire tool is K-R 20 = .96. This is a high level of internal consistency reliability. At the subsection level, K-R 20 reliability estimates range from .74 for technology operations and concepts to .89 for constructing and demonstrating knowledge. All the five subsections have at least moderate internal consistency reliability (K-R 20 greater than .70). This is the threshold deemed acceptable for the social sciences (Nunnally, 1978).

**Table 1.** Internal Consistency Reliability of ST2L Sections

| Section on ST²L | K-R 20 |
|---|---|
| Technology Operations and Concepts | .74 |
| Constructing and Demonstrating Knowledge | .89 |
| Communication and Collaboration | .83 |
| Independent Learning | .87 |
| Digital Citizenship | .85 |
| Total for ST2L | .96 |

**Table 2.** Coding for MANOVA Analysis

| Variable | Category |
|---|---|
| Gender | 0: Female<br>1: Male |
| Socio-Economic Status | 0: No<br>1: Yes |
| Ethnicity | 0: White<br>1: Non-White |

## Procedure

We collected data in the fall semester of 2010. We recruited middle school teachers from the 13 Florida school districts from the EETT grant program. Teachers were provided an overview of the ST²L, how to administer the tool, and how to interpret the scores. Teachers then administered the ST²L within their classes during the fall 2010 semester. Teachers also had the opportunity to report any problems with the administration process.

## Data Analysis

We first analyzed the data to demonstrate the internal consistency reliability of the measures (see Table 1). Table 2 shows the coding system of the three independent variables. Next, we analyzed the data descriptively by calculating the means and standard deviations of each independent measure. Finally, we conducted multivariate analysis of variance (MANOVA) to investigate the effects of gender, ethnicity, and SES on student technology literacy as measured by the ST²L. We conducted follow-up ANOVAs when we detected significance in the multivariate tests. We analyzed all data using IBM SPSS v19 and used $\alpha = .05$ for all statistical tests.

# Results

## Descriptive Statistics

The means and standard deviations of the five section scores of the ST²L based on the SES, gender, and ethnicity of the middle school students are shown in Tables 3, 4, and 5, respectively (p. 298). As can be gleaned, across the measure of the ST²L, students that are high-SES, female, or white outperformed their counterparts in each subtest of the ST²L. Descriptively, these

**Table 3.** Student Tool for Technology Literacy by SES

| | Low SES | | High SES | |
|---|---|---|---|---|
| Variable | *M* | *SD* | *M* | *SD* |
| Technology Operations and Concepts | 63.29 | 20.98 | 71.34 | 19.78 |
| Constructing and Demonstrating Knowledge | 50.90 | 22.05 | 58.67 | 21.68 |
| Communication and Collaboration | 61.32 | 21.57 | 68.21 | 19.87 |
| Independent Learning | 55.31 | 23.95 | 61.83 | 22.64 |
| Digital Citizenship | 70.70 | 21.22 | 77.88 | 19.03 |

**Table 4.** Student Tool for Technology Literacy by Gender

| | Female | | Male | |
|---|---|---|---|---|
| Variable | *M* | *SD* | *M* | *SD* |
| Technology Operations and Concepts | 71.34 | 69.36 | 63.59 | 22.21 |
| Constructing and Demonstrating Knowledge | 57.44 | 19.84 | 50.47 | 23.94 |
| Communication and Collaboration | 67.06 | 17.57 | 61.07 | 23.96 |
| Independent Learning | 62.76 | 20.40 | 53.00 | 25.67 |
| Digital Citizenship | 76.68 | 17.90 | 70.49 | 22.76 |

**Table 5.** Student Tool for Technology Literacy by Ethnicity

| | White | | Non-White | |
|---|---|---|---|---|
| Variable | *M* | *SD* | *M* | *SD* |
| Technology Operations and Concepts | 69.04 | 19.86 | 62.32 | 21.83 |
| Constructing and Demonstrating Knowledge | 55.75 | 21.85 | 51.08 | 22.54 |
| Communication and Collaboration | 65.83 | 20.41 | 61.29 | 22.08 |
| Independent Learning | 59.70 | 22.90 | 55.19 | 24.55 |
| Digital Citizenship | 76.44 | 19.70 | 69.10 | 21.35 |

data show evidence of a digital divide existing between the groups. However, descriptive statistics alone are insufficient to make this claim. Thus, we turn to inferential statistical methods.

## Multivariate Analysis of Variance

We conducted a factorial MANOVA to investigate the effects of the three independent variables (gender, ethnicity, and SES) on middle school student technology literacy measured by $ST^2L$. There are five dependent variables, which are student scores on the five subsections of $ST^2L$. The analysis revealed a significant multivariate main effect for all three of the independent variables, Wilks' $\lambda = .966$, $F(5, 4577) = 32.119$, $p <. 001$, partial eta squared = .034; race,

**Table 6.** Multivariate Testsa

| Factors | Wilks' Lambda | *F* | *p* | Partial Eta$^2$ |
|---|---|---|---|---|
| Gender | 0.966 | 32.119b | .000 | 0.034 |
| Ethnicity | 0.976 | 22.214b | .000 | 0.024 |
| SES | 0.972 | 26.261b | .000 | 0.028 |
| Gender × Ethnicity | 0.999 | 1.023b | .402 | 0.001 |
| Gender × SES | 0.998 | 1.506b | .184 | 0.002 |
| Ethnicity × SES | 0.998 | 2.165b | .055 | 0.002 |
| Gender x Ethnicity × SES | 1 | .413b | .840 | 0.000 |

*Note.* Design: Intercept + gender + ethnicity + SES + gender x ethnicity + gender x SES + ethnicity x SES + gender x ethnicity x SES

**Table 7.** Univariate Tests of Between-Subjects Effects

| IVs | DVs | *F* | *p* | Partial Eta$^2$ |
|---|---|---|---|---|
| Gender | Technology Operations and Concepts | 60.797 | .000 | 0.01 |
| | Constructing and Demonstrating Knowledge | 85.179 | .000 | 0.02 |
| | Communication and Collaboration | 68.153 | .000 | 0.02 |
| | Independent Learning | 154.42 | .000 | 0.03 |
| | Digital Citizenship | 83.462 | .000 | 0.02 |
| Ethnicity | Technology Operations and Concepts | 66.101 | .000 | 0.01 |
| | Constructing and Demonstrating Knowledge | 21.921 | .000 | 0.01 |
| | Communication and Collaboration | 29.039 | .000 | 0.01 |
| | Independent Learning | 21.031 | .000 | 0.01 |
| | Digital Citizenship | 86.89 | .000 | 0.02 |
| SES | Technology Operations and Concepts | 99.327 | .000 | 0.02 |
| | Constructing and Demonstrating Knowledge | 96.189 | .000 | 0.02 |
| | Communication and Collaboration | 76.794 | .000 | 0.02 |
| | Independent Learning | 46.176 | .000 | 0.01 |
| | Digital Citizenship | 73.621 | .000 | 0.02 |

Wilks' $\lambda = .976$, $F(5, 4577) = 22.214$, $p <. 001$, partial eta squared = .024; and SES, Wilks' $\lambda = .972$, $F(5, 4577) = 26.261$, $p <. 001$, partial eta squared = .028. As summarized in Table 6, the interaction effects were not significant.

Given the significance of a multivariate main effect for each factor, we examined the univariate main effects. Because we conducted 15 (3 × 5) tests, an experiment-wise alpha rate of .05 was required; therefore we divided the alpha rate by 15 to obtain an acceptable confidence level for each of the tests. The alpha level for each test was then set to $p < .0033$. Even by that stringent criterion, we found significant univariate main effects for all independent variables on each of the five dependent variables (see Table 7).

As can be gleaned in Table 7, the effect sizes as measured by the partial eta squared were very small across the individual differences of gender, ethnicity, and SES. Although the results provide compelling evidence of significant differences based on the individual differences for the five measures of the ST$^2$L, the effect sizes suggest that much of the variability remains unexplained. This suggests that other individual characteristics (e.g., parents' education, rural versus urban, English as a second language, etc.) of the students should be included in the models to account for the variance that remains unexplained.

## Discussion

### Limitations of the Study

The results of our study must be interpreted within the limitations and delimitations of the inquiry. This research is based on data collected from 13 counties in one state within the United States. Albeit our sample size was large (>5000), all the counties involved in this research were a part of the EETT competitive grant program and therefore may have had better access to ICT and stronger ICT education within their schools. Further, the definition of ICT literacy was based on the NETS•S and thus may not be relevant in other countries where ICT literacy may be conceived differently. Of course, defining ICT is an ongoing process, in that ICT changes quickly. Consequently, this research provides only a temporal snapshot of ICT literacy in relation to the variables of interest. Though the instrument used in this research is considered both valid and reliable (Hohlfeld, Ritzhaupt, & Barron, 2010a), the current research provided only the internal consistency reliability of the measure. Finally, student eligibility for the free and reduced lunch program may not be the strongest proxy for SES. In light of these boundaries, this study has resulted in several interesting findings.

### Key Findings

The results demonstrate a clear digital divide relative to gender, ethnicity, and the SES of middle school students within 13 districts in the state of Florida. For instance, females appear to be more proficient ICT users compared to their male counterparts, as measured by the ST$^2$L. This finding is interesting, because prior research shows that boys have better technology skills than girls, boys tend to spend more time on home computers, and boys often hold more positive attitudes toward computers (Attewell& Battle, 1999; Hargittai & Shafer, 2006; Imhof, Vollmeyer, & Beierlein, 2007: Kuhlemeier & Hemker, 2007). The results of the current study suggest that girls are perhaps more proficient with the use of ICT. Although it was not measured in this study, boys might still be more proficient in other ICT-related tasks, such as playing computer games. Future research is necessary to better understand the dimensions of the gender divide identified within this study.

In regards to the SES of students and their ICT literacy, the results are not surprising. Prior research has shown (Attewell, 2001; Hesseldahl, 2008) that lower-SES families generally have less access to ICT in their homes (e.g., computers and broadband Internet connections). As prescribed by the three levels of the digital divide, if individuals do not have access, they have less opportunity to use these tools for their personal empowerment. The current research extends these previous findings to suggest the children of lower-SES families are less likely to be proficient users of ICT. This is a troubling finding in that ICT literacy has been identified as a vital 21st century skill (P21, 2012).

Analogous to the results pertaining to the SES of a student, the ethnicity of a student has also been identified as a dividing factor in previous literature (Attewell, 2001; Hesseldahl, 2008). The results of this study indicate that white middle school students are performing significantly better on ICT related tasks. Minority families are also vulnerable to the consequences of the digital divide, especially relating to the third level.

In terms of the NETS•S, it is interesting to observe the relative strengths and weaknesses of the middle school students. Interestingly, middle school students appear to be performing best on the Digital Citizenship construct of the $ST^2L$. This section, in particular, focuses on whether students are informed users of ICT resources and whether they can discriminate between ethical and unethical uses of ICT resources. This section of the $ST^2L$ also has the most multiple-selection type items as opposed to simulated performance items. The greatest area of weakness of middle school students appears to be their ability to construct and demonstrate knowledge using ICT resources. This is especially problematic because 21st century teachers are providing more opportunities for students to demonstrate their understanding via ICT resources (e.g., Word processing or graphic design programs).

There is little doubt today that ICT literacy is a necessary skills that students should possess to be successful both in their academic and professional careers. Our students are increasingly being expected to create artifacts using ICT resources. Because our students must compete globally for technology-based careers, these skills are especially important for the workforce. It would appear that access to ICT is not the major area of concern today. Rather, we should now focus our attention on whether students in our classrooms are capable of using ICT resources for their personal empowerment.

## Implications for Practice

The compelling question to ask is whether public schools are responsible to fill the deep, broad, and dark void of the digital divide and what procedures can be taken to accomplish this overarching goal. To that end, we provide some recommendations to educational practitioners (e.g., teachers, administrators):

- Schools might partner with local community organizations and local businesses to offer ICT learning opportunities for students, families, and community members at large. Schools are perceived as the bridges to correct the social inequity within our society. We should try to mobilize partnerships to enable schools to reach this goal. Of course, schools will need additional resources to make this type of programming available. Partnerships can be the mechanism to make this programming a reality.

- Schools could provide students with an opportunity to engage in an after-school program to accelerate their ICT literacy. Several schools already offer after-school programming for their students. This choice of programming provides schools with more flexibility in the program, as it is not tied to a specific course or standard curriculum. Programs could be offered on digital storytelling, graphics design, or several other areas relevant to students.
- Schools and teachers might meaningfully integrate ICT resources into the existing curriculum when possible and appropriate. Rather than students doing worksheets or textbook work, students could be engaged with tasks involving searching the Internet (e.g., WebQuests) for relevant information or creating digital artifacts to demonstrate their knowledge and skills in a subject area.
- Schools might invest in both professional development for teachers on integrating ICT resources in the curriculum and the ongoing support necessary to sustain an initiative within a school. Research confirms that carefully planning is necessary to equip our teachers and students with the necessary skills to engage in the 21st century (Ritzhaupt, Hohlfeld, Barron, & Kemker, 2008). Successful technology integration goes beyond the initial acquisition of hardware and software.
- Educators could use these results to inform areas for targeted curriculum improvement. For instance, middle school students were not proficient in constructing and demonstrating knowledge, which is an essential skill in both academic and professional circumstances. Schools are increasingly asking students to demonstrate their knowledge and skill via digital technology. Employers are expecting graduates to perform a wide array of ICT-related tasks.

## Recommendations for Future Research

Our research provides evidence of a digital divide when examining the student as the unit of analysis using a performance-based assessment. However, our results paint only part of the picture of these complex phenomena. Thus, to educational researchers, we make the following recommendations based on our research findings and relevant literature:

- This research provides sufficient evidence of a digital divide based on gender, ethnicity, and SES within Florida schools. However, we cannot attribute the causes of the digital divide to a specific problem. Future research should seek to explore why females are performing better than males in middle school or why non-white students are not performing as well as white students. Is it just a matter of access in homes and school? Are there insufficient male role models using ICT resources in schools? These questions will ultimately need to be answered in future research.

- This research has focused on middle school students. However, we have very little evidence of when the digital divide emerges in the development of a student. At what school level and age does this divide emerge? We have a valid and reliable instrument to measure the ICT literacy of middle school students where a known divide exists. We suggest the development and validation of an instrument that can measure elementary school student ICT literacy. Few studies have specifically examined the ICT literacy of elementary grade students (Wood & Howley, 2012).
- This research focused exclusively on gender, ethnicity, and SES. However, several other troubling demographics have been shown to relate to the digital divide. For instance, the geographic region (e.g., urban, rural) of a school or residence and the education level of a student's parents might be factors that relate to the digital divide. All possible variables should be examined in our discourse about the digital divide. Further, our small effect sizes suggest that much of the variability in student ICT literacy remains unexplained in the model. Future research should attempt to simultaneously examine all of the relevant variables in a robust statistical model.

## Conclusions

We have provided ample evidence of the existence of a digital divide within Florida middle schools specifically relating to gender, ethnicity, and SES. This research contributes to the literature on the digital divide by providing a large sample of middle school students as the unit of analysis. Though these results may not generalize to all states within the union, it is important to point out that Florida is currently the fourth largest state in the United States, with a diverse makeup of students. We have also added to what is known about the NETS•S as it pertains to students in middle schools in general. Our results show that middle school students have substantial room for improvement in ICT literacy, as measured by one instance of the NETS•S (e.g., scores on the $ST^2L$ ranging from 50% to 77%).

One of the more significant areas of digital divide research has been its focus within K–12 public schools. Schools are often perceived as the mechanisms to narrow the digital divide within the United States by providing access to ICT and educating populations on how to use ICT to improve their livelihood. We feel this manuscript is a strong starting point for this important conversation by highlighting some areas for improvement.

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Manuscript received September 18, 2012 | Initial decision November 7, 2012 | Revised manuscript accepted November 19, 2012

## Appendix

The following are the constructs and associated indicators for each construct based on the National Educational Technology Standards for Students (NETS•S). These are how the constructs for the Student Tool for Technology Literacy ($ST^2L$) are defined and matched to the NETS•S.

## I. Technology Operations and Concepts

The student can:

1. Respond appropriately to information presented in a dialog box (e.g., replace a file dialog).
2. Create a new file.
3. Locate and open a specific file.
4. Rename a file.
5. Move a file to a different location.
6. Search for specific files.
7. Select the best device to complete a given task, such as a digital camera, scanner, or external storage device.
8. Select appropriate uses for word processing software.
9. Select appropriate uses for spreadsheet software.
10. Select appropriate uses for Web browser software.
11. Select appropriate uses for graphic organizer software.
12. Identify a Web browser.
13. Select appropriate uses for presentation software.

## II. Constructing and Demonstrating Knowledge

The student can:

1. Select correct printer.
2. Print a specific page range.
3. Identify and locate the standard menu bar.
4. Use the ordered and unordered list features of a word processor.
5. Use the table creation feature of a word processor.
6. Insert a hyperlink into a document.
7. Insert an image into a document.
8. Set page margins within a word processing document.
9. Adjust line spacing within a word processing document.
10. Insert an object using the drawing tools feature of a word processor.
11. Edit images within software using cropping.
12. Edit images within software using resizing.
13. Edit images within software using rotating.
14. Edit images within software using brightness/contrast.
15. Identify and use the address bar in a Web browser.
16. Identify and use the back function in a Web browser.
17. Identify and use the refresh function in a Web browser.
18. Identify and use the bookmarks/favorites elements in a Web browser.
19. Perform Web searches that produce relevant results.
20. Use the advanced search features of search engines (e.g., Boolean, date limits, language, etc.).
21. Access information through online resources, including encyclopedias, libraries, education and government Web sites, and electronic catalogs (a.k.a. card catalogs).
22. Evaluate Internet sites for accuracy.

## III. Communication and Collaboration

The student can:

1. Demonstrate practical keyboarding skills.
2. Use e-mail to send a message.
3. Use e-mail to receive/open a message.
4. Use e-mail to forward a message.
5. Use e-mail to reply to a message.
6. Use e-mail to add attachments to a message.
7. Create new slides within presentation software.
8. Enter content within presentation software.
9. Play a slide show within presentation software.
10. Perform basic digital video editing by removing a section of video.
11. Perform basic digital video editing by adding narration and/or music.
12. Insert an edited video clip into presentation software.
13. Use “Save As” to change the name of the working file.
14. Use “Save As” to save a file to a different location.

## IV. Independent Learning

The student can:

1. Use print preview.
2. Change page orientation between landscape and portrait.
3. Create flowcharts as a learning strategy.
4. Create concept maps as a learning strategy.
5. Enter data into a spreadsheet.
6. Format data in a spreadsheet.
7. Delete data in a spreadsheet.

8. Use help functions within an application for assistance.
9. Use spreadsheets to compute basic formulas.
10. Use spreadsheets to create a graph.
11. Import and export data (e.g., copying and pasting from spreadsheet to presentation software).
12. Toggle between two open software applications.

**V. Digital Citizenship**

The student can:

1. Differentiate between appropriate and inappropriate use of school computers (acceptable use policy).
2. Use and appropriately cite electronic references.
3. Understand and follow copyright laws pertaining to software and/or Internet resources, including duplicating and/or plagiarizing text and media files.
4. Identify an appropriate procedure to follow when inappropriate content is encountered on a computer.
5. Display an awareness of potentially inappropriate language while using technology.
6. Display an awareness of potentially inappropriate media use in regards to technology.
7. Display an awareness that technology is in a state of continual change/advancement.
8. Identify security risks that are involved with giving out personal information (e.g., fake eBay sign-in to steal password).
9. Understands there is no guarantee of privacy on a network.
10. Recognize and report potential online predators (e.g., strangers asking inappropriate questions).
11. Recognize the risks of downloading files and documents.
12. Recognizes the permanency of electronic data.
13. Maintain password security.
14. Understand the need for virus scans, pop-up blockers, spyware blockers, firewalls, and filters.