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Mind the Emotional Gap: The Impact of Emotional Costs on Student Learning Outcomes

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MIND THE EMOTIONAL GAP: THE IMPACT OF EMOTIONAL COSTS ON STUDENT LEARNING OUTCOMES

Kuo-Ting Huang, Laura Robinson and Shelia R. Cotten

ABSTRACT

Purpose – This paper makes a significant contribution to the growing field of digital inequality research by developing an operational definition of emotional costs. To examine this understudied aspect of digital inequalities, we build on Van Dijk's concept of mental access. We define emotional costs as anxiety toward using information and communication technologies instigated by a lack of prior technology experience and limited computer access.

Methodology/approach – We examined the influence of emotional costs on lower-income students' technology efficacy, academic efficacy, and computer application proficiency in the context of a computing intervention. Specifically, we examined the relationship between home and school computer usage with self-perceived technology efficacy, computer

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application proficiency, and academic efficacy. Data from surveys of 972 students were analyzed in order to better understand the importance of technology access on our outcome variables. We also investigated the possible mediation effects of emotional costs on our outcome variables.

Findings – The results revealed that home computer usage was a determinant of students' self-perceived technology efficacy while shared school access was not. After conducting mediation tests, the results further indicated that emotional costs mediate the effects of home computer usage on technology efficacy.

Originality/value – We conclude that emotional costs might help explain why access inequalities lead to skill inequalities in the context of computing interventions and offer a replicable operational definition for future studies.

Keywords: Digital inequality; emotional costs; technology; self-efficacy; information communication technology (ICT)

INTRODUCTION

This paper contributes to the body of work exploring the deleterious impact of digital inequalities on those without access to computer resources. Previous research on digital inequalities has identified many different factors contributing to various digital divides. These include material access inequalities stemming from economic disadvantage (Warschauer, 2003), psychological factors such as emotional anxiety (Jackson, Ervin, Gardner, & Schmitt, 2001), and detrimental information and communication technology (ICT) usage patterns that may further contribute to disadvantage (Hargittai, 2008). As these studies indicate, lack of material ICT access may be compounded by a host of other barriers such as a lack of digital experience, digital skills, and/or usage opportunities (Van Dijk, 1999).

As a whole, previous research indicates that we must build a more sophisticated understanding of digital inequality as a multifaceted phenomenon that cannot be solved by simply increasing material access (Van Dijk, 1999). We begin to do so in this paper by introducing an operational definition for emotional costs. To shed light on this under-examined facet of digital inequality, we explore the effects of emotional costs on underprivileged youth in educational settings. Many school districts utilize either “one-to-one”

computer programs or “bring your own device” approaches in order to increase students’ opportunities for computer access by integrating computers into everyday classroom instruction. Studies of such interventions reveal benefits that span both first- and second-order digital divide effects. Briefly, first order digital divide effects concern actual access to ICT. Second-order digital divide effects concern the attitudes and skills associated with the actual use of ICT. Previous studies have found that computer-based interventions provide students with access to ICT technologies in the school setting, thus solving material access inequities in the classroom. Research shows that computer-based interventions can influence students’ ICT-related attitudes and learning outcomes, thus addressing a number of second order effects. For example, [Gibson et al. \(2014\)](#) collected data from a technology intervention among 12 schools which focused on the effects of the intervention on students’ computer usage. The intervention had a positive impact on students’ attitudes toward using computers and their educational computer usage. These results comport with other previous studies indicating that both of these factors – access and attitudes – are important contributors to overcoming digital inequality (e.g., [Hargittai, 2010](#)).

Although prior studies have pointed out many of the barriers to ICT access, the actual mechanisms that link first-order and second-order inequalities have not yet been clarified. Unequal access, experience, and skills are all possible causes of digital inequality in the context of computer-based education. In two multiple-method analyses of digital inequality, [Robinson \(2009, 2014\)](#) found that economically disadvantaged students with low-quality or no at-home access had higher anxiety and lower information seeking skills when compared to their better resourced peers. Significantly, the negative effects of anxiety hold true even when students were provided with limited material ICT access in the school setting. Here, Robinson’s findings delineate the potential relationships that may exist among first and second order barriers to access.

To make this linkage, [Robinson \(2009\)](#) employs the term “emotional costs.” Emotional costs refer to the significant stress experienced by digitally disadvantaged youth when they struggle to obtain ICT access and/or keep up with their more skilled peers. This emotional angst may prevent students’ learning from casual ICT usage because their learning opportunities are mediated by negative emotions ensuing from both: (1) their sense of falling behind their better-resourced peers and (2) overcoming temporal and material constraints. In other words, students’ limited access generates anxiety toward using technology. In turn, this anxiety prohibits skill building and ultimately learning outcomes if there is no intervention ([Robinson, 2014](#)).

In this research, we build an operational definition for emotional costs and examine its role as a mediating factor between first- and second-order digital divides. When viewing computing interventions through the lens of emotional costs we can see that students' lack of prior computer experience may affect the potential impact of various computer-based interventions. Among the looming disadvantages already facing poverty-stricken school districts, the cost of poor computer access may inhibit students from capital-enhancing activities and skill-building opportunities. Research has shown that long-term material deprivation causes students to experience negative emotions, such as low self-efficacy or high anxiety when they use ICTs (Robinson, 2014). These findings point out a need for further investigation into the emotional factors that might mediate the relationship between computer access and usage in a student's daily life and the outcomes of computer-based interventions. We seek to build upon extant literature by examining the relationship between ICT access, technology efficacy, and academic efficacy. In examining the role of emotional costs as a mediating factor in computer use, we make a contribution to the field by revealing the hitherto unidentified mechanisms that may lower anxiety and thereby contribute to positive attitudes with the potential to enhance learning.

LITERATURE REVIEW

Inequalities of Access to Information and Communication Technology

What is the digital divide? Early research on the digital divide primarily focused on issues of material access (Van Dijk, 1999). According to Van Dijk's classification, material access inequality is the first tenant of the digital divide. Yet even Van Dijk's early work pointed to the need for more sophisticated notions of the digital divide beyond material access. Van Dijk therefore introduced additional categories of access that began the reconceptualization of the digital divide. In addition to material access, Van Dijk (1999) added: (1) usage access (opportunities to use ICT), (2) skills access (access to adequate education or social support for learning digital skills), and (3) mental access (unequal access caused by computer anxiety, interest, and other psychological factors).

Following Van Dijk's lead, other scholars also started to discuss the digital divide and its relation to computer access inequalities from a variety of perspectives (e.g., DiMaggio, Hargittai, Celeste, & Shafer, 2004). These

more nuanced classifications of digital inequality encompass the majority of recent research into the digital divide. For example, a number of researchers began to make linkages between material access and other facets of the digital divide. DiMaggio et al. (2004) found that unequal material access leads to different internet usage patterns between people with internet access and those with limited internet access. To be more specific, people those who only have limited material access and resources to Internet will show a different information-seeking patterns than those who have access and resources. Here we begin to see the connection between unequal material access to the internet and the acquisition of different internet skills. Subsequently, Hargittai (2008) found that digital disparities may cause different ICT usage patterns, which could in turn result in social inequalities. Specifically, digitally advantaged people gain more return over time than those who do not have sufficient ICT access or skills. These studies have led some researchers to posit that the digital divide should be considered a range of digital inequalities.

Certainly this shift in thinking makes sense in terms of education. In the early years, one of the common explanations for unequal digital skill distribution was simply unequal ICT usage. Therefore, many school districts started integrating computer education into their classrooms. However, educators have found that exclusively addressing material access is not enough. Combatting the digital divide necessitates a broader concept of digital inequality. Today, researchers focus on multiple dimensions of digital inequity such as unequal skills, usage opportunities, and digital experiences (Robinson, 2014; Robinson et al., 2015). Digital inequality now provides a more accurate term for expressing the gap between digitally advantaged and disadvantaged students since material access to ICT is no longer seen as a quick fix.

Pushing the field forward, we argue that in addition to material access and skill building opportunities, the emotional aspect of digital inequality also merits serious consideration. Here we take our cue from Van Dijk and Hacker (2003) who shifted the focus from material access resources to mental access inequalities, which they posit may be a more important form of inequality than material access alone. Celik and Yesilyurt (2012) also found that there is a correlation between computer anxiety and learning results in the context of computer-supported education. Robinson (2014) further found that economically disadvantaged youth have emotional barriers and anxiety even when they have an alternative ICT access, such as the access found in public libraries or schools. Further still, Robinson et al. (2015) argued that digital inequalities should be defined more expansively in terms of access, usage, skills, and self-perceptions and should be discussed in a

broad range of outcomes. In sum, these studies have shown that mental access inequalities have the potential to influence the effects and outcomes of computer-based interventions. The following section examines the mechanism of mental access inequalities, which mainly focus on the cause and effect of emotional costs.

Emotional Costs as an Extension of Inequalities of Mental Access

Recently, scholars have examined digital inequalities as they relate to self-conception. Building on this, we argue that self-conception can be regarded as an extension of mental access. Taking issue with previous research on highly wired youth, [Robinson \(2009\)](#) argued that it is exceedingly problematic for researchers to assume that most American youth have computer and internet access. Knowledge gap theory argues that the speed of knowledge acquisition is different between high-status and low-status individuals ([Tichenor, Donohue, & Olien, 1970](#)). This theory may help us better understand access issues since a major cause of access disparity is socio-economic status. [Robinson \(2009\)](#) found that access disparities between privileged and less privileged students might shape their attitudes and skills related to digital devices and information sources. Access disparity includes shared computer access (e.g., at school or at home) and little to no home ICT access. In order to achieve even nominal internet access, economically disadvantaged students may have to overcome significant spatial and temporal barriers as well as bear the “emotional costs” ([Robinson, 2009](#)) previously mentioned. Therefore, those who have limited time or material access to ICT devices will have higher emotional burdens. Moreover, these emotional barriers may prevent them from having a positive attitude toward using computers, which could later influence their computer learning and academic performance.

So what are the “emotional costs” that these digitally disadvantaged students must deal with? Emotional costs are basically defined as feelings of anxiety or stress that can be associated with using computers, ensuing from temporal or spatial constraints. These costs can include feeling like a burden when “bugging” relatives or friends for computer access, feeling stressed when using a shared computer to complete a time sensitive task, feeling anxious when internet access is limited or temporary, and the feeling of wasting valuable temporal resources when trying to use a computer ([Robinson, 2009](#)). In other words, these students who struggle to get material access will

experience the emotional costs or stress associated with budgeting their limited internet access. Therefore, we posit our first hypothesis:

Hypothesis 1. Students who (a) have no home computer usage, and (b) share a computer with others at school in the pre-test will have higher emotional costs scores in the post-test than those who do not.

Robinson (2014) also found that the ICT attitudes and skills that were cultivated through limited ICT access were unlikely to increase if emotional costs were not also addressed. In other words, increased material access without skill-building opportunities is unlikely to be sufficient to relieve emotional costs. This finding echoes Van Dijk's (1999) classification of mental access and material access. Van Dijk (2006) further extends mental access to include motivational access that prevents people from using technology and includes concepts such as computer anxiety and technophobia. The concept of emotional costs links the gap between material access and mental and motivational access. Based on Van Dijk and Robinson's findings, long-term low-quality computer access, whether home access or alternative access at school, should have an impact on the emotional costs associated with computer usage. Therefore, emotional costs, as an extension of mental access, will still have an impact on students' digital experiences, skills, attitudes, and learning results even after they have gained computer access. Hence, our second hypothesis is:

Hypothesis 2. Students' emotional costs in the post-test will have a negative impact on self-perceived technology efficacy, the ability to learn computer skills (application proficiency), and academic efficacy in the post-test.

Furthermore, students' self-perceived technology efficacy will also be influenced by psychological and self-related factors. According to social cognitive theory, a person's level of anxiety will influence their self-efficacy, which will later have an impact on their performance of a task (Bandura, 1977). Recent research on technology-based learning also shows that technology anxiety and self-efficacy, as psychological factors, have important impacts on an individual's performance while using technology (Celik & Yesilyurt, 2012). Other studies have noted that both anxiety toward using ICTs and self-perceived technology efficacy are related to computer learning. For example, Sam, Othman, and Nordin (2005) examined the differences among undergraduates in regards to their technology self-efficacy.

The results indicated that college students with lower ICT anxiety and higher self-efficacy demonstrated an increase in positive attitudes toward the internet, which may lead to better learning results.

As the previous research mentions, the computer access-related variables may have an impact on students' attitudes. As a form of self-evaluation, self-perceived technology efficacy is highly correlated to digital inequality. Specifically, people who have no access to ICTs or a lack of computer usage experience will have less chance to have an "enactive experience," which is a direct learning experience and a source of self-efficacy (Bandura, 1977). Moreover, access to internet will have an impact on the level of users' online activities due to lack of skills, personal barriers, and limited literacy (Haight, Quan-Haase, & Corbett, 2014). Also, students' computer access, such as computer usage at home and sharing a computer at school, will have an impact on the results of the computer-based intervention (Robinson, 2009). Based on previous research, we propose the following two hypotheses:

Hypothesis 3. Students who have home computer usage in the pre-test will have higher scores on (a) self-perceived technology efficacy, (b) academic self-efficacy, and (c) application proficiency in the post-test than those who do not.

Hypothesis 4. Students who share a computer with others at school in the pre-test will have lower scores on (a) self-perceived technology efficacy, (b) academic self-efficacy, and (c) application proficiency in the post-test than those who do not.

Emotional Costs as the Mediator

The term "emotional costs" has been used to describe a feeling of "emotional angst" which occurs among students who have limited temporal or spatial access to ICT (Robinson, 2009). As the previous sections have noted, the inequalities of mental access and motivational access will prevent people from using technology and lead to computer anxiety and technophobia (Van Dijk, 2006). Besides, while controlling for internet access, young adults will still have different levels of web-use skills (Hargittai, 2010). Further still, in order to avoid emotional burdens, students who have little to no quality of access will focus on task-orientated use of the internet, which may prevent them from learning other

internet-related skills (Robinson, 2009). These emotional costs may result in different usage patterns between underprivileged and privileged students, which may contribute to disparities in digital skills and literacy. Some underprivileged students may avoid surfing the internet without a purpose due to these emotional barriers. Thus, they also lose their chance to learn new computer skills by experiencing different aspects of the internet.

To summarize previous research on inequalities of mental access and emotional costs, people’s prior experience of using computers in a limited capacity can lead to emotional costs when forced to use a computer to finish a particular task, such as homework. Emotional costs will also have a negative effect on students’ digital skills, learning outcomes, and even academic performance. To be more specific, emotional costs could have an impact on the relationship between access and technology efficacy, academic efficacy, and computer skills. Therefore, we argue that emotional costs, which is the anxiety toward computer use under temporal and spatial constraints, will mediate the effects of access-related variables on self-perceived technology efficacy, computer application proficiency, and academic efficacy. The following is our fifth hypothesis:

Hypothesis 5. Emotional costs in the post-test will be a mediator between the computer access-related variables in the pre-test and the previously proposed outcome variables in the post-test (e.g., information and communication self-perceived technology efficacy).

Fig. 1 details our proposed conceptual model illustrating the relationships between these factors.

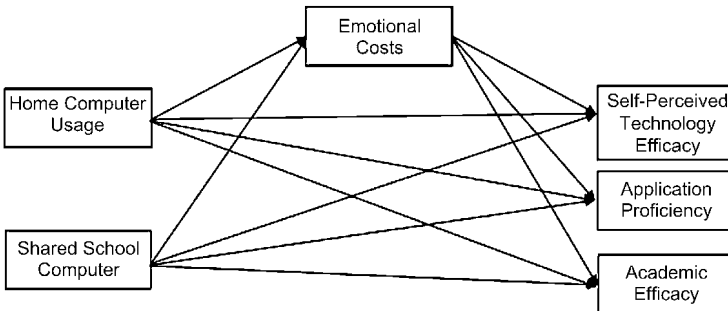


Fig. 1. Proposed Research Model.

METHODOLOGY

Data Collection and Sample

Previous literature on computer-based interventions has shown the importance of students' attitudes and anxiety levels when using computers in the classroom. This study is based on a computing intervention project, Integrating Computing Across the Curriculum (ICAC). The ICAC program was a multi-year, technology-focused intervention which was implemented in a large, urban minority school district in the southeastern region of the United States. The goal of this intervention was to increase the number of minority students entering Science, Technology, Engineering, and Math (STEM) careers by enhancing students' computer usage and increasing student computer access by integrating computing across the curriculum. Fourth and fifth grade teachers and students were recruited for various activities during the ICAC intervention. Teachers learned how to integrate computing across the curriculum by participating in computer-based trainings (e.g., blogging and computer programming, to name a few examples) during the summers. Teachers later applied what they learned in the classroom and promoted student interest in STEM.

The purpose of this study is to investigate the effect of emotional costs on students' self-perceived technology efficacy, computer application proficiency, and academic efficacy. Furthermore, this study seeks to investigate if emotional costs have an effect on students with no access to a computer at home and students that must share a computer at school.

Data were collected from pre- and post-test surveys administered to fourth and fifth grade students enrolled in 12 schools in a large southeastern city school district in the fall of 2012 and spring of 2013. Participating students completed paper and pencil surveys before and after the intervention. The pre-test survey (T1) was conducted at the beginning of the school year and the post-test survey (T2) was administered at the end of the school year. A total of 1,666 students completed either the pre- or post-test survey. Out of the 1,666 students that took either the pre- or post-test survey, 1,201 participated in both the pre- and post-test. After eliminating all of the cases with missing values, 972 students were included in the final regression analyses. Participation was voluntary, and students were provided with small incentives whether or not they completed the survey.

Dependent Variables

In order to measure computer usage in terms of the educational intervention, the dependent variables were comprised from a series of items derived

from the *Birmingham Youth and Technology Study* (Cotten, 2010). Dependent variables included: (1) Self-perceived technology efficacy, (2) Academic self-efficacy, and (3) Application proficiency. All dependent variables were measured during the post-test.

The measure of self-perceived technology efficacy was created using a five-item scale, which asked students how proficient they felt using a computer or laptop (not the XO), tablet computer (iPad, Kindle, Fire, etc.), internet, cell phone, or game system (Xbox, PS3, PSP, Game Boy, Game Cube, Wii). After averaging the scores of the five items, the range of scores was from 1 to 4 ($\alpha=0.61$).

The academic self-efficacy scale was adapted from previous research (Bracken, 1992). It used a 9-item scale which included true or false statements such as: "Learning is hard for me," "I usually do a good job on tests," "I can spell as well as most kids my age," "I can read as well as most kids my age," "I usually work very hard," "I get good grades in school," "I am able to do my schoolwork well," "Going to school is fun" and "I am able to complete my homework on time." After conducting a reliability analysis, we took out one item. We then averaged the total scores of all items. The score scale ranged from 1 to 3 ($\alpha=0.75$).

In order to measure students' computer application proficiency we used a 9-item scale. This scale included items regarding students self-perceived proficiency using a number of computer programs such as, Microsoft Word, Microsoft Excel, Microsoft PowerPoint, Kidblog, Comic or Cartoon Maker, Movie Maker (e.g., Xtranormal), Scratch, Prezi, and Wall Wisher. The response options ranged from 1 (Not Good) to 4 (Very Good). After averaging the total scores of all items, the scores ranged from 1 to 4 ($\alpha=0.79$).

Independent Variables

Independent variables included: (1) sharing computer at school (2) computer usage at home, and (3) emotional costs. The first two variables were measured in the pre-test survey and the last one was measured in the post-test survey. We assumed that the access-related variables before the intervention would have an impact on students' anxiety toward computers in the post-test.

The access-related variable measures asked students to report how often they shared a computer at school and how much they used a computer at home. Sharing a computer at school was measured by a single item and the answers included "1 = almost never, 2 = sometimes, and 3 = almost always." Computer usage at home was also measured by a single item: "How much do you use computers" and the answers included "1 = none, 2 = a little, and 3 = a lot."

The concept of emotional costs was operationalized as anxiety toward using a computer in several classroom situations, and emotional costs might not start to affect participants before the intervention in the classroom setting based on the operationalization. Therefore, we only included emotional costs measured in the post-test in the model. The measure of student's emotional costs was adapted from a 16-item scale which asked about the students' attitude toward using computers in the classroom. Specifically, question items asked about the student's affective attitudes toward computers, perceived control of computers, and behavioral attitudes toward computers. Sample items included, "Computers make me uncomfortable," "You have to be smart to work with computers," and "I don't want to use a computer in case I look stupid" (Selwyn, 1997). After conducting a reliability analysis, we took eight items out. The scale items are listed in the appendix. Participants' emotional costs scores were calculated by averaging the total scores of participants' answers ($\alpha=0.75$). The range of scores was from 1 (do not agree) to 3 (agree).

Control Variables

There were two control variables used in the regression analyses – gender (1 = male, 0 = female) and grade level (1 = 5th grade, 0 = 4th grade). When regressing the outcome variables on the independent variables and the mediator, the outcome variables measured in the pre-test also served as control variables. For example, when we examined the predictors of self-perceived efficacy in the post-test, we could also control students' self-perceived technology efficacy in the pre-test. By controlling all outcome variables in the pre-test, including self-perceived technology efficacy ($\alpha = 0.67$), self-assessment of using computers ($\alpha = 0.85$), and academic efficacy ($\alpha = 0.72$), we could then argue that the power of the independent variable was not influenced by the same variable in the pre-test survey.

Analysis

The statistical analyses included paired-sample *t*-tests, Ordinary Least Squares Regression (OLS), and mediation tests. First, paired-sample *t*-tests were used to examine if there was a difference between the dependent variables before and after the computing intervention. We also conducted a series of OLS regressions to predict self-perceived technology efficacy, computer

application proficiency, and academic efficacy at post-test. In the regression models, we also controlled for the outcome variables from the pre-test.

The concept of emotional costs was hypothesized to have a mediating effect between the independent variables and the outcome variables. We tested for mediation based on Baron and Kenny's (1986) four-step mediation tests. First, we conducted a simple regression which regressed the dependent variables on the independent variables. Second, we conducted another simple regression that regressed the mediator on the independent variables. Third, we conducted a simple regression, which regressed the outcome variables on the mediator. Lastly, we conducted a multiple regression, which regressed the outcome variables on both the independent variables and the mediator. The Sobel test (1982) was used to examine if the effect of the independent variables were reduced significantly after the mediator was put into the models. We used a Sobel test to examine if emotional costs had a significant mediating effect on the computer access-related variables and outcome variables.

Three models for each dependent variable were created for this research. The first model only controlled grade level and gender. The second model included sharing computers at school, computer usage at home, and the same dependent variable in the pre-test. The third model included all the independent variables in the first two models. All analyses were conducted using SPSS 20.

RESULTS

Descriptive Statistics and Paired-Sample t-Tests

Preliminary analyses were conducted to ascertain the descriptive statistics of the sample set ($N = 972$). Of the total sample set, 49.5% were female and 82.4% were African-American. The high percentage of African-American students in the sample reflects the population of the school district. The average age of research participants was 10.43, and 55.2% were 5th graders. The changes in outcome variables between the pre-test and post-test survey are reported in Table 1.

There was a consistent, statistically significant change between all pre-test and post-test variables. This computing intervention demonstrated improvements in self-perceived technology efficacy and computer application proficiency over the course of this study. However, there was a negative change with regards to academic efficacy between pre-test and

Table 1. Change of Technology Efficacy, Application Proficiency, and Academic Efficacy.

| Variable | Pre-test | | Post-test | | Change | |
|-------------------------|----------|------|-----------|------|----------|------|
| | Mean | SD | Mean | SD | Mean | SD |
| Technology efficacy | 3.20 | 0.84 | 3.47 | 0.63 | 0.27*** | 0.81 |
| Application proficiency | 1.43 | 1.10 | 1.98 | 0.92 | 0.55*** | 1.09 |
| Academic efficacy | 2.58 | 0.30 | 2.49 | 0.33 | -0.09*** | 0.34 |

Note: $N = 972$.

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$.

post-test. One explanation might be that the post-test was measured at the end of the semester when students had just completed standardized testing, which may have led to the decrease in academic efficacy. Based on these results, a series of regression and mediation tests were conducted to examine the relationship between the independent and outcome variables, along with the mediating effects of emotional costs.

Regression Analyses

Building from the descriptive statistics, we conducted multiple regression analyses. First, we tested computer access-related variables on emotional costs. Next, we tested for the relationship between computer access-related variables with self-perceived technology efficacy, academic efficacy, and computer application proficiency. Finally, we tested emotional costs as a mediating variable in order to examine if emotional costs cause the effect of independent variables on dependent variables.

Regression analysis first tested the effect of computer access-related variables on emotional costs while controlling for certain descriptive variables (see Table 2). Computer usage at home ($\beta = -0.115$, $p < 0.001$) was a significant predictor of students' emotional costs. For shared computer access, the regression model showed that sharing computers at school was positively related to increased/higher emotional costs, but not at the statistically significant level.

Next, the analyses revealed that self-perceived technology efficacy could be predicted by the computer access-related variables (see Table 3). Before putting emotional costs in the regression, computer home usage ($\beta = 0.072$, $p < 0.05$), grade level ($\beta = 0.060$, $p < 0.05$), and self-perceived technology used in the pre-test efficacy ($\beta = 0.539$, $p < 0.001$) were shown to be

Table 2. Access Variables and Emotional Costs.

| | β | SE |
|--------------------------------|-----------|-------|
| Grade level | -0.074 | 0.022 |
| Gender | -0.007 | 0.022 |
| Home computer usage | -0.130*** | 0.028 |
| Sharing computer at school | 0.053 | 0.022 |
| <i>F</i> | 6.195*** | |
| Adjusted <i>R</i> ² | 0.021 | |

Note: *N* = 972.

p* < 0.05, *p* < 0.01, *** < 0.001.

significant predictors of self-perceived technology efficacy. After putting emotional costs in the regression, computer home usage was no longer a predictor of self-perceived technology efficacy. Instead, emotional costs ($\beta = -0.208$, $p < 0.001$) was a significant predictor of self-perceived technology efficacy in the post-test.

For computer application proficiency in the post-test (see Table 3), none of the access-related variables predicted self-assessment of computer application proficiency. After emotional costs were added into regression model 3, emotional costs significantly predicted this outcome variable ($\beta = -0.084$, $p < 0.01$). In addition, grade level ($\beta = -0.057$, $p < 0.05$), gender ($\beta = -0.080$, $p < 0.01$), and self-assessment of computer application proficiency in the pre-test survey ($\beta = 0.416$, $p < 0.001$) were also significant predictors. Access-related variables were still not significant predictors of this outcome variable.

For self-assessment of academic efficacy in the post-test (see Table 3), the results also revealed that none of the access-related variables predicted self-assessment of academic efficacy. After putting emotional costs into model 3, students' self-assessment of academic efficacy in the pre-test ($\beta = 0.397$, $p < 0.001$), emotional costs ($\beta = -0.078$, $p < 0.01$), and grade level ($\beta = -0.104$, $p < 0.05$) were significant predictors. However, access-related variables still had no effect on students' academic efficacy.

Mediation Test

Based on the results of the regression analyses, we also tested to see if emotional costs could be a mediator between home computer usage and our outcome variables. After conducting Baron and Kenny's (1986) mediation tests (see Table 4), we found that emotional costs mediate the effects of

Table 3. Regression Coefficients-Outcome Variables Regressed on Access-Related Variables and Emotional Costs.

| | Technology Efficacy | | | Application Proficiency | | | Academic Efficacy | | |
|--------------------------------|---------------------|-----------|-----------|-------------------------|-----------|-----------|-------------------|-----------|-----------|
| | Model 1 | Model 2 | Model 3 | Model 1 | Model 2 | Model 3 | Model 1 | Model 2 | Model 3 |
| Grade level | 0.074* | 0.060* | 0.045 | -0.066* | -0.051 | -0.057* | -0.087** | -0.063* | -0.070* |
| Gender | 0.013 | 0.007 | 0.006 | -0.086** | -0.079** | -0.080** | -0.010 | -0.012 | -0.012 |
| Computer usage at home | | 0.072* | 0.058 | | 0.037 | 0.026 | | 0.045 | 0.036 |
| Sharing computer at school | | -0.004 | 0.006 | | -0.040 | -0.036 | | -0.047 | -0.044 |
| Pre-test outcome variables | | 0.390*** | 0.357*** | | 0.419*** | 0.416*** | | 0.411*** | 0.397*** |
| Emotional costs | | | -0.208*** | | | -0.084** | | | -0.078** |
| <i>F</i> | 2.784 | 43.897*** | 47.089*** | 5.709** | 46.266*** | 40.231*** | 3.731* | 44.545*** | 38.474*** |
| Adjusted <i>R</i> ² | 0.006 | 0.185 | 0.226 | 0.010 | 0.189 | 0.195 | 0.006 | 0.183 | 0.188 |

Note: $N = 972$.

* $p < 0.05$. ** $p < 0.01$. *** $p < 0.001$.

Table 4. Mediation Test on Self-Perceived Technology Efficacy.

| Independent Variable | Dependent Variable | β | SE |
|---|------------------------------------|-----------|-------|
| Home computer usage | Self-perceived technology efficacy | 0.072* | 0.051 |
| Home computer usage | Emotional costs | -0.065* | 0.030 |
| Emotional costs (controlling home computer usage) | Self-perceived technology efficacy | -0.209*** | 0.053 |
| Home computer usage (controlling emotional costs) | Self-perceived technology efficacy | 0.059 | 0.050 |

Notes: $N = 972$. This analysis controls grade level, gender, and pre-test outcome variable.
 * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$.

home computer usage on self-perceived technology efficacy. After conducting a Sobel test (1982), the results also showed that the effects of independent variables on outcome variables were reduced by 19.4% after including the mediator into the research regression model, and the reduction was significant ($Z = 3.65$, $p < 0.001$). In other words, emotional costs mediated the relationship between home computer usage and self-perceived technology efficacy. Hence, students' emotional costs were the reason why digitally disadvantaged students did not have increased self-perceived technology efficacy scores after the computing intervention.

DISCUSSION

These results provide support for most of the proposed hypotheses. First, regression analyses supported Hypothesis 1(a): students who have no home computer usage will have higher scores on emotional costs than those who do not. Conversely, we did not find support for Hypothesis 1(b): sharing school computers was not a predictor of emotional costs. This is consistent with Robinson's (2009) findings that illustrate how the temporal and spatial constraints on ICT devices lead to emotional costs, such as limited computer usage producing higher emotional anxiety during future computer usage. When students that already experience limited computer access do engage in computer usage, anxiety will perpetuate hindrances already present in education. The next hypotheses all expand on this concept by examining specific areas of ICT accessibility and usage.

Analyses associated with all the components of Hypothesis 2 were fully supported and Hypothesis 3 was partially supported: emotional costs were

the predictor of our outcome variables and home computer usage was the predictor of only self-perceived technology efficacy. First, home computer usage was found to be a predictor of self-perceived technology efficacy in the post-test survey. However, after adding emotional costs to the regression analyses, home computer usage was no longer a predictor of the outcome variable. The relationship between home computer usage and self-perceived technology efficacy in the post-test was mediated by emotional costs. More specifically, what influenced a student's self-perceived technology efficacy was not home computer usage but rather emotional costs. In other words, when accounting for emotional costs as a mediating factor, home computer usage was no longer a predictor of self-perceived technology efficacy and academic efficacy.

These findings contribute to the notion that emotional costs can have an impact on the benefits gained from computer access and usage. Namely, despite having access to a home computer, a student's emotional costs were a more significant predictor of how effective computer access was to self-efficacy, computer skills, and academic efficacy. In other words, a student that suffered from high anxiety toward computer usage with limited internet and computer access was unlikely to address this problem in order to better his or her effectiveness with the computer. This lack of efficacy could have future impacts on their academic success.

Unlike the previous hypotheses, Hypothesis 4 was largely unsupported. There were no statistically significant findings that suggested that sharing a computer at school was detrimental to the outcome variables. This result suggests that students did not differ in emotional costs, whether they had their own computer at school or they shared one. This finding indicated that students' ICT access at school did not have the same impact on their anxiety toward technology as their ICT access at home. Since sharing computers at school did not increase students' emotional costs, it would not have an impact on students' technology efficacy, computer skills, and academic performance self-assessments. A possible explanation was that using computers together at school might lessen anxiety for students who only had limited home ICT access or skills. Students could team up with more skilled peers and learn from them. Future research can investigate both positive and negative effects of sharing computers in the context of computer-based interventions in a more detailed way.

The last Hypothesis 5 posited that emotional costs would serve as a mediator between the computer access-related variables and the outcome variables. This hypothesis was partially supported because emotional costs were found to be a consistent predictor across all models and a mediator

between computer usage at home and self-perceived technology efficacy in this study. Therefore, it might be prudent to say that emotional costs were preventing these economically, and digitally, disadvantaged students from truly being successful with computers and other devices. Any success in addressing this problem is therefore dependent on creating situations in which students are not hindered by computer anxiety and poor self-perceived technology efficacy. Pedagogical programs that provide time-intensive, low-stress, computer-learning scenarios for students are inherently the best structured for addressing the digital divide which hinders economically disadvantaged students' competitive capabilities.

Comparing these results with previous studies, this paper utilized quantitative data to determine whether students who had no or limited ICT access pay/experience emotional costs associated with computer use. The results found here not only tested previous theories on digital inequalities, but they also provided evidence supporting the indirect effects of emotional costs on outcome variables such as self-perceived technology efficacy, academic efficacy, and computer application proficiency. In summation, this study found that simply providing digitally disadvantaged students with access to digital devices in the classroom is not enough. Emotional costs, which result from a lack of home computer usage, must be addressed. Future interventions should create safe opportunities for digital skill building in order to reduce ICT-related anxiety. In essence, addressing emotional costs should be an emphasis for any future computer-based interventions.

Limitations

This study provides informative results based on surveys from a year-long computing intervention project. However, it still has some limitations. First, the intervention was in a high poverty, urban school district in the southeastern United States. The effects of the intervention worked very well in this low socio-economic status (SES) area in terms of increasing the students' technology self-efficacy, computer application proficiency, and academic efficacy. However, future research needs to be conducted examining these correlations with students from more varied socio-economic backgrounds.

Another limitation of this study is also related to SES: students who completed this survey were from a high-poverty school district. This study reveals the mediating effects of emotional costs on the relationships between computer access-related variables and outcome variables. However, these

results may be limited in their inherit ability to predict the degree to which emotional costs affect students from different SES backgrounds.

CONCLUSION

Although there are some limitations in terms of generalizing the results found here, this study still provides several important findings and contributions. First, the results of this study show a positive effect on students' self-perceived technology efficacy and computer application proficiency stemming from a computing intervention. These findings echo previous research on computing-based intervention effects (e.g., Gibson et al., 2014). Second, these results indicate that digitally disadvantaged students have lower self-perceived technology efficacy than digitally advantaged students, which results from inequalities of actual access and computer usage.

Another important finding of this study is that this research strongly supports the notion that emotional costs have a mediating effect on ICT access and students' subsequent learning outcomes. Therefore, these findings support the qualitative results found in Robinson's research (2009). This study also articulates the relationship between different access inequalities. More specifically, it was found that emotional costs, as an extension of mental access, partially mediate the relationship between actual access (home access and school access) and skills access (technology efficacy and application proficiency). In other words, these types of access inequalities are closely linked and we recommend that future studies measure them together.

This research provides preliminary results on the effects of emotional costs; however, this paper also provides us with some questions that must to be answered in the future. For example, how can school districts use computer-based education to decrease digitally disadvantaged students' emotional costs? Can alternative access, such as school access, compensate for the inequalities in home computer usage? Further research should also investigate if emotional costs influence students' computer usage patterns and orientations. For instance, could different computer usages further enlarge the knowledge gap and digital divide between advantaged and disadvantaged students?

Emotional costs might be a key concept when dealing with the problems associated with the digital divide and digital inequalities moving forward. This study found that access was not the most powerful predictor of outcome variables. Instead, emotional costs are the reason that home access

could be used to predict our outcome variables. Emotional costs prevent digitally disadvantaged students from having the same beneficial returns as those who have good digital access. This reveals the importance of mental and emotional factors related to technology use in computer education. In order to bring about better results from our computing interventions, future studies should consider mental, emotional, and affective components in the context of computer-based interventions.

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APPENDIX: SCALES AND SCALE ITEMS

Information and Communication Technology (ICT) Self-Efficacy Scale Items

1. XO laptop
2. Computer or laptop (not the XO)
3. Tablet computer (iPad, Kindle Fire, etc.)
4. Internet
5. Cell phone
6. Game system (Xbox, PS3, PSP, Game Boy, Game Cube, Wii)

Computer Program Self-Assessment Scale Items

1. Microsoft Word
2. Microsoft Excel
3. Microsoft PowerPoint
4. Kidblog
5. Comic or Cartoon Maker
6. Movie Maker (like Xtranormal)
7. Scratch
8. Prezi
9. Wall Wisher

Academic Performance Self-Assessment Scale

1. Learning is hard for me
2. I usually do a good job on tests
3. I can spell as well as most kids my age
4. I can read as well as most kids my age
5. I usually work very hard
6. I get good grades in school
7. I am able to do my schoolwork well
8. Going to school is fun
9. I am able to complete my homework on time

Emotional Costs Scale

1. I can make the computer do what I want it to (reversely recode)
2. I usually need help to use a computer (reversely recode)
3. I could teach myself most of the things I need to know about computers (reversely recode)
4. Computers are hard to use
5. If I have problems using the computer I can usually solve them one way or the other (Reversely recode)
6. Sometimes I don't know what the computer is doing
7. Once I start to work on the computer, I find it hard to stop (reversely recode)
8. I'm no good with computers
9. I don't think I could do advanced computer work
10. Computers make me uncomfortable
11. You have to be smart to work with computers
12. I don't want to use a computer in case I look stupid
13. If given the chance to use a computer I am afraid that I might damage it in some way
14. To use computers in a job you have to go to school for a long time
15. Using a computer does not scare me at all
16. I don't want to use a computer because I might make a mistake I can't fix