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Does technology empower urban youth? The relationship of technology use to self-efficacy

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ABSTRACT

Many propose technology as a tool for empowerment of lower SES urban students, but little research has investigated the relationship between technology and empowerment for this population. We investigate how different aspects of technology use and ownership could empower urban youth through increasing their self-efficacy. Instead of simply a general measure of self-efficacy, we focus on several important domains related to STEM (Science, Technology, Engineering, and Mathematics) subjects including technological, mathematics/science, academic, and general self-efficacy. Our investigation incorporates many aspects of technology use by considering first level digital divide characteristics, such as ownership and total amount of use, and second level digital divide characteristics, such as specific communication, multimedia, content creation, and social networking activities. We use a unique survey of fourth and fifth grade students who were given a laptop, thereby controlling for the typical disparity in computer ownership and access among lower SES students. We found that technology use influences each domain of efficacy in specific ways, indicating the importance of considering multiple domains of self-efficacy. Most notably, frequency of communication and especially frequency of email use related to all four domains of efficacy and frequency of playing games related to general, mathematics/science, and academic efficacy. However, social networking activities had a negative association with academic and general efficacy. We conclude by considering the importance of multiple domains in self-efficacy research and policy implications for students and their schools.

1. Introduction

Many have proposed that youth's access and use of affordable computer technology would level inequalities, enhance learning opportunities, and lead to academic and career success. The research generally supports that: youth's engagement with information and communication technologies increases their integration in the community, development of skills, and social capital (London, Paster, Servon, Rosner, & Wallace, 2010; Valaitis, 2005), politiosocial participation (Thackeray & Hunter, 2010), and reduces disparities between genders (Khan & Ghadially, 2010). Not surprisingly, among lower SES youth, technology interventions promote academic interest in STEM (science, technology, engineering, and mathematics) subjects (Martin et al., 2011; Nugent, Barker, Grandgenett, & Adamchuk, 2010) and careers (Wilson, Iyengar, Pang, Warner, & Luces, 2012). One important outcome of young peoples' engagement with technology is whether they are empowered to succeed within and beyond the domain of technology (Amichai-Hamburger, McKenna, & Tal, 2008). Students' self-efficacy – the belief in one's own abilities, control, and agency – is a key component in students' academic success and STEM-related careers. In this paper we explore the relationship of technology use to different domains of self-efficacy for a population of particular interest and surprisingly understudied: disadvantaged urban youth.

We ask if and how engagement with technology can empower youth by considering self-efficacy in general and in relation to STEM subjects. Following the trajectory of digital divide literature (Attewell, 2001; van Dijk, 2006), we model the relationship between efficacy and first level digital divide factors (i.e., ownership and access frequency), then add to this model second level digital divide factors (i.e., specific uses of technology). In our sample of a high-poverty urban school system, students were given specialty laptops called XO laptops. Because this scale of XO laptop dissemination was unprecedented in the United States (Warschauer, Cotten, & Ames, 2012), our sample

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provides a unique opportunity to examine a large number of students with access to resources useful for empowerment. Aside from our unique sample, we add to the literature in three major ways. First, we study elementary school children, a group understudied in self-efficacy research. Second, while most research considers only one domain of self-efficacy, we simultaneously consider four domains of self-efficacy in order to understand how technology use empowers students in general and in relation to STEM education. Third, we do not use a simple measure of time spent on computers, but engage in a detailed examination of computer and Internet activities.

2. Background

2.1. Self-efficacy

Social psychologists view the perception of the self as one's self-concept (Rosenberg, 1979, 1981), which includes multiple elements developed through self-reflection and cultural perceptions (Mead, 1934). The meanings associated with the self primarily include self-esteem and self-efficacy. Self-esteem – the evaluative component of the self – has often been studied in its relationship to technology (e.g., Rohall, Cotten, & Morgan, 2002; Wang, Jackson, Zhang, & Su, 2012; Witt, Massman, & Jackson, 2011). Self-efficacy – the power and control component of the self – has been less studied in its relationship to technology, especially among disadvantaged youth, yet self-efficacy remains important for the long-term development and success of youth (Hackett, 1997; Halleröd, 2011). Whereas particular technological skills may become outdated and communities change, an internal sense of empowerment and ability can carry an individual throughout her life (e.g., Halleröd, 2011).

The terms empowerment and efficacy have historically been used in many different ways. Some use the terms interchangeably (e.g., Enderlin-Lampe, 2002), while others propose that empowerment either requires two people – one empowering and the other becoming empowered (e.g., Robbins, Crino, & Fredendall, 2002). Some conceptualize empowerment as including other components besides efficacy, such as autonomy and motivation (e.g., Edwards, Green, & Lyons, 2002; Vincenz, 1990), whereas others refer to it as a philosophy of business management (e.g., Lee & Koh, 2001). In spite of the range of uses (see Gecas, 1989; Lee & Koh, 2001 for reviews), we have elected to follow Bandura's self-efficacy research tradition (1997). He describes self-efficacy as a psychological perception that is predictive of behaviors. This efficacious perception empowers people as it is coupled with agentic action and meaningful outcomes (Bandura, 1997). Here we seek to understand how engagement with technology relates to empowerment by focusing on how patterns of interaction with technologies alter self-efficacy.

One form of self-efficacy is the general belief about one's own empowerment, agency, and abilities, while other forms apply to specific domains. Bandura (1997, 2006) proposes that if different domain-based self-efficacies rely on common skills or are developed in a common social context they are more likely to be related. In schools, for example, "students are likely to develop similarly high perceived self-efficacy in dissimilar academic subjects, such as language and mathematics" (Bandura, 2006: p. 308). Others view domain-specific self-efficacy as simply general self-efficacy applied within a domain. For example, "computer self-efficacy is based on an already formed sense of self-efficacy and represents its fundamental elements applied in the fields of use and mastery of computers" (Paraskeva, Bouta, & Papagianni, 2008: p. 1085).

Bandura argues that a general measure of self-efficacy is limited in its predictive power as it cannot be relevant to all of the behavioral domains (2006). Therefore, domain-specific efficacy predicts better than its global counterpart but is a less parsimonious explanation of human behavior. Surprisingly, scholarship shows little discussion of the boundaries among domains, especially in the areas of STEM education. In relation to academia, Bandura argues that academic efficacy encompasses too broad a domain with fundamentally different scholastic skills (1997: pp. 47–50). In contrast to Bandura's domains, some researchers conceptualize general self-efficacy as a dimension of a larger construct itself, e.g., efficacy and worth have been considered two components of self-esteem (Cast & Burke, 2002; Gecas & Schwalbe, 1986).

This tension between domains of self-efficacy is especially problematic when considering STEM academic fields and technology more generally. Most research in this area considers only one type of self-efficacy: general technological self-efficacy (Huffman, Whetten, & Huffman, 2013), computer self-efficacy (Kher, Downey, & Monk, 2013; Vekiri & Chronaki, 2008), Internet self-efficacy (Chang et al., 2013; Kim & Glassman, 2013), science self-efficacy (Chen & Usher, 2012; Kıran & Sungur, 2012), mathematics self-efficacy (Phan, 2012), mathematics/science self-efficacy (McMahon & Wernsman, 2009), or academic self-efficacy (Putwain, Sander, & Larkin, 2012). However, a few researchers have considered multiple types, such as general and computer self-efficacy (Paraskeva et al., 2008), academic and Internet self-efficacy (Joo, Bong, & Choi, 2000), or even general, Internet, and computer self-efficacy (Broos & Roe, 2006). None of this research considers the relationship of multiple domains of self-efficacy with participation in a range of Internet activities.

In this paper we seek to add to this literature by examining the complex relationship among computer use, Internet activities, and the multiple domains of self-efficacy associated with academic STEM subjects. It is well-documented that both perceptions of ability and actual outcomes within a domain relate to domain-specific efficacy (Bandura, 1997). For example, academic achievement relates to academic self-efficacy (Caprara, Vecchione, Alessandri, Gerbino, & Barbaranelli, 2011) whereas computer use, accomplishments, and confidence relate to computer self-efficacy (Hsiao, Tu, & Chung, 2012; Vekiri & Chronaki, 2008). Furthermore, academic and technology-based efficacies often are only related to outcomes within their own domains (Joo et al., 2000). While particular studies consider efficacy as either a cause or an outcome, the causal direction of the relationship is often reciprocal (Gecas, 1989).

We propose a more complex understanding of the forms of self-efficacy in relation to students' interaction with technology. The specific uses of technology could empower students in the realm of technology, or, alternatively, technology could simply function as a medium through which one becomes more or less efficacious. To tease out the different possibilities, we examine four domains of self-efficacy. General self-efficacy, perhaps the most studied, provides an overarching measure. In relation to computers and Internet use we have selected technological self-efficacy. As opposed to computer or Internet self-efficacy, both used in other research, we opted for technological self-efficacy because it captures the breadth of empowerment through and with a range of computer platforms, applications, and websites. Considering the assumption in STEM programs that mathematics and science are directly related to technology, we include the domain of mathematics/science[1] self-efficacy. Finally, as a comparison with the mathematics/science self-efficacy, we consider academic self-efficacy

[1] Although engineering is one of the four STEM fields, it is not a course in elementary schools. Therefore, we elect to use the combination of science and mathematics to represent the non-technology domain of the STEM fields.

which does not focus on any specific school subjects. While general self-efficacy is the broadest concept, academic self-efficacy in many ways bridges general self-efficacy and the more specific domain of mathematics and science. We perceive technological self-efficacy as tangential to the academic domain, because students encounter technology both inside and outside of the school setting. By considering multiple domains of self-efficacy with the expressed purpose of comparison, this study seeks to expand the understanding of domain-based self-efficacy.

2.2. Digital inequalities

Digital inequality research considers patterned arrangements of individuals to access, ownership, and use of technology. Originally called digital divide research, digital inequality research has shifted over the years in response to new technologies and the reduction of prior inequalities. For example, the first level digital divide literature found large gender, racial, and age inequalities in the ownership of computers and access to computers and the Internet (Gunkel, 2003; van Dijk, 2006). Now, access and ownership are less stratified; however scholars warn that the greatest stratification continues among the most disadvantaged, such as urban youth (Cotten, Hale, Moroney, O'Neal, & Borch, 2011; Robinson, 2009, 2011). Because some disparities in computer ownership and Internet access persist in the United States (Lenhart, Purcell, Smith, & Zickuhn, 2010; Rideout, Foehr, & Roberts, 2010), a complex analysis of specific uses of technology must also consider the first level digital divide issues. These issues include personal or shared computer ownership, time using the computer or Internet, and age when one begins using computer technology.

Second level digital divide scholarship focuses on the specific ways computers and the Internet are used (Attewell, 2001), as well as forms of access (Davison & Cotten, 2010), computer skills (Hargittai, 2002, 2010), and web-based content creation (Blank, 2013; Schradie, 2011). We consider four specific uses of computers and the Internet that are most prevalent among youth: communication, social networking, content creation, and multimedia entertainment (Lenhart, Madden, Smith, & Macgill, 2007; Lenhart et al., 2010; Rideout et al., 2010). We conceptualize communication as encompassing a range of older and newer forms of Internet communication such as sending email, instant messaging, blogging, going to chat rooms, and social networking communication. While overlapping with social networking in many regards, we distinguish communication use as a conceptually different phenomenon. Our concept of communication focuses on *direct* communication, such as when one submits information with specific receivers in mind. In contrast, we define social networking as using social networking sites – for instance Facebook, MySpace, or Bebo – to make connections and share information among friends, which may or may not involve direct communication. For example, we categorize emailing and instant messaging as direct communication in contrast to observing and sharing profile posts and media. While we expect these to be confounded in actual interaction, we developed our measures to capture our conceptual distinction.

Content creation, or web 2.0 activities, involve participation, production, and often collaboration in creating new media content (Blank, 2013; Hargittai & Walejko, 2008; Schradie, 2011). They include activities such as blogging, remixing material, and creating webpages. Some adolescents devote large amounts of time to these creative activities, facilitated by information and communication technology (Ito, 2010). Unsurprisingly, youth of all ages – both on and off the computer – value multimedia entertainment and often engage with technology for accessing videos, music, and games (Rideout et al., 2010).

To our knowledge, no one has considered a complex analysis of second level digital inequalities with regard to STEM empowerment outcomes. Furthermore, while many hail the importance of STEM-related empowerment, few studies of efficacy have considered multiple cross-cutting STEM domains. As such, we make no grounded predictions. Strictly domain-specific hypothesizing would simply predict that technological efficacy relates to technology encounters and has no relation to the other forms of empowerment. A more integrative theory could propose that all four types of efficacy would be related in similar ways to different digital histories, branching out from technological efficacy to more general empowerment. That perspective would suggest that technology empowers youth across areas of their lives including STEM and other fields of education.

3. Methods

Leaders of the city of Birmingham, Alabama, USA distributed specialty laptops to first through fifth graders in the city school district in order to improve students' education (see Zucker & Light, 2009 for an overview of student laptop programs). These specialty laptops, called XO laptops, were designed by the One Laptop Per Child (OLPC) organization to be used by children. As such, they included both physical features such as a durable frame, small keys, and software programs called *activities* designed for younger users (Warschauer et al., 2012). Although the intention of the XO laptop design was for dissemination to children in underdeveloped nations, several distributions have occurred in the United States, of which the one to Birmingham schools was the largest (Warschauer et al., 2012). Studies have compared this XO distribution with other XO distributions (Warschauer et al., 2012) and shown the key factors that influence XO use, activities, and attitudes (Cotten, Hale, et al., 2011).

Because Birmingham city schools contain a high percentage of low-income students, the dissemination of the XO laptops provide a unique opportunity to study disadvantaged youth with allegedly 100 percent laptop ownership.[2] Since disadvantaged youth are less likely to own or have access to computers (Lenhart et al., 2010; Robinson, 2009), the XO laptop dissemination partially controls on the first level digital divide issues of ownership and access. Therefore, we are able to examine second level digital divide issues – multimedia, content creation, communication, and social networking – and their relationship to empowerment within the context of essentially complete laptop ownership. We still control for non-XO computer ownership as well as both XO and non-XO time use as separate factors, but address digital inequalities and empowerment without focusing on specific technology platforms (XO or non-XO computer). This is also appropriate in light of the trend of increased mobile Internet access.

[2] While the goal of the XO dissemination project was 100 percent ownership, we acknowledge at any given time some students' XO laptops were broken, lost, or stolen.

3.1. Sample

The Birmingham Youth and Technology Study (BYTS) included two surveys of fourth and fifth graders in Birmingham City Schools in 2008–2009. Our sample, in which approximately 84 percent of the students are African American and approximately 82 percent of students qualify for free or reduced price lunch, has similar characteristics to the school district. The first survey occurred just prior to the XO laptop dissemination and the second survey occurred approximately 4.5 months later. Because we are interested in the XO laptops as a situational control for ownership and access, we opt to use only the second survey. Further, the time between surveys was insufficient for detecting meaningful longitudinal changes in non-XO computer use, ownership, or self-efficacy. The cross-sectional nature of the data means that we cannot establish causal direction with these analyses, and in the discussion we return to this issue. All variables come from this second survey except for stable demographic data which were collected only in the first survey.

Of the 39 elementary schools in the district in 2008–2009, 25 participated in the BYTS study. Students whose parents returned signed consent forms were allowed to participate in the survey, and of the students who were allowed to, over 95 percent took the surveys. Research assistants read them aloud to the students in the classroom or at another school location and guided the process by assisting with questions or difficulties. Students received small incentives for participating. The number of students enrolled at the participating schools was 2915 with 1583 (52 percent) of them participating in the first survey and with 1261 (43 percent) participating in the second survey. Students were required to have taken the first survey to be eligible to take the second.

3.2. Dependent variables

The dataset included three measures of self-efficacy developed from research on empowerment and motivation among youth (North Castle Partners Advertising Inc., n.d.; Ross, 2007). This in-depth qualitative research uncovered five dimensions of empowerment: altruism, freedom, belonging, accomplishment, and expression that Ross (2007) suggested are particularly applicable for empowering youth in STEM fields. Whereas one use of these dimensions involves motivating adolescents into technology areas by incorporating the five dimensions into advertising (North Castle Partners Advertising Inc., n.d.), we attempted to appropriately quantify these research results into measures of self-efficacy for STEM domains. Our reason for using these measures instead of previously developed self-efficacy measures is that it allowed us to develop parallel measures for general, technological, and mathematics/science self-efficacy.

Of the five dimensions of empowerment, the belonging dimension partially depends on an individual's social situation and therefore could confound the measures of self-efficacy with social status or social skills. Therefore, we created four items corresponding to the remaining four dimensions of empowerment for three of the four domains of self-efficacy (general, technology, mathematics/science). Students answered each item with disagree (coded 1), not sure (coded 2), and agree (coded 3), which simplifies self-efficacy confidence scales suggested by Bandura (2006). We created scales ranging from 4 to 12 by summing the items and dropped all cases with missing items from the sample (61 cases).

We measured general self-efficacy with the following items. (1) Altruism: "I am able to get to know and help other people; " (2) Freedom: "I will have chances to do a lot of different things in my future; " (3) Accomplishment: "I do important things in my life; " and (4) Expression: "I am able to express my creativity and curiosity" ($\alpha = .723$; confirmatory factor analysis: 1 principle factor with an eigenvalue of 1.48). We measured technological self-efficacy using the following items. (1) Altruism: "Technology and computers make it easier for me to get to know and help other people; " (2) Freedom: "Knowing how to use technology and computers increases the chances I will have to do lots of different things; " (3) Accomplishment: "I often accomplish important things using technology and computers; " and (4) Expression: "Technology helps me to be creative and express myself" ($\alpha = .701$; confirmatory factor analysis: 1 principle factor with an eigenvalue of 1.37). For mathematics/science self-efficacy, we used the following items. (1) Altruism: "I can use Math and Science to help others and make the world a better place; " (2) Freedom: "Having good Math and Science skills increases the chances I will have to do a lot of different things; " (3) Accomplishment: "Math and Science help me do important things; " and (4) Expression: "Math and Science help me to be creative and express myself" ($\alpha = .752$; confirmatory factor analysis: 1 principle factor with an eigenvalue of 1.62).

Unfortunately the dataset did not include a measure of academic self-efficacy with similar empowerment scales as the other three domains. For academic self-efficacy we drew items from Gresham and colleagues' Student Self-Concept Scale (Gresham, Elliot, & Evans-Fernandez, 1993). We only included those that measured academic self-efficacy and, due to the younger age of our respondents, reduced the number of options from a seven- to a three-item Likert scale. The directions for these items read "We want to know how often you can do the following things" and the response options were *almost never* (coded 1), *sometimes* (coded 2), and *almost always* (coded 3). In contrast to the other three efficacy scales this one focuses more on behaviors within the school setting. The six items include (1) "Concentrate on school subjects," (2) "Do a good job on all my classwork if I have enough time," (3) "Learn the class material, even if it is hard," (4) "Figure out how to do the hardest classwork," (5) "Remember things from class and books," and (6) "Motivate myself to do schoolwork." We summed the items, creating a scale from 6 to 18 ($\alpha = .808$; confirmatory factor analysis: 1 principle factor with an eigenvalue of 2.40).

3.3. Independent and control variables

We created communication frequency and multimedia frequency scales using items adapted from the UMBC Survey of Middle School Students. The questions assessed how often students did specific activities when using a computer: "Never," "Less than once a week," "At least once a week," "Several times a week," and "Every day", coded from 0 to 4, respectively. The items used for communication frequency included *emailing, instant messaging, using chat rooms, reading/creating blogs*, and *visiting social networking sites*[3] (summed for a scale range of 0–20; $\alpha = .828$; confirmatory factor analysis: 1 principle factor with an eigenvalue of 2.44). The items used for multimedia frequency

[3] Because the *visiting social networking sites* item substantively overlaps with social networking activities scale, we also constructed the communication frequency scale without this item. The results of this alternative scale do not change any substantive conclusion. Because our final analyses consider each individual item from all of the scales, we do not present the results of the alternative scale construction. Due to measurement of the *visiting social networking sites* item on a range of 0–4, we do not include it in the social networking activities scale which uses dichotomous items.

included *playing games online, watching videos online, listing to music online,* and *creating and uploading videos* (summed for a scale of 0–16; $\alpha = .812$; confirmatory factor analysis: 1 principle factor with an eigenvalue of 2.12).

For content creation and social networking, we focused on the number of online activities by drawing items from the Pew Internet and American Life Project's "Teens and Social Media 2007" (Lenhart et al., 2007). For content creation we asked if students ever *create blogs, create their own webpages, create others' webpages, share their own creative products online*, and *remix online material*. We summed the responses (range of 0–5; $\alpha = .714$; confirmatory factor analysis: 1 principle factor with an eigenvalue of 1.56). Likewise, for social networking we asked if students ever use social networking sites to make new friends, stay in touch with often-seen friends, stay in touch with rarely seen friends, make plans with friends, and *observe their friends lives* (total of 0–5; $\alpha = .807$; confirmatory factor analysis: 1 principle factor with an eigenvalue of 2.19). We excluded cases with any missing items on these four independent variable scales (143 cases).

Finally, we included a number of controls in the analyses. We asked students their race, grade in school, and gender in the first survey. Because the majority of our sample reported their race as black, we code race as black or nonblack. All students were in fourth or fifth grade, which highly correlates with and serves as proxy for students' age. In the first survey, we also measured the age they first used of a computer. We assessed non-XO computer ownership by asking, "Do you have another computer at home besides your XO?" with options for *no computer at home*, *personal computer at home*, and *shared computer at home*. We recoded this data into dummy variables with *owning a personal computer* as the reference category. For computer time use and XO time use, we asked how many hours per day the student used each computer with six options ranging from *not at all* to *more than 8 h a day* (coded from 0 to 5).

3.4. Analytic strategy

After highlighting a few descriptive statistics, we conduct OLS regressions for our primary analysis. First, we regress the forms of self-efficacy on the control variables, then we add first level digital divide characteristics for the second model, and add second level digital divide characteristics for the third model. This allows us to observe changes in the first level characteristics when the more specific second level Internet and computer activities are included as predictors. Finally, we disassemble the second level digital divide scales replacing them with their component items in our fourth model. Comparison of the third and fourth models indicates whether the scale or its items have the greatest influence on forms of self-efficacy. For all OLS regressions we checked for multicollinearity among the variables in each model. The largest VIF (Variance Inflation Factor) in any of the models presented was 2.64, well below the threshold for high multicollinearity (O'Brien, 2007).

4. Results

4.1. Descriptive results

Of the 1261 students that completed the second wave, we retain the 980 (77.7%) cases which did not contain any missing data on the individual variables or scales used in the analyses. The sample (see Table 1 for all descriptive statistics) divides almost equally between fourth and fifth graders and between boys and girls, yet the sample is overwhelmingly black (83.5%). This suggests that it would be difficult to find racial differences within this sample and prevents detailed comparisons between racial groups. Mean general self-efficacy slightly exceeds all domain-specific self-efficacies (10.12; technological 9.27; mathematics/science 9.52; academic 14.93 – scaling academic self-efficacy to a 4–12 scale the mean becomes 9.95). However, all four remain above the midpoint of their scales, suggesting, on average, positive self-efficacy in all domains. We conducted pairwise correlations for each form of efficacy and found midrange correlations ranging from .324 (technological with academic self-efficacy) to .701 (technological with mathematics/science self-efficacy).

Many of these students report owning (26.0%) or sharing (56.0%) a non-XO computer, however we do not know the condition or quality of these computers. Students reported both computer and XO laptop time use with an average closest to the category "3–4 h" a day (coded as 2). Several students listed the age of first using a computer as 0. Due to the difficulty of remembering the first years of life they may have been guessing, relying on information from others, or just realizing they had no recollection of *not* using a computer. The data does not allow us to determine their reason. Given the number of computers and computer-like systems for young children, the young ages may be accurate. Only 3 (.31%) students selected 0 years, and only 10 (1.02%) selected 1–2 years. We retain these students in our sample, and supplemental analyses indicate that removing them would not change our conclusions.

4.2. Main analysis

First, we regress the forms of self-efficacy on the control and independent variables (Table 2). For each efficacy domain in Model 1, we consider only the demographic control variables. The only significant effects indicate that boys in this sample have lower general and academic self-efficacy than girls and this finding remains in subsequent models.

In Model 2 we include the first level digital divide predictors. Those who began using computers earlier in life report greater general and academic efficacy, possibly due to an effect of increased resources early in life. Surprisingly, mathematics/science efficacy is greater for those that share a computer compared to those that own their own computer; however, none of the other domains of efficacy are affected. Daily computer use relates to higher academic self-efficacy whereas XO computer use relates to higher general, technology, and mathematics/science efficacy, and does not relate to academic efficacy. We are not surprised at this finding excluding academic self-efficacy given that the XO was neither well-implemented in the classroom nor were teachers properly trained to use it (Warschauer et al., 2012). Those students that often use the XO laptop could have learned the details of it on their own or with friends or family. Either the most empowered took on this challenge, or those who engaged most with the XO enhanced their self-efficacy. In Model 3, the daily computer or XO use's effect on efficacy drops out of significance, supporting the assertion that second level digital divide variables apply across both XO and non-XO platforms. It also indicates that what one does on a computer has a stronger relationship to efficacy than simply the frequency of computer use in this sample.

Table 1
Descriptive statistics.

	Mean	Standard deviation	Minimum	Maximum
Self-efficacy				
General	10.12	1.97	4	12
Technological	9.27	2.10	4	12
Mathematics and science	9.52	2.14	4	12
Academic	14.93	2.56	6	18
Demographics				
Black	.835	.37	0	1
Fifth grade	.519	.50	0	1
Male	.466	.50	0	1
First level digital divide				
Does not own a computer	.178	.38	0	1
Shares a computer	.560	.50	0	1
Owns personal computer	.260	.44	0	1
Age of first using a computer (years)	6.57	1.85	0	11
Computer use per day	2.30	1.82	0	5
XO use per day	1.72	1.51	0	5
Second level digital divide				
Frequency of communication	8.18	6.08	0	20
Emailing	1.56	1.57	0	4
Instant messaging	1.36	1.52	0	4
Using chat rooms	1.88	1.60	0	4
Reading/creating blogs	1.27	1.50	0	4
Social networking	2.11	1.71	0	4
Frequency of multimedia entertainment	10.14	4.73	0	16
Playing games	2.90	1.33	0	4
Watching videos	2.66	1.48	0	4
Listing to music	2.72	1.44	0	4
Creating videos	1.86	1.69	0	4
Number of content creation activities	2.39	1.68	0	5
Create journal/blog	.446	.50	0	1
Create own webpage	.509	.50	0	1
Create other's webpage	.411	.49	0	1
Share own creative work	.555	.50	0	1
Remix online material	.468	.50	0	1
Number of social networking activities	2.38	1.86	0	5
With new friends	.485	.50	0	1
With friends you see a lot	.573	.49	0	1
With friends you rarely see	.495	.50	0	1
Make plans with friends	.461	.50	0	1
Observe friends' lives	.363	.48	0	1

$N = 980$.

Model 3 includes the second level digital divide indicators of specific Internet activities. We find the most robust result for the frequency of communication which has a positively association with all four types of self-efficacy. The frequency of multimedia entertainment positively relates to general self-efficacy and positively relates to technology and mathematics/science self-efficacy at a marginally significant level. Finally, social networking activities negatively relate to both general and academic self-efficacy.

4.3. Second level digital divide components analysis

Now that we have established that relationships exist between second level digital divide scales and self-efficacy, our interest turns to understanding if specific computer and Internet activities drive that relationship. We take the four second level digital divide scales in the full model and break them down into their components. Simultaneously modeling all components provides a more conservative test compared to modeling each set of components separately. Supplemental analyses (not shown) indicate that all the statistically significant results remain when considering each set of components separately. Table 3 displays the new component models (Model 4) and repeats the full models from the previous analysis (Model 3) for ease of comparison.

In Model 4 we regress the form of efficacy on the computer and Internet activities. Frequency of emailing, like the scale for frequency of communication, positively relates to all four domains of self-efficacy. It remains the only communication activity with a positive relationship to any domain of self-efficacy at a statistically significant level. Frequency of social networking has a negative association with general self-efficacy, mirroring the earlier finding of the scale for social networking activities. The scale for multimedia frequency positively relates to general efficacy and – at a marginal level of significance – to both technological and mathematics/science efficacy (Model 3). The component models (Model 4) indicate that the frequency of playing games positively relates to general, mathematics/science, and academic efficacy, and – at a marginally significant level – technological efficacy. Recall that the number of social networking activities negatively relates to both general and academic self-efficacy (Model 3), but the component model revealed only one significant effect: social networking with new friends negatively relates to academic efficacy. Finally, the content creation components, like the scale, have no relationship with self-efficacy.

Table 2
Regression of forms of efficacy on demographic controls, first and second level digital divide variables.

	Self-efficacy											
	General			Technological			Mathematics/science			Academic		
	Model 1	Model 2	Model 3	Model 1	Model 2	Model 3	Model 1	Model 2	Model 3	Model 1	Model 2	Model 3
Demographics												
Black	.89	1.05	.86	−.07	.08	−.19	.38	.49	.27	−1.15	−.60	−.72
Fifth grade[a]	1.48	1.83†	2.05*	.03	.51	.51	−.89	−.51	−.50	1.22	1.30	1.59
Male	−2.48*	−2.19*	−2.10*	−.26	−.12	.15	.14	.39	.55	−3.42***	−3.03**	−2.71**
First level digital divide												
Does not own computer[b]		−.03	−.02		1.04	1.05		2.37*	2.39*		−.03	.00
Shares computer[b]		1.95†	1.98*		1.63	1.89†		3.45***	3.63***		.70	.80
Age of first using computers		−1.98*	−1.68†		−1.28	−1.01		−1.20	−.94		−2.36*	−2.10*
Computer use per day		1.27	.09		1.27	−.69		1.63	.06		1.99*	.35
XO use per day		2.07*	1.28		2.86**	1.56		2.05*	1.05		.86	−.32
Second level digital divide												
Frequency of communication			2.09*			2.69**			1.99*			4.73***
Frequency of multimedia entertainment			2.67**			1.80†			1.86†			1.21
Number of content creation activities			−.26			1.42			.73			−.31
Number of social networking activities			−2.71**			−1.24			−1.13			−3.59***

$N = 980$. †≤.1, *≤.05, **≤.01, ***≤.001.
Note: for ease of comparison, t values, not coefficients, are presented in the table.
[a] Reference category is fourth grade.
[b] Reference category is owns personal computer, specified as a non-XO computer.

5. Discussion

5.1. Major findings

Our analyses lead us to advance four primary take-home points from our findings. First, we found that all domains of efficacy were related to using some type of computer with either daily non-XO computer time use or daily XO time use positively relating to at least one domain of efficacy. Other findings also dovetail with this relationship between using technology and efficacy, such as students who began using computers at a younger age reporting greater general and academic efficacy. Together these finding suggest that when youth engage with technology at higher rates they feel more empowered in multiple domains (Amichai-Hamburger et al., 2008). Alternatively, youth with greater self-efficacy might engage with computers more than their less efficacious counterparts.

Secondly, we found unexpected difference in mathematics/science efficacy based on non-XO computer ownership. Compared to owning one's own computer, both not owning a computer and sharing a computer were positively related to self-efficacy in the domain of science and mathematics. We speculate that not owning a computer may have driven students to collaborate more and potentially use their XO laptops more often. A meta-analysis of small group learning and collaboration finds that science and mathematics are better learned in small groups (Springer, Stanne, & Donovan, 1999) suggesting one possible explanation for why sharing computers increased self-efficacy in this domain.

A third finding highlights that specific measures of Internet and computer activity account for the general daily use measures in predicting self-efficacy. While this may not be surprising, it is not empirically inevitable. We find, however, that when specific activities are included in the models, there is no longer a relationship between total use per day and any of the domains of self-efficacy. This supports research by Cotten, Goldner, Hale, and Drentea (2011) who have noted that the *types* of computer/Internet use need be examined in addition to the *amount* of computer/Internet use. Other research has found that computer use relates to self-efficacy in the computer domain (Paraskeva et al., 2008) and likewise Internet use relates to Internet self-efficacy (Joo et al., 2000). However, our research finds that the specific activities are better predictors of self-efficacy than general measures of computer or Internet use.

That leads to our fourth major finding, that several of the scales were equally or less influential as one of their components. While the frequency of communication was positively related to all four types of efficacy, the frequency of emailing – a component of the communication scale – accounted for the scale's influence. Emailing was both a consistent and primary communication factor related to self-efficacy in our sample. In a similar vein, the frequency of playing games on a computer was affiliated with greater general, mathematics/science, and academic efficacy. This accounted for the effects of the multimedia scale on self-efficacy plus the frequency of playing games was associated with additional domains. These indicate that the frequency of emailing and gaming were the paramount factors in predicting self-efficacy, not communication and multimedia more generally. We tentatively conclude the mechanism of empowerment is not the general use of technology, but rather the urban youth in our sample were empowered through these specific computer activities.

5.2. Limitations and future research

Our study's limitations prompt avenues for future research. First, although our research did not focus on comparing levels of socioeconomic status, race, or urban/rural status with self-efficacy, those have been found to be important factors related to efficacy (e.g., Boardman & Robert, 2000; Debies-Carl & Huggins, 2009; Hughes & Demo, 1989). So while we assert that engagement with certain technology alters youth's efficacy, our sample of principally lower socioeconomic status, black, urban youth limits our generalizability. Second, we selected four specific domains of self-efficacy. While most studies only consider one or perhaps two domains our consideration of four is

Table 3
Regression of forms of efficacy on control and independent variables with second digital divide scales broken into component items.

	Self-efficacy							
	General		Technological		Mathematics/science		Academic	
	Model 3	Model 4	Model 3	Model 4	Model 3	Model 4	Model 3	Model 4
Demographics								
Black	.86	.85	−.19	.11	.27	.49	−.72	−.41
Fifth grade[a]	2.05*	1.68†	.51	.28	−.50	−.69	1.59	1.23
Male	−2.10*	−1.52	.15	.34	.55	.91	−2.71**	−2.04*
First level digital divide								
Does not own computer[b]	−.02	.29	1.05	1.29	2.39*	2.61**	.00	.13
Shares computer[b]	1.98*	1.84†	1.89†	1.72†	3.63***	3.47***	.80	.72
Age of first using computers	−1.68†	−1.41	−1.01	−.88	−.94	−.96	−2.10*	−1.88†
Computer use per day	.09	.16	−.69	−.68	.06	.15	.35	.41
XO use per day	1.28	1.14	1.56	1.60	1.05	1.09	−.32	.31
Second level digital divide								
Frequency of communication	2.09*		2.69**		1.99*		4.73***	
Emailing		3.24***		2.48*		2.39*		4.37***
Instant messaging		.60		.12		.05		.44
Using chat rooms		−.88		−.79		.05		.53
Reading/creating blogs		.76		1.84†		−.07		.58
Social networking		−1.98*		−.29		.14		−.04
Frequency of multimedia	2.67**		1.80†		1.86†		1.21	
Playing games		4.42***		1.89†		2.02*		3.46***
Watching videos		−.28		1.28		.70		−.43
Listing to music		1.03		−.20		.17		−.69
Creating videos		−1.89†		−.87		−.92		.27
Content creation activities	−.26		1.42		.73		−.31	
Create journal/blog		−.75		−.04		.54		.52
Create own webpage		−.97		−.96		−1.93†		−.35
Create other's webpage		1.72†		1.79†		1.43		1.56
Share own creative work		1.28		1.28		1.93†		.99
Remix online material		.37		1.21		.63		−1.56
Social networking activities	−2.71**		−1.24		−1.13		−3.59***	
With new friends		−1.73†		−1.14		−.98		−2.15*
With friends you see a lot		.86		.24		−.08		−1.21
With friends you rarely see		−.64		−1.29		−.91		.36
Make plans with friends		−.04		.34		.07		−1.93†
Observe friends' lives		−.98		.83		.73		.65

$N = 980$. †≤.1, *≤.05, **≤.01, ***≤.001.
Note: for ease of comparison, *t* values, not coefficients, are presented in the table.
[a] Reference category is fourth grade.
[b] Reference category is owns personal computer, specified as a non-XO computer.

by no means exhaustive, even in the area of STEM education. In fact, our findings illuminate how choosing domains can alter the results obtained (Miles & Maurer, 2012). While several factors such as communication and more specifically email communication led to empowerment in all domains, other factors only related to specific domains of self-efficacy. Future research should carefully consider sub-domains in close proximity (e.g., academic and mathematics/science) to reveal important insights into how empowerment functions similarly or differently among them. A related limitation stems from our academic self-efficacy scale's adaptation from different research than our other three scales. While we believe that all the scales adequately encapsulate domain-based self-efficacy, the academic self-efficacy scale clearly preferences behavioral measures compared to the other scales.

Finally, we cannot tease apart causality from cross-sectional data. We echo Gecas in his review of self-efficacy research when he cautions that "the direction of causality is not always clear and is probably reciprocal in most situations" (1989: p. 311). Frequency of communication or multimedia entertainment could lead to empowerment, or greater empowerment could enable youth to engage more with these technologies. While we presented our arguments and discussion as if technology was the influencing factor, we carefully presented the results in the language of association and relationship instead of causality. We encourage future researchers to fully examine the direction of causality with appropriate longitudinal data.

5.3. Policy implications

Our conclusions from this research also suggest how education interventions, youth development programs, and technological changes in elementary schools might empower students through technology use. First, of all domains of self-efficacy, technology influenced technological self-efficacy the least. Technology use most often related to general and academic self-efficacy, suggesting how technology serves as a medium to be utilized by educators. While Bandura points out that domains of self-efficacy lead to behavior in that domain (1997), here we find evidence that engagement with technology affects *many* domains of empowerment, not just the most proximate.

Specifically email use and game playing in this sample were extremely important in all domains of self-efficacy. Emailing – as opposed to instant messaging, chatting, reading blogs, and going to social networking sites – may represent a more engaged and controlled orientation toward life. It could also indicate a larger network of social capital as students communicate beyond just friends to family, teachers, mentors, and organizations. The other forms of communication tend toward enabling social life or entertainment, whereas email and related types of communications may be most optimal for schools to promote. Much research exists on the effects of playing games, but two particularly relevant studies are those that suggest playing games has no effect on self-efficacy in the domain of computers (Hasan, 2003) and those that suggest video games can be utilized to positively affect STEM education through increasing self-efficacy (Mayo, 2009). Online game playing can be an efficacious activity both motivating youth to engage in video games and increasing their mastery of such games (Klimmt & Hartmann, 2006). We suggest that as youth learn to master these games they are empowered to problem solve and persevere in other areas of their life, leading to the observed higher levels of general and academic self-efficacy.

Based on these findings, we suggest policy focuses on individual activities, not the technology as a whole. Technologies such as email and gaming may improve self-efficacy in some domains, but certainly not all uses of technology have this same effect. For any program or policy it would be important to identify concrete goals: schools improving academic self-efficacy or a community program to enhance technological self-efficacy. One implication of our research is that not all empowerment is the same, and therefore a cookie-cutter empowerment program would be ill-advised. Instead we recommend identifying specific technologies important to specific empowerment goals. For example, email in our sample increased all type of efficacy, so access to email, along with training in the process and etiquette of email, could be beneficial for urban youth. Playing games may also empower youth in important ways, such as their development and education (Mayo, 2009), but should be considered carefully as violent games can enhance aggressive and antisocial behavior (Anderson et al., 2010).

6. Conclusion

While Bandura and others link domain-specific efficacy to mastery and performance in that domain, our data indicate a more complex reality. Domain-specific empowerment related to digital inequalities and engagement with technology in multiple ways. While some technology use such as email communication had similar effects across domains, others such as social networking were only related to general and academic efficacy. Therefore, we hope that researchers will consider multiple domains of efficacy in future research, especially in STEM subjects.

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