

One-to-one laptops in K-12 classrooms: voices of students

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In planning educational technology initiatives, the concerns of many stakeholders are typically taken into account, including the concerns of administrators, teachers, parents, and employers. The perspective of students are recognized as valuable, but not often queried or considered. This paper explores the opinions of K-12 students about a one-to-one laptop programme implementation through content analysis of 362 blog postings made by these students expressing their thoughts on the topic at three time points in two years. Employing a bottom-up coding strategy, this paper identified seven themes that represented students' opinion of technology use in schools: more efficient and productive learning, tools for better writing, access to information, engagement with new media, remaining relevant in a technological world, share and learn from peers, and individualized and differentiated instruction. This study suggested that, when new technology tools are used in schools, students should not only be viewed as learners but also be considered as real writers with valuable opinions. Students also should be provided the opportunity to write for an authentic purpose and audience using diverse forms of digital media.

Keywords: digital media; student voices; technology literacy

Introduction

While the role of digital technology in schools has been an important policy question for more than a quarter century (Culp, Honey, & Mandinach, 2003), the US appears to be at a tipping point for this matter as issues of online education, digital reading and writing, and one-to-one digital device programmes come to the fore. In recent years, for example, Idaho has launched a programme to provide every high school student and teacher with a laptop (Idaho State Department of Education, 2012), school districts in Florida will be required to spend half of their annual instructional materials budget to purchase digital content by 2015–2016 (Florida Department of Education, 2012, p. 12), and the US Department of Education and Federal Communications Commission have unveiled a plan to switch schools to digital textbooks by 2017 (Federal Communications Commission, 2012). There is also a push for changes in testing, with the National Assessment of Educational Progress conducting all writing tests on computers in its most recent study (National Center for Education Statistics, 2012) and two large consortiums associated with the Common Core State Standards also implementing computer-based tests.

Though a national consensus is developing towards increased use of technology in learning, there is no such consensus on *how* technology should be used. Given the potential for technology to exacerbate differences in access and literacy practices (e.g.,

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Neuman & Celano, 2006), schools must consider carefully how best to integrate technologies into the classroom. Competing visions of technology use have emerged in research and practice, with some emphasizing the potential merit of individualized tutorial learning (e.g., Dynarski et al., 2007), and others calling for more social constructivist approaches involving networked groups of student peers working to construct knowledge together (e.g., Cummins, Brown, & Sayers, 2007). Evaluating the designs and implementations of technology programmes in schools is imperative to understanding whether, to what extent, and in what contexts these new technologies may or may not afford students with more effective and equitable learning environments. As districts create and implement policies to deploy technology in schools, policymakers typically take into account the concerns of community stakeholders such as administrators, teachers, parents, and employers; the perspectives of students, however, are less often queried or considered. Through content analysis of 362 student blog postings, this paper explores the opinions of K-12 students about technology in the classroom. We first discuss prior research on the development of one-to-one computing and students' attitudes towards and perceptions of technology use, and then introduce the methods and findings of the study. We then discuss how these findings may inform policy, programme evaluation, and future research.

Prior research

In recent years, the presence of technology in schools has expanded dramatically. With this increase in technology deployment, additional problems have emerged. Issues such as cost of maintenance, student misbehaviour, and lack of teacher support (Silvernail & Lane, 2004), as well as problems of student digital literacy and curriculum development (Attewell & Winston, 2003; Warschauer & Matuchniak, 2010) are among the many obstacles in implementing technology in schools. This paper draws from prior research in: (a) One-to-one computing; (b) Perception of technology use from different stakeholders; and (c) Students' and teachers' perceptions about one-to-one computing.

One-to-one computing

Over the last two decades, the number of computers used in public K-12 schools for teaching and learning has rapidly increased. According to the National Center for Education Statistics (2010), the average public school contained 189 instructional computers in 2008 compared to 110 instructional computers in 2000, and the student-to-computer ratio fell from 7 students per computer with internet access in 2000 to 3 students per computer with internet access in 2008. Instead of installing more and more desktop computers in stationary labs, a growing number of US schools have adopted one-to-one laptop programmes, in which all students in the class, grade level, school, or district are provided with individual laptop computers for use throughout the school day, and in many cases, to use at home (Johnstone, 2003; Warschauer, 2006).

One-to-one laptop programmes have existed in the United States since Microsoft's *Anytime Anywhere Learning* and Toshiba's Notebooks for Schools programme in the mid-1990s (see Johnstone, 2003). By the year 2000, 800 schools and 125,000 students and teachers were participating in this laptop programme (Gulek & Demirtas, 2005). Although that particular programme ended within a few years, other similar programmes have grown steadily over the years. The Maine Learning Technology Initiative (MLTI) launched a one-to-one initiative in Fall 2002, which made Maine the first state to use technology to transform teaching and learning in classrooms statewide. MLTI provided all

seventh- and eighth-grade students and teachers with laptops, technical support, and professional development to integrate the technology into curriculum and instruction (Silvermail & Lane, 2004). With Maine at the forefront, other states have implemented similar one-to-one laptop programmes, such as Michigan's Freedom to Learn (FTL) programme, Texas' Technology Immersion Pilot (TIP), and Pennsylvania's Classroom for the Future (CFF) programme.

Despite growing interest in one-to-one laptop programmes among policymakers, administrators, teachers, parents, and students, such programmes nevertheless involve considerable cost. For this reason, many policymakers and administrators await evidence of the benefits of these programmes for teaching and learning before investing in them (Bebell & O'Dwyer, 2010; Lei & Zhao, 2008).

Many studies on one-to-one laptop programmes and student learning emphasized the benefits of laptop programmes for engaging students in writing and improving students' writing skills (e.g., Gulek & Demirtas, 2005; Lowther, Inan, Ross, & Strahl, 2012; Warschauer, Arada, & Zheng, 2010). It is suggested that writing and editing is the principle use of laptops in one-to-one classrooms (e.g., Warschauer et al., 2010; Zheng, Warschauer, & Farkas, 2013) and that laptops provide an environment conducive for student-centred, project-based learning (Cavanaugh, Dawson, & Ritzhaupt, 2011; Drayton, Falk, Stroud, Hobbs, & Hammerman, 2010). In addition, students in one-to-one programmes tend to spend more time writing, to write more, and to receive more feedback from peers and teachers (e.g., Russell, Bebell, & Higgins, 2004). For these reasons, teachers and students participating in laptop programmes tend to report overall positive attitudes towards using laptops in their writing classrooms (e.g., Ross, Lowther, Relyea, Wang, & Morrison, 2003; Warschauer et al., 2010).

Perception of technology use from different stakeholders

Approaches to integrating technology into classrooms vary widely across many stakeholders, including administrators (e.g., Technology Information Center for Administrative Leadership), teachers (e.g., Gray, Thomas, & Lewis, 2010), business representatives (e.g., Partnership for 21st Century Skills, 2004), and parents (e.g., Project Tomorrow, 2011). A few prior studies have also examined the perspective of students on this issue. For example, the 2010 SPEAK UP survey (Project Tomorrow, 2011) polled a sample of high school principals, teachers, parents, and students from 6541 schools and posted the question: "Is your school doing a good job using technology to enhance learning and/or student achievement?" While the majority (74% of high school teachers, 72% of high school principals, and 62% of parents of high school aged children) of adults surveyed answered "yes" to the question, only 47% of high school students agreed. A similarly negative response was received from middle school students. This disparity in attitudes towards school technology implementation suggests that there may be a gap between student and educator expectations regarding the use of technology in schools. In addition, while most students placed a high value on the ability to produce digital media such as blogs, videos, podcasts, and digital stories, only 29% of teachers shared the same view. Another national study examined the ways students use technology. In May 2011, CDW-G (CDW Government, 2011) surveyed 1000 high school students, high school faculty, and district IT professionals to understand teachers' and students' opinions of technology use in school and at home. One finding from this study was that there appeared to be a disconnect between the behaviours of students and the behaviours expected by their teachers: while only 46% of teachers surveyed said that they regularly

assign homework requiring the use of technology, 94% of students said they use technology to study or work on class assignments at home. Survey responses also suggested that students have higher technology expectations than what schools provided. While 94% of students agreed that technology skills will improve their educational and career opportunities, a mere 39% of students said that their high school was meeting their technology expectations. Given that 74% of teachers and 70% of IT professionals said that they understood how students want to use technology in learning while only 49% of students agreed with the way technology was being used, CDW-G proposed that teachers and IT professionals may be overconfident about their understanding of student needs. These findings and those of Project Tomorrow highlight the discrepancy between the perceptions and expectations of students and educators; however the extent to which this discrepancy affects student learning – and the extent to which it exists in technology-based classrooms such as one-to-one laptop programmes – is not fully understood.

In addition, students are not the only voices that must be heard when deploying and evaluating classroom technologies. Students' opinions are influenced by the way technology is used in their district, school, and classroom; however, students' perspectives should be represented when discussing how to implement, improve, and assess these programmes. Empirical studies of classroom technology use tend to find that students have positive reactions to similar initiatives. Students' generally positive assessments of such programmes point to the potential benefits of a more constructivist approach to integrating technology into the classroom. Proponents of a constructivist approach, as opposed to a more traditional teacher-centric approach, suggest that classroom technologies enabling students to simultaneously develop diverse academic, technical, and interpersonal skills as they engage with course content will have more positive outcomes and will be more enjoyable for students (e.g., Wenglinsky, 2005). In contrast, when computers are used primarily for drill exercises, the time taken away from traditional instruction and spent on computers may be detrimental to student learning (Llosa & Slayton, 2009). In another study, no benefits were found when students used a variety of tutorial software for reading and math (Dynarski et al., 2007). Dynarski and colleagues additionally found that while students worked more independently in classrooms using tutorial software, this work was predominantly individual rather than collaborative. In their comments, students in the current study praise activities where the goal is to explore and construct knowledge, such as independent and collaborative inquiry, peer sharing, and using computer-based tools to support these activities.

In addition, perceptions of laptops may vary depending whether they are used across curricula or emphasized more in certain subjects. Achievement outcomes vary depending on the amount and types of use. In one study, for example, the majority of students were positive towards laptops; however, the laptops were used much less in math classrooms and thus could not be credited with any math gains (Grimes & Warschauer, 2008).

Students' and teachers' perceptions about one-to-one computing

Research on student and teacher perceptions about one-to-one computing revealed positive attitudes overall. A number of studies suggested that students had very positive attitudes regarding the effects of one-to-one computing on their learning, based on data from surveys, interviews, and observations (e.g., Lowther, Ross, & Morrison, 2003; Rosen & Beck-Hill, 2012; Suhr, Hernandez, Warschauer, & Grimes, 2010). A large number of students mentioned that they preferred learning with laptops and that their schoolwork became more interesting when they worked with their own laptops (Grimes & Warschauer, 2008; Suhr et al., 2010). In another study, students felt that laptops helped

them with their homework significantly (Lei & Zhao, 2008). A large majority of students (90%) surveyed in Lowther et al.'s (2012) study indicated their willingness to use laptops again in the following year. In a longitudinal study that tracked students' attitudes towards laptop programmes over time, Lei (2010) found that students' attitudes towards laptops gradually improved as they became used to having their own laptops in school.

Teachers, on the other hand, revealed that they had initial concerns about laptop use in classrooms, either due to limited technology skills, or fear of losing control in the classrooms (e.g., McGrail, 2006; Windschitl & Sahl, 2002). After sufficient technical support and professional development were provided, and after growing used to integrating technology into their classroom instruction, teachers tend to be more positive about one-to-one laptop programme for student learning. For example, all 28 teachers surveyed in Lei and Zhao's study (2008) agreed that laptops were important to both themselves and their students, after one year of programme implementation. Similarly, in a laptop programme in three California middle and elementary schools, Grimes and Warschauer (2008) found that about 90% of teachers recommended laptop programmes be implemented continuously at their schools, and about 80% of teachers recommended other schools adopt similar laptop programmes.

The current study examines attitudes towards technology use by youths who have daily access to laptops in a school environment. By examining the attitudes of students who have been provided substantial access to computers in school, this study seeks to illuminate potential themes and ideas put forth by a too often unheard stakeholder in the discussion about how best to use classroom technology. The aim of this study is to address the questions: What are students' perspectives on the role of digital media in learning? What effects, if any, do students see when participating in a one-to-one laptop programme?

Method

Sample

This study took place in Littleton Public Schools, a K-12 district outside of Denver, Colorado. In support of the district's Universal Literacy Framework, which is a curricular initiative intended to guide "research-based, effective practice in reading and writing instruction" (Littleton Public Schools, 2008, p. 1), a one-to-one laptop initiative was implemented among all fifth grade classes, sixth grade reading classes, and ninth grade language arts classes in the 2009–2010 school year. Each student was provided with an Asus Eee netbook for use throughout the school day using the open source Linux operating system and primarily open source software. A key component of the literacy framework was an emphasis on increased student writing. A districtwide curricular approach to writing, based on Lucy Calkins's (1994) Writers' Workshop model, was implemented. Calkins' approach emphasizes authentic writing for real purposes and audiences. In alignment with this model, elementary school students, for example, spent a total of 45–60 minutes a day on writing including three activities: (1) a 10–15 minute whole-class *Mini-Lesson* in which a teacher presented and students discussed models of writing, (2) a 30–35 minute *Writing Time* session in which students drafted and edited their own written work while the teacher conferred with individuals, and (3) a 5–10 minute time to *Share Writing* and receive feedback from others. Netbooks and social media such as blogs and wikis were used extensively in these schools to support these writing activities. For example, during *Share Writing*, students published their work on a

classroom wiki and blog. Their peer students and teachers, students and teachers in the district, and even a broader audience from all other places could comment on their blogs. In addition, students also had Skype discussions with experts around the world, including authors and photojournalists, and then blogged about their discussions. Teachers in this laptop programme participated in a week-long training on hardware and software use and how to integrate the technology into the curriculum. Throughout this programme, students were provided with opportunities to share their opinions about the use of laptops in the classroom.

Sources of data

All students in the school district have access to a districtwide blog, which was owned by the district chief information officer. At three times, open questions were posted on the blog to ask students what they thought about the laptop programme and the use of technology in schools. Students were encouraged but voluntary to post their comments. In March 2009, the fifth grade students were provided with questions such as, “What happens in your classroom now that you have laptops that could not happen before?” and “Now that you have had laptops in your classroom, how would you feel if you didn’t have them next year?” A total of 130 student comments were posted on the blog by May 2009. In January 2010, the question provided for fifth, sixth, and ninth grade was: “Lots of people think that computers are a waste of money, and that students should be learning important skills like writing and reading rather than wasting time on computers. Do you agree that computers in the classroom are a waste of time and money? Why or why not?” Until March 2010, a total of 121 student comments were posted on the blog. The final set of questions was posted in March 2010. Several open questions were provided for fifth, sixth, and ninth grade students such as: “What is it like to have laptops in class?”; “What can you do now that you could not do before?”; “How have you changed as a student since you started using laptops in class?” For these questions, there were a total of 111 student comments by April 2010. In summary, over the duration of the study, a total of 362 student responses were posted in response to these questions regarding computer use in classrooms.

Data analysis

To analyse these 362 blog posts, we performed both qualitative analysis (i.e., content analysis) and quantitative analysis (i.e., descriptive statistics). For the content analysis, rather than using pre-imposed categories, an open-coding system was used to search for potential patterns emerging from the data. The unit of analysis is each response post by students. The research team (including one professor and two graduate students) held meetings to merge and refine categories to best capture the students’ overall sentiments. Two graduate students coded posts according to seven themes, and an inter-rater reliability (measured by kappa value κ) was calculated for each theme. From this analysis and coding system, seven themes around classroom computer use were developed: *more efficient and productive learning* ($\kappa = 0.537$), *tools for better writing* ($\kappa = 0.693$), *access to information* ($\kappa = 0.685$), *engagement with new media* ($\kappa = 0.589$), *remaining relevant in a technological world* ($\kappa = 0.737$), *share and learn from peers* ($\kappa = 0.523$), and *individualized and differentiated instruction* ($\kappa = 0.517$). For the descriptive statistics, we counted the percentage of each theme as (number of all posts that reflected this theme)/total number of posts (equal to 362). Since some posts reflected more than one theme, the sum percentages will be over 100%. We discuss these in the order of frequency that they appeared in student comments.

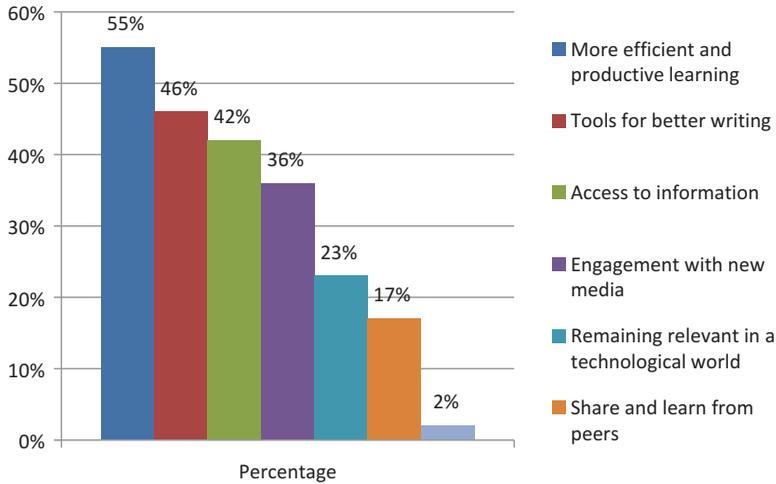


Figure 1. Themes reflected in posts and their percentages for each theme.

Results

All themes that emerged from student posts about the use of laptops and different technologies for learning and the percentages for each theme are shown in Figure 1. In the following sections, we present the results by theme.

More efficient and productive learning

The most frequently mentioned theme in student posts was that learning was more efficient and productive. Among the 362 posts, 200 of them (55%) mentioned that laptops helped to create a learning environment that enabled students to learn more efficiently. Students complained that prior to the one-to-one laptops, many of their daily classroom tasks – such as attendance and work submission – were lengthy processes. With the introduction of laptops, many of these tasks became virtual; students wrote that the transition to virtual tasks created a more productive learning environment. In their posts, multiple students used words and phrases such as “faster” and “more efficient” to describe how laptops had changed their learning experience. The students further explained that the migration of administrative tasks to a virtual space decreased the time spent on these tasks and resulted in more time spent on core learning. Several students suggested that time spent traveling to a computer lab and situating the students at computers was now spent working: fifth grader Landon wrote that “it is a whole lot easier to just go on our [personal] computers instead of the class going into the computer lab.” In general, student comments noted a decrease in time spent on tasks unrelated to their writing and schoolwork and an increase in time spent on researching and improving their work. Students also wrote about another way that laptops may have improved productivity. Whereas a discussion might normally exclude students from participation in group discussion due to lack of time and the need to cover many topics, ninth grader Brooke described classroom discussions where individual laptops enabled the majority of students to participate:

Whenever we do them about half of the class in the “inner circle” and they just talk about the book or subject that we are discussing. Meanwhile, the rest of the class is in the “outer circle” and they all talk about the same subject as the inner circle, but they just do it on a blog instead of talking. This way, the whole class can talk about something and we all wouldn’t have to wait to hear what everyone had to say about one thing before moving onto another because everyone has their own time to say things.

In blog posts such as these, students repeatedly mention how the instantaneity of communication and access to information accelerated class learning. Particularly in discussions, students explained how the ability to rapidly switch between discussion and research improved their learning; this switching enabled students to make immediate connections between their lessons and their research. Students also mentioned how laptops – by providing students a way to engage in online discussion – provided additional opportunities to discuss and more thoroughly explore topics.

Tools for better writing

In addition to productivity and efficiency in learning, students frequently wrote about how they felt laptops shaped their writing. A total of 168 posts (46%) indicated that individual laptops provided students with better tools for writing. Many students wrote that they found the use of laptops preferable to pen and paper when editing their work. Students also noted that writing with laptops not only enhanced the content and appearance of their writing, but also improved their physical ability to write, fostered their creativity, improved the overall approach to their class work, and increased their writing productivity.

The most basic of the possible affordances of writing in one-to-one laptop environment identified by students focused on the physical act of writing. Students explained that writing by hand, especially for long periods of time, was much more strenuous and tiring than typing on a computer. They cited these difficulties as deterrents to their creativity and efficiency. Many students wrote that because writing on laptops was less physically demanding, assignments were easier to complete in a timely manner. Conversely, students reasoned that they were forced to work at a slower pace due to the pain and inconvenience from handwriting. One ninth grader, Tristan, elaborated upon the difficulties and pain issues that he had experienced with the traditional method:

Having laptops in the classroom has been an amazing experience coming into my first year of high school. I’ve actually enjoyed writing more, because personally, in the past, I haven’t been able to write for very long without my wrist starting to hurt. Having a laptop, the pain has ended, and my writing has improved so very much within just this year, whereas in middle school my levels of writing stayed just about the same, only adding a few new spiced up vocabulary words every so often. I’ve written my best essays, poems, summaries, anything, you name it, this year.

Besides identifying his improved physical ability to write, Tristan’s blog post suggests that digital writing in a one-to-one laptop environment had a positive effect on his motivation to write. Like Tristan, many students explained that typing their work on a computer gave them the opportunity to express their thoughts more quickly, encouraged them to write more than they would have with pen and paper, and helped them to discover new-found confidence in and enjoyment of writing. For example, ninth grader John wrote that he had previously received poor marks from his teachers as a result of his messy handwriting.

John suggested that the typed assignments were beneficial because they improved the readability of his work and consequently brought reader focus to the content: “Luckily, I am a fairly good typist and am constantly improving. I don’t have any more problems with [handwriting] because I don’t need to write down anything.” Kailyn, another ninth grader, wrote that “[h]aving a laptop helps students to focus on their format and content rather than the look of their paper...forcing the student to become a more confident and efficient writer.” Spending less time and effort on the aesthetics of their work, many students wrote that they were able to concentrate more on developing not only the substance of their work but also their skills as writers.

Students also identified tools that were instrumental in the improvement of the grammatical organization of their work. During the study, most students discovered that the use of word processing tools such as spell- and grammar-check minimized spelling and grammar errors. In their blog posts, many students recognized these features as the most beneficial learning features in a word processor for their writing. Students wrote that the tools encouraged them to re-read their work for possible mechanical errors. Additionally, they described how the word processing feature that highlights possible errors on-the-fly enabled them to more quickly identify mistakes. This finding is consistent with previous research that regards these features as *scaffolding tools* (Warschauer, 2006); by instantly identifying spelling or grammar problems, these tools may be able to scaffold mechanical conventions for students. Whereas without laptops these types of errors would have been identified and corrected by a teacher (a process that would take more time for both the teacher and student), students could use these checking features to handle these errors. A few students also explained how word processing features not only assisted in error checking but also in improving fluency and vocabulary. Aizja, a fifth grader, wrote about how her use of computers assisted her in vocabulary development: “I think it helps students write better because if the word is misspelled, then the computer underlines it in red, so they could go back to that word and fix it. Also they can highlight the word in a different color so that they can memorize that word.” Aizja’s experience highlights how a student might explore and adapt laptop and word processing features outside of their intended use to assist in learning. Students also expressed that the felt these scaffolding tools were not merely crutches. Students asserted that they gradually abandoned incorrect spelling and grammar habits with continued use of the scaffolding. This finding echoes some of the perspectives examined in another one-to-one laptop programme study conducted at three high schools (Drayton et al., 2010), where nearly 50% of the teachers’ responses mentioned how the use of Microsoft Word improved students’ thinking, organization, or understanding.

A transformation in students’ relationships with their writing was also described as a benefit by students. Fifth grader Crystal wrote that laptops played a role in her improved writing abilities:

Things that happen in our class room now that we have laptops that could not happen before are that I actually want to write now and that is a huge change for me and how I have improved: Suddenly there was a black figure walking toward them from the driveway. It was a monster Bill thought. A dangerous blood sucking monster thought Garey. As the figure came closer and closer Garey realized it was his dog poler. A big fat hairy dog. The reason this is different from what I would actually write is because I hated writing so much in all my other grades that all my writing would have sounded like this: Bill and Garey saw something coming. Garey saw that it was his dog.

Crystal's comment suggests she is aware of changes in her writing – not only that she has improved in general terms, but that her style and fluency had changed. She reflects on how before the one-to-one programme, she would have used relatively simplistic sentences to construct a story, whereas now, she demonstrates her pride in her ability to write more complex and vivid sentences. In her blog post, ninth grader Carolyn proposed a possible reason for students' increased motivation to improve their writing. She wrote about how the online availability of her work prompted her to become a better writer:

Using laptops and using the Internet daily in the classroom has helped me to practice my writing each day. The pressure of knowing that the whole world is going to see everything that I write and post online, makes me want to do my absolute best. The world is watching and I know that I only want my best work to be online. The laptops have helped me write like I never have before.

Like Carolyn, students at both the elementary and high schools reported that they were more compelled to improve their writing due to the fact that their work can be accessed by a broader audience via blogs, wikis, and other new media. While not every implementation of one-to-one laptops necessarily involves online publishing, these comments suggest that an authentic audience may motivate students to attend to the quality of their writing structure, format, and content. Many of the students indicated that they realized how their work would be a reflection of themselves and of their school; they wrote that this awareness inspired them to work beyond their perceived limits as writers.

Access to information

A total of 152 student posts (42%) indicated that laptops improved information access in the classroom. Common among many of the student testimonies was the idea that personal laptops were a valuable asset to their learning due to the relatively speedy and simple access to knowledge that a computer provided. Students emphasized that individual Internet access in particular allowed them to instantly look up information and thus to work and learn at a faster pace. The quantity of information, that they “have more information at fingertips,” was also seen as a benefit. In what could be described as *just-in-time learning* – the idea that people learn best when information or instruction is provided at the point of need (Warschauer, 2006) – many students reported occasions where laptops enabled them to immediately acquire additional information to supplement the classroom content. Kara reflected on how she saw improved information access affecting her learning:

The presence of laptops in class enable(s) instant learning. If no one knows the answer, they can look it up and learn immediately. This has contributed a lot with discussions of any sort. Without laptops, many things would go un-learned or researched at a later date. This makes things more complicated because everything relevant to a subject should be learned at one time, so it can be grouped in a brain as one.

This ability to research many facets of an issue at once was described in many student comments. Students wrote that because they could research a topic at time it was addressed in class, their understanding of the learning material was improved. When asked whether they would like to continue the use of laptops in their classrooms, the majority of student comments expressed the concern that a lack of laptop access would decrease their ability to immediately retrieve a wide range of knowledge. Student Katie

summarized these benefits, writing that “rather than spending hours in the library looking through countless reference books, students can look online and access many of the same sources and more.”

Engagement with new media

The use of new media in the classroom emphasizes how laptops may bring with them the potential for departure from traditional K-12 education. A total of 132 student blog posts (36%) expressed that the laptop environment enabled them to be better engaged with new media. Many of the students voiced their preference for laptops over traditional methods due simply to the fact that laptops represented a change from conventional lectures. Part of this enthusiasm may have been a result of students’ prior perceptions of laptops: many students stated that they traditionally associated schoolwork with pen and paper, whereas they viewed computers as a source of entertainment. Diana, a fifth grader, commented: “Now students can’t wait for math, writing, and science because we get to use the laptops and it is way more fun with the laptops.” Another fifth grader, Jessica, wrote that “the little laptops make 5th grade a little bit easier and more exciting.” While it is possible that the novelty of laptops could dissipate, blog posts such as those written by Diana and Jessica may suggest that the introduction of laptops into the classroom changed students’ attitudes towards media; where they used to view media technology purely as a source of play, they now found these media to be possible tools for learning.

In using laptops, many students reported greater enjoyment in their schoolwork due to improved ability to access and produce multimedia; personal laptops enabled them to interact with information in kinesthetic, visual, and auditory ways. That students reported multimodal information as a benefit is not surprising. Other studies (e.g., Warschauer, 2006) note that young learners may typically find working with music and images to be highly engaging. Author additionally suggests that *hybridization* of learning materials – the creative mixing of modes, media, genres, formats, and dialects – can promote enthusiasm and enable more meaningful learning for students. Ninth grader Megg cited this type of multimodal work and work with laptops in general as the source of her recently developed interest in school:

Having the laptops in class increases my enthusiasm to actually come to class, and participate in online discussions. I look forward to having my laptop everyday, and that makes me enthusiastic before I even step in the door, and that positively affects my writing [style] and pieces. I also think it is just easier to get my thoughts out while typing rather than writing.

Students further described a myriad of technology-based activities that encouraged them to get involved with their learning and to participate in class projects, including online games, Skype, blogs, and wikis. They mentioned that with these tools, they could actively research their topics and “tap into [their] creativity” not only by writing but also by creating other types of media. This hands-on, hybridized approach was mentioned by many students as the basis of new-found interest in school and writing.

A research project in one ninth grade classroom provides an example of these hybrid multimodalities. Students were assigned a Wikified research project in which they would use a wiki to gather, arrange, and present their research. In addition to writing, students were able to incorporate images, songs, videos, and hyperlinks in the presentation of their work. Allison enjoyed experimenting with different media in composing her paper and found it more engaging than traditional methods:

Having laptop computers has greatly aided my learning. I now feel that what I am writing is much more relevant. This semester our class wrote a paper but instead of writing a black and white paper, we made a website and added links, pictures, and videos. Writing that paper, or website for a lack of a better term, made me feel empowered because I felt that what I was doing mattered and related to the world around me.

Student comments additionally explained that they enjoyed the researching and writing process because laptops assisted them in pursuing their specific interests – and in modes that they found interesting – as they related to the course content. They explained that the ability to use multimedia “enhanced the quality of [their] arguments so much more than a hand written paper ever could.”

Remaining relevant in a technological world

With the development of new communication and information technologies, new skill sets become prerequisites to attaining many types of jobs. While technology skills and the technologies that necessitate them have always been in flux, the explosion of new communication technologies poses potential new challenges for the current generation of young people. They must become what Gee (2004) terms as *shape-shifting portfolio people*, those with the ability to constantly reinvent themselves, adopt new identities, and develop new skills. Among student blog posts, a total of 84 (23%) noted the importance of twenty-first-century technology skills to their future employment and education. In her blog post, high school student Melissa expressed her thoughts on the importance of computer skills:

There are very few jobs left that do not require knowledge of computers in some way. In colleges, students will be required to type up their papers, fill out online applications, and use the Internet to complete research papers. If schools are to prepare students for success in today’s world, they must spend money on computers. Otherwise, students will be unable to compete for places in colleges and for jobs in the work force.

Many of the students, like Melissa, recognized the prevalence of technology in their lives and wrote that they anticipate that technology – and the skills necessary to use this technology – will play an even greater role in their futures.

While many students wrote about the need for technology skills in general, other responses suggest that students are aware that mere basic computer skills are not enough to succeed in a technology-driven economy. One student, Taylor, maintained that the opportunities to practice technology use would be vital to learn these skills:

Computers in the classroom are also money and time well spent because technology is the future, and kids need to be exposed to their futures early on in life. The old saying, “practice makes perfect” applies to computers in the classroom because if children use them frequently, or even occasionally, they will become better typist and good troubleshooters, which are both very helpful skills in the business world.

While many students wrote about what they saw as immediate benefits of laptops on their school work, students were also preoccupied with the potential impact of technology on their future. Blog posts such as those written by Melissa and Taylor point to how students view laptops as a way to take charge of their current learning. From their blog posts, many students seem to see a strong correlation between technological skill level and success; to

them, continual exposure to new technology may be seen as a necessary experience for them to become adults.

Share and learn from peers

Prior laptop studies find that laptop classrooms may provide the means for students and teachers to make writing more public, visible, and collaborative than in traditional classrooms (Warschauer, 2006); however, the extent to which students might see (and see benefit in) collaboration has not been fully explored. In the current study, students reported that they were given more opportunities to interact with peers, express their thoughts through writing, and improve their work through collaboration. A total of 60 blog posts (17%) indicated that laptops improved communication with peers, teachers, and individuals outside of the classroom and that this communication provided students with an enriched, collaborative learning experience.

In their blog posts, students noted that the introduction of laptops into the classroom made participation in class discussions easier and more enjoyable. One student, Britni, asserted that laptops and online chatting and blogging facilitated participation especially for students who might otherwise not have joined in the discussion: “This allows the shy people in my class to be able to participate in discussions, without speaking aloud. Also, without computers, one person usually dominated the conversations.” Britni’s comments suggest that the ability to participate in discussions not only provided benefits for timid students but also created a richer discourse environment for the group in general. Whereas not all student voices could be heard before, now many perspectives could be shared. Other students wrote that they disliked participating in traditional classroom discussions because they were forced to speak aloud and were afraid that they might be judged harshly by their peers. With laptops and supplementary online discussions, students wrote that they were more comfortable participating. Many students wrote that they had more time to gather their thoughts and express them coherently when posting in an online discussion. They also explained that although their names were connected with their online writing, online discussions provoked less anxiety because students were not confronted with face-to-face criticism.

According to student blog posts, laptop-facilitated online communication did more than allow students to participate in discussion; these new venues for communication also enabled students to write for and interact with authentic audiences. The use of laptops, and in particular online writing, was largely viewed by students as a place for discussion and exchange. Fifth grader Kyler viewed the Internet as a “forum for the trading and debating of ideas and knowledge” and sharing perspectives – both of those of his peers and also of those outside of his classroom. Students described their use of online communication as useful for expressing themselves, conversing with others, and for simply having more opportunities and space to write, as ninth grader Btrinidade notes:

On computers, students are not limited by physical space and can write or comment to their full ability. Having more comments, and having them more thoroughly explained helps me catch a lot more of my mistakes in my writing.

Here, Btrinidade appears to portray online writing as multidirectional. When other students provide feedback, Btrinidade was able to ask for clarification and then make adjustments to his writing. Students described this process as useful not only to the writer but also to the reviewer; they claimed that they learned to critically examine others’

writing while also gaining a better understanding of their peers' perspectives and writing techniques.

Knowledge sharing included audiences beyond these students' classrooms and local communities. Students remarked that online activities with other schools introduced them to a variety of cultures, ways of thinking, and different styles of writing that they would not have been able to access without online communication technologies. While Diane Duckworth, GATE Facilitator and Program Director at East Elementary, said that the computers made her students "more aware of the world and the opportunities that surround them," student comments further explained how opportunities to participate in an international dialogue may have transformed the ways they communicate and expanded their perspectives on other cultures. In particular, students who participated in one project – a collaboration between Arapahoe High School and a school in Qatar – maintained that the international sharing allowed for deeper learning. In this collaboration, students from both schools wrote essays and then reviewed each other's work. Ninth grader Paul wrote: "we got to learn a lot about these students and their life and cultural experience something that never could have been without laptops." Other comments additionally mentioned how writing for and receiving feedback from their international peers transformed their style of writing, their perspectives, and their creativity while enhancing their understanding about a country many of them "had never heard of." Students also claimed that in addition to supporting their writing development, online projects such as the international school partnership helped improve their ability to work collaboratively in a professional and productive manner.

In addition to international collaboration, students wrote that they were motivated to collaborate and cooperate with their peers. Student Kate explained how the switch from paper and pencil to laptop-based work changed classroom interactions:

With a paper and pencil, all a student can do is read and write. Students not only can write and read on a computer, but they can also do interactive blogging that is available for later use. With a regular discussion the classroom has a boring atmosphere, but when a student has the option of using blogging or a spoken discussion, he or she will be more interested and involving. Personally, when I have gotten the privilege of blogging, I am more active and aware of the topics and lessons my teacher wants me to learn.

Kate's response and others like it echo a common sentiment amongst students in this study: to them, pencil and paper seemed an outdated method. Many students wrote that they were attracted to the modernity of the Internet, the ability to view and create multimedia, and the channels of communication that these tools opened. Students remarked that in addition to enjoying online communication and digital writing over traditional means, they were more likely to participate when given the option to communicate with their peers in a virtual environment.

More individualized and differentiated instruction

One concept that Warschauer (2006) proposes was a benefit of laptop use is the cultivation of students' aptitude for *inventive thinking*, or the ability to negotiate reasoning, creativity, risk taking, self-direction, and adaptation in complex situations and environments. In their thoughtful comments, students appear to exercise this type of thinking. In addition, a small number (9 posts or 2%) of student posts indicate that laptops create an environment conducive to individualized learning and inventive thinking. These comments describe

students' preference for laptops due to the ability to exert control over their individual learning and to explore and reflect upon their own interests in their writing. In similar one-to-one laptop programmes, teachers also report an increase in students' independent work. Bebell and Kay (2010, p. 25) found that in a one-to-one laptop programme in Massachusetts middle schools, teachers noticed that students were better able to work as individuals and in differentiated ways:

Teachers were stronger in their assessment that the [laptop] program had positively impacted students' ability to work independently. For example in the final year-end survey, [program] teachers largely reported that their students' ability to work independently had increased as a result of the program.

Over 4 out of 5 of the teachers in this Massachusetts laptop programme reported that students were more engaged and actively involved with their learning. Similarly, over 70% of the teachers in a Maine one-to-one programme reported that laptops helped them more effectively meet their curriculum goals and individualize their curriculum and instruction to meet particular student needs (Silvernail & Lane, 2004). Kay Bolerjack, a technology coach at an elementary school that took part in the current study, provided her opinion on the subject:

I feel that independently pursued and paced learning can have a strong impact on true knowledge, which is achievable with the right tools, training and technique in place. The more we can expose these students to the tools they need, the better.

While the above comments provide some insight into teacher perceptions of the effects of one-to-one laptop programmes on individualized learning, the current study findings suggest that students too believed that laptops provided them with agency and control over their learning. Students commented that laptops afforded them new-found independence; whereas they used to rely on their teacher or peers for information, students explained that they now looked to their personal computer and used their research skills to answer their questions. Students described a classroom where each student was able to learn and write at his or her own pace. One student mentioned that where before he found the pace of learning games too slow, he could now play at his own pace with "the correct game, the perfect level" on his personal laptop.

According to student comments, two components of their ability to pursue personalized learning was the development of a sense of autonomy and the acquisition of information literacy skills to act on this autonomy. Students wrote that they learned to research the pertinent information needed for assignments and to look for supplemental data to enrich their understanding and help them extract meaning. Laura, a ninth grader, wrote: "I have learned responsibility and I have also learned that thinking outside the box isn't just going farther than the question asked, its finding things out for yourself and challenging the system that is given to us." In their comments, Laura and her peers suggest that one-to-one laptops helped shift some of the responsibility of learning from the teacher to the student. While teachers still played a leading role in classroom learning with laptops, students noted that technology supported their ability to take initiative and learn on their own. In an example of how laptops allowed teachers to relinquish some control to students, ninth grader Bayley remarked: "I remember once that our teacher once told us that we had fifteen minutes to find out all that we could on a subject. We could find out what we needed to know by ourselves. She was putting us in charge of our

education.” Regarding activities such as the one Bayley describes, students commented that they found the limited guidelines from their teachers refreshing and that they preferred to actively search for information on their laptops over passively receiving a lecture. Many students additionally remarked that this active, independent research motivated them to work harder than in a traditional setting, and that this motivation enabled them to explore their interests within classroom content. Students reported that improved information access had advantages beyond the speed and amount of research they could perform; students explained how this access resulted in engagement with material and a sense of independence. While some research suggests that student engagement increases with the enhanced information access afforded by one-to-one computing (Bebell & O’Dwyer, 2010), other research asserts that this engagement is by no means guaranteed (Selwyn, 2009) and requires teacher support and curriculum development (Silvernail & Lane, 2004). In the laptop programmes studied, students had largely positive comments about their access to information and its effects on their learning. Student Jessica found that the freedom to search online at any time could both satisfy and heighten her curiosity about a wide range of subjects:

Computers open a door from the classroom into the world. There is so much more knowledge accessible to students who have access to computers than there is to those in traditional classrooms. They allow one to find information about any topic, any time by simply typing a question into a search engine. With information so accessible, the ability and expectation to learn and ask questions is much more present. Computers make the research process far more efficient and allow students to explore every side of a topic. Instead of remaining ignorant to the issues that spread all over the world, students can educate ourselves in order to make a difference.

Jessica seems to describe laptops as a gateway to the rest of the world and as a means for agency. This and similar statements from the students suggest that while students use laptops for understanding course materials, they may additionally employ laptops and the Internet as a means for learning from others and acquiring information outside the scope of their classroom and tailored to their personal interests.

Laptop limitations

In addition to these seven themes, some students discussed the limitations of one-to-one laptops within the classroom. Students stated that computers could be distracting and may pose challenges related to media literacies. For example, one student described how evaluating sources and being aware of privacy issues is important when students have access to personal laptops: “They can be distracting or time consuming....When somebody turns on a computer, they need to take the responsibility of all of their actions, so they need to be smart with what websites they visit and the things they post on their computer.” Having access to one-to-one laptops enabled constant access for both academic and recreational purposes. Another student wrote that “although laptops are nice I think that are very distracting as well because you are tempted to go online and play games and do things that you should not be doing.” These comments suggest that individual laptops were not universally well-regarded and that for some, they could be distracting. The need for scaffolding was also mentioned. For example, a student praised one-to-one laptops for improving learning in her classroom but cautioned against the belief that computers alone were responsible for this change: “Do I think that they help enhance the learning and help keep the school up-to-date? Yes, I do think so. However, I

think the teachers also need to help make that work.” Several students mentioned the role of teachers in learning with laptops, including the development of collaborative online activities such as class wikis and teaching students how to evaluate information sources.

Discussion

This study, by analysing students’ opinions about the use of laptops and different technologies in their classroom, revealed several themes about the role that laptops played in students’ learning: promoting more efficient and productive learning, tools for better writing, bringing easier access to information, more engaged interaction with new media, remaining in a technological world, getting opportunities to share and learn from peers, and more individualized and differentiated instruction. This finding is consistent with previous research in laptops and learning that students’ learning in laptop environment tends to be more student-centred and project-based (e.g., Cavanaugh et al., 2011; Drayton et al., 2010); promote student writing in various ways, such as increasing writing quantity (e.g., Russell et al., 2004), receiving more feedback (e.g., Grimes & Warschauer, 2008), writing in different formats and genres for more authentic purposes (e.g., Corn, Tagsold, & Patel, 2012; Lei & Zhao, 2008); and enhance individualized learning (e.g., Mouza, 2008).

Although the students in this study provided primarily positive comments, the benefits of one-to-one laptop programmes that they described by no means apply to all implementations (for examples of less successful programmes, see Warschauer, Cotten, and Ames (2012)). Student participation in the blog survey was voluntary and not random; not all student perspectives were represented in this sample. In addition, the selection of these schools was not random or necessarily representative of laptop programmes in general. Not all laptop programmes provide sufficient technical support (such as routine laptop maintenance) and curricular support (such as activities that enable students to use laptops and the Internet in ways that support their learning), nor is there a consensus about what makes for sufficient technical and pedagogical supports. That almost half of the student comments described how laptops provided tools for better writing was also likely due to the writing focus of the laptop programme; as we mentioned earlier in the “Method” section, the district’s one-to-one laptop initiative was originally implemented to support the district’s literacy framework which emphasized students’ authentic writing. Despite these limitations, these student comments provide some glimpse into possible student perceptions of the effects of one-to-one laptop programmes. While student comments in this study were largely in line with the positive comments of their teachers, they also shed light on what students may value most about classroom laptop use. More than half of student comments indicated that laptops improved learning efficiency. This finding suggests attention to creating activities that are made more efficient with laptops may be important in garnering and sustaining student support for the programme. Student comments grouped around several other main themes such as how laptops provided tools for improved writing, information access, creating and viewing new media, collaborative and differentiated learning, and developing relevant technology skills. These themes may indicate activities and strategies in laptop-based instruction that students would view as particularly valuable and that may benefit from attention during the implementation process. Students additionally identified what they viewed as potential problems of laptops. Distraction and the need for teacher support were recognized as possible disadvantages of having one-to-one laptops.

Previous studies of youth online activities reveal how out-of-school pursuits may provide opportunities to collaborate and share writing or multimedia with peers (Black,

2009), to seek out and produce knowledge of personal interest (Ito et al., 2009), to practice digital literacy skills (Ba & Tally, 2002), and to engage in social, identity building interactions (Lam, 2000). That students in the current study seem to find similar authentic opportunities in their laptop-supported classroom appears promising. While these findings must be considered within their specific and limited context, and although the use of technology in schools is by no mean guaranteed to have positive effects on student learning, recent research is driving the push for increased technology access and use in the classroom. The recent National Assessment of Educational Progress (NAEP) 2011 Writing Report (National Center for Education Statistics, 2012) found that writing and revising with computers correlates with increased student writing skills. Students were more likely to revise and edit their work; when they did revise, their revisions tended to improve their scores. With this most recent NAEP writing assessment conducted via computers and with one-to-one programmes becoming more widespread, understanding how to develop student support for and skill with computer-supported instruction and writing has become even more critical. As the debate shifts from *whether* to *how* to implement technology programmes, student insight into classroom technology may support the development of future programmes and pedagogical strategies.

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