Perspectives From Students: How to Tame the Chaos and Harness the Power of Technology for Learning

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Abstract

Technology continues to form an important part of the educational landscape, although the value of portable devices as learning tools is still being explored and debated. In light of the technology-based teaching methods suddenly brought into effect in response to the COVID-19 pandemic, the deliberate use of technology for learning is increasingly significant. The purpose of this article is to highlight student perspectives of learning with portable devices to inform the use of portable technology in the Canadian school system going forward. To gather student perceptions, the research team surveyed 704 students in Grades 6 to 9 about their use of iPads in the classroom during a 1:1 technology initiative. While students were enthusiastic about the presence of portable technology, they also shared mixed feelings about the use of such technology as a learning tool. Key themes fell into three categories—engagement, inclusivity, and learning—as students shared their insight into the academic, social, and physical barriers that exist as a result of the technology. In the discussion, we identify lessons learned, especially in the area of self-regulation, and make recommendations on how to harness the power of this multi-faceted learning tool and minimize the chaos it can create when not utilized deliberately and carefully.

Keywords: student perceptions, 1:1 iPad initiative, self-regulation, tablet technology

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New technologies continue to be a significant part of the educational landscape in the 21st century (Ditzler et al., 2016). The implications of new technologies on student learning are often perceived differently by various stakeholders (e.g., Blackley & Walker, 2017; Keane & Keane, 2017). Some cite technology's role in helping students "work collaboratively, develop problem solving and critical thinking skills, be motivated to learn, take ownership of their learning, and develop creativity skills" (Project Tomorrow, 2015, p. 1). Others raise concerns about the potential for "distraction overload and continuous partial attention" (Rader, 2009, p. 44) and call for technology bans to mitigate these risks (Andrew-Gee, 2015; Young, 2006). Regardless of diverse views, many schools have been forced to modify education as a result of the COVID-19 pandemic. The recent increase in online learning may even compel the emergence of a more permanent hybrid model for education (Li & Lalani, 2020).

Portable technology as a learning tool is quickly becoming an essential platform. Pre-pandemic research examining the use of 1:1 tablet technology in K-12 classrooms often excludes student perspectives on the value and effectiveness of implementing these tools (Ditzler et al., 2016). As the effects of the pandemic linger, student perspectives can provide insight into the ways in which technology can enhance or challenge their learning, as well as other potential impacts introduced alongside the implementation of technology for learning.

Extant studies on student perceptions about portable devices have found that students generally perceive technology in the classroom positively (Baytak et al., 2011; Ditzler et al., 2016; Ferguson, 2016; Hilton, 2018). Students commonly reported increased levels of engagement after receiving devices because they perceived learning as more fun and interactive (Corbett, 2015; Ferguson, 2016; Maich et al., 2017). Those who participated in 1:1 initiatives also perceived tablet technologies as enabling increased agency over learning by providing easier access to resources and applications that support self-organization and self-direction in learning (Baytak et al., 2011; Heinrich, 2012; Maich et al., 2017). In addition, several studies have highlighted students' perception of feeling smarter or more capable in using a tablet to support their learning (Ferguson, 2016; Heinrich, 2012; Ozdamli & Uzunboylu, 2015).

Studies have also revealed several student concerns. Notably, students reported that the devices could be distracting and lead to behavioural issues (Corbett, 2015; Ditzler et al., 2016; Ferguson, 2016). Some students expressed that technology use needed to be limited or monitored by the teacher (e.g., Baytak et al, 2011; Maich et al., 2017), suggesting a need for teachers to facilitate the development of self-regulation skills surrounding technology use. As well, internet connectivity issues, impacting consistent access to web-based resources, were also commonly described (e.g., Beckman et al., 2014; Humble-Thaden, 2011; Maich et al., 2017).

Overall, literature on student perceptions of 1:1 portable device initiatives reveals diverse student responses. To further contribute to this body and to examine the potential influences

compelling such diverse responses, our team participated in a multi-year, district-wide study where iPads were used across classrooms. As part of a broader study into the role of educational technology in learning, students participated in a survey that allowed us to examine two key questions:

1. How do students perceive the implementation of an educational technology initiative?
2. What can we learn from student perceptions to guide teaching and learning with technology?

Our study highlights student voices related to learning with devices. While data were collected on device usage in a classroom setting, one cannot help but wonder how these student perceptions about portable devices might inform educational decision-makers as they navigate emergency education and learning beyond the current crisis.

Context

In Canada, educational decision-making occurs at the provincial level with funding from local and provincial taxes subsidized with some federal funds. Therefore, practices and policies vary, depending on the context, priorities, and initiatives within each province. At the time this study was initiated, the Ministry of Education in Ontario partnered with the Council of Ontario Directors of Education to create *The Technology and Learning Fund*. The fund was dedicated to continuous improvement of student learning by optimizing technology in education (Council of Ontario Directors of Education, 2016). This focus on technology is grounded in the growing number of Canadians who have access to the internet; in 2019, Statistics Canada reported that 94% of Canadians had home internet access.

Our study reflects one component of a multi-year technology initiative implemented in a rural school district serving two counties in Ontario. These counties contain more than 160,000 residents and 40 publicly funded schools attended by approximately 16,000 students and 1,600 teachers. All participants in this research were part of an educational technology program implemented during the 2014-2015 school year, with data collection ending in 2016. Each teacher and student in Grades 7 and 8 received an iPad; in total, more than 2,000 iPads were distributed during the program.

To ease logistical considerations, students in split grade (e.g., Grades 6/7) classes also received devices. Students received devices in three phases during the 2014-2015 and 2015-2016 school years. Devices were kept by students for the duration of the project or as long as they remained in the district. While students may have had access to other technology at home, the iPad was the technology used at school and supported by the system. Students received the iPads pre-loaded with district provided applications at the start of the school year and were

responsible for the devices for the duration of the school year. When the iPads required updating or repair, technicians visited school sites and loaner iPads were available.

Some of the authors were a part of the external team who worked in collaboration with the district to monitor the educational technology initiative. Additional authors are graduate students in education interested in technology for learning.

Method

Ethical approval was obtained through an Ontario and an Alberta university, as well as from the school district. Data were originally collected as part of a program evaluation initiated by the district. Following the evaluation, a secondary analysis was conducted for the purpose of examining student perceptions about educational technology. Eisner (1994) wrote that "evaluation requires a sophisticated, interpretive map not only to separate what is trivial from what is significant, but also to understand the meaning of what is known" (p. 193). Stake (1995, 2005) similarly emphasized the value of the qualitative case study in drawing one's focus toward deeply understanding not only the phenomena at hand, but also the unique intersection of contexts in which these phenomena are occurring. Given the diverse and conflicting responses found across studies on student perceptions of technology for learning, we use the qualitative case study to frame this study in order to rigorously analyze student responses and go beyond simply listening to their experiences.

Participants

As part of this research, a total of 704 students in Grades 6 to 9 (aged 10 to 14) in a rural school district in Ontario completed a survey. The majority of the student respondents were in Grades 7 and 8 (aged 11 and 12). Some students from split classes who received the iPads also completed the survey. Table 1 shows the breakdown of participants.

Table 1

Student Respondents by Grade

Grade	Number of students	Percentage of respondents (%)
6	45	6.39
7	310	44.03
8	316	44.89
9	33	4.69

Data Collection

A survey was used to obtain a representative sample across each school within the school district. The survey was designed collaboratively by the external research team and district stakeholders to collect student perceptions of the use technology and implementation process. The survey consisted of 15 closed-ended and six open-ended questions and was distributed to all students who received iPads using their district email addresses. Recipients were given class time to complete the survey. As the goal of this paper is to contribute detailed and nuanced student perspectives, the analysis focused on two open-ended questions: (a) "The iPad helps my learning because …" and (b) "The iPad gets in the way of my learning because …."

Data Analysis

Survey data were analyzed in two ways. First, the answers to the open-ended survey questions were analyzed qualitatively. Using an evaluative (+/-) coding structure, responses were coded for emerging patterns and relationships in the data based on Saldaña's (2013) three-cycle coding approach. Initially, responses were coded using descriptive coding techniques (Miles & Huberman, 1994; Wolcott, 1994) to describe students' perceptions of the 1:1 technology initiative. We then generated a list of codes based on the descriptive coding used to categorize student perceptions about their learning (see Appendix). Finally, the authors discussed the codes to develop a shared understanding of students' perceptions, in a process much like "theming" the data (Auerbach & Silverstein, 2003; van Manen, 1990).

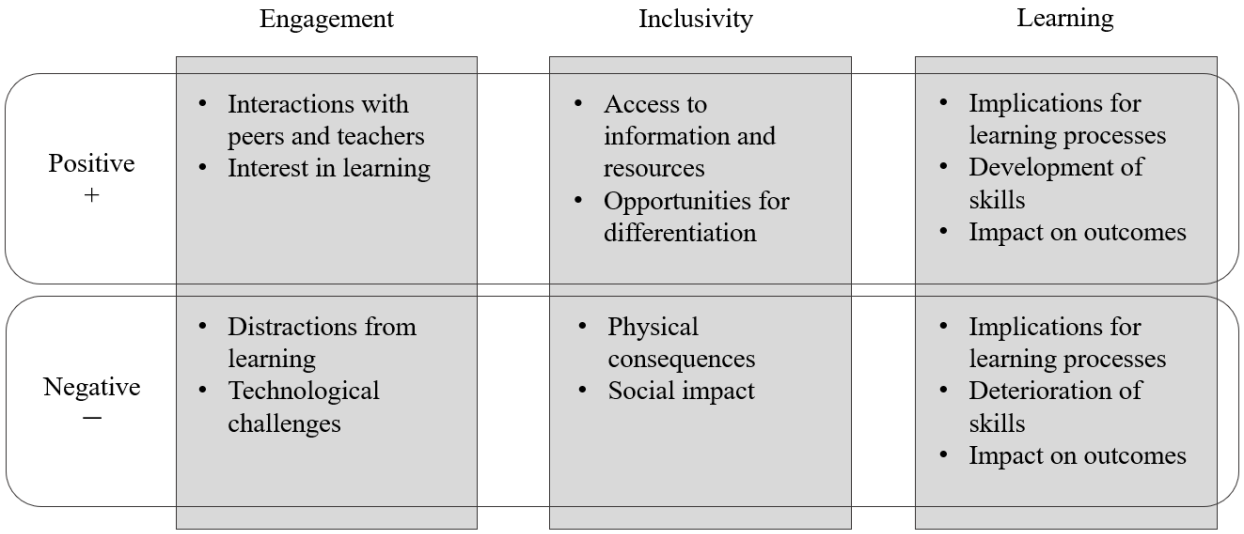
Results

Students reported diverse perceptions regarding how the educational technology initiative directly supported and hindered their learning. While some students' responses were either wholly enthusiastic or unenthusiastic, many revealed mixed perceptions. Additionally, some aspects of the initiative perceived positively by some students were perceived negatively by others. For example, some students stated that the devices made learning "easier" while others stated that it made learning "too easy." Students also reported perceptions regarding how the initiative influenced other aspects of their school experience, such as student-teacher relationships and opportunities for differentiation, which in turn impacted their learning.

Here, we present findings on our first research question: How do students perceive the implementation of an educational technology initiative? Three categories—engagement, inclusivity, and learning—and 11 emergent themes across the categories are described. Some themes have been divided to reflect both positive and negative perceptions within the themes, resulting in a total of 14 key points. Although themes have been labelled discretely to highlight key perceptions using exemplary quotes, it is important to note that some themes overlap given the interconnected nature of student learning.

Figure 1

Summary of Themes Organized by Positive and Negative Perceptions



Engagement

Students' responses revealed that they perceived the initiative to influence their engagement in learning. While there are many lenses through which to examine engagement, students focused primarily on engagement in in-class and independent learning and on engagement with peers and teachers. Overall, students perceived the devices as facilitating their interest in learning and interactions with others but hindering their ability to stay focused given distractions and disruptions caused, at times, by the devices.

Interest in Learning

Students commonly commented on how the devices made learning more interesting through "helpful apps," "interactive learning activities," and "class-directed educational games." One student wrote that having access to applications made them feel as though they were "liv[ing] the experience on [their] own little screen," rendering learning experiences more immersive. This increased interest led students to "work more on things at home that aren't even due yet" and to become "interested in topics [they are] not usually interested in," suggesting that the devices promoted a snowball effect in growing students' motivation to engage in learning. Overall, students' comments that their devices made learning more "fun" and "exciting" also reflected the devices' positive influence on attitudes toward learning.

Interactions With Peers and Teachers

Students reported that their devices increased their engagement with peers by making it easier to communicate about, share work for, and collaborate on schoolwork. One student

commented: “My projects are easy to share with my friends, peers, and teachers now that I have an iPad.” Students also reported increased engagement with teachers by providing them with additional channels to ask questions, share drafts, and receive feedback. One student wrote, “it is much easier for teachers to go into my work and edit it and send it back.” Another echoed: “if I’m at home working on a project and I have a question for a teacher, instead of waiting until the next day, I can email the teacher.” These comments suggested that the devices supported engagement in learning by serving as a collective means for students and teachers to connect. As well, being able to take the devices home increased students’ opportunities for interactions for learning outside of school.

Distractions From Learning

In response to the survey question on how the devices impeded their learning, students most commonly described the devices’ potential to distract them from their learning. While some students noted that the devices helped them “stay focused” or made it “easier to focus,” around one-third of the students mentioned feeling tempted to use their devices for games when in class or trying to study. Students wrote: “the games tempt me” and “I get notifications and feel the need to answer them sometimes during class.” Seeing peers get distracted also diverted students’ attention: “it’s hard when you are doing work and people are playing games” and “I feel a bit distracted when working in groups and others are goofing off and doing off-topic things on the iPads.” Several students noted that access to social media apps and texts led to distractions as well.

Students’ misuse of devices sometimes caused class disruptions. Students commented on how teachers needed to spend time addressing misuse: “some people will be on games during class and it takes time for teachers to notice them and tell them to set it down, which decreases the amount of lesson time” and “it takes even longer for us to actually learn something … students are playing games!” Access to games also appeared to impact student engagement in learning outside of the classroom. For example, students wrote: “Sometimes it is hard to not play games during free time instead of reading books” and “when I am at my house doing homework unsupervised, I am tempted to play games.”

Some students expressed the desire for limitations for themselves and others on device use. These students commented: “I feel we should still have them but limit the use”; “there should be new rules set into play for school boards and the iPads”; and “there should be more consequences [for misuse].” A few comments revealed the perception that teachers were not appropriately managing misuse. One student stated, “all that the teachers do most of the time is yell at us to put them down.” Another student suggested that regulation was the teachers’ responsibility: “when you get kids in trouble for doing things on the iPad, it’s not our fault. You guys were the ones who gave us iPads. What did you expect? We’re teenagers.”

Overall, students' frequent discussion of distractions indicated that they were aware of the potential for misuse of their devices and conscious of how distractions impacted their learning. Many students expressed a desire to engage in learning in and outside of class, but found it difficult to regulate device use, calling on teachers to provide more guidance and rules.

Technological Challenges

In response to the survey question on how the devices impeded their learning, students' second most commonly expressed concern was technological challenges. Many students expressed frustration with Wi-Fi connectivity issues and software glitches, which impacted the pace of the class and their ability to stay on task. On Wi-Fi issues, students wrote, for example: "When the Wi-Fi isn't working or you forget your iPad, you don't get all your learning done and you're behind." On glitches, students wrote: "Sometimes, the iPads crash, so it puts us a little bit behind in work" and "if an app doesn't work, I am stuck with nothing to do … for half an hour at a time."

Additionally, students noted that there were learning curves associated with using the devices, which impacted students' ability to work at their regular pace. Students commented: "I think [learning] is [at a] much slower pace because you have to learn how to do the assessment on the iPads first" and "when we are trying to use a new app, it's hard to keep up with the lesson." These comments suggested that students needed more time or perhaps more instruction to develop the technical skills required to use the devices effectively or efficiently.

Inclusivity

Students appeared to strongly perceive increases in inclusivity and accessibility as a result of their devices. As with engagement, there are many lenses through which inclusivity can be examined. Students' responses focused primarily on how the devices increased students' access to educational information and served as a tool for increased access to resources that met students' individual needs or preferences. Negative perceptions of the devices' influence on inclusivity included physical strain and social impacts.

Access to Information and Resources

In response to the survey question on how the devices helped their learning, students most commonly described significant increases to information and resources in terms of ease, speed, and quantity. Students noted that the devices allowed them to "easily get the answers a little quicker" or "find more information faster." This increased accessibility facilitated the exploration of students' interests. One student wrote: "I can look up more things that I'm interested in and that helps [with] getting through the stuff I don't like." Another student

elaborated: “You can search up topics more easily than before, which encourages us to ask more questions, become more curious, and think outside the box.”

Students also described how technology supported their learning outside of the classroom because it “has apps for certain things that [they] need to learn in class” and allowed them to “research things any time.” These comments suggested that the devices provided students with access to educational resources outside of the classroom that they might not otherwise have had. Additionally, students perceived the devices as a means to access their schoolwork and teacher support from home: “I can take my school life and homework to my house” and “I can email my teacher questions from home if I need help.”

By extension, the devices also allowed students to access missed work: “if I missed a day of class, I can access the work we did that day and do it at home.” However, some students noted that they had inconsistent internet access at home. One student commented, “I have to be at school when I have some work to do, due to the limited Wi-Fi range at home.” Comments such as these highlighted implementation challenges in ensuring that the technology itself was an accessible learning tool for all students.

Opportunities for Differentiation

Some students perceived that the devices helped their learning because it allowed them to independently differentiate their learning processes. Several students explicitly recognized instances of differentiation: “I can adapt to the work and still stay on track with the rest of my class even though I learn differently” and “I can do stuff individually at my own level instead of having to work at the same level as the rest of the class.” Other students commented on how having access to the educational technology allowed them to “work [at their] own pace instead of staying at the same pace as the whole class” and to “look up what [they] want … rather than have to raise [their] hand and wait.”

Several students expressed a preference for their devices over paper, noting that technology suited their learning styles. For example, one student wrote: “The iPad helps my learning because it is technology, it’s something that I’m used to instead of a pencil and paper, which helps my learning speed.” Other students stated more broadly that the devices were “more fun than writing on a piece of paper” and that “technology gets my attention more than any textbook would.” A few students also referenced leveraging device- or software-specific features (e.g., speech-to-text function) to support their learning.

Physical Consequences

Negative perceptions included concerns about how overuse of devices could lead to physical consequences. A small number of students (around 2%) reported experiencing eye strain,

noting that: “staring at the screen hurts my eyes” and “after a long period of time, I will get a headache or blurry vision.” Two students similarly voiced concerns about back strain: “our spines are going to deform” and “we all slouch now.” A few students also commented that the screens caused overstimulation: “[I] can’t fall asleep right after doing homework.” As students noted, many classes relied significantly on the devices. Comments about strain suggested that, at times, the devices challenged some students’ ability to participate in technology-based learning over extended periods of time.

Social Impact

Some students felt the devices discouraged social connection among peers while in the classroom. For example, two students commented: “We as a class don’t get enough social interaction,” and that as a result of the use of the devices, “people talk less.” Another student elaborated: “our social lives have gone down [and] I really just want this to go back to the way it was before all this iPad stuff happened.” Given one student’s comment, “If I don’t understand something, I can just search it up because I’m shy and don’t feel comfortable talking to my teachers,” it is possible that having access to these devices reduced the need for students and teachers to interact directly in certain situations, perhaps to the benefit of some and to the detriment of others. Although students also described using their devices to send messages to one another, these comments indicated that some students desired more face-to-face interaction.

Learning

With regard to the initiative’s influence on learning processes, skills acquisition, and outcomes (i.e., perceptions of overall learning, grades), student responses revealed highly mixed perceptions. In response to the first survey question, around 95% of students discussed ways in which the devices supported their learning, while the remaining students wrote responses such as “it doesn’t [help my learning].” On the other hand, in response to the second survey question, around 90% of students discussed ways in which the devices impeded their learning; the remaining students wrote responses such as “it doesn’t get in the way.” Some commented that the positives of the initiative were negated by or outweighed the negatives; others commented that the devices had no impact. These results highlighted challenges in ensuring that technology initiatives are effective in supporting all learners; we elaborate upon these challenges in our discussion.

Implications for Learning Processes

On implications for learning processes, students commonly described how the devices made it easier to keep both schoolwork and their thoughts organized. Keeping organized helped them to “complete work instead of having to look for things,” “remember … work that needs to be

completed" and "look back in [their] notes without getting lost" suggesting that the devices played a supportive role in their learning.

Students' comments also revealed varying perspectives on how and to what extent the devices challenged their learning. For example, some students stated that the devices made learning less challenging, while others stated otherwise. Of those who stated that the devices made learning less challenging, some suggested that learning *should* be more challenging. In describing how they used their devices, students most discussed searching for information, and some students noted: "[Learning] is different because people can just look things up instead of thinking" and "[The device] is also in the way because the answers to everything [are not] that hard to find, unlike not having [a device], where you have to find out and learn as you go."

Some students remarked that having immediate access to information changed the pace of learning: "Learning goes faster when we can access everything immediately. It doesn't give us much time to finish things, or actually learn them." Another student felt that teachers' expectations changed: "Teachers expect us to turn things in faster. They also expect more things from us when it comes to using the iPads." These comments suggested that some students perceived the devices to reduce opportunities for critical thinking or may have felt compelled to prioritize product over process.

Students also observed that device influence varied by subject and individual learning styles, with several students identifying math as an area where devices complicated learning. In response to the second survey question, students' third most commonly expressed concern was that it took longer and was more difficult to show their thinking on their devices. For example, students commented: "Writing math problems is hard" and "when doing tests, especially math, it's harder to write and takes longer than writing on paper." Many students expressed the desire for paper, both for math and in general: "I like using paper to do my math" and "I'm a hands-on kind of learner … I prefer learning the old way."

Several students called for balance or choice: "[The devices are] all that we ever use"; "For some things, I don't like using the iPads over paper"; and "We should try and do some subjects on pencil and paper." These comments suggested that some students perceived an overreliance on devices, which impacted especially students for whom technology did not suit their learning needs or preferences.

Development and Deterioration of Skills

Several students felt the initiative aided them in developing new skills that would be valuable in the future. Students stated: "When we go to college or university, this might be how it is with the iPads and electronics, so we already will have experience" and "It gives us the experience to look up everything that we need extra help on." Some students also appeared to value the

integration of technology, given its prevalence in their lives. One student stated that "there is a lot of technology for [our] age group, so [we are] getting more used to using technology for learning." Another student wrote: "We were born into a technology life. So, we are used to them [and it] really helps because we know how to use them better."

Conversely, there was notable concern about the deterioration of handwriting and spelling skills. One student wrote: "… when we do things by hand, our writing is messier and we need to have legible writing when we get to high school." Several students described using their devices primarily as dictionaries or calculators, and of those students, some felt that this negatively impacted their spelling and calculation skills. For example, one student wrote: "People rely on them [devices] and don't try to spell because it [automatically] corrects."

Impact on Outcomes

Fewer than 2% of students explicitly connected the initiative to general outcomes such as their overall learning or their grades. This may be because the survey was distributed before final grades were released. However, those who discussed outcomes voiced mixed perceptions. Some students felt technology had a positive impact on their learning and grades: "It improves the way I'm working and my marks" and "I get better marks when using … apps that help." Others suggested that having devices made a negligible or no difference. One student explained: "I don't think iPads have changed how well I learn. It may be useful (e.g., typing essays), but my grades have been the same since I have got on an iPad."

Other students expressed concern that their devices were negatively impacting performance: "I have noticed a dramatic drop in my grades." Another student commented: "People get yelled at for playing games and because of that I'm failing my classes." The latter comment suggests that the influence on the other aspects of learning was recognized by students as limiting outcomes. Students perceived the devices as useful for different purposes and to varying degrees, resulting in diverse conclusions about their overall value and influence on their learning.

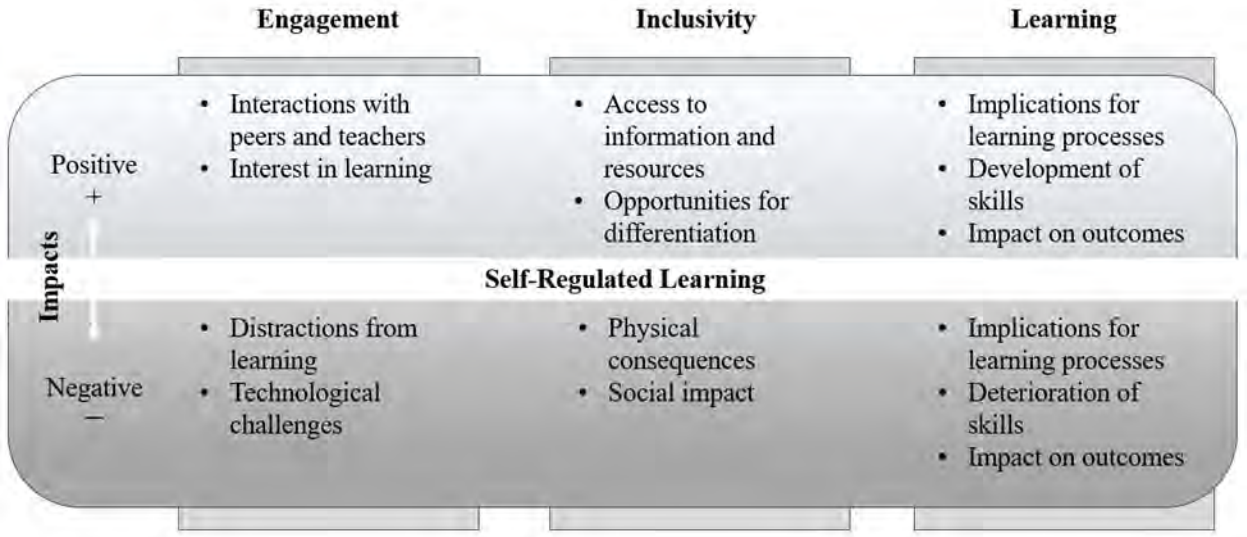
Discussion

As technology is increasingly integrated into classrooms to support learning (People for Education, 2019) there is a need to continuously check-in with students and examine how they are experiencing the influences of technology. In this study, students' responses alluded to an emerging awareness that the impacts of the 1:1 initiative depended on multiple factors. These factors included not only students' own use of the devices, but also their peers' use and their teachers' regulation of use. Notably, some students recognized the importance of moderating device use to mitigate negative influences due to misuse or overuse.

Figure 2 represents the impacts of 1:1 devices as a positive-negative continuum, whereby the negative impacts can be moderated through self-regulated learning. Students who develop self-regulation skills are better able to monitor and continually modify their technology use to achieve their learning goals (Liou & Kuo, 2014; Sandars, 2013) and likely become less susceptible to potential undesired impacts of technology for learning. They are also better able to self-assess after a learning task (Sandars, 2013) to determine how technology might have helped or hindered their performance.

Figure 2

Maximizing Positive and Minimizing Negative Impacts of 1:1 Devices Through Self-Regulated Learning



Some students in this study described self-regulating or attempting to self-regulate their device use. However, to varying degrees, some students also expressed a desire for teachers to provide more guidance surrounding use. Given that students experiencing technology for learning are of diverse ages and possess a range of self-regulation skills, teachers play a critical role in supporting self-regulated learning using technology and promoting positive impacts of technology for learning.

To support teachers in this role, school districts might consider offering self-directed professional development modules for teachers to access based on individual need. It is worth noting that teacher education programs are increasingly providing instruction on integrating technology into the classroom. Below, in responding to our second research question—What can we learn from student perceptions to guide teaching and learning with technology?—we provide practical recommendations and strategies to promote self-regulated learning using technology for each of the categories discovered in our results.

Engagement

Although some of the students in this study recognized their susceptibility to distractions caused by their devices, very few described implementing specific self-regulation strategies to overcome distractions. Accordingly, students need strategies that will support both in-class and independent learning. In their study examining teachers' perceptions of the impacts of mobile technology on learning, Domingo and Garganté (2016) found that participants' choice of apps was influenced by their perceptions of how mobile technology can serve learning (e.g., content learning, information management, skills development). Accordingly, beyond reminders to turn off notifications or to check notifications only at predetermined times, teachers can introduce students to and normalize the use of apps aimed at distraction management, such as Anti-Social.[1] As well, time-management methods such as the Pomodoro Technique[2] can be shared to teach students to take intentional breaks, which can improve focus.

Additionally, teachers may consider capitalizing on ways in which devices support engagement to reduce opportunities for disengagement. Given students' desire for "interactive learning activities" and "class-directed educational games," teachers may use more immersive and experiential resources or applications. For example, CoSpaces[3] allows users to create virtual reality settings with interactive elements. Google Earth[4] allows users to create virtual trips and add annotations to selected placemarks. More generally, students could be guided to discover new resources or applications related to burgeoning interests to further motivate the appropriate use of devices.

Inclusivity

Technology for learning has the potential to play a significant role in creating an inclusive learning environment and in meeting students' needs (Starcic, 2010). However, ensuring technology supports inclusivity can be difficult if students and/or teachers are not knowledgeable about how a technology can be used to meet those needs. As seen in our results, some students may readily recognize when and how to adapt the technology to their benefit, while others may simply use it only as instructed—for better or for worse.

Positioning students as active co-constructors of their learning and the learning environment can encourage students to identify their learning needs, to evaluate the suitability of the technology, and to use or find alternatives, as appropriate. Drawing on metacognitive practices, teachers may guide students in recognizing when and how their devices are helping or

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[1] https://antisocial.80pct.com

[2] https://lifehacker.com/productivity-101-a-primer-to-the-pomodoro-technique-1598992730

[3] https://cospaces.io/edu

[4] www.google.com/earth

hindering learning by asking reflection or self-assessment questions. Turner-Smith and Devlin (2005) noted that teachers themselves often are not aware of opportunities for differentiation or accommodation when using technology in their classrooms. Thus, when possible, teachers should consult online or system resources to learn more about the functions and limitations of technologies in order to proactively prepare students to optimize their use.

Learning

More broadly, learning is a complex and dynamic process. Given students' mixed perceptions on the impacts of 1:1 devices on student learning overall, teachers need to consider how and when technology is used in the classroom. Clearly communicating instructions and expectations surrounding technology may support students in making more informed decisions about their use. As students in our study noted, some applications may be more suitable for certain tasks or subjects. Teachers may consider identifying specific points in students' learning processes during which a recommended technology can facilitate or enhance learning rather than proposing technology as a universal tool.

More specifically, within the context educational technology initiatives, heuristics—such as the substitution, augmentation, modification, and redefinition (SAMR) model (Puentedura, 2006, 2013), technological pedagogical content knowledge (TPACK; Mishra & Koehler, 2006), and Bloom's digital taxonomy (Churches, 2008)—can guide teaching and learning with increasing use of technology in classrooms. These frameworks can support both teachers and students in understanding the roles that technology can play in teaching and learning. Teachers can also use these frameworks to design digital learning that encourages students to practise a range of lower-order and higher-order thinking skills using technology (i.e., to avoid only using technology for basic tasks such as spellcheck). Additionally, teachers may consider coaching students in analyzing and evaluating information retrieved online so that students move beyond simply searching for and repeating information and toward critically examining information quality and integrating knowledge for deeper learning.

Conclusion

With the potential power and utility of technology for learning comes great responsibility to effectively manage and balance its implementation and use. Tucker (2015) writes that, as technology in classrooms becomes the norm, teachers are called upon to co-develop classroom norms around technology. Both teachers' and students' existing skills need to be applied in new ways, and new skills (i.e., 21st century skills) become important as we work toward developing culturally relevant transferable knowledge and skills (National Research Council, 2012).

As with any teaching and learning tool or approach, the potential positive influences of technology on students' learning and learning experiences depend significantly on student response. Students may use technologies in different ways and to differing extents and, as evidenced by our study, may hold diverse perceptions of technologies for learning. These perceptions may then influence decisions about technology use as they move forward in their education, resulting in highly variable impacts on learning. Thus, the opportunities for and benefits derived from learning via technology need to be equitably and explicitly offered to all students.

It is also important to be aware that students' perceptions of educational technology initiatives may be influenced by the media and the conversations they hear around them. Younger students in particular may be more likely to adopt or repeat the views of their parents, teachers, et cetera. Educators should consider their own attitudes toward and approaches to technology—the discourses they produce around technology—and how they might promote growth-oriented mindsets in their students toward using technology to best support individual learning.

Based on our findings, we posit that the positive influences of technology can be promoted by proactively supporting students in developing relevant self-regulation skills. The value of developing these skills in supporting classroom and lifelong learning extends beyond the context of effective educational technology use and is strongly supported by research (e.g., Biggs, 1988; Paris & Newman, 1990; Weinstein et al., 2011). Ultimately, the hope is for students to leverage these skills to more independently individualize and gain mastery over their learning processes (Mooji, 2009; Yot-Domínguez & Marcelo, 2017). The power of technology for learning can be both daunting and exciting to imagine and to wield; learning to harness it for both teaching and learning is a matter of ongoing informed and intentional practice. The recent pandemic has further reinforced that questions, tensions, and evidence related to educational technology are essential as research aims to support teachers and students optimize learning experiences. Student perceptions presented in this paper can guide educators as they consider the conditions and structures required to effectively implement and sustain technology in support of learning.

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Appendix

CODE LIST

Theme	Category	Example codes
Engagement	Interest in learning	Interactive apps, explore interests
	Interactions with peers and teachers	Increased collaboration, more opportunity for feedback
	Distraction from learning	Games, peers' misuse, class disruptions
	Technological challenges	Learning curve, reliance on Wi-Fi
Inclusivity	Access to information and resources	More access to resources, access after school, ease of access
	Opportunities for differentiation	Work at own pace, varied learning
	Physical consequences	Eye strain, back strain, headache
	Social impact	Less face-to-face, overcome social barrier
Learning	Implications for learning processes	Stay organized, slows down class, doesn't support learning style, easier on paper
	Development and deterioration of skills	Develop technology skills, future skills, lose skills
	Impact on outcomes	Worsens grades, negligible impact on grades