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The Interactive Whiteboard: Uses, Benefits, and Challenges. A survey of 11,683 Students and 1,131 Teachers

Le tableau blanc interactif : usages, avantages et défis. Une enquête auprès de 11 683 élèves et 1131 enseignants

***Thierry Karsenti**, Université de Montréal*

Abstract

Over the past five years, the interactive whiteboard (IWB) has been massively introduced into schools across the province of Quebec, Canada. This study explores how the IWB is being used, and the associated benefits and challenges. Data on 11,683 students (from 4th year elementary to grade 12) and 1,131 teachers were collected with five instruments: 1) a survey questionnaire for all students, 2) a survey questionnaire for all teachers, 3) individual interviews with teachers, 4) group interviews with teachers, and 5) group interviews with students. Far from calling into question the need to integrate technology into education, the results reveal that certain tools, such as the IWB, may be more complicated and time-consuming to integrate than others. However, despite teachers' reports of technical problems, the IWB appears to have real educational potential.

Résumé

Au cours des dernières années les tableaux blancs interactifs (TBI) ont été massivement introduits dans les écoles du Québec (Canada). Cette étude explore comment cet outil numérique est utilisé, de même que les avantages et les défis qui y sont associés. Les données ont été recueillies auprès de 11 683 élèves (de la 4e à la 12e année) et 1 131 enseignants avec cinq outils de collecte de données: 1) un questionnaire d'enquête pour tous les élèves; 2) un questionnaire d'enquête pour tous les enseignants; 3) des entrevues individuelles avec des enseignants; 4) des entrevues de groupe avec des enseignants; 5) des entrevues de groupe avec des élèves. Loin de remettre en question l'intégration des technologies en éducation, les résultats de cette étude révèlent plutôt que certains outils, comme le TBI, peuvent parfois être plus complexes et chronophages à utiliser que d'autres. Néanmoins, même si plusieurs enseignants ont souligné les nombreux problèmes techniques, le TBI comporte un grand potentiel éducatif.

Introduction

At the 2003 World Summit on the Information Society, Kofi Annan proclaimed that rapid technology advancements can "propel" us to "improve standards of living for millions of people on this planet."He also foresaw that the power of these tools will be increasingly felt in economic, societal, and educational spheres. In Quebec, across Canada, and around the world, more and more classrooms feature an interactive whiteboard (IWB) (Figure 1). Also called an IW or an interactive digital whiteboard (IDW), it is an electronic whiteboard that displays content projected by a computer, tablet, or other source. The IWB combines touch (pen-and-finger) control of the screen with computerized input from a variety of devices operated by teachers or students. However, while the IWB has become practically standard in the education systems of certain American states, and countries such as Australia—and especially Great Britain, where they are present in 100% of elementary schools (Kitchen et al., 2007) and 72% of high school classrooms (Lee, 2010)—IWBs began to be introduced into Quebec's education system only in the last five years.

The usual justification for this massive introduction of technologies—put forward by both governments and businesses—is that IWBs can improve school and academic outcomes by improving teaching practices, by diversifying teaching resources (e.g., graphics, videos, audio), and by introducing more interactive teaching and learning activities (e.g. Karsenti and Collin, 2013). Nevertheless, questions have been raised about its actual usefulness for schools, particularly from a cost–benefit perspective.

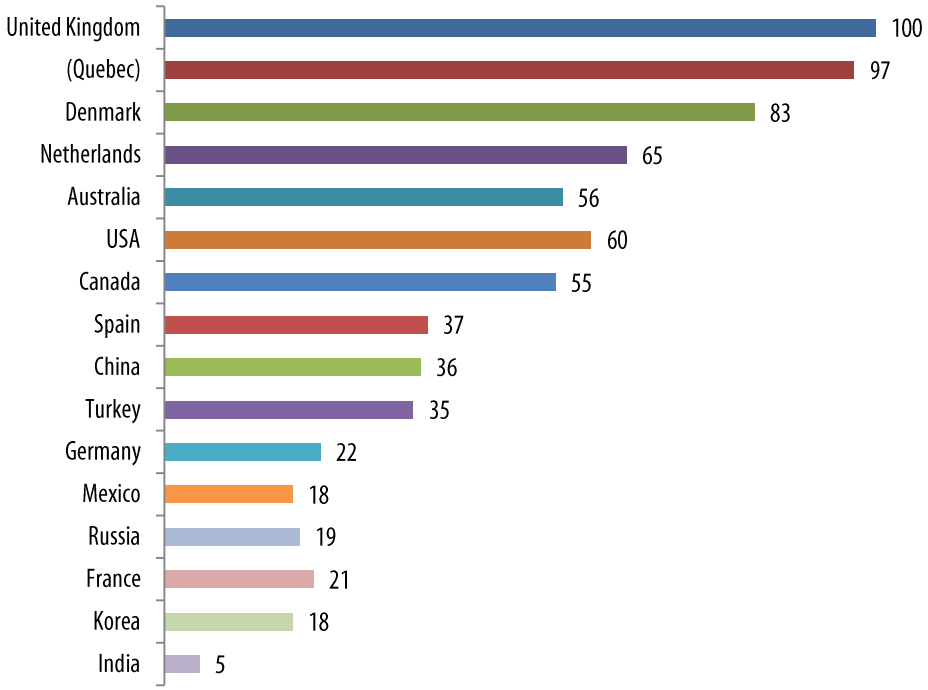

Figure 1. Presence of interactive white boards (IWB) in classrooms in various countries (http://futuresource-consulting.com/2014-06-EducationHardware-1176.html).

As of 2016, not much is known about how the IWB is actually used or the real impacts on educational outcomes, and the results on the educational impacts are contradictory. Sometimes the impacts are modest, with no real significance for learning. Alternatively, many case studies, action research studies, and anecdotal accounts describe how exceptional teachers use the IWB (e.g. Raby, Bergeron, Tremblay-Wragg, Gagnon, Charron, 2015). These instructive studies predict how teachers might eventually integrate the IWB. However, there is usually a particular focus: how the IWB is used by exemplary teachers who have fully integrated the IWB into their teaching practice. There are very few accounts of failed experiments.

As Türel (2010, p. 3050) argued, we do not yet have enough rigorous empirical evidence on the impacts of educational technology on learning and academic performance. This calls for careful reflection on IWB uses, as well as the real educational impacts.

Theoretical Framework

What Does the Research Say About the IWB in Education?

Our literature review reveals that although many publications have addressed the IWB, very few have assessed the educational impacts empirically (see Khambari et al., 2014; Lopez, 2010; Türel, 2010). Despite the many pedagogical recommendations for teachers, only a handful of authors, such as Hennessy (2014), have explored the impacts. Several case studies (e.g., Kennewell and Beauchamps, 2007; Kennewell, Tanner, Jones, and Beauchamp, 2008) have examined small groups of highly tech-savvy teachers and their use of the IWB. Studies tend to sing the praises of the IWB, but often without solid grounds, somewhat like advertising flyers. This is not surprising, given that many reports are funded by IWB producers (Glover et al., 2005; Smith et al., 2005). Furthermore, the claimed benefits are not necessarily consistent with actual teaching approaches.

Among the touted benefits, the IWB is said to allow better teaching through demonstrations "at the front of the class" (Khambari, Hassett, Thomas, and Wong, 2014). However, in the current era of student-centered learning, many argue for less lecturing by teachers and more engaged students (e.g. Raby et al., 2015). Khambari et al. (2014) argue that teachers may feel caught between recommended open-ended, student-centered learning approaches and use of the IWB. However, Cutrim Schmid (2008) demonstrated certain benefits—as well as some major challenges—of IWB use for language teaching, and Slay et al. (2008) found plenty of challenges in using the IWB in South Africa, particularly underuse of its interactive features.

We also retrieved 15 literature reviews or meta-analyses on this topic, including Miller and Glover's (2010) exhaustive synthesis of 100 sources. However, the authors' objective was not to judge the methods used, but instead to draw an overall portrait (p. 1) of the results without assessing them. Furthermore, of the 15 reviewed syntheses, only four included a detailed description of the research methodology (DiGregorio & Sobel-Lojeski, 2010; Golonka et al., 2012; Saltan et al., 2009; Twiner et al., 2010), indicating a lack of rigor. Overall, these studies and meta-analyses mentioned two potential benefits of the IWB: better presentation of certain theoretical content using multisensorial techniques (Saltan et al., 2009), but at the same time using a lecture-style approach (see Littleton, 2010); and higher student interest, at least in the

short term (see Balta & Duran, 2015; DiGregorio & Sobel-Lojeski, 2010; Wall et al., 2005). Greater student motivation (see also Higgins et al., 2007, 2010; Hall & Higgins, 2005) was the most frequent finding across the studies, although appetite for the IWB appears to wane over time (see Balta & Duran, 2015; Dostal, 2011; Türel, 2010).

For example, Balta and Duran (2015) noted that, "As students get older, their positive attitudes toward interactive whiteboard technology decrease …" (p. 16). DiGregorio and Sobel-Lojeski (2010) propose that the strength and duration of the IWB impact depends primarily on the teaching practices used (p. 268). Harlow et al. (2010) showed that certain IWB uses add shared interactional spaces where students can save and retrieve their work (p. 239). In other words, the IWB has the potential to allow students to collaborate (see also Littleton, 2010; Saltan et al., 2009; Warwick et al., 2010), but only in certain circumstances. For Littleton (2010), the IWB, by enabling teaching at the front of the class, actually "saves time" (p. 287). Finally, Dostal (2011) notes that the IWB can also make it easier to archive and share written work. Nevertheless, few serious studies to date have demonstrated any real impacts of the IWB on academic achievement. Instead, they have generally found either no impacts (see, e.g., Lopez, 2010) or else minimal positive impacts for certain subjects, such as mathematics (see Swan et al., 2008), which could be attributed more to the attention paid by the participating students rather than the IWB itself. Others have found negative impacts (see Moss et al., 2010).

Türel (2010) and Khambari et al. (2014) contend that no study to date has concluded that the IWB has positive impacts on academic achievement. In fact, it is just the opposite: the many technical issues, combined with lack of support (see also Fekonja-Peklaj et al., 2015), tend to undermine both student and teacher motivation. Several of the reviewed meta-analyses underscored negative impacts of the IWB, such as wasting teachers' time and the scarcity of technical support help (see Dostal, 2011). Other researchers say that teachers who use the IWB spend more time dealing with technological than educational issues (see Sundberg et al., 2012).

Overall, the findings lead to only two solid conclusions: greater student motivation—which diminishes with time—(see Higgins et al., 2007), and better presentations of theoretical content by teachers—albeit using a lecture-style approach (see Littleton, 2010).

A recent OECD report (September 2015) called "Students, Computers and Learning: Making the Connection" addresses issues of the educational use of the IWB. The impacts of information and communication technology (ICT) on education across 30 countries were examined, revealing that countries that were early adaptors of computer technology for education tend to show poorer learning outcomes. And it gets worse, as the more that students use new technology, the worse the learning outcomes: "…but students who use computers very frequently at school do a lot worse in most learning outcomes, even after accounting for social background and student demographics" (p. 3). Nevertheless, certain exceptions to this trend suggest that even though technology holds enormous potential, the teacher still plays a central role.

In Quebec and abroad, many instructive studies (accounts of practices, action research) have illustrated how teachers can appropriate the IWB and other technologies (see, e.g., Ersoy & Bozkurt, 2015; Raby et al., 2015). Although highly inspiring for future teachers, and for teachers who want to improve, these studies do not fully address the uses, benefits, and challenges of the

IWB in the classroom. Despite the scientific legitimacy of these studies, more extensive research is needed on actual IWB use, and on the real educational impacts, in order to guide policies and actions by government and education decision makers.

Method

Participants

The study participants included 11,683 students (from 4th year elementary to 5th year high school) and 1,131 teachers in Quebec schools. The students (6,211 girls, 5,472 boys) were from 10 to 18 years old, with an average age of 14.1 years; 88.4% were in high school (*n* = 10,324) and 11.6% (1,359) in elementary school (mainly 6th year). Of the teachers, 67.4% (634 women, 497 men) had from 11 to 25 years of teaching experience (see Figure 2). They taught a range of subjects in the Quebec education system. Participants were selected on a voluntary basis from schools in which the IWB was used in class. Data were collected from August 2014 to May 2015.

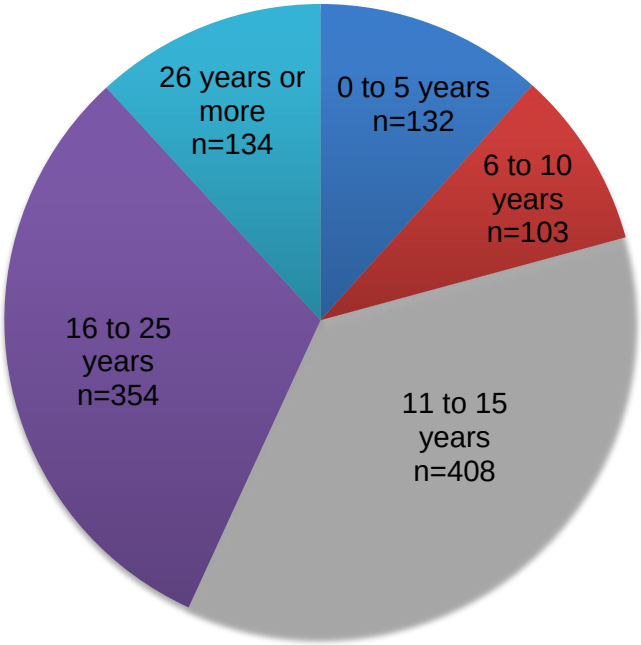

Figure 2. Number of years of teaching experience for participating teachers.

Data Collection Instruments

Data were collected from 12,814 participants who were currently in the education system (11,683 students; 1,131 teachers). Five instruments were used:

- A survey questionnaire for all students (*n* = 11,683)
- A survey questionnaire for all teachers (*n* = 1,131)
- Individual interviews with teachers (*n* = 31)
- Group interviews with teachers (8 groups of from 6 to 17 teachers)
- Group interviews with students (16 groups of from 8 to 24 students)

Data Treatment and Analysis

The questionnaires contained both Likert scale responses and open-ended questions. Responses were subjected to a mixed analysis. A quantitative analysis, including descriptive statistics, was conducted using SPSS 23 and the online survey tool SurveyMonkey. A complementary qualitative analysis of the open-ended questionnaire responses was conducted using QDA Miner, including a content analysis (see L'Écuyer, 1990; Miles & Huberman, 2003) with semi-open coding constructed from the participants' responses concerning the main research issues (uses, benefits, and challenges).

The individual and group interviews were analyzed by content analysis, following L'Écuyer (1990) and Miles and Huberman (2003). Qualitative analyses were conducted using QDA Miner, a widely used qualitative data analysis tool (Karsenti et al., 2011).

Main Results

How Was the IWB Used by Teachers and Students?

The results revealed that 48.2% of teachers used the IWB "always" or "often" versus 39.3% who used it "sometimes" or "rarely" and only 12.6% who "never" used it (Figure 3).

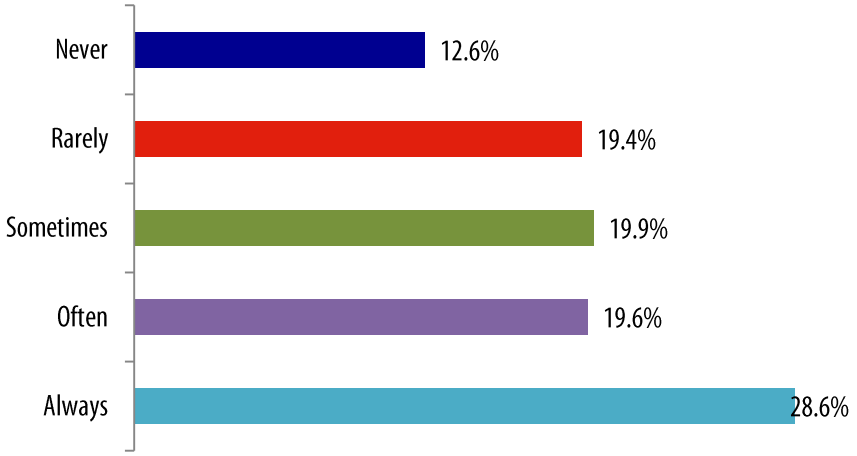

Figure 3. Use frequency of the IWB by teachers.

The individual and group interviews provided a general overview of the use frequency. Teachers who "always" or "often" used the IWB explained that it "made it easier to present material to the class" (high school teacher). Others also found it easier to show information that they found online: "I can show my students all kinds of things that I find on the Internet" (high school teacher). Some teachers who used the IWB regularly found that it simply replaced the old blackboard, including one high school teacher who said they had no choice, as they no longer had a blackboard."

Teachers who used it "sometimes" or "rarely" felt that it was overly complicated to use, and that the technological problems were daunting:

- "…sometimes, it's not programmed… it takes a long time to do and I don't have the time before class …" (high school teacher).
- "… because it doesn't always work … I only use it when I have extra time …" (high school teacher).
- "… I sometimes use it … but I have my plan B … it hardly ever works …" (high school teacher).

Of the teachers who never used the IWB, some were put off by technical problems: "… I've been waiting now for over two months … the lamp doesn't work anymore …" (elementary school teacher). Others felt that they didn't need it to teach: "… I never asked for it … it's complicated … and I don't think it's very useful … so, no … I don't use it" (high school teacher).

With respect to student participation, did the teachers have their students use the IWB? The data revealed that only 4.0% "always" or "often" had their students use it, versus 23.4% who had them use it "sometimes" and 72.6% "rarely" or "never" (Figure 4).

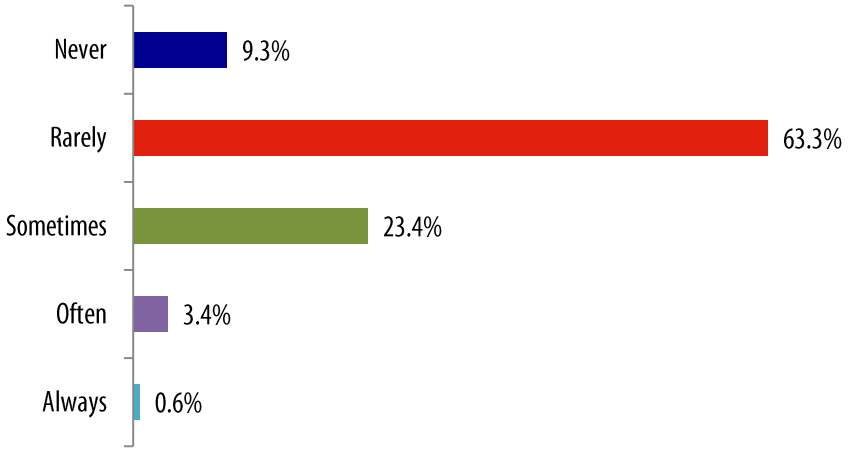

Figure 4. Use frequency of the IWB by students according to teachers.

In the individual interviews, the teachers had many reasons for not having their students use the IWB:

- "… in high school … the classes are big … it's hard to manage the class when you get everybody to the front of the room …" (high school teacher).
- "… it doesn't work very well … and if on top of that I let the students use it … I think that it would never work …" (high school teacher).

We also asked the students how they used the IWB in order to compare their responses to those of the teachers (Figure 5). The responses showed little variation overall, confirming that they did not use the IWB very often. Thus, 4.4% of students felt that their teacher "always" or "often" let them use the IWB, with 12.9% "sometimes," "29.5% "rarely," and 53.2% "never" responses.

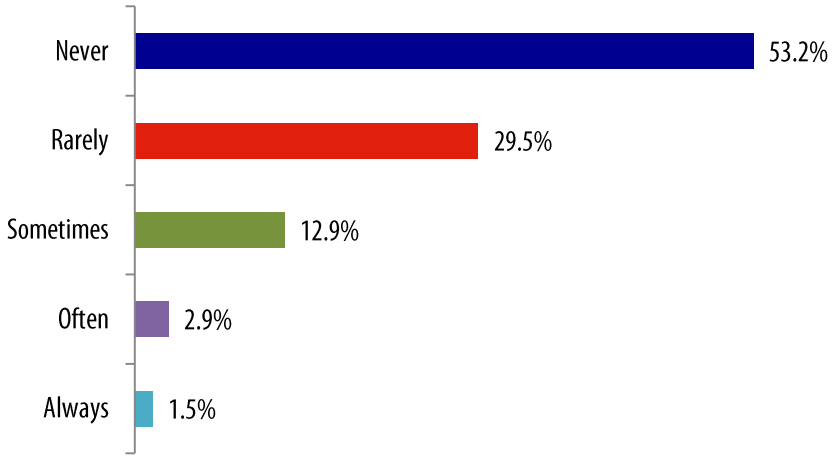

Figure 5. Use frequency of the IWB by students according to students.

The group interviews with students provided further insight into why the teachers had them use the IWB:

- "… our teacher lets us go on the Internet sometimes …" (elementary school student).
- "… as soon as it stops working … she [the teacher] asks one of the students for help …" (high school student).
- "… when we do math … I sometimes come up to the front of the class and write the answers …" (high school student).

They also revealed why students were rarely asked to use the IWB:

- "… it's not very interactive … the teachers just write on it …" (high school student).
- "… it's usually not working … I don't think that my teachers want us to touch it …" (high school student).
- "… if we touch it …, the teachers are going to think that it's our fault that it doesn't work anymore … so we don't touch it …" (high school student).

Furthermore, we asked the teachers to describe the main ways that they used the IWB in class, revealing ten main uses (Figure 6). The most common (51.6% of teachers) was creating multimedia presentations with programs like Notebook or PowerPoint. This was followed by Internet searches (19.3%), video presentations (10.8%), presentation of class notes as PDG or Word documents (6.9%), and math and science demonstrations, particularly math (4.8%). Group corrections of written work, especially French texts (1.7%), presentation of digital books and textbooks (1.5%), interactive activities and exercises (1.4%), students' oral presentations (1.2%), and geographic maps (0.8%) complete the list. Apparently, the IWB was used mainly to project content onto the screen, and not as an interactive digital tool to support teaching and learning, with only 2.6% of the main uses reported by teachers described as interactive.

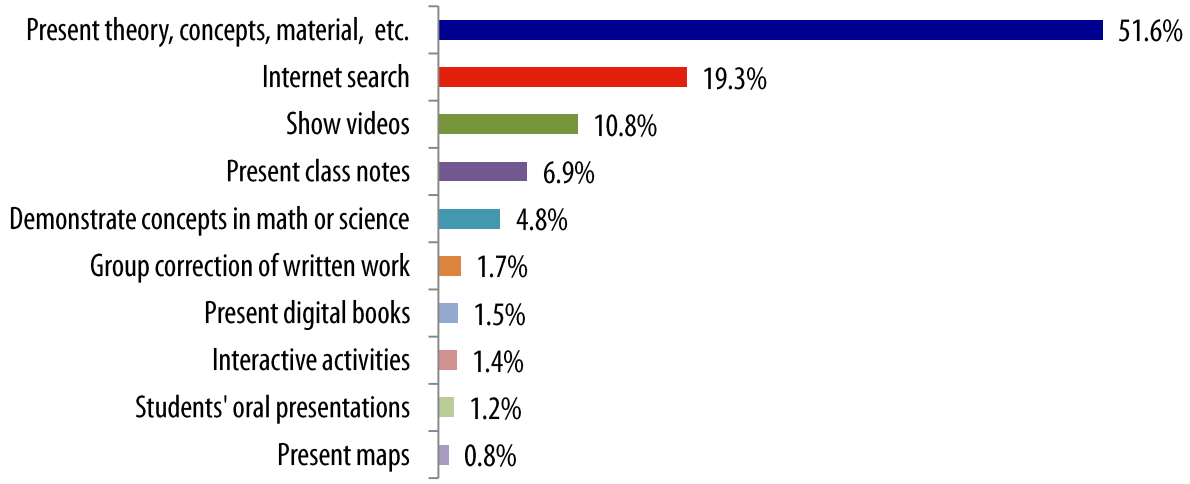

Figure 6. Main uses of the IWB in class.

What Were the Main Benefits of the IWB?

Both students and teachers came up with a substantial number of benefits. First, we asked all the students (11,683) and teachers (1,131) if they preferred the IWB or the traditional blackboard. The students were almost unanimously in favor of the IWB (99.2 %) over the blackboard (0.8 %). The group interviews with the students confirmed this:

- "… it's definitely better … the teacher can go online …" (high school student).

Although a large majority of the teachers preferred the IWB (73.6%), they were notably less enthusiastic about using it in class, and the interviews revealed why some continued to prefer the traditional blackboard:

- "… it never works … it's complicated … I'd prefer a blackboard and chalk …" (high school teacher).
- "… I have several groups … in some classes, it doesn't work … so I have to prepare different lesson plans … I prefer not to use it …" (high school teacher).
- "… I never wanted it, I didn't ask for anything … I don't use it … I find it a waste of time …" (high school teacher).

We also asked the students and teachers more specifically about the benefits of having the IWB in the classroom (Figure 7). According to the students, the main benefit was permanent Internet access in class (23.5%). They found it amazing that they could "have Internet access through the whiteboard" (high school student). They also appreciated the visual support for teaching (19.1 %), watching videos (12.2 %), their greater motivation to learn (11.8 %), more varied teaching strategies (9.3 %), learning better and more (9.1 %), saving time—when there were no technical problems (7.2 %), having a more organized teacher (5.8 %), communicating with classmates (1.3 %), and doing interactive activities (0.7 %).

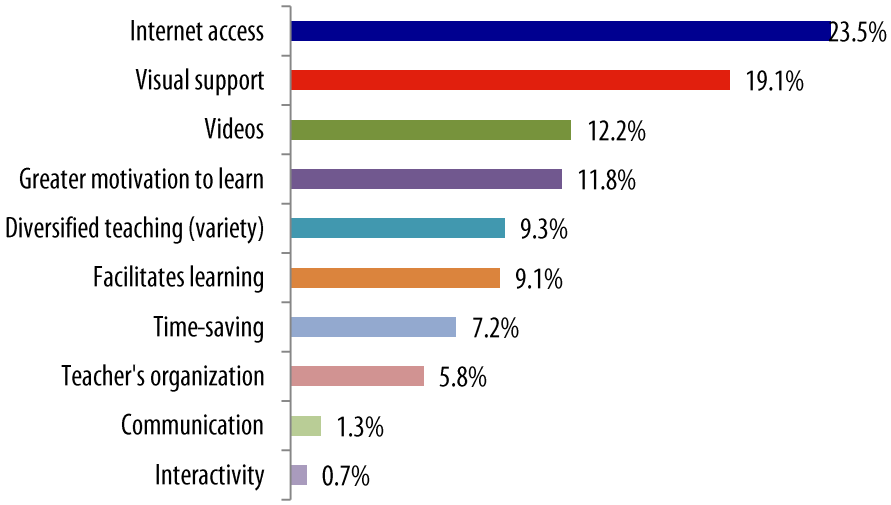

Figure 7. Main benefits of the IWB according to students.

The main benefit of having the IWB in the classroom, as reported by 29.2% of the teachers, was "finally, having Internet access in the classroom" (high school teacher). Other benefits (Figure 8) were visual support for teaching (18.8 %), and particularly multimedia presentations such as PowerPoint. Many teachers also mentioned higher student motivation (11.6 %). They also found that the IWB helped them diversify their teaching approach (9.5 %), usually enabled more effective teaching—as long as there were no technical problems (6.3 %), and was generally beneficial for learning (6.1 %), regardless of the subject being taught.

Some teachers said that, despite the extra time involved, the IWB helped them organize their work (5.9%), including planning lessons, managing documents, and so on. A few (4.0%) said that the IWB helped students concentrate.

Only 3.9% thought that the IWB could have positive impacts on students' academic outcomes. A small number—particularly math and science teachers—emphasized the benefits for learning certain concepts (2.8%).

Some (1.3%) liked the ability to "communicate with others, in front of the students, from the front of the class …" (high school teacher). Only 0.6% mentioned interactivity as a benefit.

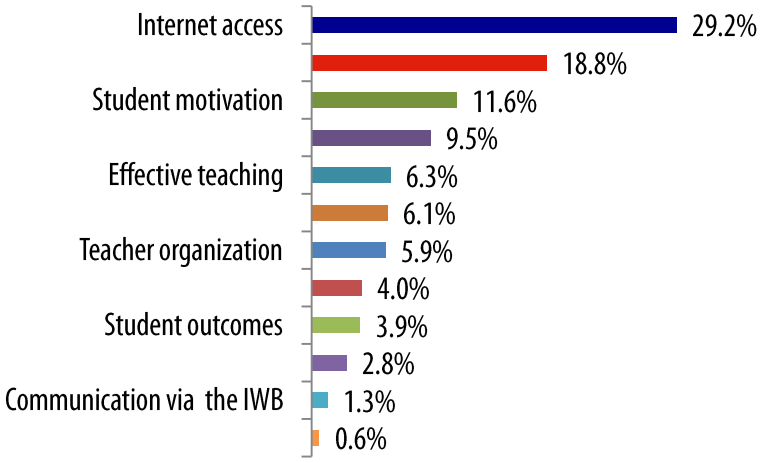

Figure 8. Main benefits of the IWB according to teachers.

Specific Benefits of IWB Use

The large study sample (11,683 students) enabled performing more advanced statistical inferences. Briefly, the characteristics of a given population (i.e., students and teachers across Quebec) were induced from the population sample (i.e., the participating students and teachers). We then ran diverse statistical correlations. The results revealed some significant relationships (see Table 1), for instance, between the use frequency of the IWB by students and student-perceived impacts on variables known to be closely associated with academic achievement (academic grades, concentration in class, school motivation, overall satisfaction at school).

Table 1

Correlations Between Impacts Perceived by Students and IWB use Frequency

Academic grades	0.308**
Concentration in class	0.265*
School motivation	0.367**
Overall satisfaction at school	0.312**

*p < 0.001; **p < 0.0001.

The results show that the more students used the IWB in class, the more positive the perceived impacts on their grades, school motivation, concentration in class, and overall satisfaction at school (Table 1). In line with previous studies, this indicates increasing impacts with more frequent use. Previous studies have also found that teachers who had their students use the IWB frequently perceived similar impacts, but this was not the case here.

The results of the present study do not allow concluding overall positive or negative impacts of IWB use on students' academic achievement. In fact, only 3.9% of the teachers reported such impacts. However, the results in Table 1 reveal positive perceptions by the students.

Nevertheless, only 4.0% of the teachers said that they "always" or "often" had their students use the IWB. We may propose two explanations for the students' positive perceptions. First, IWB use could have provided some interactive situations where students participated actively in learning. Second, the IWB could have provided students with opportunities to use specialized software that would help them learn academic content.

Challenges of IWB Use in Class

We asked both students and teachers about the challenges they encountered as well. Figure 9 depicts the major challenges for teachers, the most formidable being technical problems, cited by 70.6%: "… I've never seen anything that broke down so much … and you have to wait for the technician … he spends all his time fixing them …" (high school teacher). At 17.3%, the time spent working with the IWB was another major issue. It was viewed as a time-consuming tool, for many reasons:

- "… it takes up a lot of teaching time … you see, to learn how to use the IWB, I have to give up even more of my evenings and weekends …" (elementary school teacher).
- "… preparing lessons for the IWB … it really takes a lot of time … which I don't have …" (high school teacher).
- "… I find that I have to fool with the Interactive whiteboard before every class … it takes too much time …" (high school teacher).
- "… learning how to use all the IWB features … it takes time …" (high school teacher).
- "… for me, it's finding materials that takes up my time …" (high school teacher).

In addition, several teachers (9.6%) brought up the size of the screen: "… I have 32 students in my class … the screen is too small if you're sitting at the back [of the class]" (high school teacher). Class management was mentioned by a few teachers (1.4%). Last came inadequate training (1.1%). For many teachers, the problem was not a lack of training, but rather a lack of time to learn how to use the IWB before trying it out with the students:

- "… I took some useful training sessions … but I didn't have the time to really sit down in class and try it out … I need that … without my students around me …" (high school teacher).
- "… the training, it's only part of the problem … what I would need is training in my classroom … that way I could be ready for my students …" (high school teacher).

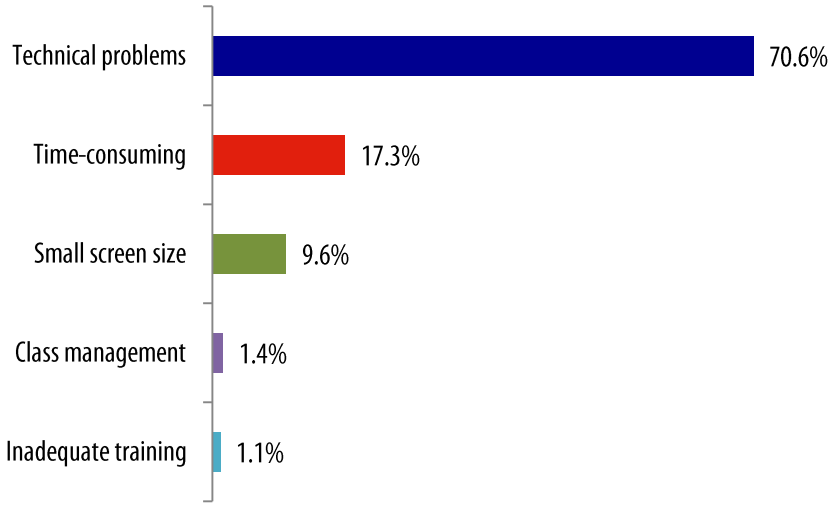

Figure 9. Main challenges of the IWB according to teachers.

In terms of how frequently they dealt with technical problems in class (Figure 10), 93.5% of the teachers felt that they "always" (23.6%) or "often" (69.9%) had such problems. Only 6.5% felt that they "sometimes" (2.9%), "rarely" (2.3%), or "never" (1.3%) did. Clearly, technical problems constitute the greatest challenge of IWB use in class.

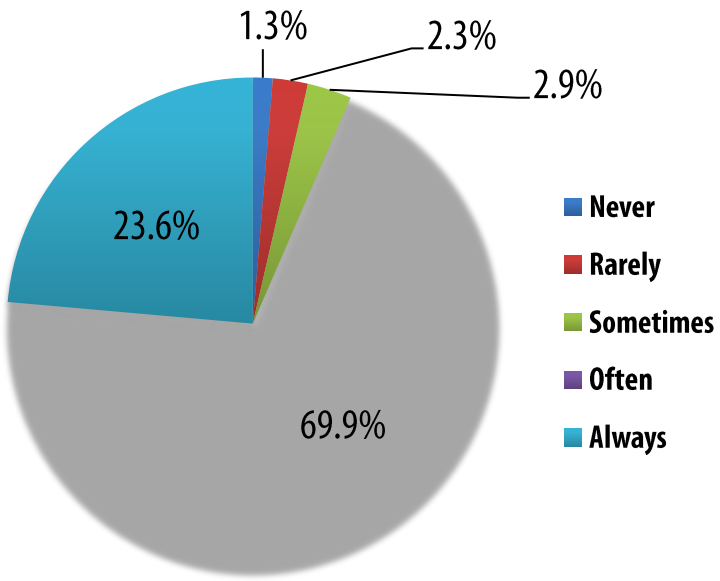

Figure 10. Frequency of technical problems according to teachers.

These frequencies were confirmed by the results of the individual and group interviews:

- "… I have technical problems very often … and then I have to wait for the technician …" (elementary school teacher).
- "… there's always something that needs fixing … it gets in the way of my teaching …" (high school teacher).

We also asked the teachers how many of the technical problems they managed to resolve on their own. Overall, the results show that the IWB incurred major and frequent technical problems that the teachers were usually unable to resolve by themselves with only 7.4% of the teachers reporting that they could resolve technical problems on their own.

In other words, 92.6% of the teachers had technical problems that required outside help, usually a technician. Thus, the great majority of them felt that they were more or less at the mercy of the technician—employed by the school board or the IWB provider—who had to come to their rescue: "… whenever there's a problem … we have to wait for the technician … sometimes it takes weeks …" (high school teacher).

Due to the many technical problems, teachers (especially high school teachers) who used the IWB had to prepare two sets of lesson plans. Planning a lesson with the IWB already took up too much time, and on top of that, they needed a back-up lesson plan in case the IWB didn't work: "… if the interactive whiteboard wasn't working with a group … I have to make another lesson plan … this doubles the work … " (high school teacher).

The students' responses (Figure 11) were somewhat different, with a few similarities. For example, technical problems headed the list (33.5%): "… it usually doesn't work … the teachers waste a lot of time installing it …" (high school student).Second came the small screen size (25.4%): "… the screen's too small … my TV at home is bigger …" (high school student). This was a particular sore point for high school students, some of whom had a bigger TV screen at home for watching films and playing computer games.

Many students also complained that their teacher was inept at using the IWB (19.0%): "… even though it's not always their fault … but it breaks anyway" (high school student). The problem appeared to be that the teachers were too often unable to resolve technical problems:

- "… my teacher can never fix it when there's a problem … she always says she has to wait for the technician …" (high school student).
- "… the digital whiteboard is super complicated … my teachers can never get it to work … we have to wait for a technician …" (high school student).

Many students cited loss of motivation as a challenge (18.3%):

- "… at first, I liked it … but after a while … it got boring … a lot of students are practically asleep …" (high school student).
- "… it wasn't interesting to look at hundreds of pages scrolling down …" (high school student).

At the bottom of the list (3.8%) was the lack of interactivity in the lessons when their teacher used the IWB: "… it's monotonous … there's only the teacher talking all alone … we students … don't do anything …" (high school student). In other words, the vast majority of the teachers used the IWB as a digital projector and neglected the interactive features.

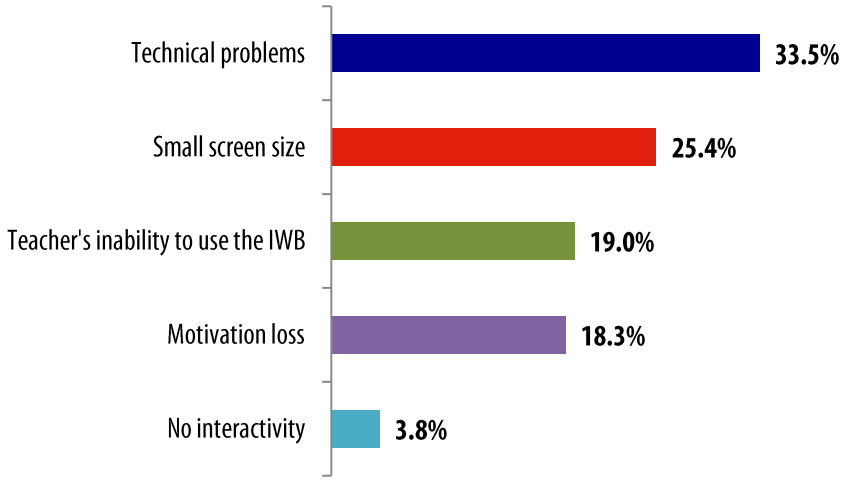

Figure 11. Main challenges of the IWB according to students.

Conclusion

For the OECD (2015), technology represents the "very future" of education. Moreover, as technology becomes all-pervasive, it becomes increasingly vital for upcoming generations to acquire technology skills if they want to succeed professionally and socially. Being able to self-train, self-learn, and communicate via technology will be the *sine qua non* condition for adapting to and fully participating in societies that are in permanent flux. Learning with technology is therefore a key competency that will enable youth to succeed in all spheres of life.

The aim of this study was to identify how the IWB is used in Quebec schools as well as the associated benefits and challenges. Data were collected from 11,863 students and 1,131 teachers.

Despite the critical need to integrate technology into education, the results underscore that certain technology tools—such as the IWB, which gave the participating teachers substantial technical problems—may be excessively complicated and time-consuming to use. Nevertheless, the IWB has real pedagogical potential.

The IWB has been introduced en masse into schools across Quebec over the last five years. It appears that students appreciate having this technology in the classroom: 99.2% preferred the IWB over the traditional blackboard. However, whereas the large majority (73.6%) of teachers preferred the IWB over the traditional blackboard, a non-negligible percentage (26.4%) actually preferred the blackboard. Perhaps it was because the IWB was imposed on them. A mandatory new method or technology is palatable only when some degree of choice is involved. Self-determination theory (SDT, Deci & Ryan, 1985) provides some insight into the possible motivations of teachers who preferred the blackboard over the IWB.

That said, our results also show that slightly over half the teachers did not use the IWB regularly (48.2%), and that 51.8% used it "sometimes," "rarely," or even "never." It may not be easy to persuade teachers to use the IWB more often in class.

The problem does not lie solely in the teachers' uses of the IWB. The students had few opportunities to work with the IWB in class: only 4.0% were allowed to use it regularly in class.

Moreover, the teachers used the IWB primarily as a digital projector while neglecting the interactive features (1.4% of reported uses), which posed technical challenges. We propose that for the great majority of teachers, a simple electronic projector would be more suitable for teaching purposes, at far less cost and with a much larger screen. Furthermore, the IWB may represent a conflict for teachers who are reluctant to revert back to lecture-style teaching. Our results are fairly consistent with those of Khambari et al. (2014), who observed some conflict between open teaching approaches (also called student-centered learning, among others) and IWB use, often with lecture-style teaching.

Nonetheless, it is noteworthy that our results show that the IWB offers significant benefits for classroom use, including Internet access, visual teaching support, video presentation, motivation to learn, more effective learning, and efficient organization. We may therefore conclude that a judicious use of educational technology, accompanied by adequate training, could have positive impacts on academic outcomes. Furthermore, the impacts on the students in this study depended mainly on how the teacher used the IWB in class. Hence, despite the enormous educational potential, it remains up to teachers and students to take advantage of all that the IWB has to offer in order to realize that potential.

Overall, the results of this study show that the more students worked with the IWB, the more positive their perceptions of its impacts on their academic achievement, school motivation, concentration in class, and overall satisfaction at school. These are promising results, and the hope is that more than just 4.0% of teachers will venture into new territory and encourage their students to work with the IWB. There is an exciting new world of educational treasures to explore, and teachers who take the plunge will reap the rewards.

Clearly, technical problems pose a daunting challenge for teachers. Over 92.6% of the participating teachers reported technical problems that they were unable to resolve on their own. Other significant problems included the extra effort required—often on their own time—to learn how to use all the IWB features, the small screen size (especially for large high school classes), classroom management problems, and training issues. In short, classroom use of the IWB can be both time- and energy-consuming.

Hence, teachers need adequate technological and pedagogical support. The IWB should not be installed in classrooms until teachers are fully prepared for it. Teachers need pedagogical days so they can take individual or group training sessions to learn how to use all the IWB features and functions, especially the interactive aspects that foster student engagement. Many studies have demonstrated the effectiveness of hands-on technology training sessions as well as adequate technical and pedagogical support.

We cannot definitively conclude that the IWB has either negative or positive impacts on student outcomes. Only 3.9% of the participating teachers felt that the IWB could positively impact students' academic grades. This does not mean that the other 96.1% felt that the IWB had negative impacts. What it means is that the vast majority of the teachers felt that the ways that they used the IWB did not positively impact students' grades. They also felt that their uses of the

IWB had similar impacts, in many respects, to their uses of more traditional educational tools, such as the blackboard.

Because the vast majority of the teachers used the IWB as an electronic projector—which costs less, has a much larger screen, and entails fewer technical headaches—we believe that the 2011 imposition of the IWB on all of Quebec's teachers was a hasty decision. It might have been wiser to provide the IWB only to teachers who were inclined to use it more often, and were ready to exploit its full potential.

Whether or not technology impacts educational outcomes may not be the right question to ask; instead, we could try to identify the conditions that foster positive impacts of technology on student engagement and academic outcomes. In assessing the potential of technology for learning, the central issue is how that potential can be realized. We believe that, regardless of the potential, effective use of technology tools such as the IWB depends on how teachers and students use them. The critical question then becomes how to tap that potential through reflective use.

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Author

Thierry Karsenti, *M.A., M.Ed., Ph.D.* holds the Canada Research Chair on Technologies in Education. He is also a Full Professor at the University of Montreal. He is the director of CRIFPE (Research Center on Teachers and Teacher Education), which received the Canadian Education Association Whitworth Award for Best Education Research Center in Canada. Email: thierry.karsenti@umontreal.ca