

TPACK in Elementary and High School Teachers' Self-reported Classroom Practices with the Interactive Whiteboard (IWB)

Connaissances abordées dans les pratiques déclarées d'enseignants du primaire et du secondaire qui exploitent le tableau numérique interactif (TNI) en classe

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Abstract

The interactive whiteboard (IWB) is increasingly used for teaching and learning in the classroom. Nevertheless, the ways that teachers incorporate this tool within their teaching practices remain poorly understood. This paper examines elementary and high school teachers' self-reported practices with the IWB. The conceptual framework centers on teachers' self-reported practices as well as the Technological Pedagogical Content Knowledge (TPACK) model, a framework for successful integration of technology into teaching. Data were collected from discussion groups with 30 teachers. Overall, the results show a predominance of technological pedagogical knowledge (TPK) and technological knowledge (TK) regardless of grade level, gender, or years of teaching experience.

Résumé

Le recours au tableau numérique interactif (TNI) à des fins d'enseignement et d'apprentissage à l'école est de plus en plus fréquent. Cependant, les pratiques des enseignants qui exploitent l'outil sont encore mal connues. L'objectif de cette recherche est de rendre compte des connaissances que des enseignants du primaire et du secondaire mobilisent dans leurs pratiques déclarées au regard du TNI. Le cadre conceptuel repose sur des pratiques enseignantes déclarées et des connaissances (modèle TPaCK) à déployer pour assurer une intégration réussie des outils technologiques. Les données ont été recueillies auprès de 30 enseignants participant à des groupes de discussion et traitées selon une analyse de contenu. Globalement, les résultats montrent une prédominance de connaissances technopédagogiques (TP) et technologiques (T) chez les participants, peu importe l'ordre d'enseignement, le genre de l'enseignant ou l'expérience en enseignement.

Introduction

Use of the interactive whiteboard (IWB) is growing, and it is increasingly present in the classroom. However, the fact that the IWB is available does not necessarily mean that it is used, let alone effectively integrated into teaching practices.

Considered an innovation in terms of worldwide classroom use, albeit to varying degrees across nations (BECTA, 2007), the advantages of the IWB, according to Lefebvre and Samson's 2013 review, include keeping students interested and motivated, helping them understand abstract concepts, and enabling teachers to improve their teaching practices. The IWB can also accommodate a wide variety of needs, such as students' learning problems (Knight, Browder, Agnello & Lee, 2010), such as the possibility of representing better disciplinary concepts. It is an effective tool for implementing pedagogical changes (Warwick, Hennessy & Mercer, 2011). It is also an effective tool for implementing pedagogical changes (Warwick, Hennessy & Mercer, 2011). Despite these recognized advantages, teachers rarely use the interactive potential of the IWB (Lefebvre & Samson, 2013). What gets displayed on the screen appears to depend mainly on the resources that are available, as well as the teacher's ability to use the IWB for learning (CEFRIO, 2014). Whereas Al-Qirim (2011) noted a preference for traditional teaching with the IWB, Lewin, Somekh, and Steadman (2008) and Miller and Glover (2002) found that teachers were willing to change their pedagogical practices when they used it. However, many authors acknowledge that limited scientific data is available on the IWB's pedagogical uses (Gashan & Alshumaimeri, 2015; Karsenti, 2016; Kneen, 2015; Ormanci, Cepni, Deveci & Aydin, 2015; Winzenried, Dalgarno & Tinkler, 2010). Thus, the practices of teachers who integrate the IWB in the classroom remain poorly understood.

According to Mishra and Koehler (2006), effective classroom integration of technologies, which include the IWB, requires an understanding of the interplay between technological, pedagogical, and content knowledge. However, there is a lack of consensus in the literature on the kinds of knowledge that teachers need in order to integrate technological tools (Lefebvre, 2014). For the IWB in particular, this question remains unanswered, as there appears to be limited research in addressing the role of the teacher's knowledge in connection with classroom use of the IWB.

Consequently, the present study aims to identify the roles of different kinds of knowledge deployed in technology integration, based on teachers' self-reports of how they integrated technology, and more specifically the IWB, into their teaching practices—as previously suggested by Hsu (2010) and Lefebvre (2014). This type of research is vital in a context where government institutions—in Quebec and elsewhere—are investing large sums of money to purchase this technology and train teachers in its use.

This article provides an overview of the kinds of knowledge that Quebec elementary and high school teachers deploy in their self-reported uses of the IWB. We first present the conceptual grounds and the methodological design, followed by the main findings. We conclude with a discussion of the findings, suggested avenues for future research, and some limitations of the study.

Conceptual Framework

The conceptual framework for this study begins with a definition of the IWB. We then describe the collection, treatment, and analysis of the data on teachers' self-reported practices, and the kinds of knowledge they employed to effectively integrate technological tools, particularly, the IWB.

Definition of the Interactive Whiteboard (IWB)

The interactive whiteboard (IWB), also called the interactive whiteboard (IW) or the interactive digital whiteboard (IDW), is an electronic whiteboard on which the teacher can display content projected from a computer, tablet, or other source, and which can be used as a touch screen (using a pen or finger) to move content around (Karsenti, 2016). The IWB is usually used for multimedia presentations that can include images, audio, video, and Internet links (Glover & Miller, 2001).

Teachers' Self-reported Practices

It is difficult to establish an unequivocal definition of what teachers' practices means. Teachers' practices include what they do in class when students are present as well as what they do when they prepare their lesson plans and learning activities (Lefebvre, 2005). The art of teaching not only involves conducting teaching activities and interacting with students, but also implementing activities in diverse teaching situations. According to Beillerot (2000), the essential feature of what we call "practice" is its double dimensionality. On the one hand, there are actions, behaviours, and language; on the other hand, there are rules, objectives, strategies, and ideals. Hence, to examine self-reported practices, we must listen to what teachers have to say about their practices (Bru, 2004).

In this study, we focus on practices with the IWB, and more specifically, self-reported practices. To do so, we examine the kinds of knowledge that teachers deployed according to self-reports in discussion groups.

TPACK

The kinds of knowledge that teachers use have been increasingly investigated to address issues of technology integration into education. Many studies have adopted Koehler and Mishra's (2008) Technological Pedagogical Content Knowledge (TPACK) model. For example, Rosenberg and Koehler (2015) reviewed 193 peer-reviewed TPACK-based articles published in English journals from 2005 to 2013. More recently, Boschman, McKenney, and Voogt (2015), Figg, Jaipal Jamani, and Ciampa (2014), and Walker Beeson, Journell, and Ayers (2014), among others, considered deployed knowledge in their examinations of technology use in diverse settings. We chose the TPACK model because it allows specific targeting of teachers and their actions.

The TPACK model is a framework that identifies three kinds of knowledge used to integrate technology, here the IWB, for purposes of teaching and learning. Technological knowledge (TK) corresponds to knowledge about the IWB, the available resources, and the skills required to use it for various tasks. Pedagogical knowledge (PK) refers to how teaching and

learning occur, including didactics, learning assessment, and classroom management. Content knowledge (CK) refers to knowledge of the subject matter as prescribed by the school curriculum.

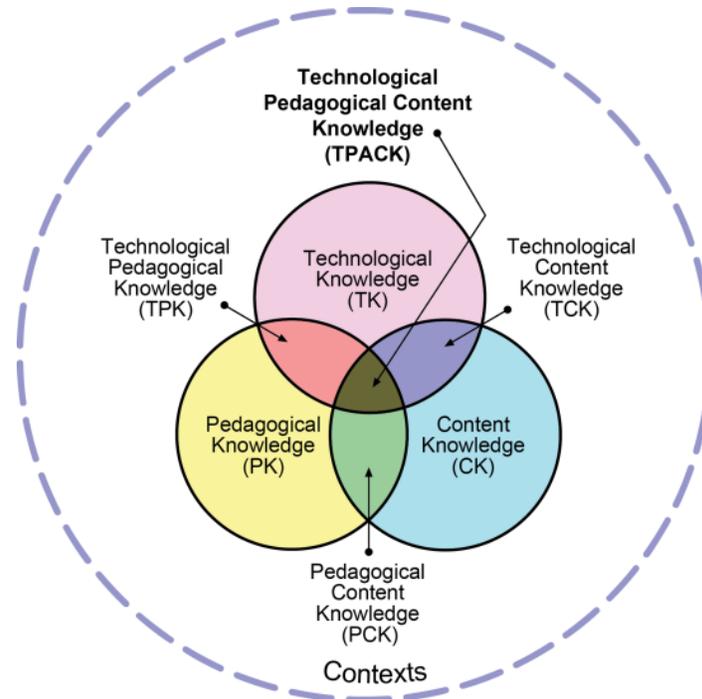


Figure 1. The Technological Pedagogical Content Knowledge (TPACK) model (reproduced with permission from the publisher, Copyright 2012, tpack.org).

The different kinds of knowledge may be combined in multiple ways. For example, technological content knowledge (TCK) corresponds to knowledge about interrelationships between content and the IWB, or ways in which this tool can enhance teaching and learning. Technological pedagogical knowledge (TPK) concerns knowledge of how to use the IWB with students. Pedagogical content knowledge (PCK) refers to consolidated knowledge about the most appropriate teaching methods for different subjects in the education program. According to Koehler and Mishra (2008), successful integration of technological tools requires an understanding of the complex interplay among technological, pedagogical, and content knowledge (TPCK).

Initially constituted of three subsets of knowledge, the model now considers the context (the dotted circle surrounding the kinds of knowledge) in which these kinds of knowledge operate. At school, the context could be the school itself, or the classroom and its dynamics. The context appears to be a significant component for understanding ICT integration (Rosenberg & Koehler, 2015).

This study attempts to answer the following question: what kinds of knowledge do Quebec elementary and high school teachers deploy when they use the IWB, according to their self-reported practices?

Methodology

The research question raised various methodological choices. This section briefly describes the research design, the participants, the data collection, and the data treatment and analysis.

Research Design

This study is part of a large funded research project that examined Quebec teachers' practices with the IWB at two measurement points (2012 and 2015). This article focuses on one aspect of the project: the kinds of knowledge that teachers used to integrate the IWB into their teaching practices, according to self-reports obtained in phase 1 of the study.

Many authors have applied the TPACK dimensions to quantitatively assess the integration of different technological tools, notably Chai, Koh, and Tsai (2016) and Jen, Yeh, Hsu, Wu, and Chen (2016). In contrast, the present study qualitatively examines the self-reported practices of elementary and high school teachers in connection with IWB use. According to Koh, Chai, and Tsai (2014), a qualitative approach would more adequately capture knowledge from teachers' discussions of their practices with the IWB compared to a quantitative approach. Accordingly, Dawson, Ritzhaupt, Liu, Rodriguez, and Frey (2013), Jang (2010), and Schmidt-Crawford, Tai, Wang, and Jin (2016) used this type of approach.

Given that the overall research objective was to describe teachers' practices with the IWB, we therefore adopted a qualitative approach (Ormston, Spencer, Barnard, & Snape, 2014) within a qualitative/interpretive study design in order to grasp the participants' perspective. Qualitative studies are frequently used to examine specific social situations or phenomena through the eyes of those who actually experience them (Marschall & Rossman, 2011). Here, we focus on how elementary and high school teachers use the IWB in their teaching practices.

Participants

The target population for the project comprised teachers working in both public elementary schools and high schools in the province of Quebec, Canada. About 300 teachers responded to a survey. Of these, 30 teachers agreed to participate in the qualitative phase (16 elementary school, 14 high school; 20 women, 10 men). The inclusion criteria required that the teacher have an IWB in the classroom, or access to one in another classroom, and used it regularly. In demographic terms, the 30 teachers worked in various regions of Quebec, both rural and urban. Their years of teaching experience varied from 4 to 30, with an average of 13 years.

Data Collection

Data for phase one were collected from November 2013 to June 2014. Given the wide geographic distribution of the teachers in the study, it was decided to hold group discussions, including face-to-face talks ($n = 1$) and synchronous online discussion groups ($n = 7$). For the synchronous online discussions, we used the Via eLearning & eMeeting Web conferencing tool (<https://www.sviesolutions.com/>). Although this type of group discussion has certain advantages, it also comes with some limitations (see Guillemette, M., Luckerhoff, J., & Guillemette, F., 2011, for more information). The advantages included the ability to reach participants located

across geographic regions, present documents to all participants simultaneously, and videotape the discussion sessions for later viewing. The limitations included certain technical difficulties related to limited Internet connections (e.g., response lag) and a higher risk of participant absenteeism.

The interview protocol contained 13 questions designed to elicit teachers' descriptions of their practices with the IWB in class. Topics included the frequency of IWB use and using the IWB for planning, pedagogy, teaching, and assessment. We also invited the participants to express their concerns about the IWB. Finally, we asked the participants to describe how they had used the IWB in class to carry out an activity, and whether or not they were satisfied with the result, along with the reasons for the result, in their opinion.

Data Treatment and Analysis

The data were subjected to content analysis, as described by Leray (2008), whereby the verbal reports were organized into meaning units according to defined categories. In this case, a meaning unit corresponds to an idea, generally expressed as either part of a sentence, a complete sentence, or several sentences. Seven categories corresponding to the kinds of knowledge in the TPACK model were considered: technological knowledge (TK), pedagogical knowledge (PK), content knowledge (CK), technological pedagogical knowledge (TPK), technological content knowledge (TCK), pedagogical content knowledge (PCK), and technological, pedagogical, and content knowledge (TPCK). Meaning units were double-coded by two team members, and over 90% inter-rater agreement was obtained on 30% of the overall data.

Results

Pamuk (2012) suggests that technology use can be explored in terms of various teaching profiles. Here, we differentiated the results according to gender, grade taught, and teaching experience. First, we present the overall results. The descriptive statistics apply to the overall results, namely the distribution in the teachers' self-reported practices of the kinds of knowledge deployed according to the TPACK model. Excerpts from the participants' verbal reports are provided to more explicitly illustrate the results.

Overall Results

The results reveal the proportions of meaning units contained in the teachers' statements during the group discussions. Figure 2 highlights an overall predominance of meaning units referring to technological pedagogical (TPK) and technological knowledge (TK), with equivalent proportions of 36% of the total meaning units ($n = 392$).

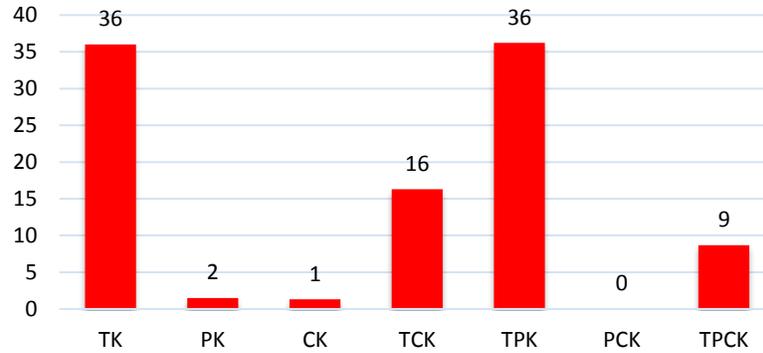


Figure 2. Distribution of teachers' self-reported kinds of knowledge according to the TPACK model ($n = 392$).

Note that technical content knowledge (TCK) accounts for 16% of all meaning units, compared to only 9% for technological, pedagogical, and content knowledge (TPCK). Coming last are pedagogical knowledge (PK) and content knowledge (CK), which teachers did not appear to have much to say about, with only 2% and 1% of meaning units, respectively. No meaning units were obtained for pedagogical content knowledge (PCK). In sum, TK and TPK predominated in the teachers' accounts of their practices with the IWB.

Gender Perspective

The results in terms of gender showed a similar distribution. Figure 3 shows that women as well as men cited mainly TPK (36% vs. 37%) and TK (36% vs. 37%) in connection with their teaching practices with the IWB. However, women tended to mention TCK slightly more often than their male peers did, at 19% and 13%, respectively. For the other kinds of knowledge, the results are similar for women and men: women mentioned TPCK at 8%, with 9% for men. Both women and men appeared to have made little use of PK or CK, at 1% and 2%, respectively. Neither women nor men mentioned using PCK.

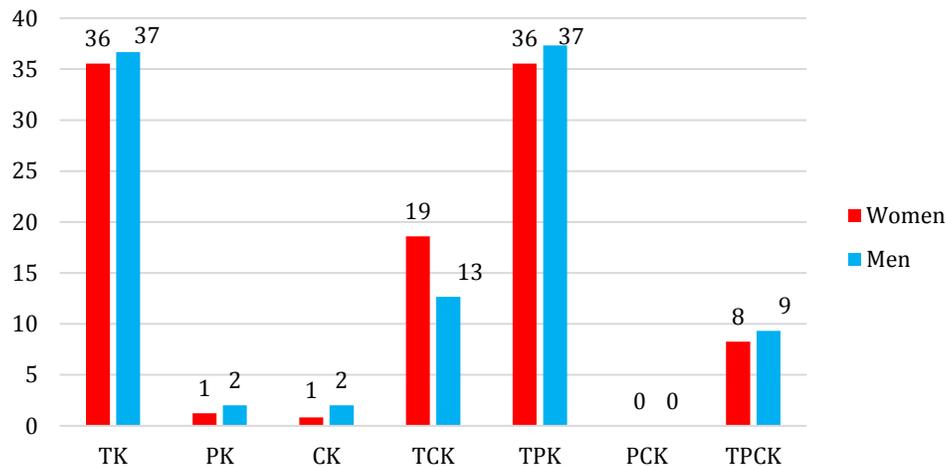


Figure 3. Distribution of teachers' self-reported use of kinds of knowledge by gender ($n = 392$).

Both women and men generally reported drawing on TK and TPK when they used the IWB. Notably, however, women reported using TCK slightly more than men did.

Elementary School and High School Teaching

Figure 4 provides a detailed breakdown of the meaning units for elementary school teachers: TPK and TK account for 42% and 40%, respectively. The following excerpt is an example of a statement concerning TPK: “It [the IWB] also lets me do differentiated teaching, because I have many more tools at my disposal. So I feel better equipped to help my students according to their specific needs” (Participant 12 – elementary). The next example, provided by an elementary school teacher, testifies to the benefits of his technical knowledge (TK) when using the IWB: “... I usually look for resources, visit sites, get good examples, and find things that we don’t necessarily have in the classroom” (Participant 7 – elementary).

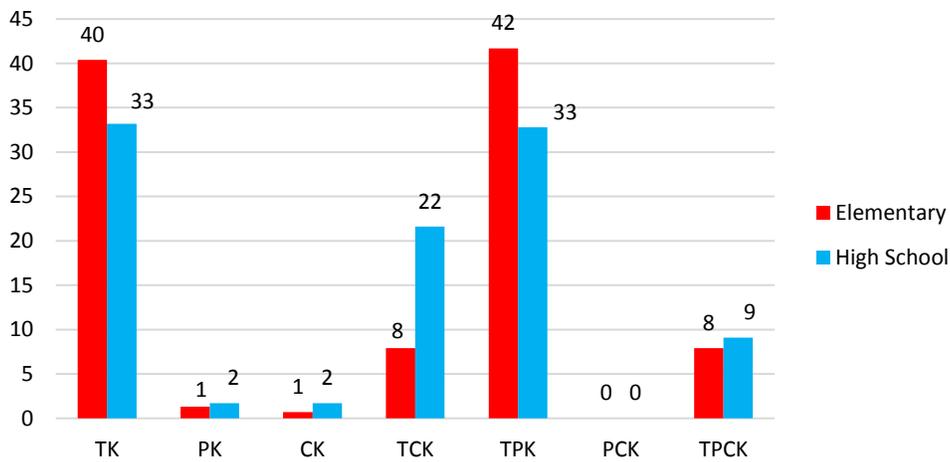


Figure 4. Distribution of teachers’ self-reported kinds of knowledge by grade level (n = 392).

At identical percentages, TCK and TPCK each accounted for 8% of the meaning units. The following statement illustrates how TCK were combined: “I’ll take an example from Math. I usually look for apps related to the concept that I want to look at. I look for websites and ready-made materials like PowerPoint presentations. I try to put it all together” (Participant 12 – elementary). An example of combined TPCK is: “In second cycle, I work on developing solid shapes in Math class. Each group has a foam cube. We put the cube together, using the app, and we work with the cube on the IWB. The students see the shapes as they take it apart and put it back together, and they can rotate it to view all the sides. They really see all the pieces. After, when I ask them to invent an animal based on a solid shape, they find it easy, because they’ve seen it. They’ve seen it rotated in space” (Participant 10 – elementary). Lastly, only a few meaning units referred to PK or CK, at 1% each, and no statements referred to PCK.

Similar percentages of meaning units were found for high school teachers. In fact, TK accounted for 33% of all meaning units. For example, they referred to creating digital visual support materials or using programs like *tébéciciel* (a type of program that can be used with the IWB, for example, Activ Inspire and Notebook): “That’s how I make links, Internet links. I insert an icon, so I can make another link, a link to a page in my Word documents. In my case, I

usually use the same things over and over” (Participant 2 – high school). Similarly, TPK is referred to 33% of the time, as shown by the following statement: “Well, me, what I tried, was to enlarge the graphics that I make ... so it’s easy to review things. I find that this makes it easier for the students” (Participant 4 – high school). As for TCK, it accounted for 22%. The following excerpt illustrates how some teachers used the IWB to teach specific content: “For fractions and money. They’re given an imaginary sum of money, and then they have to take quarters, loonies [the Canadian one-dollar coin is called a “loonie” because it features a loon, an aquatic bird found in northern countries] and two-dollar coins [called toonies in Canada] to make up the exact amount. We can do this with the IWB. It’s fun! It’s something we could never do before” (Participant 29 – high school). However, TPCK accounted for only 9% of the meaning units, and PK and CK accounted for only 2% each. The next example provides a good illustration of TPCK use: “Me, during the last module I did with my students in electricity, I designed a formative assessment with the IWB using the Activote program, which I’m slowly but surely introducing into my teaching. The students really liked it. They could see how everyone else was doing too. It calculates the voting results, so it’s really a way for them to situate themselves. Many of them liked the activity, and so did I. For a trial run, it worked out pretty well” (Participant 6 – high school). Finally, like the elementary teachers, the high school teachers never referred to PCK.

These results indicate that elementary teachers tended to talk more about their use of TK and TPK compared to their high school counterparts. In addition, both elementary and high school teachers rarely reported using PK, CK, or PCK. However, the main difference that emerges between elementary and high school teachers lies in the use of TCK: elementary school teachers mentioned this only 8% of the time, compared to 22% for high school teachers.

Years of Teaching Experience

With respect to years of teaching experience, teachers who had from 1 to 9 years of experience spoke more about TPK (45%) and TK (41%). The next most-often reported kinds of knowledge, CK and TCK, were identical at 6% each. TPCK accounted for only 2% of the meaning units. Lastly, these teachers made no mention of either PK or PCK.

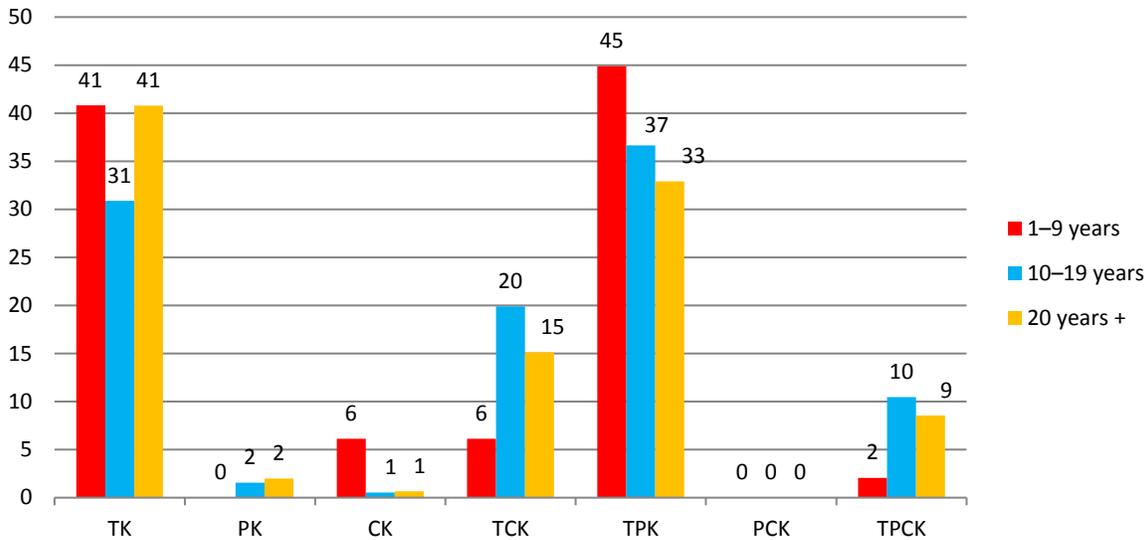


Figure 5. Distribution of teachers' self-reported use of knowledge in terms of years of teaching experience ($n = 392$).

Teachers with 10 to 19 years of teaching experience referred mainly to their use of TPK and TK, at 37% and 31%, respectively. TCK accounted for 20% of the meaning units, with 10% for TPCK. PK and CK accounted for 2% and 1%, respectively. Lastly, these teachers made no mention of PCK.

Teachers with 20 or more years of teaching experience referred to technological TK 41% of the time and TPK 33% of the time. TCK and TPCK accounted for 15% and 9%, respectively. Fewer references were made to PK and CK, with only 2% and 1%, respectively. Finally, like the other teachers, these more experienced teachers never referred to PCK.

Regardless of years of teaching experience, the participants spoke mainly about TPK and TK. Of note, however, is that CK, including all its combined forms, was mentioned more often by teachers with 10 years or more of experience compared to less experienced teachers.

Discussion

This study examined the kinds of knowledge that elementary and high school teachers reported deploying in order to use the interactive whiteboard (IWB) for teaching. The results show that the teachers referred most often to their use of technological knowledge (TK) and technological pedagogical knowledge (TPK) in self-reported practices with the IWB. Results were similar for women and men, regardless of grade level or years of teaching experience. These findings are in line with the findings of other authors, such as Lefebvre (2014) and Lefebvre, Melançon, and Lefrançois (2012), who investigated ICT integration within the practices of in-service and pre-service elementary teachers and in a teaching team that collaborated on an ICT integration project.

The results revealed that elementary and high school teachers rarely referred to either pedagogical knowledge (PK), content knowledge (CK), or pedagogical content knowledge

(PCK) in isolation. In other words, few teachers spoke about their practices in connection with teaching methods and subject content without referring to technological knowledge at the same time. This would explain the lack or absence of meaning units (discourse) concerning these specific kinds of knowledge. Because the study focused on IWB use, the participants may have felt obliged to talk mainly about the IWB, for a social desirability bias. However, the fact that high school teachers generally specialize in specific subject content while elementary teachers generally teach a wide range of subjects could explain the greater number of references to content knowledge (CK) by high school teachers compared to elementary teachers. High school teachers also appear to broach subject content more from didactical and epistemological perspectives than elementary teachers do. In this perspective, Tzavara and Komis (2015) investigated the particularities of subject area teaching and its underlying epistemological dimension. These authors suggest changing the “P” in the TPACK model to a “D” for didactics to consider subject-specific epistemic axes. A promising avenue for future research would therefore be an exploration of the didactic dimension (Samson, Lefebvre & Gareau, 2015) jointly with the TPACK model.

Furthermore, content knowledge in all its forms, including technological, pedagogical, and content knowledge (TPCK), appears to have been rarely deployed. These results corroborate the findings of Dawson et al. (2013), who found that science and mathematics teachers who integrated ICT into their practices placed little emphasis on TPCK. However, our results contradict the findings of Schmidt-Crawford et al. (2016). There are at least two possible explanations for this difference. First, Schmidt-Crawford et al.’s (2016) case study included only four participating teachers, compared to 30 in our study. Second, the interview protocol differed between the two studies. Schmidt-Crawford et al. (2016) used open-ended questions, which would allow teachers to more freely associate their teaching practices with TPCK, whereas our semi-structured questionnaire as well as the online format of the group discussions could have de-emphasized the participants’ use of TPCK.

Nevertheless, our results reveal that TPCK was used more frequently by teachers with ten or more years of teaching experience compared to less experienced teachers. This suggests that many years of teaching experience, including trial and error, could be required to become comfortable with the three kinds of knowledge, and hence to understand and operationalize the TPACK framework and its dynamics.

Dawson et al. (2013) note the low prevalence of TPCK in professional development programs that are offered to teachers, particularly with respect to the length of activities. According to Jang (2010), mentoring teachers, especially for IWB integration in the classroom, is another promising avenue to consider to obtain a better understanding of the TPACK dynamic: providing peer feedback on teaching practices that integrate ICT would give science (and other) teachers opportunities to deepen their understanding of TPACK. Consequently, studies could consider mentoring programs for both in-service and pre-service teachers.

Finally, female elementary school teachers tended to mention technical content knowledge (TCK) more than their male counterparts, and even more so compared to male high school teachers (Yeh, Lin, Hsu, Wu, & Hwang, 2015). These authors believe that content knowledge depends on the subject being taught as well as the nature of the content. For example, a biology teacher does not apply the subject knowledge in the same way as a physics teacher

does. Similarly, a first-cycle elementary teacher does not deploy the same subject knowledge as a third-cycle peer does. Accordingly, taking particular subjects and grade levels into account could shed more light on the understanding of TPACK, and hence IWB integration.

Conclusion

To conclude, one of the limitations of this study, as suggested by Samson, Lefebvre, and Gareau (submitted), concerns the use of synchronous online discussion groups. It is harder for researchers to control the flow of the discussion in such situations compared to face-to-face interviews, which would influence the data collection. For example, one or two participants may dominate the discussion, making it difficult for all participants to express their opinions. The majority of the teachers in this study participated in synchronous online discussion groups. The host therefore had to maintain the flow of exchanges and ensure smooth running of the discussion groups despite incomplete control of the participants' interactions (Guillemette, Luckerhoff & Guillemette, 2011).

Authors' Note:

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