# Teachers' Perspectives on the use of Interactive Whiteboards in Mathematics to Support Students' Learning

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This paper reports how twenty six New South Wales public school teachers creatively integrate interactive whiteboards into their mathematics instruction to support students' learning through adopting a variety of digital resources in conjunction with the interactive whiteboard including online applications, educational software and presentation software. The use of online video clips on the interactive whiteboard was perceived to be very beneficial in engaging students in mathematics lessons. Lack of access and time were considered to be the main barriers to maximising the potential of the interactive whiteboard in mathematics education.

## Introduction

With increased access to technology in schools, teaching practices must change. Teachers are drivers of this change; as such, it is important to ascertain how they believe different technologies, specifically the interactive whiteboard (IWB), can be used to support students' learning in mathematics. While some research exists on how IWBs are being used in teaching and learning, Maher, Phelps, Urane and Lee (2012) identified that there was minimal research on what resources are being used by teachers in conjunction with IWBs during instruction. Few studies have focused on how IWBs are being used by teachers and how this supports students' learning (Hall, Chamblee, & Hughes, 2008; Wang, Cheon, Hamman, & Han, 2015). This paper reports some of the findings from a larger study undertaken as a Masters project which investigated New South Wales public school teachers' perceptions on the use of the IWB during mathematics instruction. The study specifically investigated the choices made by teachers in relation to software applications and resources used in conjunction with IWBs, with the intention of identifying and describing how and why teachers used IWBs during mathematics instruction to support students' learning.

## Literature Review

One of the most notable benefits of the IWB is the large interactive screen that can be observed and manipulated by the entire class (Chamblee, 2016). Research has shown that IWBs have been integrated into teaching and learning practices to facilitate: active learning, the development of knowledge, review and reinforcement, student engagement, catering for diversity, and multimodal teaching and learning (see Betcher & Lee, 2013; Mercer, Hennessy, & Warwick, 2010; Northcote, Mildenhall, Marshall, & Swan, 2010). IWBs encourage students to actively engage in their learning through collaboration, classroom discourse, game play, and interactivity (see de Koster, Volman, & Kuiper, 2013; De Vita, Verschaffel, & Elen, 2018; Fraser & Garofalo, 2015; Northcote et al., 2010). They facilitate learning by promoting student participation and allowing students to visualise mathematical figures, learning tasks and processes (McQuillan, Northcote, & Beamish, 2012). As well as supporting both visual and kinaesthetic learning, IWBs also support auditory instruction and, in many cases, teachers are aware of these benefits (Lutz, 2010).

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The potential for IWBs to be beneficial in supporting students' learning of mathematical concepts is in the ever increasing range of software and digital tools that can be used with IWBs (Betcher & Lee, 2013). There are many software packages available to assist in mathematics instruction. Maher et al. (2012) surveyed 116 Australian teachers and found that the decision to adopt software for use with IWBs is deeply grounded in whether it will engage and motivate students and be beneficial in differentiating learning. Their results indicated that teachers' awareness of digital resources that are available to support student learning is heavily influenced by their colleagues (80%) and professional development (62%). Maher et al. suggested greater emphasis should be placed on the digital resources teachers choose to incorporate into their instruction to improve student achievement.

Northcote et al. (2010) found that resources used with IWBs were either internet based or software packages including multimedia and specific applications. The findings did not elaborate on the effectiveness of these different types of resources, instead Northcote et al. only stated that both were used to increase the interaction between students.

## Conceptual Framework

How technology is integrated into mathematics instruction is influenced by the relationship between teachers' mathematical knowledge and skills, pedagogical practices and a recognition of how to use the technology (Koeler, Mishra, Kereluik, Shin & Graham, 2013). Thomas and Hong (2005), within their research into mathematics teachers' use of graphics calculators, highlighted the importance of pedagogical technology knowledge (PTK) in teachers and defined it as "knowing how to teach mathematics with technology" (p. 258). Based on their research into the PTK of teachers, Cavanagh and Mitchelmore (2011) proposed a sequence of roles that teachers adopt when utilising technology to support student learning, including: technology bystanders who are characterised by a lack of knowledge and skills in using technology in the classroom; technology adopters who utilise technology but make very little change in their pedagogy, instead using technology to simply improve efficiency in the classroom by supporting existing classroom practices; and technology adapters who are prepared to modify their teaching pedagogy and demonstrate concern for how students' conceptual understanding could be enhanced through the use of technology. Although they did not observe it in their study, Cavanagh and Mitchelmore hypothesised the existence of a final stage of development, technology innovators, suggesting that teachers would reach this level when they used "technology to encourage and support students' mathematical development in novel ways to promote student-generated knowledge, inquiry and reflection" (p. 430). The continuum for teachers' development of PTK described by Cavanagh and Mitchelmore was used as a conceptual framework to frame the research questions and data collection instruments for the study.

## Method

A mixed methods triangulation approach was adopted in the form of a quantitative and multiple-instrument case study, where quantitative and qualitative data were collected and analysed separately then merged. Quantitative data was collected using a questionnaire that was sent to thirty NSW public schools which were selected from a convenient sample. The questionnaire was also available online and contained ten questions which focussed on collecting demographic information and data on how and why teachers utilise IWBs in their mathematics instruction. Question types included multiple choice, Likert scale and open ended response styles. Each item from the questionnaire was allocated a variable and possible responses were given a code. A data analysis software package was used to calculate the percentage of respondents adopting different digital resources in conjunction with the

IWB as part of their mathematics teaching practices. Bivariate correlation analysis was also used to determine whether any significant relationships existed between the perceived advantages of using an IWB and the adoption of specific software or digital resources used on an IWB during mathematics instruction.

Twenty six teachers elected to complete the questionnaire. Twenty two primary school teachers were from seven different primary schools including two from large metropolitan cities, three from metropolitan towns, 12 from large regional cities or towns and five from small country towns. Four secondary teachers also volunteered to participate; two were from a regional city and two were from a rural town. From these 26 respondents, five were systematically selected, from those who volunteered, to participate in a semi-structured interview, which provided qualitative data. During the semi-structured interviews, participants were provided with the opportunity to describe how and why they utilised the IWB during mathematics instruction to support students' learning, including sharing their favourite resources. Five teachers were interviewed: Annette, Elizabeth, Kaitlyn, Simon and Sue (all pseudonyms). Annette is a teacher in a regional primary school; Elizabeth teaches in a large metropolitan primary school; Kaitlyn teaches in a rural primary school; Simon is a secondary mathematics teacher from a regional city and Sue teaches mathematics in a rural secondary school.

With the participants' approval, each interview was conducted, recorded and then transcribed by the researcher. Word processing software was used to aid in a preliminary exploration of qualitative data. Each transcript was then dissected into a series of statements. The Framework approach, recommended by Bryman (2012) was used to synthesise findings. Each case was analysed individually, using the identified themes and then a cross case analysis was undertaken to identify similarities and differences.

## Results and Discussion

The results from this study demonstrated that teachers utilise a variety of software applications and online resources to support their students' learning in mathematics. Results from the questionnaire showed that the most popular software used in conjunction with IWBs during mathematics instruction was IWB software, followed by online video clips. In fact, more than three quarters of respondents indicated that they used online video clips either frequently or always during mathematics instruction. Web-based mathematics resources were reported as the next most popular resource to assist in teaching mathematics concepts. More than half indicated that they used commercial mathematics software, at least frequently, when teaching mathematics. The least used resources included HotMaths (https://www.hotmaths.com.au/), dynamic geometry software, graphics calculators and online audio files. Results are shown in Table 1.

In her interview, Sue made an explicit link between utilising online video clips and reinforcing conceptual understanding. Although reinforcement of mathematical skills and knowledge was not explicitly addressed in the questionnaire, it was a significant theme arising from the interviews. This was similar to the findings described by Northcote et al. (2010). However, unlike Northcote et al., none of those interviewed indicated they utilised the IWB to save their lessons and review their own teaching material in a later lesson. Rather, all interviewees in this study indicated that they achieved this reinforcement and/or review of mathematics concepts by providing a different method of delivering explicit instruction. Rather than the teacher explaining the concept again, or in a different way, they utilised the IWB to display an internet source that provided an explanation/demonstration/instruction of the concept. Some teachers ($n$ = 3) even discussed how they believed providing the opportunity for students to watch and listen to a different person explain or demonstrate the same concept assisted in strengthening understanding and maintaining student engagement. Annette stated that she believed this was influential in developing students' confidence.

Table 1
*Summary of the adoption of resources in conjunction with an IWB in mathematics instruction*

| Resource | N | Never | Seldom | Frequently | Always |
|---|---|---|---|---|---|
| Commercial Mathematics software | 26 | 3.8% | 38.5% | 46.2% | 11.5% |
| Web-based Mathematics resources | 26 | - | 30.8% | 61.5% | 7.7% |
| Web-based games and puzzles | 26 | 3.8% | 46.2% | 42.3% | 7.7% |
| Data Analysis Software | 26 | 38.5% | 46.2% | 11.5% | 3.8% |
| Calculator | 26 | 34.6% | 38.5% | 19.2% | 7.7% |
| Graphing Calculator | 26 | 65.4% | 23.1% | 11.5% | - |
| Online Data Sets | 26 | 46.2% | 50% | 3.8% | - |
| Dynamic Geometry Software | 26 | 73.1% | 11.5% | 15.4% | - |
| Mapping Software | 26 | 26.9% | 50% | 23.1% | - |
| Interactive Whiteboard Software | 26 | 3.8% | 19.2% | 19.2% | 57.7% |
| Presentation Software | 26 | 7.7% | 38.5% | 46.2% | 7.7% |
| Web 2.0 Tools | 26 | 53.8% | 26.9% | 19.2% | - |
| Online video clips or streaming TV | 26 | 3.8% | 19.2% | 42.3% | 34.6% |
| Mobile Applications | 26 | 38.5% | 38.5% | 15.4% | 7.7% |
| Search Engines | 26 | - | 19.2% | 57.7% | 23.1% |
| Online Audio files | 26 | 65.4% | 30.8 | 3.8% | - |
| Learning Platforms | 26 | 50% | 46.2% | 3.8% | - |
| Mathletics | 26 | 23.1% | 34.6% | 23.1% | 19.2% |
| Hot Maths | 26 | 76.9% | 19.2% | 3.8% | - |

There was a significantly high correlation between teachers who utilised online video clips or streamed TV, and those who thought that the IWB was valuable in gaining students' attention ($\rho = 0.50$, $n = 26$, $p < 0.01$). Short clips, such as those found on You Tube (https://www.youtube.com/) and Khan Academy (https://www.khanacademy.org/math), allow students to see how what they are learning inside the classroom can be applied to real-life situations. Annette indicated that she found this useful in motivating students to apply themselves in mathematics lessons.

These findings support Skilling's (2014) results which showed that teachers utilised YouTube clips as a means of engaging students by showing them the importance of making mathematics meaningful and showing its practical applications. Skilling's study was conducted to investigate practices in classrooms that engage or disengage students and whilst it did not focus on the IWB, or even mention it, the results presented from this study do support her findings.

Interestingly, while online video clips and streamed television were very popular in supporting mathematics instruction, the use of online audio files, such as pod casts, on the IWB, was not common at all. In fact, over 65% of respondents indicated that they had never used this medium with an IWB to support students' learning in mathematics.

Northcote et al. (2010) found that digital resources used in conjunction with an IWB could be categorised as either internet based sources or software applications. Although this was true for four of the five teachers interviewed, Kaitlyn indicated that she also utilised a digital camera and a document camera in order to project images onto the IWB for the entire class to view simultaneously.

The variety of software applications and online resources being used to support student learning in the classrooms of the participants, support the findings of Hennessy and London (2013). Teachers used multiple mediums for teaching mathematics concepts, ranging from web-based games and puzzles, such as Cool Maths Games (www.coolmath-games.com/) and ABCya! (www.abcya.com/), to mobile applications, such as Maths Rocks (https://itunes.apple.com/au/app/maths-rockx-times.../id996850981?mt=8). Building on Northcote et al.'s (2010) findings, this study indicated that the teachers surveyed preferred to incorporate online sources in their mathematics instruction, rather than commercially purchased mathematics software.

As previously mentioned, dynamic geometry software, such as Geogebra (https://www.geogebra.org/) was one of the least used resources with over 73% of participants indicating they had never used this type of software. This may be reflective of the skew in the data towards primary teachers. Kersaint, Ritzhaupt, & Liu (2013) found that elementary teachers were far less likely to use this type of software than middle school and high school teachers. It would be interesting to see whether the low figures achieved in this study would be replicated if the sample contained a similar number of primary and secondary teachers.

Although all teachers interviewed confirmed that they used IWBs at least most days, in their teaching of mathematics, three key deterrents were identified, including time, lack of access, and lack of knowledge. Some of the points raised during the interviews were interesting and are provided in Table 2.

The interviewees identified that extra time was required in lesson preparation when planning a lesson which involved the integration of digital resources and the IWB. They all acknowledged that with internet access there are a wealth of resources now available to assist teaching and learning practices. As can be seen in the quotes in Table 2, the fact that there are so many resources means that teachers are spending lesson preparation time searching for the most appropriate. They all agreed that this meant they spent more time in lesson preparation than prior to the introduction of the IWB. Unlike the findings of Coleman (2015) where teachers found extra time spent lesson planning was a barrier to technology integration, the teachers interviewed in this study indicated that this was a minor deterrent which did not prevent them from using these resources.

Table 2
*Deterrents from using IWB in mathematics instruction*

| Deterrent | Quotes |
|---|---|
| Time | "I just do not have the time to have a look for resources." |
| | "The big thing it is going to come down to every time is time." |
| | "No time to access resources that are compatible for the IWB." |
| Lack of access | "When the technology is not working." |
| | "You notice the difference when something happens in your school and the technology is out…It stuffs everything up." |
| | "The biggest disadvantage is that half the time it does not work properly. We do have them in every class now, but I still use my chalkboard." |
| | "Relying on the technology that does not always work." |
| Lack of knowledge | "I wish I had an opportunity to say right here is a couple of days professional learning…I just need to sit and learn how to use that." |
| | "I think sometimes you need a little bit more guidance." |
| | "Lack of knowledge and skills and appreciation of a lack of skills." |
| | "Confidence to be able to say alright this is what I need to do." |
| | "More training is needed." |

All teachers interviewed agreed that their colleagues were a valuable source of information regarding new digital resources that could be used in conjunction with the IWB during mathematics instruction. These findings were similar to those reported by Maher et al. (2012). Extending findings from previous literature, this study found that teachers are now utilising social media to stay up to date with the latest software applications and digital resources that can accentuate their mathematics instruction. Annette explained how she maintained her knowledge of current mathematics resources by engaging in an online social media community of teachers from around the globe who all taught similarly aged students. She used this resource to share her ideas and gain feedback from other teachers in different contexts and believed this was particularly useful in enhancing her teaching practice.

Similar to findings from other studies (see Carver, 2016; Coleman, 2015; Maher et al., 2012), interviewees reported that one of the largest barriers for utilising specific software even if they knew about it was related to a lack of access. A lack of access to specific knowledge and training was cited as a major reason for not adopting new software applications and/or resources during mathematics instruction. This was similar to findings reported by Kersaint et al. (2013) and Kopcha (2012), however, both of these studies also linked this to a lack of confidence by the teachers in the classroom. The findings from this study did not support this link being made. Instead, three of the teachers interviewed indicated that their choice not to use these resources was linked to their perceived capacity to impact positively on student learning. Annette, Kaitlyn and Sue indicated that it was important to know how to use specific software in order to maximise students' learning of mathematics concepts. If they did not have enough experience with a specific program or resource to achieve this, then they would use an alternative resource because they did not want to negatively impact students' understanding, not because they lacked confidence in how to use the resource.

Annette discussed how she was limited by the version of interactive whiteboard software loaded to the school network. While, Maher et al. (2012) found this was a barrier to technology integration, Annette demonstrated the ability to overcome this by researching and identifying a work around. She believed the use of the IWB during her mathematics instruction was so important that she utilised her own resources to overcome this barrier.

Teachers reported that access to the Internet was another barrier that sometimes prevented them from utilising specific software. Although this was raised by most teachers interviewed, they did state this was not a constant barrier, but was in fact influenced by other factors, sometimes external to the school even. When asked to reflect on this further, all agreed this was a large inconvenience. It did not prevent them from using the software at a different time, but it did disrupt their lesson organisation.

## Conclusion

The introduction of the IWB into the mathematics classroom has allowed teachers to embrace technology as a means of enhancing their teaching. The results from this study showed that participants had modified their teaching practices to maximise the use of the IWB in supporting students' learning in mathematics. This study builds on existing literature by providing some insight into effective teaching practices that are being used by teachers which combine the IWB with digital resources to provide a more engaging, supportive, student-centred approach to mathematics learning. These findings should be used as examples of what can and is being achieved in mathematics education in NSW.

Participants described how they lacked time to experiment with new resources and develop knowledge and skills in their use. Hence, a recommendation would be to implement regular professional development sessions, possibly as a segment in a staff or team meeting, where time is allocated for teachers to demonstrate digital resources to their colleagues and provide hands-on workshops where they can share their knowledge and skills with their colleagues and assist in the co-construction of professional knowledge and skills. By schools utilising their own staff to upskill others, they minimise the cost of purchasing professional development. Also, as participants indicated that they found out about new software from their colleagues, this provides a structured forum for this to occur and for leadership skills to be developed amongst teaching staff.

It should be acknowledged that this study relied on teachers reporting their own teaching practices and perceived benefits of and barriers to, using an IWB during mathematics instruction. No classroom observations were undertaken and hence, the findings may not accurately represent classroom practice. Additionally, participants were recruited from a convenient sample and all had experience using an interactive whiteboard during mathematics instruction. This may have positively skewed the data and any further research should include teachers with little to no experience in integrating the IWB into their teaching.

Further, more explicit research, preferably involving lesson observations over a substantial period of time, is recommended to determine why teachers are utilising online video clips and/or streamed television during mathematics instruction and whether or not these online clips are replacing, or simply reinforcing direct mathematics instruction. This would supplement research which already exists showing that online clips are being used to flip the classroom.

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