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Transforming pedagogy through interactive whiteboards: Using activity theory to understand tensions in practice

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ABSTRACT

There has been considerable investment in the use of interactive whiteboard technology in Australia, particularly in primary schools. School leaders and teachers are seeking advice on effective ways to support teachers' pedagogical development to achieve the potential benefits of these devices. Using activity theory as a framework for lesson observation, analysis and interview data, this paper presents vignettes to illustrate major tensions in the uptake and use of interactive whiteboards (IWBs) to support student learning across the curriculum in one primary school. The findings suggest that the resolution of these major tensions is critical to teachers' effective use of the technology.

INTRODUCTION

The use of IWBs in education is relatively new and there is little Australian research into their use (Schuck & Kearney, 2007). International research suggests that IWBs can have positive effects on both teaching and learning (Smith, Higgins, Wall, & Miller, 2005). They are well adapted to whole-class teaching, particularly in terms of enlivening formal expositions, including demonstrations of practical procedures and explanations of complex concepts (Somekh, 2007).

Many of the envisaged benefits of IWBs are not always realised (Gobbo & Girardi, 2001). Advocates suggests that pathways to successful pedagogic transformation are multiple and easily navigated yet research evidence reveals more varied results (Rudd, 2007). It is clear however, that "the introduction of an IWB does not in and of itself transform existing pedagogies" (Moss et al., 2007), p. 6). Indeed, it is possible to use digital technologies to reinforce any manner of educational approaches (Green, Facer, Rudd, Dillon, & Humphreys, 2005). The effective use of IWBs requires developing and sustaining a conducive school culture in which people work together to improve outcomes for students. This requires attention to the multiple conditions essential to leverage digital technologies for learning that include: proactive leadership, planning, adequate funding, technical support, curriculum frameworks, skilled personnel, ongoing teacher professional development, assessment and evaluation, equitable access, student-centred learning, engaged communities, supportive policies and a supportive external context (International Society for Technology in Education, 2007); (Moyle, 2006); (Robertson, Webb, & Fluck, 2007).

As the teacher is the single most powerful influence on student learning within a school (Barber & Mourshed, 2007); (Hattie, 2003), the development of teachers' skills and knowledge using IWBs is critical to their effective use (Higgins, Beauchamp, & Miller, 2007). Teachers require a significant amount of sustained experience to become technically and pedagogically accomplished in using IWBs (Beauchamp, 2004); (Glover & Miller, 2001); (Levy, 2002); (Sweeney, 2008) . Teachers need advice and support to make choices about how and when to use IWBs based on pedagogical content knowledge, combined with the process of pedagogical reasoning (Kennewell et al., 2005). The impact of advice provided by school leaders and professional development activities to teachers on the use of IWBs has not been examined extensively.

Research suggests that teachers' use of new technologies progresses along predictable patterns of development. During the early stages of development, as teachers are learning to deal with concerns related to efficiency, organisation, managing, scheduling and time demands, the technology is applied to old tasks (Naisbitt, 1984) such as the creation and delivery of information and skills (Illinois Institute of Design, 2007). At this time, teachers' efforts tend to focus on short-term use of the technology with little time for reflection (Hall & Hord, 2006). Later, once teachers are competent and reliant upon the new technology, they become receptive to changing their techniques and modifying its use as a pedagogical tool to improve student learning (Glover, Miller, Averis, & Door, 2007); (Hall & Hord, 2006). Thus, the research literature points to a progression from technology to pedagogy (Glover et al 2007).

According to Hooper and Rieber (1995), many teachers are unable to realise the potential benefits of using technology because they fail to 'break through,' a critical third 'Integration' phase. This 'break through' is only possible if teachers see their role as supporting and facilitating students to construct and shape their own knowledge using the technology. Thus, teachers must be able to draw together contemporary understandings of technology, pedagogy and content knowledge (Borthwick & Pierson, 2008). Hooper and Rieber argue that a failure to 'break through' this phase results in the technology being misused or discarded. One example of the misuse of IWBs is when teachers are reluctant to deviate

from their prepared lesson presentations using native software to respond to students' needs (Zevenbergen & Lerman, 2007). This can cause frustration among students who prefer to participate actively in the learning process and physically interact with the IWB. The use of the IWB in this way "militates against any pedagogic shift towards greater intellectual challenge" (p. 861).

As yet, there is limited and unproven evidence available about the rate at which teachers progress towards more effective use of IWBs (Glover et al., 2007). However, the report 'Evaluating the Primary Schools Whiteboard Expansion Project in the U.K.' argues that consistent findings suggest that it takes approximately two years for IWBs to become embedded in teachers' pedagogy. After this time teachers have had sustained experience and are able to change their teaching practices to make best use of its facilities (Somekh, Haldane et al., 2007).

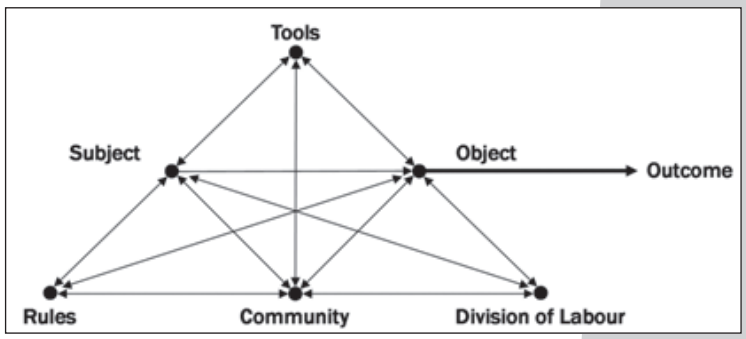
This paper reports on a study which investigated the impact of IWBs on eight teachers' pedagogy in one Australian primary school over a two-year period. Activity theory is drawn upon to investigate the dialectical process by which teachers' consciousness, professional learning and development simultaneously shape and are shaped by the uptake and use of IWBs (Gay, Rieger, & Bennington, 2001). Specifically, the study focuses on teachers' perceptions about the tensions that arise in their practice related to the impact of advice from professional development activities and school leaders. The paper concludes with a discussion about the implications of the findings for effective teacher pedagogical development.

Activity Theory

Activity theory provides a versatile tool to inquire into various aspects of educational technology (Murphy & Rodriguez-Manzanares, 2008). It focuses attention on the processes by which activities shape and are shaped by their context (Lim & Chai, 2003). To date, there is limited use of this research methodology in relation to the use of IWBs.

The main unit of analysis in activity theory is the activity system. A model of the second-generation activity system was formulated by Cole and Engestrom (1993) and is represented in Figure 1.

Figure 1:



Second generation activity system (Cole & Engestrom, 1993)

The *subject* node refers to the individual or group whose agency or point of view is taken in the analysis of the activity. The activity of the *subject* is directed towards the *object node* or goal and is transformed into *outcomes* with the help of physical and symbolic external and internal *tools* which mediate the object into an outcome (Engestrom, 1993). Thus, the object embodies the meaning, motive and purpose of the system. The base of the triangle represents the contextual characteristics of the activity system. The *community* node refers to the participants who share

Table 1: Nodes in the activity system for this research project.

Node	Teachers
Subject	Includes teachers' tacitly understood ideological and practical beliefs about teaching and learning, their teaching experience, attitude, knowledge and skills about ICT and IWBs.
Object	The objective or goal of using IWBs in the learning and teaching process e.g. to manage the use of the IWB or use it in ways that enhance specific student learning outcomes.
Tools	Physical and semiotic tools directly related to curriculum content, classroom discourse and communications, classroom management and assessment: IWB and other ICT resources; non-ICT tools (administration, learning and teaching tools and NSW Quality Teaching Framework) (NSW, 2006).
Rules	School policies and procedures, expectations of teachers and students by the school and wider education system.
Community	School leaders, parents, external professional development providers, students, middle-management (teacher-librarian, technician and support staff).
Division of labour	The different roles and responsibilities of students and teachers, the cooperation among staff and the support of administration.
Outcome	Effects on the use of IWBs in the learning and teaching process. What actually happened?

the same general object with the subject. The ***division of labour node*** refers to how tasks are divided between community members (horizontally as well the vertical division of power and status). ***Rules*** are explicit or implicit regulations, norms and conventions that constrain actions and interactions within the activity system (Centre for Activity Theory and Developmental Work Research, 2003).

In the context of this research into the use of IWBs, each node can be identified in Table 1 on page 29.

In activity systems, "equilibrium is an exception, and tensions, disturbances, and local innovations are the rule and the engine of change" (Cole & Engstrom, 1993). The implementation of new technologies creates tensions and disturbances in the activity system in the form of resistance to achieving the object. In addition, the adoption of a new technology often leads to aggravated secondary tensions where some old element of the activity system collides with the new one leading to disturbances and conflicts that may give rise to innovative attempts to change the activity (Engestrom, Miettinen, & Punamaki, 1999).

Activity theory is used in this paper to describe how the uptake and use of IWBs causes tensions within the activity system. These tensions arise from advice from school leaders and professional development activities. The resolution of these tensions is critical to support teachers to progress their pedagogical development using IWBs.

Data Collection

The eight participants in this study volunteered to use an IWB. Four participants were new users. The other four volunteers had been using an IWB for twelve months prior to the commencement of the study.

The study was conducted over an 18-month period and proceeded in four stages. The first stage was an individual interview to establish teachers' existing attitudes, beliefs and practices related to the use of IWBs and their knowledge of the South Australian Curriculum Standards and Accountability Framework (SACSA). The second stage involved a video taped lesson observation and a second individual interview to examine the use of the IWB in teachers' classrooms before any intervention. A group interview provided a forum for participants to reflect on their beliefs about learning and their use of the IWB. Participants then undertook a one-day professional development workshop on the use of the NSW Quality Teaching Framework (NSW, 2006) and applied this knowledge by independently coding their own video taped lesson and moderating the results with a peer and the researcher. A second group interview provided a forum for participants to describe tensions and changes to their pedagogy using IWBs.

The third stage of the project involved a second video-taped lesson observation and coding. At this time, two participants in this study (Teacher A and B) attended professional development related to inquiry learning and the use of ICT (Murdoch, 1998). In addition, Teacher A attended a 3-day professional learning event about the 'Backwards by Design' approach (Wiggins & McTighe, 2005) with the Principal and Assistant Principal. As a result, a curriculum planning template was created and implemented with some teachers (not all study participants). During the fourth stage, the third individual interview focused on participants identifying the tensions that had occurred in the activity system and exploring ways to address these.

Understanding the use of IWBs

Rather than explain the outcomes in a deficit framing, activity theory allows the tensions in the activity system to be understood holistically. The tensions described relate to the advice provided by professional development activities and school leaders. Of particular interest, is the way these tensions were resolved resulting in a 'break through' (Hooper & Rieber, 1995) for participants to continue 'moving forwards' in their IWB use. These tensions were persistent in the research data for all eight participants. However, evidence suggests that only two experienced IWB users and two new IWB users experienced such a 'break through'. To illustrate these tensions, the following vignettes focus on Teacher A (an experience IWB user) and Teacher B (a new IWB user). These two teachers clearly articulated a resolution to these tensions.

The rationale for adopting IWBs at the school was that they would be an effective strategy for supporting teachers to easily integrated ICT across the curriculum without the need for radical pedagogical change. Participants identified that the potential benefits of IWBs were to use the devices as an organisational tool to integrate digital resource, and improve student behaviour by engaging students using quality presentations and physical interactivity.

Teacher A (New IWB user. Year 4/5 and Acting Assistant Principal)

Teacher A had over twenty-five years experience and had been at the school for five years. She had previously taught in a disadvantaged school, had a good understanding of the SACSA Framework and valued explicit teaching because it improved literacy and standardised testing results. Teacher A described herself as a "quick learner" whose ICT skills were "pretty good". She explained that she integrated ICT into meaningful experiences for students by adopting a project learning approach where students completed a set task to create an ICT product such a PowerPoint presentation, PhotoStory or brochure. Teacher A decided to use an IWB because she liked the work shown by colleagues at another school and thought they would make ICT tools a part of the process of learning rather than the end product.

Teacher A provides an example of a tension that was resolved between the Subject, Tools and Object and the Division of Labour. The primary source of this tension originated from the provision of professional development workshops aimed at developing teachers' technical skills using the native IWB software. The IWB retailer hosted the workshops. After viewing and coding her first video taped lesson observation, Teacher A commented that her use of the native IWB software was similar to using 'digital worksheets' where students were asked to demonstrate their understanding of concepts

in limited ways by simply 'dragging and dropping' missing answers. Ironically, Teacher A explained that she had agreed to use an IWB because she thought that it would improve her practice by increasing interactivity in her classroom. However, after reviewing her video using the NSW Quality Teaching Framework, she felt that her lessons were teacher-centred and that students had limited opportunities to develop their higher order thinking skills. Furthermore, she was doing all of the work spending hours preparing her lessons.

Having reached this conclusion, Teacher A felt that a resolution to this tension was to spend less time creating her own lessons and use more hyperlinks to available resources online. In addition, she needed to create more opportunities for students to share and receive feedback about their learning. She explained that this meant that she could be more responsive to students' needs and interests by avoiding delivering scripted lessons. In particular, she could immediately access information with students to follow-up on their questions and interests (rather than waiting up to a week to visit the library). She could also critically analyse information with students from diverse perspectives. Thus, she could focus less on the technology and more on student learning as the object of the activity system. Teacher A commented:

> *I am so over flip-charts! I've moved on from how I was using it. ... It was time consuming in putting it all together, almost like a digital worksheet. I now like the spontaneity of having [the IWB] there (Interview 2).*

At the conclusion of the study, Teacher A explained that as a result of her recent professional development, she had adopted an inquiry learning approach when using the IWB and used the native IWB software ('flip-charts') differently. She now made greater use of visual resources to represent concepts in multiple ways and encouraged students to reflect on their learning rather than focusing on solely creating opportunities for physical interactivity with the IWB. She also improved the connection between relevant lessons by saving, reviewing and extending 'flip-charts' as a regular part of lessons. In addition, Teacher A provided opportunities for students to develop their skills using the native IWB software to share their personal inquiry findings. Teacher A emphasised that the initial school focus on developing teachers' technical skills with the native IWB software was an appropriate starting point for all new users because "if you start searching on the Internet for resources, you can get lost in cyberspace. There's heaps out there but it takes a lot of time to filter it".

Teacher B (Experienced IWB user. Year 5/6 teacher and ICT Coordinator)

Teacher B had been teaching for nineteen years and had been at the school for six years. He was also an Advanced Skills Teacher and was familiar with the SACSA Framework. Before becoming the ICT Coordinator, he always designed complex units of work focused on developing students' information literacy and ICT skills. However, this was more difficult now that he spent less time in the classroom and there was limited access to the computer room.

In his current role, Teacher B provided professional development support for colleagues and was expected to lead other staff in the effective use of IWBs. Due to the considerable investment in the equipment, it was clear that the school Principal and parents had high expectations for the positive impact of IWBs on the improvement of student learning. Many teachers at the school had expressed interest in receiving an IWB and there was a view that the 'pioneer' teachers who already had one would influence future decision making about the purchase of additional IWBs. In the first interview, Teacher B expressed concern that a Principal in another school had advised him to take care that the IWBs were not simply used as presentation devices that could be achieved with a computer and data projector. Rather, focus needed to be on innovative tasks not possible without the technology.

To resolve this primary tension, Teacher B focused on the use of the native IWB software since he considered this as unique to the IWBS. However, intense use of this software aggravated a secondary tension as Teacher B found that he spent a considerable amount of time creating presentations. After reviewing his first video-taped lesson observation, Teacher B lamented: "I felt like I was giving a keynote to my class! It sort of sounds like I am giving a workshop not talking to kids". This resulted in him questioning whether once-off lessons and explicit-teaching using the native IWB software really was the most effective way to use the IWB. Teacher B commented:

> *I went through a stage, when I first got the board, thinking that this resource costs a lot of money and I should be using it. I sat down one night and spent two and a half hours preparing something that only took forty minutes to teach the next day! Then I thought this is not a good use of time.*
>
> *I'm really pleased that I'm starting to use it more now for creating stuff on the fly or as I go, and not coming in with something prepared but more like a list of hyperlinks or ideas, or I am prepared to actually write up things as we go using some of the tools available. [The Principal] likes the term "Just in Time Learning" and I probably agree that's what it is.*

This vignette described primary tensions between the community and the tools. Specifically, tensions originated from the Principal and parents in the community in the form of expectations to ensure that the IWBs were used effectively as tools to improve student-learning outcomes. To resolve this tension about the effective use of the IWBs as tools, Teacher B followed the advice of retailers who provided professional development workshops to use the technical features of the native IWB software. However, this aggravated a secondary tension related to the division of labour. Teacher B found that the intensive use of 'flip charts' was unsustainable. To resolve this tension, he decided to transform his pedagogy to adopt a "just in time" teaching approach using the Internet and online resources. Subsequently, Teacher B created a complex joint project with a class in Alaska that focused on developing students' cultural knowledge and critical literacy skills.

In addition to Teachers A and B, two other study participants described the resolution of tensions related to advice from school leaders and professional development activities. These two teachers worked collaboratively and together brought a high level of technical, pedagogical and content knowledge to the unit of work they designed.

Teacher C (an experienced teacher-librarian and new IWB user) provided an example of a resolved tension between the Community, Tool and Division of Labour. Teacher C was asked by the Principal to mentor colleagues to implement the Society and Environment strand of the SACSA Framework. This was because this area was new content knowledge to teachers and would provide a focus for improving IWB use. To facilitate this process, Teacher C received professional development about the Dimensions of Learning Framework (Marzano, 1992) to assist her in designing curriculum, planning instruction and assessing student performance. This caused tensions related to the division of labour as Teacher C had limited time to plan with teachers and could not share IWB files. This was resolved with a day for collaborative planning with teaching teams each term and the establishment of a shared drive on the network

Teacher D (an experienced Reception – Year 1 teacher and experienced IWB user) provided an example of a tension within the objective that was resolved by sharing the division of labour. At the start of the study, the objective of lessons was to engage students through physical interactivity with the IWB. However, students were observed getting distracted as they waited for long periods for 'their turn'. During the second lesson observation and interview, Teacher D described how she had changed her practice as a result of working with Teacher C to collaboratively design a unit of work that focused on the achievement of identified student learning outcomes. Specifically, a series of lessons were implemented. These used multiple resources to develop students' conceptual knowledge and provide opportunities for them to demonstrate their understandings. For example, students reviewed digital photos they had taken of guest visitors and used audio recordings to role-play making phone calls to emergency services.

'Break throughs'

The vignettes suggest that Teachers A, B, C and D experienced a 'break through' as they progressed along predictable patterns of development through the 'integration' stage (Hooper & Rieber, 1995). They transitioned from concerns about managing the technology to using it to enhance student learning (Hall & Hord, 2006). Teachers', development of their pedagogy, technology and content knowledge facilitated this progression.

Although the configuration of tensions in the activity system may be unique to individuals, the 'break through' experienced by participants in are similar as they relate to the resolution of tensions associated with the use of native IWB software and the division of labour. This similarity in tensions appears interconnected with the expectations from the Principal and the initial emphasis placed on the development of teachers' technical and pedagogical skills using IWBs.

The resolution of tensions between the IWB as a tool and the division of labour, are similar to those identified in recent research concerning primary mathematics using activity theory (Zevenbergen & Lerman, 2007). That is, Teachers A and B in this study resolved tensions by reducing the amount time spent on the preparation of lessons and making use of existing online resources. In this study, four teachers demonstrated their ability to 'move on' from the use of the IWB to primarily present content knowledge. Thus, there was evidence that they had experienced a pedagogical transformation.

A supportive Principal who encouraged teacher-leaders to access high quality professional development and share their learning with colleagues as part of their leadership role facilitated this transformation. This is an example of building the capacity of the school by developing 'in-school champions' (Moss et al., 2007); (Somekh, Underwood et al., 2007). Furthermore, the Principal was a strong advocate for teachers to provide daily opportunities for students to develop skills and confidence using the IWB tools and create a supportive learning environment where teachers and students could learn together and help each other. The rationale was that this would help shift the focus away from the teacher and the technology towards the use of the IWB as a shared tool to enhance learning.

The vignettes support suggestions in previous research that teachers require a significant amount of sustained experience to become technically and pedagogically accomplished using IWBs (Somekh, 2007). The four participants who experienced a 'break through' possessed high levels of competence using a range of ICTs (not just native IWB software); they had access to high quality professional development focused on curriculum design and pedagogical techniques; or received individualised support from a trusted peer mentor/curriculum leader who had completed this professional development.

Teacher professional development played a significant role as a source of tension originating from the community. All participants attended professional development workshops provided by the IWB retailer. These workshops developed their technical skills. Furthermore, the school applied for recognition as an official site of excellence. This required teachers to create lessons using the technical features of the IWB software to share with others via the vendor's website. In addition, Teachers A, B and C attended quality professional development to advance the school's curriculum planning, assessment and instruction. This experience also served as a significant source of tension as these teachers' resolved how and when to use IWBs based on pedagogical content knowledge and the process of pedagogical reasoning.

The findings presented support previous research which suggests that achieving a 'break through' by resolving the major tensions within the activity system does not exclusively depend on the length of time that teachers use IWBs. Among the four teachers who experienced a 'break through' to resolve

the tensions in their activity system, two were experienced IWB users and two were new IWB users. Teachers A and B experienced this 'break through' within the first year of using an IWB while the other two participants experienced a similar 'break through' after using an IWB for approximately three years.

Four participants showed no indication of experiencing a 'break through' despite using the IWB for between 18-months and three years. They appeared to continue to struggle with tensions related to how best use the IWB to support the object of improving student learning. It is likely that these tensions would be resolved in subsequent years as a result of ongoing personalise support from the 'in-school' champions and the emphasis on curriculum planning, assessment and instruction using the planning template developed.

It is important to highlight that both Teachers A and B took the view that learning to use the native IWB software is a desirable starting point for new IWB users. This is because this approach reduces the 'cognitive load' on teachers as they develop their technical skills using the IWB and develop confidence to use the IWB more spontaneously whilst working with students. By preparing lessons beforehand using the native software, teachers are able to focus on the implementation of lessons knowing that the content is structured in a satisfactory sequence to meet lesson objectives. However, there comes a point along the predictable pattern of progression (Hooper & Rieber, 1995) when teachers become competent in routinely using the native IWB software and become receptive to changing their techniques to improve student-learning outcomes. It is likely, because Teachers A and B had spent considerable time using the native IWB software and had a high level of ICT skills, that these were prerequisites for 'moving forwards' in their development. Thus, it may be unwise for other teachers to miss or prematurely abandon the use of native IWB software as this may provide necessary foundational skills for using the IWB more spontaneously with students, in supporting students' IWB skill development, the customisation of online resources, and the integrated use of other ICT tools.

CONCLUSION

IWBs have the potential to enhance student-learning outcomes but use of the technology alone does not transform education into the 21st Century. That transformation is always mediated by other experiences and necessitates teachers progressing beyond a critical 'break through' phase of development. Achieving this 'break through' using IWBs is likely to relate to 'moving on' from the intensive use of native IWB software. Although the use of native IWB software is a common and valuable starting point for teachers new to using the technology, it is important that teachers receive ongoing technical and pedagogical professional development so that they continue their progression along the predictable stages of development. Without this support, teachers may not be able to make informed decisions about how and when to use IWBs and are likely to misuse or discard use of the technology.

BIOGRAPHY

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