Vertical whiteboarding: Riding the wave of student activity in a mathematics classroom

Tricia Forrester
University of Wollongong
<tricia@uow.edu.au>

Carolyn E. Sandison
University of Wollongong
<sandison@uow.edu.au>

Sue Denny
Department of Education, NSW
<sue.denny@det.nsw.edu.au>

In 2014 we commenced working on the Inspiring Mathematics and Science in Teacher Education (IMSITE) project, aimed at improving mathematics and science education in Australia by improving the recruitment, development and retention of mathematics and science teachers. In this project we undertook a range of activities, the most exciting of which was the introduction of whiteboarding as a tool to actively engage high school students with mathematics.

This paper describes our journey introducing whiteboarding into local high school mathematics classes, and teachers' and students' perspectives of whiteboarding.

What is whiteboarding?

The term 'whiteboarding' has been in use since the early 1990s and is "the action or process of using a whiteboard, especially as a means of collaborating with others" (English Oxford Dictionary, 2016). Using an erasable whiteboard as a learning tool to promote higher order thinking and collaborative learning has been described in primary, secondary and tertiary settings across a range of disciplines (Henry, Henry & Riddoch, 2006; MacIsaac, 2000; Wenning, 2005; West, Sullivan and Kirchner, 2016). In the cases reported above, the whiteboards were used horizontally, usually on desks, by small groups of students as they brainstormed, recorded their ideas and learning, and then presented their work to their classmates.

Small handheld whiteboards are becoming more common in Australian classrooms and used across all Key Learning Areas. Their usefulness from students' perspectives appears to be the opportunity for everyone to share their answers to questions, and to give every student a valued voice in classroom discussions (Wiliam & Leahy, 2015; Swan, 2006). Their non-permanence enables students to experiment, take risks in their learning and readily modify their written responses (Swan, 2006). From a teacher's perspective, whiteboards increase students' interactivity in the class-room (Beauchamp & Kennewell, 2008). They are a useful tool for accessing students' thinking, using feedback to inform and modify teaching to meet students' learning needs (Wiliam and Leahy, 2015; Beauchamp & Kennewell, 2008). Liljedahl (2016) found that, in mathematics classrooms, the use of erasable surfaces rather than permanent surfaces, such as work books, butchers' paper, sticky notes or pads, positively impacts classroom behaviour, and vertically mounted non-permanent surfaces (VNPS) are most effective.

Vertical whiteboarding in the mathematics classroom is the practice of doing mathematics on vertical erasable whiteboards (or any non-permanent vertical surface;

see Figures 1 and 2), while standing, rather than doing mathematics seated at desks and writing in workbooks. Ideally, whiteboarding classrooms have whiteboards vertically mounted on all of the walls, however, other vertical non-permanent surfaces such as blackboards, windows and electro-static plastic sheets also work. Individually and/or in groups, students do their mathematics on these boards in view of their peers and the teacher.


Figures 1 & 2. Secondary students doing maths in a whiteboard room.

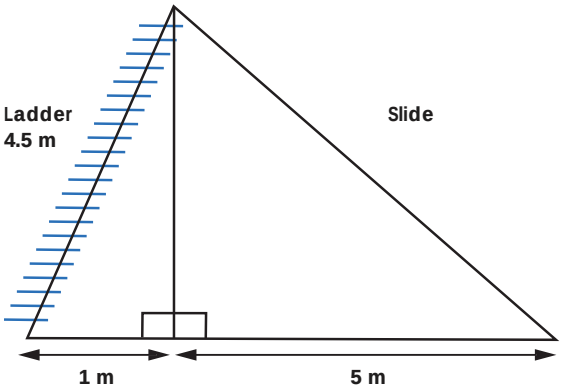
Background—whiteboarding in tertiary mathematics classes

Since the early 1970s, whiteboarding has been used in some Australian universities for teaching and learning mathematics. It was introduced to the University of Wollongong in 1992, and since then, all first year calculus tutorials have been run in whiteboard rooms.

Caz Sandison, one of the authors of this paper, a mathematician (and tutor at that time), was very impressed with the impact whiteboarding had on student behaviour in tutorials, as well as the impact it had on her role in these classes (Seaton, King and Sandison, 2014). In working on the whiteboards, instead of at desks, students produced considerably more work in tutorials, were more engaged with the work, and developed collaborative practices, looking at each other's work, asking peers for assistance, sharing ideas and solutions. Those students previously reluctant to attempt tutorial activities could not hide their lack of involvement, effort or understanding. Those who struggled with the work were able to access other students' solution attempts to assist with their understanding. Caz's role in the classroom also changed. She no longer occupied the front of the room. She no longer had to constantly encourage reluctant students to do their work and was able to see how students were progressing without looking over their shoulders. While she still responded to students' requests for assistance, she could easily identify common and individual difficulties and give whole class, small group or individual assistance where required. Students no longer relied solely on her assistance; they commonly looked to each other for ideas or clarification. Time previously wasted on waiting for assistance was spent seeking ideas from others' work. The classroom culture changed radically; students were now actively doing mathematics, talking about mathematics with their peers and tutor, with many students moving around the room to access or give assistance.

Testing the water—introducing two classes of high school students to whiteboarding [1]

We organised two excursions to the University to attend 'Work Like a Mathematician' (WLAM) sessions. There were 24 Year 8 students and two held for 27 Year 9 students from a local high school. For each WLAM session, undergraduate students studying mathematics and considering mathematics teaching as a possible career option, prepared four learning experiences for these classes, two to be conducted in a desk room and the other two in a whiteboard room. The tasks undertaken in the desk room were highly interactive and hands-on, involving games, treasure hunts and manipulative materials. The tasks in the whiteboard rooms were application questions, those typically found at the end of the chapter in textbooks (Figure 3). At each WLAM session, the teacher divided the high school students into two groups, each group having two learning experiences, one in each room, and we tracked students' behaviours in both rooms. Following the WLAM excursions we surveyed students' responses to whiteboarding, and interviewed their classroom teacher for his perceptions of whiteboarding as a teaching and learning strategy.



A playground slide is made up of two right-angled triangles.

a. Find the height of the slide.
b. Find the lenght of the slide

Figure 3. Sample problem for whiteboard room session, Year 9.

A brief summary of observations of students' on-task and off-task behaviours

- In six of the eight whiteboard room learning experiences, students' on-task working was considerably more evident when whiteboarding
- In seven of the eight whiteboard room learning experiences, students' on-task talking was considerably more evident when whiteboarding.
- In six of the eight desk (non-whiteboard) room learning experiences, students' off-task behaviours were considerably more evident.

A brief summary of students' survey responses

- Nearly all students in both classes had fun whiteboarding and felt that they were more involved in their learning in the whiteboard room.

1. A more detailed account of this research can be found in Sandison, Forrester and Denny (2017).

- Many felt they learnt more in the whiteboard rooms, they liked the collaborative nature of whiteboarding, enjoyed talking to their classmates about the mathematics, and liked being able to see other students' thinking represented on the boards.
- Best things about whiteboarding:
  - Nearly all students felt that the experience of working on whiteboards was enjoyable compared to writing in a book. Students liked the large work space, the ease of erasing work, and enjoyed the process of writing on the boards.
  - Interacting and collaborating with classmates was seen as very positive. Students enjoyed being able to share and discuss ideas with other students, they liked being able to look at other people's work and the ease of accessing assistance from peers and the teacher.
- Worst things about whiteboarding:
  - Fourteen students said there were no negatives.
  - Five students mentioned their initial embarrassment as the worst thing, while two students felt the classroom was noisy, with one student concerned about students copying others' work.
  - Standing up was identified by five students as the worst thing, while two students felt that the worst thing was getting their hands dirty.
- All students wanted a whiteboard room at their school.

The teacher's perspective of whiteboarding

After the four excursions, where he had observed both classes in the whiteboard room and the desk room, the classroom teacher concluded:

- Students were more engaged, both behaviourally and affectively, than they would normally be in class: "They were all engaged. Like you'd walk in that room and if you said, 'This is a high school maths class', there's no way you'd expect to walk in and see everyone engaged …". In contrast to their behaviour in their normal classroom, where many would start to pack up before the bell, they became so engaged that they were reluctant to stop: "If they were halfway through a problem … [they'd say] 'Oh no, I want to finish it'."
- The ease of identifying students having difficulties was a great benefit: "I can easily see straight away who's having trouble whereas a quiet kid will sit in the corner with his head down and look like he's writing [but really having trouble] and unless I physically get to him, I can't see."
- Whiteboarding supported 'peer-to-peer learning', highlighting pair work as being particularly beneficial in the whiteboarding activities.
- All classes, regardless of age and mathematical ability, would benefit from whiteboarding. He also felt it could be beneficial in settling students' classroom behaviours.
- Whiteboarding would be suitable for introducing new topics or problem-solving after a topic has been introduced.
- He needed to address students' need for notes and suggested this might be possible through building a photographic portfolio of whiteboard work.
- He would need to think through ways of coping with the increased noise levels.
- He wanted a whiteboard installed for use at his school.

The whiteboarding wave gathers momentum

In reporting to his principal on his students' excursions, the classroom teacher requested that the school set up a whiteboard room. The data gathered was sent through to the school and at the beginning of 2015, the school installed whiteboards around the walls of a new collaborative learning space to be used across all Key Learning Areas. This venture was so successful that the school has now installed five whiteboard rooms, two in mathematics and three for use in Human Society and Its Environment (HSIE) and Personal Development, Health and Physical Education (PDHPE) classes. Two mathematics teachers began utilising the whiteboard rooms for most of their mathematics lessons.

Over the last two years we have assisted 11 teachers from eight local high schools to install whiteboards and to experiment with whiteboarding in their mathematics lessons. This has looked different for each of these teachers, with some commencing enthusiastically and others easing into it. We are continuing to research the use of whiteboarding as a pedagogical tool, and whiteboard rooms as a learning environment for developing positive learning outcomes in a range of educational settings. We are still very excited by the increased levels of student engagement, promotion of mathematical thinking and reasoning, and student-centred, collaborative learning. These benefits appear to apply to all teachers and teaching styles, all grades and ability levels.

Thinking of trying whiteboarding? Here are some tips:

In sharing our experiences and research we have found many teachers very keen to try whiteboarding, but unsure of how to set up their classrooms or where to start. We have a few suggestions for getting started:

1. Set up the classroom with whiteboards on all available wall space—preferably on all four walls. If funding is not available for this, fixing electro-static plastic sheets on walls and windows will do the job. These are reusable and quite cheap.
2. Insist that all students stand and work on the boards. You might need to move your furniture to accommodate walking around the room and minimising students sitting down.
3. Whiteboarding is a great tool for problem solving, but it can be used for any mathematics lesson. Using your "normal" lesson plan, when it is time for students to work in books, get them to work on the boards instead.
4. If you are concerned students will not have notes, provide them with photocopied or online notes you have prepared for your lesson. You can also encourage students to photograph their work for future reference.
5. Experiment with individual, pair and group work. (Peter Liljedahl's work on random grouping is worth reading—Liljedahl, 2016). Experiment, too, with providing a marker to each student, or providing only one marker to a pair or group.
6. Take time to stand back and watch what your students are doing. You will be able to see what students are thinking, their common and individual difficulties, as well as monitoring their behaviours. They will have the opportunity to seek assistance from their peers, so don't jump in too quickly.
7. Whatever you try, persevere for a period of several weeks; it takes time to establish new classroom routines and norms.

If you are whiteboarding or thinking about trialling it in your own classrooms, we would love to hear about your experiences. Visit our website for more information, resources and research and to share your ideas: https://clowdsite.wordpress.com/

References

Beauchamp, G., & Kennewell, S. (2008). The influence of ICT on the interactivity of teaching. *Education and Information Technologies, 13*(4), 305–315.

Henry, D., Henry, J., & Riddoch, S. (2006). Whiteboarding your way to great student discussions. *Science Scope, 7*, 50–53.

Liljedahl, P. (2016). Building thinking classrooms: Conditions for problem solving. In P. Felmer, J. Kilpatrick, & E. Pekhonen (Eds.), *Posing and solving mathematical problems: Advances and new perspectives.* New York, NY: Springer.

MacIsaac, D. (2000). *Active engagement, cooperative learning in large enrollment introductory college physics lectures for preservice teachers.* Paper presented at the NSF CETP Conference, 24 March 2000. Retrieved November 16, 2016 from http://physicsed.buffalostate.edu/pubs/CETP/.

Oxford University Press. (2016). Retrieved November 23, 2016, from https://en.oxforddictionaries.com/definition/whiteboarding

Sandison, C. E., Forrester, T., & Denny, S. (2017). "Work like a mathematician": A study of secondary students' levels of engagement "doing" maths in a whiteboard room. In B. Ferrucci & L. M. Thien (Eds.), *Revitalising mathematics teaching and learning culture towards sustainable living* (pp. 53–66). Penang, Malaysia: SEAMEO RECSAM.

Seaton, K. A., King, D. M., & Sandison, C. E. (May 2014). Flipping the maths tutorial: A tale of n departments. *Australian Mathematical Society Gazette, 41*(2), 99–113.

Swan, M. (2006). *Collaborative learning in mathematics: A challenge to our beliefs and practices.* London: National Institute for Advanced and Continuing Education (NIACE), for the National Research and Development Centre for Adult Literacy and Numeracy (NRDC).

Wenning, C. J. (2005). Whiteboarding and Socratic dialogues: Questions and answers. *Journal of Physics Teacher Education Online, 3*(1), 3–10.

West, A., Sullivan, K., & Kirchner, J. (2016). How about teaching literacy with science? *Science & Children, 53*(8), 47–53.

Wiliam, D., & Leahy, S. (2015). *Embedding formative assessment: Practical techniques for K–12 classrooms.* West Palm Beach, Fl: Learning