Creative Body-based Learning:

Redesigning Pedagogies in Mathematics

Abstract

Contemporary schooling produces unequal educational outcomes in Australia and across the globe. While mandated high-stakes tests supposedly place all students on a common scale, they can limit pedagogic practices and often fail to recognize the "abilities" or embodied knowledge of many children. In addressing these challenges, particularly as they relate to the teaching of mathematics this article reports on a qualitative study that investigated an arts integrated professional learning model, Creative Body-based Learning (CBL), at two Australian primary schools. CBL uses active and creative strategies from a range of art forms to increase student engagement and expand pedagogic possibilities across the curriculum. In this pilot study, five teachers formed action research teams with four artists to integrate CBL into mathematics. Findings drawn from interviews with teachers include higher engagement and improvement of student dispositions in mathematics and, more significantly, a broadening of teachers' pedagogical practices to engage students and provide them with multiple opportunities to present their learning.

Keywords

arts integration, arts-based pedagogy, body-based learning, participatory action research, professional development, mathematics

Introduction

Contemporary schooling produces unequal outcomes and mathematics pedagogy in particular, affects learners in disproportionate ways (An, Capraro, & Tillman, 2013; Walshaw & Anthony, 2008). While purporting to place all students on a common scale, high-stakes tests like the National Assessment Program – Numeracy and Literacy NAPLAN in Australia or the National Assessment of Educational Progress (NAEP) in the United States are politically charged to construct intelligence as something that can be objectively measured. As such, they often fail to recognize the academic skills and outcomes that are most important to educators (Van Eman et al., 2008). Testing also restricts pedagogic possibilities and does not allow many students to fully show what they know (Carter, 2012). Under pressure to perform, teachers "teach to the test" and often revert to traditional, direct and didactic approaches that are tightly controlled and teacher-directed (Comber & Nixon, 2009; Cormack & Comber, 2013). Inevitably, these approaches have limited value in supporting students to engage in higher order thinking skills or deep understanding of concepts associated with mathematics (Harris et al., 2013; Thompson, 2013; Walshaw & Anthony, 2008).

As a research team we include academics with expertise and background in arts integration, mathematics teaching and embodied methodologies. Our shared commitment to social justice in schooling frames our focus on "engagement" as a central feature of transformative pedagogy (Callow & Orlando, 2015) and underpins our interest in pedagogical practices that have transformative potential. Inclusive approaches to teaching and learning often advocate for arts integration and creative practices in learning (Belliveau, 2006; Snyder, Klos, & Grey-Hawkins, 2014) as well the use of the body as an instrument of learning (Bresler, 2004; MacKenzie, 2013). Studies related to mathematics have shown such

approaches to be effective in developing student dispositions (Erodgan & Baran, 2009) geometry achievement (Duatepe-Paksu & Ubuz, 2009), and abstract mathematical concepts (Hirsch, 2010; Walker, Tabone, & Weltsek, 2011).

Building on this research literature, this paper reports on a Creative Body-based Learning (CBL) professional development program—a pilot scoping project, which examined the impact of professional development in CBL on teacher pedagogy and student learning in mathematics at two primary schools. In this paper, we first address educational concerns in the local sector of South Australia. Next we turn to the conceptual resources offered by arts integration and embodied pedagogies. We then describe the development, implementation and assessment of the CBL pilot project as well as findings drawn from interviews with teachers. In conclusion, we argue for the value of creative body-based approaches in broadening the suite of pedagogical strategies available to teachers and in ensuring access and more equitable outcomes in mathematics for every student in the learning community.

Educational concerns around mathematics

Mathematics is valuable learning; it is key to success in economic, social and civic life (Walshaw & Anthony, 2008). However, in several Australian states, students lack confidence in mathematics, do not enjoy or see its personal relevance, and are unlikely to voluntarily continue its study (Council of Australian Governments, 2008). This is clearly a risk to Australia in terms of achieving its human capital goals of an educated workforce (MCEETYA, 2008); however, the personal and social consequences for individuals and families extend far beyond purely economic concerns.

Traditionally, mathematical knowledge has been understood to consist of rational, objective and eternal truths (François, 2007; Walshaw & Anthony, 2008). While research in mathematics education has generally focused on techniques aimed to reduce complexity, mathematical thinking continues to be understood as abstract, formal and disconnected from reality (Hall & Nemirovsky, 2012; Trninic & Abrahamson, 2012). So, when overlaid with a high-stakes testing regime that narrowly conceptualizes mathematics knowledge and works to constrain teachers' choices of pedagogical (instructional) approach, mathematics can become a series of difficult and abstract challenges which result in poor student dispositions and performance (Aguirre & del Rosario Zavala, 2013). Test-driven approaches to instruction emphasize particular skills, including memorization and recall, and favor direct instruction. Consequently, teaching and learning in mathematics often provides limited opportunities for students to demonstrate deeper knowledge, advanced ability, or problem solving skills (Hirsh, 2010).

Conceptual framework

Arts-based pedagogies

Arts-based pedagogies use one or more art forms to stimulate creative processes and deepen understanding in non-arts learning (Others & Author, 2013; Ludwig & Song, 2014). Integration of a range of disciplines with the arts has been shown to have powerful effects on learning. While the arts provide resources and conceptual ideas to engage students and personalize learning, they also support students' access to broader subject knowledge. Anecdotal and empirically based evidence has shown that the integration of arts-based pedagogies into common curricular content offers deeper, richer and embodied learning experiences. The multi-modal aspect of arts integration provides students multiple ways for

students to represent their knowledge (Leander & Bolt, 2013; New London Group, 1996). Additionally, arts-based pedagogies have identified significant language development in multilingual settings (Goldberg, 2012), improved academic outcomes for disadvantaged students (Robinson, 2013), and positive reform for middle school students (Snyder, Klos, & Grey-Hawkins).

The arts have also been linked to processes of cognition and higher-order thinking in that they encourage students to closely observe, analyze and reflect (Cunnington et al., 2014). In developing practices of metacognition, arts-based pedagogies draw awareness to individual thought processes as well as collaborative knowledge production. This links with Dewey's notion of learning that is "qualified" and characterized by reflection and connection to feelings. It also aligns with Perry and Medina's (2011) theory of critical performative pedagogy, which "aims to explore the perspective of 'knowing how' and 'knowing who' rather than a more traditional 'knowing that' and 'knowing about'" (p. 64).

As a specific form of arts-based pedagogy, drama-based pedagogy has been used in multiple locations across the United States, including Austin, Texas where the *Creative Learning Initiative* showed a 30-50% improvement in reading and math standardized test scores in classrooms using arts-based strategies (MINDPOP, 2016). The pedagogical approach has a foundation in theatre-based arts integration techniques including: activating dialogue tasks, theatre games as metaphor, image work and role-play which are used to engage teachers and students in cognitive, affective and aesthetic learning experiences. Underpinned by theoretical ideas of constructivism and critical pedagogy, DBP also engages learners in multimodal, dialogic meaning making that strives to develop understanding through interactive exchange.

In DBP, students co-construct knowledge through linked or scaffolded strategies that demand high-order thinking skills and emotional intelligence to access multiple areas of the brain (Duffy, 2014). For example, a social studies teacher might have his or her students represent or enact the opinion and actions of key historical figures or members of a specific cultural group within an imagined set of circumstances, based on their reading and synthesis of primary source documents from the time period. Or, a science teacher could have their students create a stage picture (a non-linguistic representation of a concept made with the body) of an atom on a large field so that they can visualize the distances and relationships of sub particles.

DBP strategies bring students to the center of the learning experience and allow them to actively engage with and negotiate the co-construction of new understanding. They use the body as a text and a tool (Perry & Medina, 2011) to create embodied, non-linguistic representations of knowledge that provide a shared experience for students to draw on to make meaning and share their learning.

Embodied Pedagogies

While Western educational practices have privileged mind over body, recent scholarship in sociology, philosophy, and cognitive sciences signals a growing interest in the conceptual linkages between embodied ways of knowing, lived experiences, and cognition (Ivinson, 2012; Hall & Nemirovsky, 2012). Embodiment theories assume a perceptual modality that supports learning via the sensory motor system (Koch, 2006). They also consider the biological and physical presence of bodies as an essential pre-condition for subjectivity, emotion, language, and social interaction (Rodriquez & Castilla, 2013). Minds are more practiced at knowing than bodies, so an argument for embodied ways of knowing and, by association, body-based pedagogies, indicates an epistemological and pedagogical

shift toward acknowledging bodies as important agents in knowledge production (Wilcox, (2009).

Drawing on the seminal work of John Dewey (1938) and Merleau-Ponty (2002), we argue that the learning evolves from—and is deepened by—the body's sensorial and lived experiences. The body moves and experiences life through the senses and interprets these experiences both physically and cognitively such that memories continue to live in the cells of our body (MacKenzie, 2013). A corporeally centered pedagogy invites movement, democratic participation and creative energy. However, the institutional spaces of schools can discourage movement and impede these kinds of pedagogical goals (Berdayes, Esposito, & Murphy, 2004; Bresler, 2004). Tobin (2004), for example, highlights the disappearance of bodies as instruments of learning in early childhood education while Stevens (2012), laments the 'missing bodies' in mathematics thinking and learning. We teach in a culture that fosters a body/mind split which simultaneously obsesses with bodies but disregards their role in learning (Author & Other, 2016). However, when the body is re-inserted into educational discourse, there is a renewed focus on its productive role in pedagogic practice (Ivinson, 2012). As a multi-sensory device, the body acts as pedagogical transmitter that can be recruited to boost student access to formal academic discourses, including mathematics. As Stinson (2004) suggests, the body can be a "laboratory for understanding" (p. 160).

Research that explores embodied and gestural approaches to mathematics education suggests that learning grounded in body action and perception can support mathematical understanding—not only in processing old ideas but also in creating new ones (Goldin-Meadow, Cook, & Mitchell, 2009). Hall and Nemirovsky (2012) offer insight into body engagement in their theoretical analyses of embodied mathematical cognition. They highlight how the mind and body, as well as broader social and cultural forces, can be used to support

learning in mathematics. Trninic and Abrahamson (2012) also posit the benefits of embodied pedagogies (in mathematics) through the development of "embodied artefacts." They argue that these embodied representations of concepts create pedagogical opportunities to support student learning and allow "entry into disciplinary competence" (p. 283).

In drawing on the conceptual resources that underpin arts integration, drama-based and embodied pedagogies, as well as the literature on embodied mathematical cognition, we developed a Creative Body-based Learning professional learning model for in-service teachers.

Integrating Creative Body-based Learning into Mathematics

Building on the literature of drama-based pedagogy and embodied learning, the Creative Body-based learning (CBL) approach to mathematics is experiential and problem-posing rather than sedentary and abstract; it engages participants across multiple dimensions (physical, social, emotional, and cognitive) and includes tasks that require critical and creative thinking. Strategies that 'activate dialogue' are used to encourage mathematical vocabulary as well as connect and investigate new mathematics learning to prior understandings. Games are utilised to rehearse understandings as well as fluency and recall. Image work is used to create material representations of math concepts such as angles and role work is utilised to engage students in problem solving and connect learning to real world situations. A CBL learning experience integrated into mathematics often involves an embodied review of mathematics knowledge or skills, supported by moments of direct instruction. CBL also often draws on the dramatic inquiry (Edmiston, 2014) and role-play aspects of drama-based pedagogy (Author & Lee, 2018) to explore an embodied mathematical "problem." Through a CBL, students can step into role as experts within an

imagined set of circumstances to apply their mathematics and arts skills to solve a problem in an authentic context.

For example, a middle school geometry teacher uses the *String shapes* strategy to review the formulas for 2-D or 3-D shapes. As students work collaboratively to construct a square or triangle from a single piece of string, estimate its perimeter using informal units of measurement, and work to find the area, they practice mathematics vocabulary and review skills. The CBL teacher then steps into a "role" as a character, situated in an imagined set of circumstances (what we call role-play). The teacher becomes a flooring designer for an innovative school; she is new at her job and needs help. She works with the students to find the surface areas of a series of irregularly-shaped classroom floor plans which are missing measurements. Then she invites students to use their blueprints to design an innovative learning space and select appropriate flooring for the rooms. The lesson concludes with students sharing their "innovative learning classroom designs" including an explanation of their mathematical and aesthetic reasoning. After the role-play, the teacher and students reflect on the mathematical procedures used to solve the imaginary problem and consider whether these same procedures could be used to solve other "real world" tasks. These as well as other examples were used in a professional learning experience for teachers in this study.

In CBL practice, student perspectives and feelings are actively sought and shared through a Describe-Analyze-Relate (DAR) reflection process (Author & Lee, 2018). In this way, students engage in an ongoing, reiterative cycle of reflection on action to make connections to their life-worlds. Research of conventional classroom pedagogy suggests teachers routinely ask many questions, but these questions can lack depth and are often unsystematic (Walsh & Sattes, 2005). Through DAR, the facilitator pays attention to how

each question they ask systematically scaffolds, or builds upon, prior ideas to support individual and collective understanding.

In mathematics, CBL encourages students to make meaning and author understanding of concepts through physical, written and verbal dialogue. They physically demonstrate their understanding of mathematics individually and collectively, then use mathematical vocabulary to describe and compare their multiple perspectives of, and experiences in, the mathematical inquiry. In aligning with constructivist approaches (Vygotsky, 1978), these interactive exchanges are intended to include students and encourage them to listen, respond and build on the thoughts and ideas of others.

We now report on the impact of our work in CBL through an examination of participant teachers' instructional practices and students' mathematics learning in two primary schools. In this work we use a qualitative, interpretive lens to explore two questions: What is the impact of CBL professional development on: (1) the working practices of teachers; and (2) student engagement and dispositions in mathematics?

Method

The pilot project and intervention

As a research tool, a pilot study supports the production of further investigations, detailed accounts and deeper considerations of actions, experiences and perceptions (Basit, 2010). In conducting a pilot study for this project we were able to focus on a smaller sample to carry out research, using procedures and evidence of effects in order establish the feasibility of further studies. In this work, we adopted a "practitioner action research" methodology by viewing participants as co-researchers. Educational action research

recognizes the importance of teachers in the research process and seeks to improve pedagogical practices in situations where they are enacted (Kemmis, McTaggart, & Nixon, 2014). Specifically, this study sought to investigate the enactment of redesigned pedagogical practices using creative and body-based strategies as well as capturing the subsequent reflections and meaning-making of five teachers (who we shall call Helen, Karen, Kath, Ronnie and Zac) at two schools in the northern and western suburbs of Adelaide, South Australia. These teachers and schools were contacted through their involvement in prior arts-based projects organized through a local youth arts organization and selected on the basis that they shared concerns about mathematics achievement for students in their school and were willing to partake in the pilot project.

The project began with an intensive two-day professional learning workshop conducted by visiting scholar XXXX from the University of Texas at Austin. The CBL strategies used in the professional learning program were specifically selected to support mathematics instruction. Teachers from two schools then collaborated with local artists working across a number of art genres to redesign pedagogical practices in mathematics for their classes as well as investigate the outcomes of these practices. Two artists with backgrounds in theatre and dance worked with teachers at the Northern school and another two artists experienced in visual arts and drama worked with teachers at the Western school.

The artists met and planned with teachers on ten occasions over three terms of the four-term school year. In each meeting, teachers identified mathematics concepts and student outcomes to be explored at the next artist residency session in their classroom. In response, the artists offered CBL strategies and ideas from their own artistic practice that they thought might be productive to achieve the academic learning for students. Then, artists and teachers co-designed and co-facilitated the session plans, with the artist taking the lead in the CBL

content and the teachers taking the lead in direct mathematics instruction during most classroom sessions. At one site, the three participating teachers worked as a single team with two artists to develop lessons in measurement, fractions, and weight. These lessons varied in level of sophistication and challenge so that they were suitable for a Year 3/4 class, a Year 5/6 class and a Year 6/7 class. At the other site, teachers of a Year 1/2 and a Year 5 class worked individually with an artist to develop lessons on number, addition, subtraction, and fractions, working with money and music to counting and phrases. The participating teachers and their year levels are detailed in Table 1.

Table 1 near here

As described above, teachers and artists often delivered their co-designed lessons together. These lessons drew on CBL strategies modeled during the professional learning workshop as well as the artists' personal repertoires in dance, drama and/or visual arts. For example the artist with a background in dance worked with students to develop academic work on fractions into a dance, while another theatre artist worked with her teachers and students to develop role-play problem solving tasks. In the absence of the artist, teachers took on these roles themselves and continued to incorporate CBL strategies to assess and rehearse maths understandings in their mathematics lessons.

Data collection and analysis

In order to capture the lived experiences, perspectives, and knowledge generated by teachers, we conducted six semi-structured interviews as extended conversations over a ten-month period (Basit, 2010). During these interviews we explored teacher perceptions of CBL pedagogies, its impact on working practices, and outcomes for students. Sample questions included: How do you feel about CBL strategies? What happens for students when you

engage in CBL strategies? And what do you notice about student's mathematics learning when using CBL? The teachers also collected pre- and post-intervention data during the school year in their own classrooms, including student perspectives and feelings toward mathematics from their classes. This classroom data was used by teachers' to track student dispositions towards mathematics across the year. Also collected were statements (i.e. spontaneous comments from individual students), artifacts, and evidence of key teaching moments using CBL. These were used to prompt further discussion in interviews with researchers.

An interpretative lens was adopted in order to identify patterns, insights and understandings (Patton, 2002) made by teachers. Our focus was on how our teachers made sense of (a) CBL as a pedagogical practice; (b) its impact on their working practices and (c) outcomes for their students. The analytical process took the form of reading and re-reading textual accounts of interviews and coding for the meanings made and impacts of the re-designed pedagogies. A quantitative orientated word–based analysis was also engaged to evaluate the frequency and co-occurrence of particular words or phrases in pre- and post-intervention data collected by teachers (Dey, 1993). The resulting themes and outcomes were organized around the research questions (the impact of CBL on the working practices of teachers; outcomes for students) from the perspectives of the teachers involved in the project. As this inquiry was conducted with two schools and five teachers only, we do not make claims for empirical generalizable findings; instead we present findings from these unique and particular contexts as a means to expand understandings and possibilities for others to consider (Gilmore & McDermott, 2006).

Findings

Impact on working practices for teachers

Embedding CBL in mathematics: In this case study, five teachers offered their perspectives on CBL as a pedagogical practice, its connection to mathematics learning and the impact on their pedagogical practices. Initially the teachers expressed some concern regarding the amount of time needed to develop and present CBL strategies, and how this might impact on the time available for other curriculum areas. However, generally the teachers felt that CBL offered broad and effective pedagogical practices that could be applied to daily mathematics teaching.

CBL impacted teachers' pedagogical practices in various ways. For example, early on, two teachers commented on the need to focus on the math learning when using CBL. This meant that they also saw the need for additional explicit teaching so that students didn't "all just have a good time playing the game" (Helen). Karen, in particular, had concerns as to whether the fun component in CBL might take over from the actual learning for her students. She indicated that the "Kids loved the activity … and were really involved in it, but when it comes down to the specific mathematical knowledge ... it's hard to judge that." However, during the course of the research, Karen recognized that she "actually found it better to use the CBL activities to assess knowledge." She found that CBL activities could be used at a range of points in the instructional cycle, integrated with more traditional approaches to teaching, as evident when she suggested "We actually went back and taught the lesson in a more traditional manner, and then did the CBL activity again, and it was 100% successful." In this case Karen used a CBL strategy as a pre-post assessment of student learning.

For Helen, traditional approaches to teaching focused "too much on content," while CBL activities worked to "make connections." She began classroom activities by presenting

mathematical concepts, then worked with her artist to find ways that "active and creative strategies could be woven in."

> Because what you want to do is get the content to the children … but then you don't actually do that next bit of connecting it with something else, transferring it. So that's where this got me really excited. And the DAR allows students to speak their learning and it actually gets them to articulate the mathematical language.

In taking another approach, Kath indicated that all three classes at her school engaged in a number of the CBL strategies (activating dialogue, game, role play and image work) before adding mathematical concepts and tasks so students were comfortable with the approach and strategies and so "They could focus on the activities without … trying to process the math on top." Kath felt that the CBL activities could then be used to present mathematical concepts "in a different way" as compared to traditional approaches to generate conversations about maths and build on connections to the outside world.

The value of CBL in promoting learning conversations was also indicated by Helen who noted that it supported her students to "articulate the mathematical language." She suggested that: "now some of it might have been, 'Good, we won't have pencil and paper, now we're doing sort of fun things,' but they were learning. You would notice them talking, more engaged." For Ronnie (Yr 1 /2), a shopping role-play activity was one of the most successful for her class and she picked up on her artist's lead in subsequent lessons to learn about the use of money. Ronnie also worked with CBL and fractions in attempts to encourage her students to use mathematics language.

> And they had to use a fraction, 'This is a quarter of our pizza' or, 'This is a quarter of a cup'. So getting them to use that kind of language … I saw a huge improvement.

***It's not an extra thing*:** While operating differently at the two schools, a common theme in the teachers' conversations was that they really felt that CBL could be used not just in mathematics, but also across all curriculum areas to support and enhance learning. For example, Kath used CBL strategies and activities to set up a learning culture early in the year.

> When I first came back from the training I used a lot of those activities to develop the class structure, so to get to know each other … to create the environment for the year.

At the end of the pilot project, all five teachers communicated a commitment to using active and creative strategies across the curriculum. This was reflected in Karen's statement "I'm thinking it's not an extra thing to place on a teaching program, it's just something to embed into the teaching program." Ronnie felt that CBL had changed how she saw herself as a teacher and altered her thinking about learning. She spoke of the way that CBL challenged her to make connections to "real world stuff," not just her own, but for her students to see "the point" in what they were learning in their own lives. The more CBL encouraged students to talk, the more Ronnie felt she was learning about their worlds.

Karen, too, was challenged by CBL and indicated that "it's certainly made me aware, in every lesson I do, I think 'how can I do this in more creative and body-based ways?'" She talked about CBL bringing out the best in her students as well as herself:

> It just brings out different personalities in the children … you'll give them the opportunity to display their knowledge in a different manner, and you get kids absolutely shining …

These comments give insight as to how CBL stimulated, renewed and broadened pedagogical practices, where teachers moved beyond didactic approaches to develop richer and more meaningful, connected learning experiences to meet the needs of their diverse and distinctive learners.

Teacher perceptions of student change

On a general level, teachers felt that CBL offered opportunities to make mathematics enjoyable and fun, but also required a level of accountability where the "fun" was attached to learning and working things out. As noted by Kath, the enjoyment for students emerged from "just relaxing and not being frightened of having a go." It was also identified that some students who usually struggled at mathematics were persisting with problems for longer periods. As Kath recounted:

> Two students in particular that [sic] would struggle in putting their thinking, their ideas, on paper excelled in CBL, absolutely, because there was no pressure on them. They just jumped in and had a go, and it didn't matter whether they were successful at first, but they wanted to be successful and they persisted with the task.

Generally, the teachers felt that CBL approaches operated for students in a number ways. They noticed that by engaging in visual, physical and verbal modes of sharing learning, some of their most reluctant math students began to see themselves as learners rather than failures in mathematics. Helen noticed that several of her hesitant learners were taking more risks because of the different learning environment set up in CBL activities. When discussing students who traditionally contributed very little and who were now offering answers and

responses she said: “They [students] are just having a go … because they were in a community of learners the fear of failure wasn’t so great.” Zac also commented on risk-taking:

> I find the students are more likely to take a risk with their learning. A lot of my students have a fixed mindset particularly when it comes to maths. They either realise that they’re good, or think they are not so good. With CBL … we were working as a whole learning community, so those who might have been identified as having poor dispositions … were actually having a go and involved in the activities. They obviously felt safe enough in the environment to take a risk.

There was a sense conveyed by Zac and other teachers that CBL strategies allowed students to “share their learning” in a safe and supportive environment where there were no real “wrong” answers but multiple ways of thinking about a particular problem. In CBL, students were encouraged to support and help each other work on challenges in pairs and groups rather than in an isolated way where a lack of success and “getting it right” often led to a student disengaging completely.

While the teachers felt that CBL included and encouraged students who previously resisted mathematics, they also felt it “worked” for other students. Teachers suggested that some of their capable students learned to move outside their “comfort zone” and forced them to think critically about how and why they knew their answer was correct. For example, Karen stated that: “This way of learning actually forces [students] to do the reasoning and act out the reasoning, or explain the reasoning, behind their problem-solving.” These findings echo the intent of the dialogical meaning-making process (DAR), which, as a constructivist strategy, understands “process” as a way of knowing (Other, Author, & Other, 2011).

Teachers found that CBL strategies provided opportunities for students to practice particular kinds of thinking and working out.

In focus group conversations, teachers also described how CBL provided "really speedy and effective ways" for teachers to assess students' understanding of concepts. One teacher suggested that she could judge her students' understanding of a mathematical concept or process "just by where they stood in the room" or "the body shape they created." She saw CBL as providing her with embodied ways to broaden authentic assessment and opportunities to react quickly to support individuals in their learning before they could construct deficit views of themselves as mathematics learners. She indicated, "You get … a better picture of those that were actually being successful … as opposed to the pen and paper standard test." Assessment of student learning can be a challenge for teachers. As Zac commented:

> Even looking through a maths book you don't always get to know a student's real strengths and weaknesses because you don't know if they're just copying the answer ... But CBL gives you a good visual snapshot, particularly with an activity like *Across the Room*, you can quickly see … students who might be struggling … you can respond and help them … It's quite an authentic assessment tool.

For Zac, CBL provided "… different ways to show student thinking", and it encouraged students to "talk through problems and … engage with maths." He elaborated: "Because of the active nature of the activities … it [CBL] encourages dialogue … a lot of students who might be hesitant to record answers down using pen and paper were quite happy to talk about it, move physically or even act it out."

Importantly, teachers suggested that they were sometimes surprised at "how smart" their students could be. While deficit views can be held toward students who don't necessarily have access to traditional modes of literacy and numeracy, it was noted by teachers in this

study that CBL offered alternative modes of expression. As Karen noted, CBL "threw up things" they didn't expect.

> It [CBL] does challenge all the learners … Some that we thought were really successful, maybe that success is limited to a very narrow context, and others that we thought weren't comprehending at all, when they are given this sort of wider scope, actually can show things that we wouldn't have expected they could.

Kath also commented about one of her students who: "can't read and write, but gee he's got it here, so this (CBL) gave him the tool to go, 'Oh, I can share and I can do this, and it works for me.'" These excerpts give insights into how teachers might use CBL to challenge deficit views of students and open up opportunities for them to demonstrate their knowledge.

Student perspectives around mathematics

Prior to any engagement in CBL activities, teachers were asked to collect their students' initial perspectives and dispositions around mathematics. They offered students multiple ways to represent their feelings including mind maps, "Wordles," word walls, class conversations, observations, and even through CBL activating dialogue tasks. The information gathered indicated particular levels of discomfort, dislike and aversion to mathematics and numeracy for some students. In demonstrating this point, the teacher of Year 5/6 at School 1 collected the words her students associated with mathematics and put them into a "Wordle" program that uses comparative size to visually represent the frequency of specific words in a designated corpus of text. Significantly, frequent words included: "boring," "hate," "hardest," "dumb," "rotten," "sucks," "really bad," "awful" and "excruciating" (See Figure 1).

Figure 1 near here

Less frequent words included “OK,” “kind of like,” “good” and “best” indicating the variation of dispositions and feelings towards the learning area. As the year progressed, the teachers collected data from students to ascertain the impact of their altered pedagogical practices in working with CBL. Again from the same class, a “Wordle” exercise (Figure 2) presents evidence of changes in student dispositions and perspectives. A greater variety of words were evidenced as well as more positive words and statements in relation to mathematics and numeracy.

Figure 2 near here

While mathematics was still deemed to be “hard,” indicated by the size and boldness of relevant words, student vocabulary extended to describe the nature of their maths experiences to include “challenging,” “interesting” and “easier.” We also noted the appearance of new words attached to mathematics including “cool” and “fun” which were not recorded in the first exercise.

Other data collection methods by teachers verified this shift in student feelings and dispositions towards mathematics. For example, on a *Maths Graffiti Wall* one Year 5/6 student at School 2 wrote, “Maths is still hard but easier with CBL,” and another wrote “It can be fun when we move around.” The word “enjoyable” was used by a number of students at both schools indicating the possibility of enjoying a subject area originally thought to be difficult and boring. This was echoed on a *Poster Dialogue* activity at School 2, where students had to complete the open-ended statement “Maths is …” One student responded, “enjoyable under most circumstances. I like working it out but I don’t like piled on work in large quantities. Its better when we move around though.”

Conversations with teachers also indicated increased student engagement with mathematics. For example Karen commented:

> Oh it [CBL] definitely engaged the students without doubt … it was fantastic because the kids came in on day one and did have a negative attitude towards maths, *I don't want to be here, I'm stuck in maths, I can't do this or that*. It immediately turned them around and they wanted to do maths … they are still asking if they can create their own maths games.

Teachers also commented that students were increasingly noticing and making connections to how maths was used outside the school. Ronnie found one of the CBL closing reflection strategies, *It Made Me Think*, particularly useful for encouraging student metacognition when she suggested that: "it made them think that this isn't just maths in school this is something in the real world." She indicated in interviews that her students were increasingly noticing mathematics concepts outside of the classroom, particularly in conversation about money but also with regard to angles that her students were seeing in buildings and in the home.

Discussion and concluding thoughts

In this paper we have drawn attention to pedagogical practices around the teaching of mathematics in times when high-stakes testing and teacher accountability continue to assume dominance. In exploring the development of a Creative Body-based Learning (CBL) model of pedagogy, as well as the processes of change for teachers at two primary schools, we highlight its potential for mathematics teaching.

Analysis of teacher interviews suggested similarities and differences in the ways that teachers interacted with CBL and therefore its impact on their working practices. While one teacher interspersed CBL activities with more formal mathematics teaching, others assessed their students' knowledge using CBL activities. Still another engaged her students with the CBL strategies first before adding mathematics content. Generally though, teachers saw value in learning that was embodied and learning that encouraged thinking and dialogue. They found CBL approaches to be useful in making connections, assessing student knowledge and developing supportive classroom cultures. Engagement with artists heightened and stimulated teachers' own creative and embodied approaches, and all participating teachers indicated a commitment to continued use of CBL activities across the curriculum. Their comments indicate the potential teachers saw in using creative approaches as a "laboratory for understanding" (Stinson, 2004, p. 160) and also resonate with research that promotes learning that is grounded in the body (Abrahamson & Trninic, 2015; Hall & Nemirovsky, 2012; Nemirovsky & Ferrara, 2009; Trninic & Abrahamson, 2012). Importantly for us though, in this study CBL stimulated renewed and broadened pedagogical practices that moved teachers beyond didactic approaches toward pedagogies that engaged learners (Callow & Orlando, 2015; Van Eman et al., 2008) and allowed for authentic assessment of student knowledge.

Our analysis of data also suggests that there were several key changes for students when working with CBL, including increased engagement with mathematics, particularly for those who were previously reluctant learners. This finding aligns with those of Trninic and Abrahamson (2012) who argue the value of "embodied artefacts" to support student learning and allow access to disciplinary competence. Embodied artefacts become "conceptual performances" that represent a student's knowledge and understanding where thinking is made visible and accessible rather than hidden in the heads of learners. Through the DAR process, opportunities then arise to verbally discuss physical performances and make

connections with mathematical language. In this way, abstract concepts in mathematics can be first embodied, then refined, articulated and finally reified in conventional forms.

For previously capable students, where CBL encouraged such dialogue, students were challenged to explain their reasoning. This resonates with Robinson's (2013) "critical performative pedagogy" where CBL provided students with opportunities to explore their "knowing how" as well as their "knowing what." The sharing of knowledge between students, "helping others" and "speaking and demonstrating learning in different ways" thus worked to create a community of learners where students could overcome a fear of failure and willingly contribute. This aligns with the arguments of arts integration advocates who highlight the importance of providing safe and supportive learning environments in transformative pedagogy (Hirsh, 2010; Snyder, Klos, & Grey-Hawkins).

Heightened engagement in mathematics was noticed by teachers who saw students persisting with tasks and taking risks as well as associating more positive meanings and dispositions with mathematics. We believe that students could see themselves as "learners" in these contexts because CBL allowed them to demonstrate their learning in a broader range of physical, visual and dialogic ways. Valuing and promoting these performances created a sense of community and safer places to take risks. So too, in operating as a critical pedagogy, CBL allowed students to show and speak their learning rather than having to write it down.

Findings in this study in summary, based on interviews with teachers, support the ideas of Ivinson (2012) and advocate for ways that the body can be utilised to facilitate academic learning. In CBL, this was enhanced through creative processes that invited artistic representations, dialogue, game play, and role-play to develop rich and engaging mathematics tasks where learning and problem solving became visible and accessible. The processes of

dialogic meaning-making (DAR) then encouraged students to speak to others, explain their thinking, and thus heighten the academic rigor of the learning process.

However, what stands out for us as we reflect on the value of the integration of creative and embodied approaches into mathematics learning for classroom teachers is the capacity of CBL to foster not only improved engagement in mathematics, but reinvigorated creative practice by teachers and the broadening of pedagogical practices to facilitate student learning. When teachers positioned students as "capable" and worked to design learning experiences that engaged them physically, activated dialogue, and provided multiple representations for learning, teachers saw their students begin to let go of their reluctant learner histories. Participating in altered learning communities where collaboration and dialogue became the norm also affected teachers, who noted changes in their own professional identities and a desire to continue exploring CBL possibilities across the curriculum.

It is important to note that this pilot study was limited by the small sample of students and teachers; we do not claim to provide generalizations that are representative of all students and teachers. Student outcome data was collected and self-reported by teachers through a range of semi-structured interviews over time. Classroom observations of teachers, and teachers/artists at work together in CBL were outside the scope of this study and are a recommended data point for future studies.

Despite these acknowledged limitations, the data collected does suggest that in current times, when spaces for teachers to engage in creative inquiry seem to be shutting down, CBL may hold significant promise for improving students' learning engagement in mathematics as well as professional renewal for teachers. Mathematics understanding can unfold through artistic, kinesthetic, social, and emotional experiences. Where tests reduce competencies to

those that are superficial and measurable, CBL may offer multiple ways and means for students to fully tell us what they know and show us how clever they really are.

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Table 1: Participating teachers

Teachers	Year l	School	Focus
Zac	3/4	1	
Kath	5/6	1	Team: measurement, fractions, weight
Helen	6/7	1	
Ronnie	1/2	2	Individual: number, addition, subtraction, fractions
Karen	5	2	Individual: number, addition, subtraction, fractions

Figure 1: March Wordle exercise from School 1 (Yr 5/6)

Figure 2: September Wordle exercise from School 1 (Yr 5/6)