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Calculating for creativity: Maths joins the circus

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Abstract

Following recent increases in the diversity of students, technologies, pedagogies and environments, New Zealand classrooms are sites of growing complexity. Tasked with covering a broad range of disciplines within each school day, opportunities for subject integration are of increasing value to busy teachers. Developing upon a previous piece of research (Coleman & Davies, 2018), this project sought to gain student engagement in mathematics through a dramatic framework. A key factor in developing adaptable, responsive and capable learners, creativity is an area of intense educational interest and yet substantial confusion (Jefferson & Anderson, 2017). Focusing upon the activation of students' creative capacities through drama, this project offers suggestions for future praxis and the development of classrooms that invite creativity.

We began by establishing a fictional pre-text closely related to their earlier studies of insects. Recruited to assist Professor Lee—a flea circus owner, with the redesign of her circus, this pretext deliberately offered opportunities for mathematics integration. When planning we predicted the need for students to engage with numbers and measurement, yet remained responsive to opportunities arising from the drama or instigated by the students themselves. Over the five drama-maths sessions, we collaborated with students both in and out of role, to design, plan and prepare a new cockroach circus extravaganza. We generated data for the research through reflective journal entries, student work, drama based research and focus groups. Our findings indicate an enthusiasm for the use of drama to engage students and make mathematics meaningful and highlight the vital elements for collaboration and creativity. Three distinct elements appear crucial to engaging in an effective drama-maths unit: a sense of unity in pursuing a common goal, the value of the affective and embodied elements associated with drama, and cultivation of skills for collaboration. While this project bolsters existing rhetoric surrounding STEAM integration, it advocates for further development around existing notions of collaboration for 21st century learning.

Keywords

Mathematics; creativity; STEAM; drama education; collaboration.

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Introduction

Gluing fleas to wires, making model cockroaches and enacting 'loops of doom' are perhaps not activities commonly associated with classroom maths, but unsurprisingly they are great fun. This research integrated mathematics through drama in a classroom setting to engage students creatively with core mathematical processes. As a pedagogy of exploration, drama enables participants to imagine new worlds, take on fictional roles and engage in meaningful problem-solving tasks. Over five sessions, we worked to initiate a drama that sought to teach explicit mathematics concepts and take advantage of naturally occurring teachable moments. The drama began by introducing *Professor Lee*, the owner of a flea circus recently shut down by the Society for the Prevention of Cruelty to Insects (SPCI). After meeting with *Professor Lee*, the class set about designing a new insect circus that would both satisfy the Professor and the SPCI. Underpinned by a constructivist methodology, this research remained responsive to student inquiry and discovery and employed arts-based research methods (Barone & Eisner, 1997) to illuminate the elements likely to support creative and collaborative learning.

While drawing heavily upon earlier research indicating the value of teaching mathematics through drama (Coleman & Davies, 2018), this project explicitly focused upon the shifts in pedagogy, innovations in thinking and practical conditions that might facilitate its success. We received a small research grant from the University of Waikato and ethics approval for the project.

The primary research question for the study is:

> What are the benefits and opportunities for teaching and learning when enriching mathematics through drama to cultivate creativity and engage students?

This led us to consider three underlying focus questions:

What aspects of creativity do the students and teacher engage with while engaging in the drama?

What approaches to mathematical questions are encouraged by drama?

What elements are essential to fostering creativity when working with mathematics and drama in an authentic, safe and inclusive way?

Affiliated with the local university, Sunnydale School hosts a number of pre-service teachers from the university's initial teacher education programme. The collegial relationships developed between teachers and academics provide a mutually beneficial relationship of complementary expertise. The teachers gain new theoretical (and in this case, theatrical) perspectives, whilst the academics obtain valuable contextual knowledge and insight into the classroom. Accordingly, Tom and I collaborated upon this research project from its inception, forging a productive teacher-researcher relationship to unite research and practice. As qualitative research, we acknowledge the subjective positionality of the researchers, the wider context of the research site and our relationship to it. These brief biographies identify our role within the research and interests that influenced our involvement.

Claire	I am an early career academic at the University of Waikato, teaching in the areas of innovative pedagogy and drama. I am passionate about education and the opportunity for enhancing creativity and criticality through drama. I have two children at Sunnydale School though neither was involved in this study.
Tim	I am in my third year of teaching, having completed a Master of Teaching and Learning in 2017. I am interested in drama as a pedagogy and finding ways to engage diverse learners in mathematics.

A culturally diverse school, Sunnydale has a transient population with 50 percent of its students changing schools each year. A third of its students identify as Māori, a third as Pākehā while the remainder are of varying ethnicities. At the time of this project, this composite class of year three and four students had been working together for only a matter of weeks. Prior to this project, the class had enthusiastically investigated how living things survive and thrive and motivated our drama planning. In preparation for the study, we reviewed key literature and continued to share journal reflections throughout the project.

Mapping the terrain/literature review

Straddling multiple areas of educational interest, this project employed process drama and mathematical problem solving to engage students in a primary school setting. It recognised the potential of the arts to stimulate imagination and engagement around essential but potentially abstract areas of the curriculum (Biesta, 2013). In reviewing existing research in the areas of creativity, drama as pedagogy and concepts of mathematics learning, this section strengthens the argument for subject integration and identifies key points for consideration.

Whether creativity as a force for criticality or driven by the instrumental needs of "creative economies", fostering young people's capacity to be creative is widely accepted as a vital skill for the future (Ministry of Education, 2019). Typically, creativity is valued as an indicator of artistic ability or a useful capacity for problem solving (Torrance, 1966). We view creativity as an ability to engage in divergent thinking, adapt, innovate and generate. As developed nations face the reality of increasing automation, creativity has gained substantial global currency for ensuring adaptable, inventive and resilient populations. As declared by the 2014 OECD Forum, "Creativity and innovation are now driving the economy, reshaping entire industries and stimulating inclusive growth" (Van der Pol, 2018, p. 1). International research (e.g., Collard & Looney, 2014) has established the value of deliberately nurturing creative capacities within schools and the place of creativity as a determining factor in educational success (Lucas, 2019).

For small nations like New Zealand, enhancing the creative capabilities of our young people within the competitive global market is vital (Peters et al., 2009).

Our national curriculum acknowledges human creativity as essential and acknowledges the centrality of developing students' 21st-century skills (Ministry of Education, 2007). The increasing focus internationally on *STEAM* (Science, Technology, Engineering, Arts, and Mathematics) has validated the role of the arts in cultivating creativity and divergent thinking (Watson & Watson 2013). Research suggests that incorporating *STEAM* via interdisciplinary inquiry-based learning approaches optimises the learning (Hunter-Doniger & Sydow, 2016).

Data gathered by the Programme for International Student Assessment (PISA) indicates that over the last 10 years, mathematics scores throughout Western, educated, industrialised, rich, democracies have continued to decline (Dashzeveg, 2019). Positioned as an individualistic, competitive difficult subject, mathematics is associated with didactic pedagogies of memorisation and rote learning of formulas and facts (Walls, 2009). This reputation, coupled with the status of mathematics as a signifier of intelligence, frequently elicits strong emotional responses from students (Larkin & Jorgensen, 2016), a situation likely exacerbated in New Zealand by the now defunct National Standards, which prioritised mathematics and became a major source of anxiety in schools (Thrupp, 2018).

Bonne's (2016) review of studies in mathematics and self-efficacy suggests a significant correlation between positive self-belief and higher achievement. She asserts that encouraging positive attitudes towards mathematics will strengthen student efficacy and raise achievement. Despite external pressures to focus upon basic skills and an ongoing image problem, mathematics can provoke creative and engaging learning experiences. As Bailey (2018) advocates, rich mathematical tasks can encourage problem solving, creativity and an ability to communicate and share ideas in a manner consistent with the principles of 21st century learners.

These abilities to communicate and share are essential to drama pedagogy and significantly contribute to its status as a relational future focused subject. Previous research recognises that drama as pedagogy can engage diverse learners and invoke multiple learning styles through integrated learning experiences in an imagined setting (Wells & Sandretto, 2017). An affective and embodied medium, drama is accessible to a range of learners, potentially excluded by traditional educational literacies (Stinson & O'Connor, 2012). Drama is currently employed in numerous ways as both a discreet pedagogy (Bowell & Heap, 2013), and a teaching tool (Piazolli, 2011; Swanson, 2016). As a creative aesthetically informed pedagogy, drama welcomes play and experimentation, seeking to engage in possibility thinking rather than problem-solving and crafting spaces for cultivating creativity.

Drama-based pedagogies such as process drama exemplify student-directed learning approaches and satisfy the demand for flexible teaching practices that innovate through the co-construction of new knowledge (Farrand & Deeg, 2020). As an improvised form, process drama provides students with a 'lived through' imagined experience in which they have the agency to take action. Facilitated by the teacher and typically motivated by a pre-text or dilemma, participants cooperate within the fiction and respond to the drama through active engagement and reflection (Bowell & Heap, 2013). As a teacher-in-role, the teacher participates alongside students within the drama as a colleague (Fraser et al., 2013). Invested in the fictional frame, students and teachers collaborate to create the inquiry and negotiate understandings (Heathcote & Bolton, 1995). The fictional context enhances this ethos of collaboration by offering a 'no penalty zone' where participants can explore ideas without real-world limitations or repercussions (Heathcote & Bolton, 1995).

Perhaps not obvious bedfellows, substantial research exists regarding the benefits of teaching mathematics using drama. The research highlights drama's ability to offer purposeful experiences, which increase social interaction and encourage perseverance (Cremin & McDonald, 2013). Absorbed in a fictional treasure hunt, the students in Coleman and Davies' (2018) study did not recognise the mathematics element until they discussed it later. Despite this lack of awareness, they engaged enthusiastically in mathematics, likely without the associated fear or worry. Engaged by the need to solve tangible problems and make progress, these students drew upon existing mathematical knowledge and strategies in new ways (Coleman & Davies, 2018). As learning partners, drama and mathematics seek to build upon prior knowledge and tackle problems through innovation, collaboration and creativity.

Methodology

The research is located within a constructivist paradigm and recognises knowledge as active, responsive and socially constructed. Constructivism recognises the place of individuals in the construction and creation of their knowledge about the world (Kincheloe, 2003; Moses & Knutsen, 2007). This paradigm supports our philosophical stance and offers a suitable framework for exploratory research seeking emergent findings through qualitative research. Qualitative research acknowledges the position of the researcher and pursues an understanding of phenomena through "thick description" (Geertz, 1993; Stake, 1995, p. 37) to garner the feelings, context and intentions of participants. We generated qualitative data to provide a detailed representation of the 'what, how, when and where' of the research and honour the complexity of working in the classroom.

Several elements influenced the selection of the flea circus theme including student interest, the availability of resources and desire to keep it playful. After witnessing the accidental deaths of several insects during the previous unit, Tim wanted students to think critically about handling insects as living creatures. This led to a discussion on animal wellbeing in captivity, and subsequently the idea of a flea circus. The forcible closure of *Professor Lee's* flea circus by the Society for the Protection of Cruelty to Insects (SPCI) provided the pretext for the drama.

Although designed to be responsive to the emerging narrative, while planning we anticipated some likely mathematics and drama learning opportunities. We predicted that students would encounter the mathematics of numeracy, basic facts, measurement, time and scale. Drama learning would occur through the curriculum strands of exploring practical knowledge and communicating ideas (Ministry of Education, 2007). Before embarking on this unit, Claire ran an introductory drama session to establish rapport with the group, introduce drama conventions and gage their level of drama experience.

On the Monday, after a quick warm up, Claire explained she would be going into role. The class left the room and then returned to find her frozen in role. Dressed in a sequin jacket and top hat, Claire sat miserably and clutched a lone piece of paper. Once the students had spent some time observing, questioning and discussing who she might be, Claire moved out of role and we began making sense of the freeze frame.

Dear Mr Lind

My name is Professor Dinah Lee and I am writing to you to request your help. I am sorry to say that after several protests, my flea circus has been shut down by the

The Society for the Prevention of Cruelty to Insects.

I didn't think about the distress that glueing the fleas to the attraction was causing them and I am very sorry about that. I realise now that even the smallest creatures should be well treated.

I love entertaining and want to continue to work in the circus. I cannot afford to go into the "big animal" business and don't really know how that would work??
I am hoping that perhaps I can establish another "insect based" circus and can prove to the SPCI that I can responsibly provide a circus that is both fun and safe for insects and audience alike.

I heard that you have been working with insects in your class and am hoping you might be able to help me.

Apparently, cockroaches could be a good replacement idea as they are very robust but I don't know what to do. I have spent my whole life working with fleas. I need to get back to work as my family relies upon my circus for their income. Can you help, we need to redesign the whole circus and I can't do this on my own!!

If you could assist me even with some ideas, I would be most grateful, I am happy to meet with you to discuss this further

Kind regards,
Professor Lee

* Email from Professor Lee.

An email the next day from *Professor Lee*, and deconstructed by the class, provided further details and motivated the next steps of the drama. Claire returned in role as *Professor Lee* and answered the students' questions to provide further details about the flea circus and her predicament. As you can see in the overview below, this launched the class into the idea of re-developing the circus for cockroaches whilst simultaneously influencing students' design ideas, encouraging debate and stimulating creativity. The students' suggestion that we redesign the circus for cockroaches ensured that we immediately had to consider mathematics issues around scale, measurement and area.

Table 1. Overview of The Project

Date	Overview
Wednesday 6th March	Introduction to Author and doing Drama—games/conventions etc. FFrames, Mime, Sound effects etc.
Monday 18th March Lesson 1	Introduction of effigy of Professor Lee (Claire fframe in role). Hot seating Professor Lee to learn more. Discussion of Flea Circus. Agreement to assist Prof Lee. Began thinking about size of cockroaches as alternative.
Tuesday 19th March Lesson 2	Email from Prof Lee re; help etc. Flashbacks of Prof Lee past (creating character/backstory). Concern reweight of insects + exploring the maths.
Wednesday 20th March Lesson 3	Society for Protection of Cruelty to Insects Meeting—facilitated by two students. Spilt class into teams with select tasks for Circus Creation. Issue of scaling the performances arose and maths addressed.

Thursday 21st March Lesson 4	(Previously—discreet teaching on scale, cm sq. etc.) Deciding on the number of cockroach performers required according to space available, scale, measurement + problem solving. Responded to the loss of Bertie Flea.
Monday 25th March Lesson 5	Voicemail from Prof Lee's friend Alfon regarding the SPCI. Plotting the opening number—introducing performers—rhythm, beats per bar, counting, division. Visit from SPCI inspector.

In accordance with this methodology, we collated a variety of data to document the emerging understandings of both participants and researchers/teachers. These included embodied reflections, research journals, student work and a focus group workshop. Researching through drama uncovers, investigates and makes meaning through a reflective process in action (Bresler, 2011). Invited to recreate a frozen image based upon photos of their freeze frames, a small focus group engaged in an embodied reflection to explore the meanings of this work. This sought to retrieve sense memory and honour the enactment of the drama. Once positioned back into the original freeze frames, participants discussed their thoughts in relation to one another. While students seemed to enjoy this process, they focused predominantly on remaking the images rather than articulating understandings.

Figure 1. Students mapping the flea circus.

In addition, Tim and I wrote and shared journal reflections after each drama session and collated samples of student work as seen below:

Figure 2. Flea circus planning.

Our analysis relied upon an evolving thematic process guided by the initial research questions and informed by the application of the creativity cascade (Jefferson & Anderson, 2017). The creativity cascade employs a metaphor of a cascading waterfall to encourage high quality learning. These elements are noticing, asking why, playing with possibility, and selecting and evaluating. Step one involves paying attention: thoroughly experiencing and examining what you are engaging with. Next comes questioning: asking 'why?' and going beyond the first-tier response to ask 'really, why?' The third step invites playing with possibilities to think beyond the known structures for solutions and embrace multiple options. The fourth step involves evaluating choices and responses, reflecting both by yourself and seeking feedback from others. An iterative approach, this method requires time to engage and then re-engage. This suited the timeline of the study, analysis and write up which took place over a school year.

Through this iterative analysis process, we identified three major themes: the numerous opportunities for mathematics in the drama, the supplemental integration of other curriculum and the delicate but essential need for constructive collaborative practice.

Despite our initial concerns, we incorporated the planned mathematics concepts into the drama with ease. We anticipated some mathematical activity, such as measuring for stage and set design, and enlarging the circus for cockroaches. Learning within a context increases student engagement and understanding (Meyer et al, 2001). Weist's (2001) study on children engaged in mathematics indicated that fictional contexts in particular, promote strong engagement and creativity. Unlike Wiest's study our project sought to integrate mathematics-learning opportunities as they arose.

Throughout the drama, we found numerous chances to engage students in relevant mathematical thinking, labelling these moments 'opportunity maths'. We tried to resist our urge to leap upon our perception of a good teachable moment and follow student interest instead but were not always successful. Those moments of mathematics, however, which arose organically from students' questions and discussions, were of the greatest interest. This excerpt from Tim's reflective journal illustrates how mathematical discussions transpired over the course of the lesson:

> The question arose, 'how big are they'? One student said "One metre!" and we talked about what one-metre was. The class then used rulers to estimate how big they thought a cockroach is. Using this data, we asked the class how we would work out the average. (Tim, Session 3, Reflection notes)

Conscious that cockroaches come in different sizes, one student suggested we base our circus design on the average size of a cockroach. Despite not being part of the planned curriculum for these students, we began to explore the idea of average. They each estimated the size of a cockroach, using their finger, which Claire measured and recorded upon the whiteboard. Aston knew how to work out the mean, and led the class in figuring this out based upon these estimates. He came to the whiteboard, took the marker and explained his idea to the class. Tim then explained the slight difference between the mean and the average and talked through how to find the average. Later, the weight of the cockroaches became another area, which provoked mathematical discussion.

> One student suggested that cockroaches were 0.38 grams. Lisa found a book that said the biggest in the world were 50 grams. Claire led them to focus on the NZ cockroach, and the class suggested googling. We looked it up and the largest a NZ cockroach gets is 30 grams. (Tim, Session 3, Reflection notes)

Prevented by the SPCI restrictions from handling real cockroaches, the students created model cockroaches out of the materials we had on hand, including modelling clay, toothpicks, pipe cleaners and packaging. Students decided that as the average length of their model cockroaches (3.8cm) was approximately a third of the length of the biggest known NZ cockroaches, they would apply this ratio to its weight. Through dividing the largest cockroach weight by a third, they arrived at an average weight of 10 grams for their cockroaches.

Students accounted for this weight of 10 grams when designing the circus equipment to ensure it would be safe. Student suggestions and their prior knowledge of measurement motivated the students'

desire for precision. One student, Ben, reinforced this aspect of the drama when he 'found' some scales (a piece of plastic watch) and began to weigh the models. Seizing upon this idea, Tim brought out the maths scales and rulers, and students enthusiastically weighed and measured their models. Estimation and measuring skills came into play again during the fourth lesson, when the students determined how many cockroaches the circus could safely accommodate.

> We started the day, before Claire arrived, refining our estimation of the number of cockroaches. I printed off twenty or so hundred-squares, with each square at 1 cm, and demonstrated how 100 of such squares would fit into the 1 metre square that was the stage.
>
> Students then had one hundred squares each and moved around talking to others to determine how many hundred squares would be a comfortable enough space for a single cockroach to do their acts. Following this we compared our ideas and reasoned that 4 of the squares (an area of 40 cm squared) would be needed for a cockroach. I then modelled how we might work this out, and Smith went ahead and solved it for us – the stage of 100 squares, divided by four, equals 25 cockroaches. We later decided that for health and safety reasons, a backup contingent of 10 understudies should also be included. Sam worked this out to be 35 in total. (Tim, Session 4, Reflection notes)

For some, this was their first encounter with these measurement concepts and terms, such as average and square metres. Admittedly, some students engaged more fully than others did, but as a co-created context, we worked together to ensure a common understanding. Whilst not the primary research objective, we endeavoured to integrate aspects of curriculum in a meaningful way, motivated by student interest rather than curriculum requirements. Fraser (2000) contends that meaningful curriculum integration is issues-driven, co-constructed with the students; scaffolds, not directs student learning; and draws upon learning areas that relate to the central issue of the inquiry.

Quickly established as a major concern, maintaining the wellbeing of the insects became of vital importance and reflected their prior experiences. This prior learning scaffolded the students nicely and empowered them to operate from a position of knowing. *Professor Lee's* comment, "I hear you know something about insects", affirmed this status and established the students' expertise as partners within the drama. Students actively provided the details of *Professor Lee's* history, circus designs, elements for the circus safety checklist and much more.

In addition to the intended curriculum links to mathematics (Measurement, Number and Statistics), drama (Practical Knowledge, Communicating and Interpreting) and science (Life Processes), students engaged with a number of other curriculum areas. The students explored level 2, technology, as they developed their plans for a new circus, took account of resources available and evaluated the outcome (Ministry of Education, 2007). Students similarly engaged with numerous aspects of the English curriculum when researching insects and reading or creating documents.

> We then read an email from Prof Lee about the death of Bertie, one of the prize fleas, and how the SPCI was going to be super strict about the cockroach circus. This got many of the students focused. (Tim, Session 4, Reflection notes)

As an integrated curriculum, this unit invited the cultivation of 'soft skills' such as collaboration, self-management, critical thinking and resilience. Drama is recognised for its capacity to encourage these skills both in New Zealand (O'Connor & Dunmill, 2005) and internationally (Cziboly et al., 2011). Drama can provide a meaningful motivation and link easily to other subjects to enact, explore and reflect upon life skills and social competencies. Termed the 'key competencies' (Ministry of Education, 2007), New Zealand teachers are encouraged to embed these capacities within their daily practice. Perceived as an auxiliary part of curriculum, it is perhaps unsurprising that according to the Ministry, over 25 percent of schools are not actively incorporating these competencies (Ministry of Education, 2019). This project identified the importance of these competencies for successful collaboration in drama and beyond.

We identified early in the project that collaboration for creativity is essential. As a prosocial theatre form, process drama requires engagement in the collective endeavour to build a community and common

culture (Neelands, 2009). Vital to drama, the development of self-regulating, self-managing social groups is of equal importance to numerous contemporary pedagogies. The willingness to share ideas, reflect, debate and generate ideas collectively presents both challenges and opportunities. However, within the intercultural, multifaceted classroom, this requires forethought; you cannot assign groups and hope it will work (Baldwin, 2004). In this project, the three key factors influencing the students' capacity for collaboration appeared to be a shared common purpose, physical engagement and cooperative skills.

Leading drama practitioner Dorothy Heathcote (Smedley, 1971) describes a successful pretext as one that arrests the attention and immediately fires up the imagination to create a narrative. In this study, the students immediately responded to the freeze frame of Professor Lee (sad, sitting upon the chair—holding the notice from the SPCI) as evidenced in my journal notes:

> Elicited some good questions from the group - Testing the frame - suggestions around the effigy—"she is drunk" I wrote that down and I took some of the questions ???? what if she is drunk????? (Claire, Session 1 Reflective Notes)

When facilitating a co-created drama, it is essential to acknowledge and consider all suggestions. This demonstrates a genuine commitment to collaboration and heightens the collective sense of ownership for participants. Students demonstrated this sense of ownership in various ways; they took on responsibilities, progressed the narrative and keenly participated as described below.

> Adam kept the minutes of the meeting—invited other members of the class to talk about the difficulty of the "flea circus". (Claire, Session 3, Reflection Notes)

Furthermore, Tim's shift into an active role within the drama encouraged a collegial relationship and amplified the shared sense of community. As evidenced when Tim entered the drama as a member of the Society for the Protection of Cruelty to Insects and positioned as colleague not authority.

> I took on the role of Terry, an ex-cockroach-exterminator who had changed his ways, and I shared some facts about cockroaches to make them seem more sympathetic—they are an ancient species, can learn much like humans, have the cool factor like cicadas. Lots of fun. (Tim, Session 3, Reflection notes)

Students engaged as a large community of helpers to *Professor Lee*, but their enthusiasm varied considerably when students worked in smaller groups. This may have been due to a lack of real tension, unfamiliarity with drama and its limited duration. When divided into specific tasks for each group, the unifying force of the common purpose appeared harder to sustain (Baldwin, 2004).

Drama is a multimodal pedagogy and recognises the body as a site of knowledge (Barbour, 2011). As evidenced by the literature and an increasing number of play-based classrooms, the significance of the body in learning is gaining traction in New Zealand (Bolstad & Roberts, 2018). Often, it is the physical aspect of drama, which captures student interest. Drama can unify body and mind in the learning and provide a "corporeal manifestation of a mathematical concept" (Abbott, 2014). This aligns with Dewey's (Smith & MacGregor, 1992) emphasis upon experiential learning and the value of tangible student led experiences. As noted in the excerpt below, students in this project were keen to get doing.

> Lisa's group was going all out on creating a miniature model of the circus. John had taken his plan of the recreational facilities and started to recreate it using Jenga blocks. Some students joined in to help, and I saw cool collaboration. (Tim, Session 3, Reflection notes)

Figure 3. The cockroach recreation centre model.

The use of Jenga blocks invited spatial thinkers into the collaboration and added a completely new dimension to the design. Equally, the students were noticeably energetic when making model cockroaches, exploring various ideas and materials to create models that were both functional and artistic.

Figure 4. **Cockroach models.**

In addition to engaging with materials and working in role, students employed the body to communicate ideas and make meaning through various drama conventions. The activation of ideas through drama reflects it as "a discourse which has rediscovered its connection to the concrete" (Hirschkop and Shepar, 1989, cited in Prentki, 2018, p. 35).

Figure 5. Students create the 'cycles of doom'.

As seen above, students demonstrated the various circus acts and scenes from *Professor Lee's* past through physical enactment. This contributed to the shared narrative of the drama, encouraged students to relate to one another through movement and created a collective real experience from within the fiction.

Drama is a collaborative endeavour and cooperation an essential component to successful drama praxis in both classrooms and theatres (Neelands, 2009). Aligned with Vygotsky's theories of constructivism, drama offers a space for learning and knowledge creation through social interactions between participants. McLauchlan's (2001) research into collaborative creativity highlighted the idea of creativity occurring through enactment, ultimately leading to a rich and original creation. This research acknowledges the importance of collaboration for creativity and cultivating a climate, which invites this collaboration. We naively expected that the drama frame would be enough to unify the group in a common purpose and enable them to negotiate collaboratively. Although the cohort did accept the task of assisting *Professor Lee* with the development of the cockroach circus as discussed, earlier small group work did not fare as well.

Despite being encouraged to work cooperatively, they sought a model of authority and attempted to assert other hierarchies within the drama. While Tim and I worked to minimise our position as the arbitrators of power, students sought to fill this void and began to jostle for position. As commented upon below, this took different forms: some assumed leadership roles, some seemed happy to cruise along, while others tried to assert power by rejecting or disrupting the project.

> Clear sense of leader who are confident and happy and then others trying to deliberately challenge the drama frame to see if it will hold. They are still unsure how this all works. (Claire, Session 3, Reflection notes)

Participants also had difficulty engaging in constructive disagreements without taking matters personally. They struggled to listen to each other or treat one another as colleagues and reaching a consensus became a fractious and unsatisfying experience.

> … they wanted "to be heard"—but only talking to me. Struggle with the idea of other children leading "Not particularly great at listening to each other". (Claire, Session 1, Reflection notes)

While we hoped students would work autonomously, some students found this challenge far too difficult. Although we aimed to empower students, it became evident that without the skills and mechanisms for collaboration some students were floundering. The review of research on collaborative

groups by Blatchford et al. (2003) suggests that the importance of social relationships within classrooms are often disregarded. They assert that there is a lack of consideration of the relationship between the size of groups, their composition and purpose of the learning task. Unsurprisingly, a correlation exists between effective learning and the relationship between the task and the quality of the group interaction. The social pedagogy of classrooms is delicate, changeable and, as evidenced here, vital to adopting collaborative teaching and learning practices (Kutnick & Berdondini, 2009). The discussion considers this concept further.

Discussion

As Jeffries (2016) asserts, "collaboration is a craft that requires skill" (p. 41), and creative collaboration relies upon a complex process of affective, cognitive and embodied interactions (Meill & Littleton, 2004). Although much of the current research into collaboration and creativity focuses upon achieving corporate success, these principles are equally applicable to any creative collaboration. Creativity that occurs through collaboration is more attainable than the mythology of the sole creative genius. Central to this discussion is the role, definition and composition of this collaborative community. Yet students have little control over their class affiliation or the authoritative position of the teacher. As an assigned rather than selected community, students within a classroom are obliged to engage. However, Mullen and Thomas (2016) attribute the success of collaborations for social change to the personal significance of each individual project to each community member. By comparison, in schools the curriculum and/or teacher determine the opportunities for collaboration. Motivated by external demands rather than intrinsic curiosity, these opportunities will remain of varying interest to students. If the goal is to support students' creativity then their interests must fuel and motivate them through the iterative process of creation.

Another valuable element to creativity we identified was an atmosphere that invites playfulness and resists outcomes. Embodied, reflective and exploratory drama activities, such as freeze frames or soundscapes, operate in a similar capacity to a brainstorm (McGlynn, 2009). Unlike its written counterpart, a scene, soundscape or freeze frame is transitory, unrepeatable and consequently less daunting. Equally exploring ideas through the body and in social interaction heightens the potential for emotional connection, affective sense making and cognitive links. Crucially, students in drama are often encouraged to piggyback onto one another's idea, rather than take individual responsibility. They elaborate and modify the ideas of others (McGlynn, 2009). Students had opportunities to be playful and explore tangential aspects of the problem to invoke more divergent thinking.

Drama provided a potentially braver space for tackling mathematics, as students experimented with equipment and concepts as a means of processing rather than demonstrating knowledge. Students asked genuine mathematics questions and invited contributions from students and teachers. As valued participants, student ideas were considered without judgement. A diverse range of students contributed and the negative perception of mathematics neutralised.

Conclusion

Classroom cultures are complex ecosystems and identifying the exact mix of pedagogies and practices to create the perfect alchemy for learning, a lofty goal. We witnessed moments of genuine engagement and motivation alongside those of disruption, disagreement and dismay. This study suggests that a productive classroom climate is vital for the success of innovations in pedagogy, resources or environments. It is tricky and requires thoughtful and deliberate co-construction. In drama, actively creating community through games and circles are commonplace. As bell hooks (2009) identifies, these subtle "rituals of regard" (p. 141) offer an essential brave space in which to engage. When it comes to engaging students in productive collaboration for creativity, perhaps it ain't what we do it's the way that we do it.

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