How can a makerspace in the school setting support increased motivation, engagement, and achievement for Pasifika and Māori learners?

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KEY POINTS

- Through teacher-led inquiry we created and fine-tuned a school makerspace learning environment with our aim to improve learning for a group of Māori and Pasifika students at risk of underachieving.
- Project-based learning emerged as an appropriate pedagogy for our makerspace.
- Students responded well to opportunities for taking time, making choices, accessing technology, and developing skills for future work in the makerspace.
- Our evidence, based on student voice and progress against National Standards, indicated positive gains both in student achievement and in development of key competencies.
- Further cycles of inquiry are planned to investigate how teachers can best support students to transfer skills between makerspace and classroom environments.

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This article reports on a teacher-led inquiry at Mt Roskill Primary School from 2016 to 2017. Teachers worked with a group of Pasifika and Māori students to develop a learning environment and use pedagogies inspired by the makerspace movement. Data on students' engagement and achievement levels indicated positive development in the key competencies, practical skills, and learning behaviours of these students. Through student voice we discovered what learning strategies were of benefit to these students. We can now plan another cycle of inquiry to expand the makerspace to benefit other student groups in the school and to transfer the findings and teaching strategies learnt through the makerspace inquiry into mainstream classrooms.

Introduction

There is an over-representation of Maori and Pasifika students underachieving in New Zealand (Education Review Office, 2014). Our school achievement data is part of this pattern. Mt Roskill Primary School is decile 3 with around 7% Māori and 18% Pasifika students. We cater for a diverse range of learners, including many with special needs. Many of our students do not have exposure to the technologies that might prepare them for future career opportunities. We find this makes it more challenging to develop the sorts of innovative technology-rich teaching approaches that we believe might better engage students in their learning.

This inquiry focused on how teachers could develop a school makerspace, with a focus on technology, in a way that might increase motivation, engagement, and achievement of students at risk of not meeting their potential. The inquiry was supported by funding from the Ministry of Education Grassroots Initiative.

What is a makerspace and does it belong in a school?

A *makerspace* is "a general term for a place where people get together to make things. Makerspaces, might focus on electronics, robotics, woodworking, sewing, laser cutting, programming or some combination of these skills" (Roslund & Rodgers, 2014, p. 9). Makerspaces have gained in popularity as community development projects, often located in shopping hubs, civic or community centres, private garages, or creative businesses. There are many values inherent in makerspaces, which include a philosophy of collaboration, sharing, and creating (Hatch, 2014). Many communities now have makerspaces for the public to use at venues such as libraries and community centres, as well as private centres.

The idea of creating makerspaces in schools is emerging and the potential educational benefits are beginning to be explored in the education literature. Bolstad (2017) notes that according to the 2016 NZCER National Survey of primary and intermediate schools, 41% of students had access to gaming, or coding clubs, or a makerspace at school. However, of those there was no certainty of the definition of what a makerspace was and whether the word referred to the actions within it or the physical room itself. Gilbert (2017) argues that although makerspaces *may* have the potential to be future focused and educative there is no strong evidence base to suggest that this is necessarily the case and current claims to their educational benefits may be overstated. In our inquiry, we aimed to explore the makerspace potential and see whether and how it might benefit our learners. We suspected that a makerspace environment and the pedagogies used within it could offer something new for our at-risk students.

Although school-based makerspaces are becoming increasingly common (Gilbert, 2017) we found no available models in our local area to examine at the time our inquiry began in mid-2016. Consequently, we looked to makerspace models outside the education sector, including consultation with the Auckland City Library, to consider the physical space and pedagogy we might develop.

We had a hunch that project-based learning was a pedagogy that resonated with the makerspace movement and this came to be a guiding influence in how we developed our school's makerspace. Project-based learning allows students to learn through experience. It should enable them to gather knowledge and skills through authentic contexts that are challenging, complex, and engaging. Project-based learning gives students agency over three areas: the inquiry topic; how they inquire; and how they share their learning (BIE, 2017). Our inquiry allowed us to purposefully bring project-based learning together with what we understood about makerspaces.

Two other education principles also informed how we developed the makerspace learning environment: key competencies and a growth mindset. *The New Zealand Curriculum* (Ministry of Education, 2007) (*NZC*) describes 5 key competencies which cover the attitudes, values, knowledge, and skills that support *NZC*'s vision for students to be "confident, connected, actively involved, lifelong learners" (p. 8). A growth mindset is the understanding that a person's talent or ability is not fixed. Therefore, one's achievements or capacity to learn are determined by effort, not one's fixed ability. Understanding this encourages students to show determination and expend effort to achieve. Those persons with a fixed mindset believe their capacity to learn or talent is fixed and therefore can't be improved with effort (Dweck, 2006). Our attention to key competencies and a growth mindset helped to guide interactions between the teacher and students throughout our inquiry.

The importance of teaching as inquiry and student voice

Teaching as inquiry, as defined in *NZC*, has become an inherent part of a teacher's role as educator in Aotearoa. Teacher-led inquiry is likewise central to our philosophy at Mt Roskill Primary. We often refer to the saying that "if you always do what you always did, you will always get what you always got". We see teacher inquiry as the vehicle through which we can do something different for our learners and create change. We also believe that student voice is integral to teaching. As student voice reveals what is happening for the students, it can change pedagogical practice (Davison, Sinnema, Taylor, & Mitchell, 2016) and help students to develop agency and challenge teachers' assumptions. Consequently, gathering student voice was an important part of our inquiry.

In a teacher-led inquiry such as the one reported here, teachers explore how best to meet the needs of their own learners, which are unique to each student and context. Consequently, our inquiry and what we learnt is situated in our school, and we can't claim that our findings would apply beyond our own setting. Nonetheless, we hope the story of our inquiry and what we discovered may be of interest and benefit to others.

The makerspace inquiry

We drew from our National Standards data and teachers' knowledge to select 12 students to form the makerspace group. All were Year 4 Māori and Pasifika students at risk of underachieving. Together they displayed a range of learning or behavioural needs. We chose this cohort so that we could build leadership capacity and expertise in the group. We anticipated that, after participating for a year, these students would have skills to share with other students and could act as leaders and role models in the makerspace and wider school setting.

Ongoing teaching reflection is a key part of teaching as inquiry (Ministry of Education, ND) and informed what became 3 cycles of learning for the teacher and students.

Cycle 1

The students began learning in the makerspace by considering "What is a makerspace?" The teachers running the inquiry initially began this work themselves then reflected that this was invaluable learning that the students would benefit from and would then give them ownership of the space. The group then visited technology rooms at schools and the makerspace at a central library before creating their own makerspace. They became involved in designing and planning the space and costing the materials. The group upcycled old furniture from around the school and learnt how to connect computers and 3D printers which were sitting unused in the school.

Cycle 2

From observations in the first part of the inquiry, teachers decided that for students to succeed in a project-based learning approach reflecting makerspace values, they would need to be scaffolded through a guided inquiry. This would enable specific skills and processes to be learnt. Many of these related to the development of the key competences, such as *managing self*.

The students expressed a desire to set up a TV station, so this was selected as the project for the guided phase. The students explored other school news stations and decided on what content they would like to include. The teachers visited two schools to look at how they could organise their stations. Our objective was to create a weekly news bulletin that would include news, events, sports, and notices at Mt Roskill Primary School. There was also a group that wrote and produced a song to be used as the theme song for Roskill News. Examples can be viewed at http://www.mrps.school.nz/syndicate-webpages/mrps-news.

In addition, the teachers introduced the group to experiences that would open their eyes to a range of opportunities and inquiries that they could undertake within the makerspace. All of these trips and experiences were free of charge for the makerspace group.

Cycle 3

The final stage of the inquiry was to use the new space to carry out project-based learning on a more individualised basis. The group was split into teams of 2–4 based on the

FIGURE 1. STUDENTS WORKING ON CREATING THE MAKERSPACE

FIGURE 2. A PANORAMIC SHOT OF THE COMPLETED SPACE

projects or tools they were interested in. Each group used a genius hour planning sheet and weekly plan to organise their project. Genius hour "is a movement that allows students to explore their own passions and encourages creativity in the classroom" (Kessler, 2017). It is an iteration of project-based learning. We chose to use some of the web-based genius hour teaching resources available to students. It was the students' responsibility to manage their time effectively and get their inquiries finished within the given time frame.

A highlight for one of these groups was working on designing a new senior playground. They had been learning from an engineering company in Christchurch who were helping them to use an advanced 3D design tool called Design Spark. There is now a possibility that the company will help us to design and build a climbing wall for the new playground. We are also exploring a possible collaborative inquiry with design students at our local secondary school.

Collecting data to inform our makerspace teaching practice

Student voice data

To understand the student's views on working in the makerspace and guide our teaching practice we collected student voice. An initial attempt to interview the students was unsuccessful in gaining in-depth responses as the questioning nature of the collection did not prompt the students into discussion. To encourage student voice and to gain some quantitative data, we used two activities. First was a statement-sorting activity, in which students needed to independently sort 16 statements into "agree" or "disagree" categories. The second, carried out later in the inquiry, was a bus-stop activity whereby students were able to write responses to prompt questions. Students had the opportunity to roam around the prompts and discuss in their own time. The notes from the bus-stop activity were then used to conduct informal interviews which were recorded. This was carried out at 2 points in the inquiry, at the end of 10 weeks and 30 weeks.

After the first collection of student voice it was noted that the children did not make explicit links between the skills and dispositions they had developed in the makerspace and how those could be used in the classroom other than the makerspace. Consequently, a focus in the second and third cycle of the inquiry was to try and make these links explicit and increase metacognition about how and why these children were successful in the makerspace.

We spotted a number of themes in the student-voice data. These are presented below.

Time: Students reported that a benefit of working in the makerspace was that they felt they had longer periods of time to work on a task, they did not feel rushed, and they got time to complete tasks.

Choice: Students reported that they had more choice than in the classroom on how to go about completing a task and how to present their work. This often presented opportunities that they felt were more engaging than the classroom.

Support of technology: Students reported the opportunity to access technology made tasks more accessible and easier to achieve.

Challenge: Although the students reported being able to demonstrate resilience and persist with challenge in the makerspace, they did not feel that they could manage challenge in the classroom. The skills they had developed with respect to managing challenge in the makerspace

were not being transferred to the classroom. There was also lack of metacognition around how they had learnt to manage challenge in the makerspace.

Lack of connection to classroom learning: The students did not make connections between the learning in the makerspace and how it could support them in the classroom.

Future focus: The students reported that they now had the potential to use the skills in the makerspace in their future life. For example, that careers in technology were now an option for them.

Link to classroom learning: Students reported examples of how the skills they had learnt in the makerspace were useful to them in the classroom, for example, persisting with hard tasks.

Achievement data

We found indications of improvements in the achievement data of the students in the makerspace group. During the period of our makerspace inquiry, most of the 12 students' achievement in reading and writing improved, although less improvement was seen in mathematics.

Seven students made accelerated progress in one or more subject areas. (Accelerated progress occurs when a student makes more than one year of progress within half a year.) Across the group of 12 students in three subjects we found 10 instances of *accelerated* progress and there were 17 times where a student's recorded achievement went up by *expected* progress. Three students made less-than-expected progress in one subject area.

Between mid-year and the end of the year a greater proportion of the students were achieving at or above the expected National Standard. Achievement gains appeared to be greater in literacy. The number of students achieving at or above the National Standards in reading increased from 7 to 11, and in writing from 5 to 11. We believe this reflects the kind of inquiries the students worked on, most of which demanded more literacy skills than numeracy skills. For example, the creation of *Roskill News* was dominated by reading and writing activities, including scriptwriting, and reading to source information. Some projects did include maths—for example, 3D printing and building the recording booth—but the connections to their classroom learning may not have been so explicit.

Anecdotal notes

The project-based learning approach used in the makerspace appeared to support students to develop in the key competencies. Teachers' anecdotal notes as well as student voice indicated improved confidence, concentration, and perseverance. The students learnt skills to work independently and as part of a team. Students also learnt a wide range of practical skills including 3D design, music making, stop motion, and using design software. Table 1 shows some of the specific skills and transferable learning strategies that teachers observed.

TABLE 1. TEACHERS' ANECDOTAL NOTES

Skills learnt as a result of inquiry-based learning	Learning strategies
• Making music videos • Using new technologies, e.g., stop motion movies, making music in Garageband, musical timing • How to write raps • Creation and design skills in Tinkercad • Teamwork • How to cook food by ourselves • How to make playdough • How to create tutorial videos • How to write news stories	• Keep trying • Focus/think—talk to yourself, "Stay on task", "You can do it". • Communicate with others—ask for help (experts or friends), talk to someone about what to do (collaborate) • Don't be selfish • Give your brain a rest • Try working on a different part of the task and then come back to the challenging part • Be proactive—take action, don't sit back and watch • Make connections with what you already know • Activate your prior knowledge

What we learnt about the place of data within teaching as inquiry

Collecting evidence was the most challenging part of this inquiry. As the inquiry progressed, we realised that many of the changes we were observing in the students were either impossible to measure or were not "captured" in the traditional data-generation methods we had chosen. For example, we were very proud when three of the group were awarded school leadership awards during their time in the makerspace. These were students who we hadn't previously considered to be on a trajectory to gain such recognition. Nor could we quantify how much the makerspace experience contributed to an individual student's growth in leadership. Instead we've learnt that when planning for teacher-led inquiry, the "soft" anecdotal data such as narratives and observational notes can be as important to take account of as the more rigid measures of achievement.

Gathering student voice proved particularly challenging. Although teachers observed changes in the students, the students found it difficult to articulate these changes in themselves. Our first attempt at collecting student voice straight from an interview was largely unsuccessful and elicited very few responses. For this reason, interviews to gain student voice were later

scaffolded and began with statement-sorting and bus-stop activities to provide discussion starters for the students. We were pleased to get the fuller responses, though we recognised that by "leading" the conversations, we inevitably created bias in the responses. So another thing we learnt about teacher-led inquiry is the need for this delicate balancing act between scaffolding and "directing" when gathering student voice.

Another big learning for us was about the need to collect data from the start of an inquiry. A possible flaw in our inquiry design was that we chose to begin work with the students in Term 3 2016 and thought our data collection would start with the official start of the inquiry in Term 1 2017. We did not anticipate the way in which the students would respond to the preliminary work before the start of the inquiry. As a result, we missed an opportunity to collect important data from those early stages.

Where to next?

We don't claim that the experience of engaging in the makerspace was the only contributor to indications of improved achievement and development of key competencies for these students. Learning is a complex interplay of factors and many other variables will have played a part. For example, some students in the makerspace group participated in an English as a second language class, others were part of the Pasifika culture group, several had educational interventions from individual teachers and services, and all continued to participate in their mainstream classroom during this time. What we can say is that the makerspace inquiry was part of a successful year of progress and development for these students.

From our learning so far, we have two key ideas for further cycles of inquiry.

First, it was a strategic move to choose Year 4 students as the subjects for this inquiry—if successful, they would become the leaders to expand the scope of the makerspace. In 2018 these students are Year 6 and have built considerable expertise and capacity to be a leader in the makerspace and share their learning with others. Therefore, the makerspace group is being expanded to include more students with these students as leaders.

Secondly, we noted that it proved challenging for the students to make connections between classroom learning and the makerspace and also for the skills and dispositions the students developed to be transferred to the classroom. Consequently, we wish to scale up the inquiry to see whether the principles learnt can be of benefit to students in our mainstream classes. This will involve our inquiry leader leading a group of teachers so that there can be more alignment between the pedagogies of our classrooms and the makerspace.

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