



Knowing Math as Doing Math

How well can we teach mathematics skills and knowledge through Project Based Learning?

Years 5-8

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Tātai Aho Rau

Setting the scene: the why

My area of focus is centered around mathematics learning for students in years 5-8. This interest stemmed from my love of teaching maths and some recent professional learning and development (PLD) exploring the ideas of mixed ability groupings and mathematical inquiry.

This PLD led me to think more deeply about two areas we can focus on as teachers:

- **mixed ability groupings in our classes**
- **the relevance of the task in maths learning.**

My school has recently moved to multi-level classes with students in year 5-8 working together. This move was made to provide students with greater flexibility in who they learn and interact with. A move such as this can be challenging for teachers who have been trained to group students according to their age or stage.

I have been inspired by the work of Ken Robinson. In, *The Element: How Finding Your Passion Changes Everything*, he writes “students are educated in batches, according to age, as if the most important thing they have in common is their date of manufacture” (Ken Robinson, 2009, p 230).

In contrast, he notes that children all around the world are growing up in villages where the “date of their manufacture” has never been considered (ibid). Children enjoy opportunities and experiences based on their interests and their needs. I wanted to see how we could bring this philosophy into a mathematics classroom and engage students in mathematical tasks that were relevant and engaging.

I was also aware of large numbers of students who seemed to believe they were no good at maths, that maths was only for smart people, and that it was boring. I have read some of Carol Dweck’s work and I was interested in questions Carol Dweck proposes; Why do so many learners have a fixed mindset when it comes to maths? Why do they give up so easily? (Carol Dweck, 2006).

My experience with dyslexic learners made me think about the way students see maths in the world around them, and how language can often interfere with maths learning. (For example, a clock has three hands and the third hand is the seconds hand).

I had a growing interest in project-based, student-centered learning and wanted to explore this through a mathematics lens.

With the new multi-level approach to class groupings at my school, now seemed like a good time to reconsider some of our teaching practices.



Getting stuck in: the what and the how

I wanted to use mathematical inquiries as a model for developing real life, meaningful, project-based learning experiences for my students. I wanted students to engage in projects with relevant projects and in which they would be supported to take responsibility to find a solution.

Through this process I planned to track and monitor the mathematical skills and knowledge that students were learning and address any areas where their learning needs were not being met. I was also interested in how their motivation for mathematics learning might change in this setting. The year started with me being assigned a group of mixed ability, multi-level learners for maths. I had a group of 16 learners who had been selected for my math group by their teachers based on the belief that these were students would most enjoy hands-on learning. We worked together for the whole year, but my research focus was limited to 11 students over terms 2-4.

The students and I set up some group norms that covered the way we would work in our math class. This was a mixed ability class, so it was particularly important to create an environment where all students felt comfortable and confident to share their ideas and thinking about mathematical concepts and problems.

We brainstormed the type of projects the students would like to complete, and I set up an Engagement and Motivation Survey to help me monitor this aspect of the learners throughout the year. Students completed the survey three times during the year. As I analysed this data I looked for trends that showed changes in student attitudes towards maths.

I did more research into Number Talks because I saw this as a way to cover key aspects of mathematical knowledge and skills required for students to be successful mathematicians. Number Talks were developed by Sherry Parrish to help students strengthen mental math and computation strategies. Students are given thinking time to explore their own way to solve a problem written on the board, they are then given the opportunity to share their thinking, listen to and critique others ideas.

A whānau evening was held and the approach was explained to parents. Whānau were very interested in this approach and embraced the idea of project-based learning.

Each lesson was structured to include an element of covering basic knowledge through Number Talks. I introduced regular basic facts testing as students were keen to do this and the data provided good next steps for the Number Talk sessions. Most lessons each week also provided students with time to work on their projects. They were regularly involved in hands-on activities during the week.

Throughout the year students worked on several projects and they enjoyed this aspect of the math programme. The first project was to plan a ten day holiday around New Zealand, the second project was to create a scale model of a building (either something in existence or to design their own). I chose the first project based on previous successful experiences with this type of project and the knowledge that this project would cover aspects of time, distance, money and build New Zealand geography knowledge. The second project was decided after gathering some student voice. Many were interested in 'making' something. Every student completed a project that met the same design brief.

Key findings

The aim of this action research was to engage students in project based learning. I measured the success of this in three ways:

- 1. Achievement data using e-asttle measurement tests, and numeracy project stage based basic facts.**
- 2. Motivation and Engagement Student Survey with questions such as:**
 - How do you feel about maths?
 - How do people get good at maths?
 - Being good at maths is important for my future
 - What do you think is the most important thing to be able to do to be successful at maths?

What I hoped to see through the year was an increased interest in maths and more willingness to share ideas and thinking (less fear of getting it wrong). Along with increased mathematical knowledge and skills.

1. Achievement data

This table shows the shift for each student on the e-asttle measurement test over the course of the year and the movement in their stage based basic facts results.

Student	Year	Easttle T2	Easttle T4	Stage Based basic facts START	Stage Based basic facts END
a	5	3P	3P	95% Level 3	37% Level 4
b	5	2A	2A	100% Level 3	52% Level 4
c	6	2P	3P	76% Level 2	53% Level 3
d	6	3B	4A	48% Level 2	93% Level 2
e	6	2P	3P	78% Level 2	45% Level 3
f	6	3P	3P	50% Level 3	85% Level 3
g	7	3B	3P	30% Level 3	96% Level 3
h	7	3P	4B	100% Level 3	100% Level 4
i	8	4A	4P	87% Level 4	100% Level 4
j	8	2B	2P	60% Level 2	56% Level 3
k	8	2A	3P	12% Level 3	56% Level 3

63.6% (7) of students made progress on their e-asttle level. Of those whose level didn't shift most made progress on their scale score. All students made progress on the basic facts scores.



2. Engagement

My research showed that engagement in maths increased for the group over the year and I'm keen to find ways to make this even more powerful.

One of the questions asked in the Engagement Survey was "How do you feel about maths?". The following is a summary of those results from the beginning of the year survey and the final survey.

	Start	End
Excited	9.1%	11.8%
Positive	0%	29.4%
Positive but nervous	54.5%	35.3%
Nervous	9.1%	0%
Don't like it	18.2%	17.6%
Scared and worried	9.1%	5.9%

Anecdotally I noticed a shift in many students' willingness to share their thinking with one another. Many would come up to the white board with the desire to share their thinking without the certainty that they were right.

3. Reflections on my role as a teacher

Ongoing analysis highlighted aspects that significantly challenged my thinking and changed my practice. What was missing in these projects was true student voice.

i. Release control early

Students were most engaged during sessions where I put the resources out and left them to it. During these sessions, students identified their own problems, sought advice from myself or others in the room, and were enabled to find solutions.

When I saw this happening I realised that I could have done it in a way that gave the learners more agency. I had been so focused on providing/‘teaching’ students the skills and knowledge I thought that they would need in order to complete their projects, this mindset had dominated my approach to lessons.

In the early days lessons were very much teacher directed and there were few opportunities for students to play around with the ideas we were discussing. For many students the idea of building a scale model was too abstract, they were beginning to lose some of their earlier enthusiasm.

Once I left them to it, gave them permission to have a go, their enthusiasm returned. Did they know everything they needed to be successful? No! Did they stumble, get confused, frustrated and make mistakes? Yes! Were they collaborating with others, listening and sharing ideas? Yes! Were they problem finders and problem solvers? Yes. Did they all have a completed building at the end? No. And that is the beauty of play - the focus is on the process, not the outcome.

This environment also gave me the time to check in with individual students more easily - although some days I was feeling very stretched trying to ‘get to’ everyone.

As in any learning environment, I had students who were on the edge, rarely engaged, achieving or completing very little in my eyes. I tried to balance a firm ‘on your case’ approach with the ‘let’s see what happens’ approach. As an educator, it is very difficult to avoid the ‘rescuer’ strategy - to step back and watch someone ‘fail’. Once I introduced a more playful approach to the sessions I did notice that some of those ‘on the edge’ students were more motivated - they could no longer hide, they wanted to be on the floor with the glue gun but without some pre-planning, they were lost. I suspect that the play provided them with motivation to engage in a broader learning experience.

ii. Surprises

A big surprise for me was the struggle I felt as a teacher throughout this process.

I have been constantly torn between wanting to trust the process and feeling a huge sense of responsibility to my learners.

I was trained at teachers training college to deliver x, y, and z, to measure student performance against these things, to report on this and in some way equate this to my effectiveness as a teacher. So if I’m not doing this how can I be effective?

I have read and listened to wonderful educators over the years who espoused the idea of letting go, trusting the process and finding the learning that naturally occurs. This all made sense to me but I still struggled with the question - but what if my students don’t know their times tables before they go to college?

This is my ongoing struggle. I had pressure from a wonderful colleague who kept reminding me that my students were not completing enough mathematics during the week - will they ‘fail’? I also had colleagues who reminded me to trust the process - that the formalised schooling process we were trained to deliver wasn’t serving our students well.

Alongside our play/construction sessions I did make sure that our sessions contained some aspect of number knowledge/strategy either through games or through number talks.

This is my ongoing struggle but I know that during 2018 all students in my maths

class have developed mathematical understandings and skills that go beyond their numeracy stage or curriculum level. I know that they have identified their own problems, they have had to be resourceful in order to solve those, they have asked deep questions and they have experienced both success and failure.

Recommendations for other teachers

As a result of this year of research and exploration, I have come back to the idea of process not product. I am continuing to explore the idea of Doing Math as Knowing Math.

During the year I got very caught up in the idea that I needed to have something to show for the work I was doing. I envisioned a fantastic exhibition of student work but I never checked if this what my students wanted.

For my students, I was very focused on an outcome. I wanted to be able to prove or show something in a tangible way - achievement data/engagement data etc. I kept coming back to these questions:

- How can I show progress or gains in learning using simply the process?
- Is sometimes just knowing ok? Do we always need an end product to prove we know?
- Conversations and observations are powerful mechanisms for determining the knowledge our students have - how do we capture this?

Learning through doing must continue to be a focus for educators - play, projects, maker space etc. These are all powerful, authentic, engaging and learner-centered approaches. Educators need to find a way to balance this with our need to 'know', 'prove' and 'measure'. These are our hang-ups and for the most part, our students simply want and need the opportunity to develop skills and knowledge in contexts that make sense to them, not us!





I come back to my inquiry question:

How well can we teach mathematics skills and knowledge through Project Based Learning?

It is important that teachers continue to be very deliberate about building the number knowledge students need to acquire into lessons. However, my research has shown that we can teach many mathematical skills and a lot of knowledge through project-based learning. Some of the skills and knowledge my students developed did not follow a prescribed progression (curriculum AO's or numeracy stages) and are not always easy to measure with the tools we have available. They may not have been the skills and knowledge I had decided they needed to know, rather they were the right things at the right time for my learners. This is just in time learning.

To be truly impactful, students need to be able to dip in and out of their projects. A highly timetabled environment where 'maths' is taught in a block is against the true essence of project-based learning and seems counterproductive to motivation. Project work would be better done in big chunks of time, to enable the 'flow' and better cross curricula but we need to explore bigger system shifts to make this work.

My next steps: where to from here?

My learnings from this action research will feed into a school wide review of mathematics in 2019.

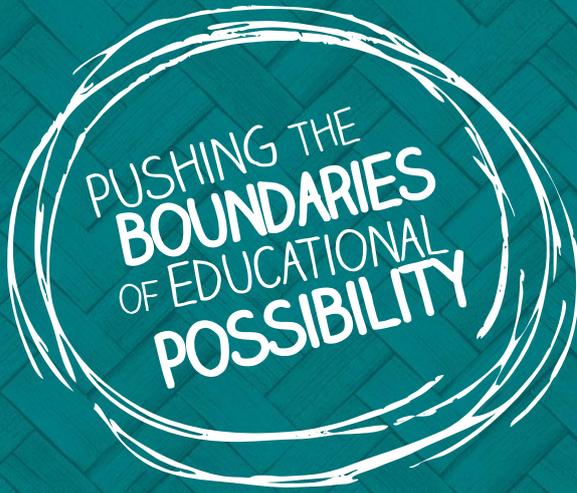
We will explore the idea of 'Project Fridays' where teachers will support students to carry out project based learning on a Friday, and then use the learning needs that arise in this environment to inform the workshops and instructional time in the following week.

We still have the question of how do we cater for target students within this environment? ALiM seems to focus on teaching students who are at the same level - this goes against the multi-level approach. Our mathematics review will consider the balance between ability grouped teaching and mixed ability teaching.

References

- Dweck, C. S. (2006). *Mindset: The new psychology of success*. New York: Random House.
- Parrish, Sherry. (2010). *Number talks: helping children build mental math and computation strategies, grades K-5*. Sausalito, CA: Math Solutions.
- Ritchhart, R., Church, M., & Morrison, K. (2011). *Making thinking visible: How to promote engagement, understanding, and independence for all learners*. San Francisco: Jossey-Bass.
- Robinson, K., & Aronica, L. (2009). *The element: How finding your passion changes everything*. New York: Penguin Group USA.





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