MIDDLE YEARS MATHEMATICS:

Improving Teaching and Learning Through Action Research

Final Report

A research report commissioned by St Francis Catholic College, Catholic Education Diocese of Wollongong

Associate Professor Catherine Attard
The Centre for Educational Research
Western Sydney University
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Executive Summary

This report details the activities and findings of a research project exploring the effectiveness of the Middle Years Mathematics Project at St Francis Catholic College. The intent of the project was to use teacher action research to improve student experiences and academic achievement in mathematics in the middle years (Years 5 to 8). The project was initiated by John Lo Cascio, the Head of School Improvement Services (Secondary) at the Catholic Education Diocese of Wollongong, and Simon Abernethy, Principal of St Francis College. St Francis Catholic College is a P-12 systemic Catholic school established in 2017.

When this research study took place, the school was in its second year, operating classes from Kindergarten to Year 8.

Three middle years teachers participated in this project. The teachers undertook professional learning in mathematics pedagogy and in action research methodology. Each of the teachers conducted their own action research, interrogating and adapting their existing practices with the ultimate goal of improving student engagement with and outcomes in mathematics.

Findings

Action Research, Mathematics Engagement and Academic Outcomes in the Middle Years

Evidence from teachers, students and assessment data revealed that the implementation of participatory action research across Years 5, 7 and 8 at St Francis Catholic College improved student engagement with and achievement in mathematics by:

- Increasing teachers’ awareness of their own practices and the effects of those practices on students’ perceptions of mathematics;
- Providing opportunities for the participating teachers to trial new practices;
- Providing opportunities for collaboration with other teachers across the various grades to deliver a more consistent approach to mathematics education across the middle years;
- Exposing students to more effective practices that, in turn, provided teachers with greater insights into student abilities; and
- Allowing teachers to trial differentiated practices to cater to the diverse range of abilities within their class cohorts.

Benefits of having an academic partner to facilitate and support action research in a school

Having an academic partner to facilitate and support the action research at St Francis resulted in the following benefits:

- Targeted professional development that responded to the needs of individual teachers and their students;
- Provision of timely feedback and advice in regard to the process of action research and the delivery of effective mathematics pedagogy;
- Sharing of high-quality mathematics resources and academic readings in response to teachers’ needs; and
- Provision of a level of accountability through the requirement of meeting attendance, feedback sessions and the completion of a research report on conclusion of the project.
Perceived benefits to students

The data collected through individual teacher and principal interviews, student focus groups and LNA assessments indicate the following benefits were experienced by students:

- Improved teacher practice that resulted in what students considered to be better explanations of mathematical concepts;
- A more hands-on approach to learning;
- More opportunities for substantive conversations with peers and teachers during mathematics lessons;
- More contextual mathematics lessons that highlighted the relevance of the curriculum beyond the walls of the classroom;
- Improved confidence through the development of growth mindsets;
- Improved academic outcomes;
- Improved perseverance and self-regulation; and
- Higher quality engagement at operative, cognitive and affective levels: students operating ‘in-task’ rather than ‘on-task’.

Recommendations

As a result of the data presented in this report, the following recommendations are made to the leadership team at Wollongong Catholic Education Diocese and St Francis Catholic College:

- Teachers participating in action research in 2018 should be encouraged to disseminate their work to colleagues to assist in the development of shared understandings in relation to effective mathematics pedagogy and action research methodology.
- Future professional learning opportunities in mathematics at St Francis Catholic College should focus on strengthening teachers’ understanding and implementation of the Working Mathematically strand to ensure it forms the core of mathematics teaching and learning.
- Given the nature of St Francis as a developing school with a new influx of teachers each year, it is imperative that those teachers who participated in action research in 2018 are encouraged to become mentors to incoming teachers within the mathematics faculty in order to promote the development of a positive culture in relation to mathematics education practices.
- Student voice in relation to mathematics teaching and learning should have prominence in relation to programming, planning, and pedagogy in mathematics.
- Further opportunities for collaboration amongst the middle years mathematics teachers is strongly encouraged to ensure alignment in pedagogical practices and to assist in the development of a community of practice where philosophies on mathematics education are in alignment.
- Support for participating teachers to continue developing the practice of action research as a ‘practice changing practice’ is strongly recommended to ensure action research is an ongoing aspect of practice rather than perceived as a finite project.
Introduction
Introduction

This report details the activities and findings of a research project exploring the effectiveness of the Middle Years Mathematics Project at St Francis Catholic College. St Francis Catholic College is a P-12 systemic Catholic school established in 2017.

When this research study took place, the school was in its second year, operating classes from Kindergarten to Year 8. The school is located in Edmondson Park a new suburb of south western Sydney rezoned for urban development in 2008 (Liverpool Council, 2019). The intent of the project was to use teacher action research to improve student experiences and academic achievement in mathematics in the middle years (Years 5 to 8). The project was initiated by John Lo Cascio, the Head of School Improvement Services (Secondary) at the Catholic Education Diocese of Wollongong, and Simon Abernethy, Principal of St Francis College.

A common challenge associated with newly established schools is the need to cater to a more diverse student population than usual, drawn from a broad range of school and family contexts. Apart from the Kindergarten and Year 1 cohorts, all of the students at St Francis would have already changed schools at least once, resulting in a population with a wide range of educational experiences. In the case of St Francis, many students experienced academic challenges, and in particular, with mathematics and numeracy. According to the school Principal, many of the students at the school were at that time achieving below the expected levels for their stage. This coupled with a diocesan wide concern over mathematics and numeracy skills resulted in a desire to pilot a professional learning program that was aimed at building teacher capacity to improve student outcomes. A focus on improving mathematics and numeracy was articulated early by the leadership team at St Francis, and as the school had a unique opportunity to establish shared understandings of effective practices in mathematics during the early stages of its development.

As St Francis is a P-12 school, it was a goal of the principal to intentionally avoid the development boundaries between the primary and secondary teachers and students, as is typical in many other P-12 or K-12 schools, with the aim of achieving a seamless school experience for all students. To this end, in 2017, the year of the school’s foundation, the entire school staff consisting of primary and secondary teachers (of all disciplines) were initially involved in a series of professional development sessions to establish a shared understanding of best practice in the teaching of mathematics and numeracy. This strategy also established an understanding that regardless of whether the secondary teachers taught mathematics, it is the responsibility of all teachers to teach and promote numeracy.

Following the initial professional learning sessions in 2018 the middle years teachers (Years 5 to 8) participated in sustained professional learning relating to action research methodology. They then conducted their own individual action research relating to mathematics teaching and learning and their own identified professional learning needs. The aim of this research was to document and explore the implementation and effectiveness of the action research on pedagogy and student engagement and achievement. It was hoped that should the initiative prove to be successful it may provide a model that could be replicated in other schools across the Wollongong Diocese.

The aim of this study was to research the effectiveness of a range of teacher-led action research projects relating to the improvement of mathematics and numeracy during the middle years of schooling. This report provides an evaluation of the Middle Years Mathematics Project at St Francis Catholic College, ‘researching the research’ conducted by the participating teachers and the impact of their research on their students. The following section provides brief background literature to provide some context to the Middle Years Mathematics Project.
Background
Background

Middle Years and Mathematics

Issues in middle years mathematics have been prevalent for several decades and are of concern in Australia and internationally (Attard, 2014; Everingham, Gyuris, & Connolly, 2017). Over a decade ago, the National Numeracy Review (Commonwealth of Australia, 2008) reported that although the levels of mathematics achievement are satisfactory when compared to international standards, “there is an unacceptable proportion of Australian students ... who are not achieving acceptable levels of proficiency” (p.xii). These concerns are yet to be resolved and the number of students continuing the study of mathematics in senior secondary and tertiary levels continues to decline (Roberts, 2013; Wang & Degol, 2014). One of the reasons for this decline is student disengagement with mathematics and it is during the middle years of schooling where students are transitioning from primary to secondary education when many students make the choice to dislike and disengage from the study of mathematics (Attard, 2013).

The transition to secondary school often results in some level of achievement loss even when some students experience a lack of academic challenge due to some overlap of content between primary and secondary mathematics (Athanasiou, Philippou, Tzekaki, Kaldrimidou, & Sakonidis, 2009), along with a tendency for secondary students to be focused on performance rather than being task-orientated in order to improve competencies (Alspaugh, 1998; Zanobini & Usai, 2002). Another long-term issue of transition identified by McGee, Ward, Gibbons and Harlow (2003) is curriculum continuity and coherence across primary and secondary schools. It was found there are gaps in subject content, differences in teaching and learning practices and inconsistencies in the expectations of students.

Whitley, Lupart, and Beran, (2007) claim secondary teachers often have higher expectations of students when compared to primary school teachers, thus explaining the decline in achievement as a mismatch between teacher expectations and students’ abilities. Related to high expectations of students, one of the issues facing secondary teachers is the amount of information they want to know about their students coming from primary school. Some teachers favour a ‘fresh start’ approach as they are often faced with students from a variety of schools, perhaps to the detriment of some students. Research has found this to be particularly the case with mathematics, causing a lack of continuity across the curriculum (Bicknell, Tzekaki, Kaldrimidou, & Sakonidis, 2009). This was the opposite case at St Francis, where the teaching staff were very interested in finding out the academic backgrounds of their students. According to the school Principal, issues arose due to inconsistencies in assessment and reporting amongst the feeder schools resulting in the teachers at St Francis experiencing difficulties in gauging the learning needs of their students.

Current curriculum documents aim to address this and minimise gaps in curriculum by presenting content as a continuum across the grades, with all teachers having access to the content requirements for learners at all stages (Australian Curriculum Assessment and Reporting Authority (ACARA), 2010; Board of Studies NSW, 2012). This particular issue was a specific concern to the leadership team at St Francis Catholic College and was a motivating factor in the development of the Middle Years Mathematics Project.
Student Engagement and Mathematics

Student disengagement with mathematics can have long lasting effects. While transition from primary to secondary schooling is often a significant influence on engagement, there are other contributing factors. These include a failure of students to recognise the relevance of the mathematics curriculum to their current and future lives, the influence of peers and family, teaching practice, and the traditional assessment style of pen and paper assessments that continue to remain a feature in secondary mathematics classrooms (Anthony & Walshaw, 2009; Attard, 2014; Boaler, 2009). A dislike of mathematics during the middle years of schooling can potentially lead students to ruling out a range of career options, effecting future life choices and opportunities (McPhan, Moroney, Pegg, Cooksey, & Lynch, 2008).

Although there are a range of elements that contribute to declining student engagement with mathematics, research by Attard (2013) revealed the teacher is the core influence on engagement. This influence was explicated through the Framework for Engagement with Mathematics (FEM) (Attard, 2014) which articulates two separate yet inter-related elements of teacher practice that influence engagement: pedagogical relationships and pedagogical repertoires. Pedagogical relationships refer to the interpersonal teaching and learning relationships between teachers and students that maximise students’ learning of and engagement with mathematics. Pedagogical repertoires refer to the teaching practices that play out in the classroom during day-to-day teaching. For example, the types of tasks that are administered, how and when they are administered, the amount of collaboration that is encouraged or allowed, and the types of assessment tasks.

As the issue of student engagement with mathematics was identified by the school Principal as a major concern, the FEM was used as the foundation for the professional learning undertaken by the teachers of St Francis.

### Figure 1: Framework for Engagement with Mathematics (FEM) (Attard, 2014)

<table>
<thead>
<tr>
<th>Aspect</th>
<th>Code</th>
<th>Element</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Pedagogical</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Relationships</td>
<td>PK</td>
<td>Pre-existing Knowledge: students’ backgrounds and pre-existing knowledge are acknowledged and contribute to the learning of others</td>
</tr>
<tr>
<td></td>
<td>CI</td>
<td>Continuous Interaction: interaction amongst students and between teacher and students is continuous</td>
</tr>
<tr>
<td></td>
<td>PCK</td>
<td>Pedagogical Content Knowledge: the teacher models enthusiasm and an enjoyment of mathematics and has a strong Pedagogical Content Knowledge</td>
</tr>
<tr>
<td></td>
<td>TA</td>
<td>Teacher Awareness: the teacher is aware of each student’s mathematical abilities and learning needs</td>
</tr>
<tr>
<td></td>
<td>CF</td>
<td>Constructive Feedback: feedback to students is constructive, purposeful and timely</td>
</tr>
<tr>
<td><strong>Pedagogical</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Repertoires</td>
<td>SC</td>
<td>Substantive Conversation: there is substantive conversation about mathematical concepts and their applications to life</td>
</tr>
<tr>
<td></td>
<td>CT</td>
<td>Challenging Tasks: tasks are positive, provide opportunity for all students to achieve a level of success and are challenging for all</td>
</tr>
<tr>
<td></td>
<td>PC</td>
<td>Provision of Choice: students are provided an element of choice</td>
</tr>
<tr>
<td></td>
<td>ST</td>
<td>Student-centred Technology: Technology is embedded and used to enhance mathematical understanding through a student-centred approach to learning</td>
</tr>
<tr>
<td></td>
<td>RT</td>
<td>Relevant Tasks: the relevance of the mathematics curriculum is explicitly linked to students’ lives outside the classroom and empowers students with the capacity to transform and reform their lives</td>
</tr>
<tr>
<td></td>
<td>VT</td>
<td>Variety of Tasks: mathematics lessons regularly include a variety of tasks that cater to the diverse needs of learners</td>
</tr>
</tbody>
</table>
Teacher Professional Development to Improve Student Engagement

There are two common models of teacher professional development (PD): the traditional type of activities that involve workshops, seminars and conferences, and reform type activities that incorporate study groups, networking, mentoring and meetings that occur in-situ during the process of classroom instruction or planning time (Lee, 2007). Although it is suggested that the reform types of PD are more likely to make connections to classroom teaching and may be easier to sustain over time, Lee (2007) argues there is a place for traditional PD or a combination of both, which may work well for teachers at various stages in their careers.

The provision of on-site PD provides a contextually responsive approach allowing the facilitator of the PD to contextualise to the teacher’s site of practice (Garet, Porter, Desimone, Birman, & Yoon, 2001). Extending this idea, Higgins and Parsons (2011) argue for “situated professional learning opportunities in the teachers’ classroom” enabling “facilitators to engage teachers in the PD core ideas and enact these in practice” (p.55).

Providing PD for all of the teachers at St Francis during 2017 prior to the launch of the middle years action research element is identified by Garet et al. (2001) as a feature of effective practice. They claim that focusing on a group of teachers from the same school “may help sustain changes in practice over time” (p.47-48) due to teachers leaving the school or extended periods of leave. An added challenge at St Francis was the annual increase in teaching staff due to the rapid growth resulting from being a newly established school.

The duration of PD has also been identified as a significant characteristic in determining its effectiveness (Lee, 2005). The literature refers to duration in terms of providing time, space and support to develop teachers’ confidence, ability and skills (Darling-Hammond, Wei, Andree, Richardson, & Orphanos, 2009; Desimone, 2009; Wayne, Yoon, Zhu, Cronen, & Garet, 2008). Some research suggests that PD programs offering substantial contact hours (ranging from 14 to 100 hours in total) with a duration spread over six to 12 months show a positive and significant effect on student achievement (Darling-Hammond & Richardson, 2009; Yoon, Duncan, Lee, Scarloss, & Shapley, 2007) and this is the model that was implemented in the Middle Years Mathematics Project at St. Francis. Furthering the influence of duration, Darling-Hammond et al. (2009a, 2009b) suggest changes in teacher practice and student learning responded to “intensive and sustained PD activities, especially when they include applications of knowledge to teachers’ planning and instruction, have a great chance of influencing teaching practices and, in turn, lead to gains in student learning” (2009b, p.44).

An additional aspect of effective PD particularly relevant to the middle years teachers at St Francis was the opportunity for collective and collaborative participation to build a professional community within the school (Borko, 2004; King, 2014). It was a goal of the school Principal to promote a shared understanding of effective mathematics pedagogy, thereby promoting the development of a community of practice at St Francis. Wenger (n.d.), defines communities of practice as “groups of people who share a concern or a passion for something they do and learn how to do it better as they interact regularly”. Other literature supports the building of a professional community through PD as a new paradigm in effective PD, promoting sustained, embedded and collaborative teacher learning strategies (Darling-Hammond & Richardson, 2009).

Since beginning the project, I have not had one student ask why maths is important!

I have a better understanding of my students and their thinking.
The Middle Years Mathematics Project
The Middle Years Mathematics Project

This section provides an overview of the action research approach undertaken by the participating middle years teachers, the professional development provided to the school in 2017, and an overview of the activities of the Middle Years Mathematics Project in 2018.

The Action Research Approach

Action research is an approach commonly utilised by teachers to improve practice and is particularly useful for bringing about change within a local setting (Cohen, Manion, & Morrison, 2018). The approach be useful for solving specific problems, to pose problems, or to pursue areas of interest for professional development (McNiff, 2010, as cited in Cohen, Manion, & Morrison, 2018). Action research can be conducted by individuals, collaboratively amongst groups of teachers within a school or network, and alongside other interested external parties such as university academics.

The action research approach typically consists of a four-step process that, depending on the research and the teachers’ reflections, can become a sequence of cycles (Figure 1). Rather than being focused on researching a problem of education, action research requires practitioners to focus on a problem of practice (Cohen, Manion, & Morrison, 2018). During the initial cycle, the teacher researcher identifies a problem of practice or an area of interest to be addressed. A plan is then formulated and put into action. At each point in the action research cycle the researcher collects and analyses evidence to assist in evaluating the success of the research and to assist in the planning of future cycles.

Professional Development Program Structure

The following professional development sessions were delivered to the foundation year primary and secondary teachers during Terms 3 and 4, 2017.

<table>
<thead>
<tr>
<th>Session</th>
<th>Duration</th>
<th>Content</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>1 hour</td>
<td>Promoting Best Practice in Mathematics Education</td>
</tr>
<tr>
<td>2</td>
<td>1 hour</td>
<td>Teaching Place Value</td>
</tr>
<tr>
<td>3</td>
<td>2 hours</td>
<td>Patterns</td>
</tr>
<tr>
<td>4</td>
<td>2 hours</td>
<td>Multiplicative Thinking</td>
</tr>
<tr>
<td>5</td>
<td>Full day</td>
<td>Fractions and Decimals&lt;br&gt;Rich tasks&lt;br&gt;Designing Creative Mathematics Tasks</td>
</tr>
</tbody>
</table>

Figure 2: The Action Research Cycle

Figure 3: Whole-school Professional Development Sessions
The Middle Years Mathematics Project

The Action Research Program Activities

This pilot program involved a group of middle years teachers designing, implementing, and evaluating participatory action research (AR) projects to improve practice to promote student engagement and improved outcomes in mathematics. Each of the teachers were provided with support from the researcher on how to conduct action research. The researcher had the roles of professional learning facilitator, critical friend, and research. The research role focused on exploring the effectiveness of the overall project.

The teachers took part in an organised sequence of activities that included professional development and mentoring regarding the conduct of action research and effective pedagogy in mathematics (Figure 3). Initially they were supported by the researcher to identify an area of their practice to research, locate and interrogate current literature pertaining to their focus area, devise a plan of action, implement the plan and gather their own data as evidence (Appendices 1, 3, and 5). Finally, they evaluated their implemented plans and if appropriate, were encouraged to develop new plans accordingly. At the end of 2018 the teachers submitted an Action Research Report detailing their research questions, activities, data and analysis (Appendices 2, 4 and 6).

Figure 4: Combined Project Activities

<table>
<thead>
<tr>
<th>Date (2018)</th>
<th>Activity</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Term 1</strong></td>
<td></td>
</tr>
</tbody>
</table>
| Day 1: 18th March | • Introduction to Action Research  
                             • Individual mentoring sessions with participating teachers |
| Day 2: 10th April | • Individual teacher interviews  
                             • Interview Principal  
                             • Whole group session: Developing a Research Question  
                             • Student focus groups |
| **Term 2**  |          |
| Day 3: 21st May | • Individual planning sessions with participating teachers  
                             • Classroom observations (3) |
| Day 4: 27th June | • Individual planning sessions with participating teachers  
                             • Classroom observation (1)  
                             • Individual teacher interviews |
| **Term 3**  |          |
| Day 5: 27th August | • Whole group session: Analysing evidence, writing a research report and planning future action research directions  
                             • Individual sessions with participating teachers |
| **Term 4**  |          |
| Day 6: 28th October | • Individual teacher interviews  
                             • Student focus groups  
                             • Interview with Principal |
Evaluation Design and Methods

A qualitative case study approach was undertaken in this research evaluation. The participating middle years teachers, their students and the school itself is considered a single case.

The following research evaluation question was investigated: How does the implementation of participatory action research projects in one school site assist in the improvement of mathematics engagement and outcomes in the middle years?

Two sub-questions assisted in informing the research question:
- What are the benefits of having an academic partner to facilitate and support action research in a school?
- What are the perceived benefits to students?

Evaluation Participants

For the purpose of triangulation there were three groups of participants in this study:

Group 1: Teachers
Three teachers participated in the project. For the purpose of this report they will remain anonymous, however details regarding the level of their focus class in this project and their teaching experience are detailed in Table 1 below.

Figure 5: Participating Teachers

<table>
<thead>
<tr>
<th>Grade</th>
<th>Years of Teaching Experience</th>
<th>Qualifications</th>
</tr>
</thead>
<tbody>
<tr>
<td>Teacher 1</td>
<td>5</td>
<td>1 Primary</td>
</tr>
<tr>
<td>Teacher 2</td>
<td>7</td>
<td>6 Secondary PDHPE and Religion</td>
</tr>
<tr>
<td>Teacher 3</td>
<td>8</td>
<td>7 Secondary Science</td>
</tr>
</tbody>
</table>

A fourth teacher was teaching Year 6 at the time of the project, however, did not participate in the project. The fourth teacher was qualified as a secondary mathematics teacher.

Group 2: Students
A group of five to six students from each of the class groups participated in focus groups. Where possible the groups consisted of girls and boys and represented a diversity of academic abilities.

Group 3: School Principal

Ethical procedures

The research methods utilised in this evaluation were approved by Western Sydney University’s Human Research Ethics Committee (approval number: H12457) and the Catholic Diocese of Wollongong. All participants were provided with a plain language information sheet about the research and all provided the researcher with informed consent to participate.

Data Sources

Data informing this evaluation were drawn from the following sources:

Interviews
Semi-structured interviews were chosen as a way of garnering in-depth information from the teachers and school principal. One of the most important sources of information within a case study approach is the interview. The interviews provided an opportunity for the researcher to explore the teachers’ practices and beliefs in relation to mathematics teaching and learning during the middle years. The semi-structured nature of the interviews provided a framework to ensure the appropriate data is collected, yet also allowed the researcher to respond to the situation at hand.

The three teachers participated in three semi-structured interviews of approximately 30 minutes duration at school during Days 2, 4, and 6 (figure 4). The school principal participated in two interviews (Day 2 and Day 6).

Student Focus Groups
Student focus groups were selected as a data source to provide the researcher with the opportunity to obtain opinions or attitudes about mathematics from a different perspective, either through group consensus or disagreement. When students may be hesitant to provide information during individual interviews, they may be more likely to share their thoughts and opinions within a group. This data was also used for triangulation with teacher interview data.

Groups of five to six children from each of the participating teachers’ classes participated in a series of two focus group discussions (one at the start, and one on completion of the project) of approximately 30 minutes duration. These discussions took place at school during school hours. The children were asked to respond to a series of discussion prompts about mathematics education.
The variety of data sources provided triangulation and allowed the researcher to determine the success of the project from three perspectives: student, teacher and leadership. The following questions and topics served as open-ended prompts for each group of participants:

**School Principal:**

**Initial Interview**
- Can you talk about why you instigated this initiative of action research in mathematics?
- Tell me about the state of mathematics teaching and learning at this school.
- What do you hope to achieve with this initiative?
- What are the things you have done so far to support the teachers in your school to participate in action research projects?

**Final Interview**
- Can you talk about the action research projects that took place in the school?
- What do you perceive to be the effects of the projects in relation to teachers and students?
- Do you consider the projects to have achieved your goal?
- Where to next?

**Students:**

**Term 2 meeting**
Students were prompted to discuss the following:
- Beliefs about mathematics teaching and learning
- The ways they have experienced mathematics teaching and learning in the past
- Things they would like to improve relating to mathematics education
- Things they enjoy/don’t enjoy about mathematics teaching and learning.

**Term 4 meeting**
Students were prompted to discuss the following:
- Changes they have noticed relating to teaching and learning of mathematics as a result of the project
- Beliefs about mathematics teaching and learning
- Advice to teachers relating to teaching of mathematics and the project itself.

**Teachers:**

**Term 1 meeting**
Teachers were prompted to discuss the following:
- Aims of their project
- What they consider to be the current attitudes and perceptions of their students in relation to mathematics teaching and learning
- Anticipated project activities
- Anticipated project outcomes.

**Term 2 meeting**
Teachers were prompted to discuss the following:
- Project activities to date
- Changes they have noticed relating to teaching and learning of mathematics
- Perceived changes in students as a result of project activities
- Where to next with project?

**Term 4 meeting**
Teachers were prompted to discuss the following:
- Project evaluation
- What are their reactions to the outcomes of the project?
- What are the perceived student reactions to the project?
- Outcomes of the project
- Surprises/unintended outcomes of the project
- Next steps
- Advice to others considering action research projects.
Timeline

The combined sequence activities were organised into three phases:

**Phase 1 (Term 1 2018):** the teachers began planning action research projects supported by the researcher in regard to the process of AR and mathematics education. Data was gathered via individual interviews to gauge the teachers’ perceptions of mathematics teaching and learning prior to them implementing their AR projects. Groups of five to six students from each of the teachers’ class groups participated in a focus group discussion to determine the engagement and perceptions of mathematics teaching and learning. The school principal also participated in an interview to document the intent and expectations in relation to students and teachers. Teachers began implementing AR towards the end of Term 1.

**Phase 2 (Term 2 2018):** The teachers were provided with time to work with the researcher to evaluate progress of their action research projects. They used this opportunity to adjust their plans and consider their evidence in relation to their research questions. Data was collected from the teachers via interviews to document changes in their perceptions of mathematics teaching and learning, and the effectiveness of their projects to date. Teachers continued their AR in Terms 2 and 3.

**Phase 3 (Term 4 2018):** The teachers evaluated and documented their individual action research projects. Final data was gathered from the teachers via individual interviews and student focus groups to explore action research projects outcomes and changes to perceptions of maths education. The principal participated in an interview to explore his perception of changes amongst students and teachers.

Data Analysis

Data was audio-recorded and transcribed verbatim. Data from each teacher and student group was analysed separately to identify emerging themes in response to the evaluation questions. Data was then analysed across the teaching groups along with the data drawn from interviews with the school principal to seek common themes and respond to the research questions.

The findings from this evaluation are presented in four themes: Changes to Practice; Student Engagement; Academic Benefits; and Action Research as Professional Development. Following this, a synthesis of the findings in response to the research evaluation questions is presented. Finally, a set of recommendations will be articulated.

.. what I’ve heard kids say is that they didn’t realise that they could achieve in mathematics.

They’re more engaged; so it’s not as if I’m trying to do a dance at the front of the room to keep them engaged. So they’re generally just more engaged.
Program Results
Changes to Practice

One of the aims of this program was to develop pedagogical practices to encourage student engagement and, in time, improve academic outcomes. Data from the three participating teachers indicated a range of new practices that emerged through the course of the project as a result of the targeted professional development and the teachers’ individual action research.

Building Student Confidence

A major barrier to student achievement is a lack of confidence. Many students develop a fixed mindset that restricts them in their beliefs about learning (Dweck, 2000). The work of the three teachers in this study indicates their students gained confidence in their ability to learn mathematics through a range of strategies. A strategy implemented by Teacher 2 focused explicitly on encouraging students to move from a fixed to a growth mindset:

After increasing my own knowledge, I was able to talk to my students about what it means to have a growth mindset and work with students to put some strategies in place to help move them from a fixed to growth mindset. Rather than giving up when a task was perceived to be too difficult, the class came up with a process that could be followed. This process encouraged students to persevere by re-reading the question, asking a partner for a suggested strategy to try and having another go before asking the teacher for assistance. I found by putting this process in place, students were less likely to give up straight away.

I have a better understanding of my students and their thinking – those who are more likely to persist when challenged and those who need more encouragement in developing a growth mindset. In my teaching I have seen the importance of students having an ability to work mathematically, in order to be able to solve problems that are new to them, communicate and reason.

(Teacher 2 report)

The success of this strategy was reflected in student comments from each of the grade groups:

I’ve changed my belief. I’ve changed it to a positive side which is more positive than before because I’ve realised that I’ve moved up a level in my personal level in mathematics so I’m understanding and, yeah, like what (student) said, growing a better mindset towards mathematics and if I go into Year 6 with a good – with a positive behaviour, I think I’ll get most of the things.

(Year 5 student)

I’ve noticed changes since before. For me personally it’s not about having fun, but when I first did maths I kind of gave up on it and thought oh, well I’m not going to try because I can’t do it. Then Miss (Teacher 3) kind of pushed me to do something and then I found out that I could do it, so then I participated in maths. Then I realised it wasn’t as hard as I thought it was, because she makes it into an easier lesson and takes us step by step.

(Year 8 student)

The changes in students’ attitudes towards mathematics was noticeable beyond the classroom. The school principal made this comment on completion of the project, indicating a successful outcome:

I think the students have had – for the most part, I wouldn’t say it’s universal, but for the most part students have had a better self-efficacy around their ability to do mathematics. Certainly, what I’ve heard kids say is that they didn’t realise that they could achieve in mathematics.
Differentiation

Another significant change to practice amongst the three teachers was a greater focus on differentiating learning to address the diverse range of abilities at the school. There were some similarities amongst the strategies implemented. The most common approach amongst the three teachers was a move from closed, text-book type tasks to more open-ended tasks that had differing entry and exit points. The implementation of these types of tasks provided opportunities for all students to experience some success in their learning and contributed to building positive self-efficacy.

I looked at high ceiling, low entry tasks as well as a way of trying to encourage that working mathematically – communication, problem solving and reasoning as well...having different entry levels within those tasks, that they’re all doing the same tasks but in a different way that’s relevant to their level, rather than having completely different tasks - where I found my kids like well, why is that person doing that and why am I doing this? So, they’re all doing the task and then if they were successful, then they could progress. Or if they needed extra time to work on like a certain aspect, then they could.

(Teacher 2)

We’re not always focusing on the lower ended students. We’re also focusing on those that are towards the middle and the top range. Through this process as well, I’ve been able to be a bit more adaptive to the tasks that I give students.

(Teacher 1)

A differentiation strategy trialled in Year 8 by Teacher 3 involved introducing flexible grouping:

Firstly, to allow a variety of grouping situations to take place in the class, students’ names were placed on laminated paper. At the beginning of every lesson, these names were adjusted, so that students were able to work with a variety of students. This immediately allowed for differentiation within the lesson – in some periods, students were grouped according to ability within the specific topic, whereas in other lessons students were grouped to allow for peer-teaching to occur.

(Teacher 3)

This strategy was particularly success for this group of students, adding some excitement and anticipation for their mathematics lessons:

...whenever we get into the classroom our tables have changed and so the people we’re sitting with change. So whenever we sit with people from our class in the table, we always do activities with them and we always engage with each other about maths. So I think that’s a good way to focus on maths when you change groups every time.

(Year 8 student)

However, this strategy did not suit all learners:

I feel like group activities are – actually I get distracted from them, because I feel like I talk to the people. But then I like working individually because I actually focus on my work and I actually improve what I do individually.

To address the distraction of working in groups and to increase accountability, Teacher 3 used a questioning strategy to ensure students were motivated to focus and contribute to class activities and discussion. Each student’s name was written on a paddle-pop stick. Teacher 3 would select a student at random to respond to a question using the sticks. This had the desired effect:

She pulls out the stick so you know that you’ve got to pay attention and focus.

(Year 8 student)

...because she makes you think, like realise, oh it might be me, so I might start to do the work instead of just...I’m just going to wait and then I’ll guess if I get called.

(Year 8 student)
From Passive to Active Learning

Some of the strategies implemented by the teachers resulted in an important shift from passive to active learning. The use of manipulatives or concrete materials in the middle years is typically minimal, however the students in this research appeared to benefit from their use and a more hands-on approach to learning:

...we have done things like using chopsticks to pick up M&Ms and we are looking at the ratio like how many M&Ms you can pick up and comparing fractions like that and then adding fractions...

(Teacher 3)

The use of active learning assisted students in retaining learning by making the contexts through which the learning occurred more memorable:

So at least if they can think of the activity that they did then they will be able to go back and remember it. Um, so we obviously do other stuff as well, not just food stuff. But the previous ... kind of introducing each thing and then we are doing more maths related activity as well. So – I have tried to include more challenging tasks in there.

The students felt that the new, more interactive mathematics lessons were beneficial:

...if it’s more interactive or it’s more fun for us to learn something, I guess it’ll stick to us more. If there’s a rule if you just write it down like a piece of paper it just doesn’t make sense, but then if a teacher goes through it and if we have questions we ask her and if that keeps on going then it’ll be fine.

(Year 8 student)

Promoting Mathematical Dialogue through Reasoning

The increased interactive nature of the mathematics lessons also led to an increase in mathematical dialogue and reasoning. Mathematical reasoning is an important element of the Working Mathematically strand of the current Mathematics K-10 Syllabus (Board of Studies NSW, 2012) and was a specific focus of Teacher 1, who used questioning and student reflection to improve her students’ skills:

...it was good because you could tell that they potentially have gone away and thought about it and reflected on it within their own time and come back. So, I thought that might be a good strategy to use at times, you know, to ask you know a smaller reflection question just to, you know, see how their thinking be changing from day to day.

(Teacher 1)

Reasoning was also initially a concern in Year 7:

I found a lot just rushed. If I put a problem up, it’s like oh I know the answer. But then they had no working out and nothing in their book to show how they got – so working on communicating as well. Like well why is that the answer? How did you get to that? How do you know it’s the answer?

(Teacher 2)

Teacher 3 also found some benefit in adding reflection to the lesson routine. Not only did the students’ ability to express their thinking improve, the teacher was also able to use the dialogue as an assessment tool that allowed her to plan the following lesson according to the students’ needs:

...by having the reflection at the end of the lesson, this gave me the opportunity to place students into groups for the following lesson, based on common abilities with the current content/lesson.

(Teacher 3)
Making Mathematics Relevant

A further commonality in the Year 5 and Year 8 classrooms was the effort to make mathematics learning more relevant for the students. In Year 5, Teacher 1 did this by using tasks that provided opportunities to teach and learn across the mathematics content strands. This was done through the use of rich tasks drawn from one of the resources, Maths300, recommended during the professional development sessions. In Year 8, Teacher 3 re-wrote her mathematics units to ensure they had explicit links to real life.

A large focus was placed on establishing context-based programs and learning and teaching experiences. This included a program on shopping for computation with integers, a unit heavily based on food preparation for fraction, decimals and percentages, and a program based on ‘The Amazing Race’ for the time unit. Students were frequently asked why their learning was important and could use their context-based learning experiences to formulate a response.

(Teacher 3)

The success of this strategy is confirmed in this statement:

The generation of context-based units has allowed me to see how important it is for students to be able to see the link between maths and real life, particularly with students who are either not strong at or do not enjoy maths. I found that the more time and effort I put in to creating learning experiences that were engaging and relevant, the more students both enjoyed coming to maths, and the faster they were able to grasp concepts and have that ‘light bulb’ moment. Since beginning the project, I have not had one student ask why maths is important!

(Teacher 3)
Student Engagement

A desire to increase student engagement was the major catalyst for this project. As articulated in the background literature, engagement is more than simply being ‘on task’. Rather, engagement should be considered as students working ‘in task’. Substantive engagement in learning requires students to be cognitively, operatively and affectively engaged (Attard, 2014) and there is evidence from the data collected from teachers and their students that engagement with mathematics improved on all three levels as a result of the teachers’ action research that led to changed practices.

The final quote in the previous section hinted that student engagement had improved. Teacher 3’s comment that “Since beginning the project, I have not had one student ask why maths is important!” is compelling evidence. Of course, there is much more evidence to indicate that all three teachers had improved pedagogical relationship and their pedagogical repertoires as articulated in the Framework for Engagement with Mathematics (Attard, 2013, 2014) to improve their students’ relationship with mathematics.

Improved Pedagogical Relationships

The increase in opportunities for interaction and dialogue in mathematics lessons promoted deeper pedagogical relationships that allowed the teachers greater insight into students’ abilities and needs. For example, Teacher 3 made these observations in her final report:

Throughout this project, I have really learnt how important grouping systems can be; they have the potential to both positively and negatively affect the learning of all students. When placing students in a seating plan at the beginning of the year, I allocated seats based on overall maths ability (using LNA data) as well as for behaviour management. However, in completing the project, it has allowed me to really see that just because a student performs low in an LNA, it does not mean that they will be low performing for every maths skill or concept. Some individual students understood concepts much faster than I would expect (based on their LNA results), whilst others that I would previously have placed in a higher ability group, sometimes struggled more than others (and more than expected).

Similarly, Teacher 2 gained a greater understanding of her students through her growth mindset approach, leading to improved self-regulation:

I have a better understanding of my students and their thinking – those who are more likely to persist when challenged and those who need more encouragement in developing a growth mindset. In my teaching I have seen the importance of students having an ability to work mathematically, in order to be able to solve problems that are new to them, communicate and reason.

(Teacher 2)

Just as important as teachers’ perceptions are the students’ perceptions of pedagogical relationships. There is clear evidence that the students gained benefit from the changes made as a result of this project. The teachers’ increased knowledge of their students resulted in student perceptions that teachers’ explanations of mathematical concepts had improved.

So the last term before, the teachers were giving us worksheets and weren’t properly explaining it; and now they’re going more into it and explaining it and after that they’re giving us questions so we know what we’re doing first. Then, we’re completing the work. Instead, before, we didn’t know what we were doing properly.

(Year 8 student)

She explained in not a super hard way and she worked through it step by step with me so I could understand it.

(Year 7 student)

When I know that I’m going to have maths in my next class I kind of think negatively, but since that whenever we go to maths our groups have changed I get more excited and wonder oh, who am I going to be with? What’s today’s lesson? So then I have a positive reaction.

(Year 8 student)

I think maths at this school is completely different to my old school. In this school they take more time to um like work out what you are doing and um the teacher gets to have a go with every student in the class.

(Year 5 student)
Engaging Pedagogical Repertoires

There is a reciprocal connection between the development of positive pedagogical relationships and engaging pedagogical repertoires. When teachers have a better understanding of their students' needs, they are more likely to implement engaging practices. Likewise, when engaging practice are employed, they give teachers better insight into students, improving pedagogical relationships. The three participating teachers in this project appear to have been successful at improving students' engagement and the evidence of this is again drawn from the teachers and their students.

This extract from the Year 7 focus group discussion at the end of the project illustrates the general sentiments of the students:

<table>
<thead>
<tr>
<th>Male</th>
<th>Facilitator</th>
<th>Female</th>
</tr>
</thead>
<tbody>
<tr>
<td>Math has gotten a little bit easier.</td>
<td>Okay, how?</td>
<td>I've improved in my grades a lot. I've been more engaged because our teacher makes our lessons very fun. We don't seem bored.</td>
</tr>
<tr>
<td>I've had more of an understanding of it.</td>
<td>Why do you think that is?</td>
<td></td>
</tr>
<tr>
<td>Because I've started to engage in the lesson more...</td>
<td>Right.</td>
<td>Usually in all our other classes everyone is very bored in them. It depends on what subjects we have really...</td>
</tr>
<tr>
<td>...instead of just looking out the window and ignoring.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>So tell me what's made you engage more?</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Just...</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Is it something different that the teacher is doing?</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Yeah. She was like getting me into it, not just - yeah.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Getting you into it, in what way? Can you think of anything...</td>
<td></td>
<td></td>
</tr>
<tr>
<td>She was encouraging me.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Oh okay, does that make a difference?</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Yeah.</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

There is also evidence of affective engagement that has been the result of improved cognitive and operative engagement afforded by more interactive and challenging tasks:
The three teachers noticed their students were more enthusiastic about mathematics lessons as a result of their action research and resulting changed practices. Comments ranged from describing how students had demonstrated increased perseverance, better classroom behaviour, improved willingness to complete homework tasks and more positive attitudes towards mathematics.

The structure of the lesson as well, the kids are saying let’s do our success criteria. They are referring back to that learning intention. Little things like that shows that they’re thoroughly engaged in what they’re doing. 
(Teacher 1)

Like they’re less likely to just give up straight away. One student, in particular, has made quite big growth and he was one that was in the little Year 6 class last year, where there was only eight of them. So for him to keep progressing and progress quite well, in a bigger class, has been good. He’s one who I think with the challenging tasks has really jumped on board, and he’s gone home and gone, oh I haven’t got the answer yet. So I want to go and find out. Then will come back the next day and go, oh can you have a look at this?
(Teacher 2)

They are giving it a go straight away. Like they might not, they might not be at the same level as other kids in the class but they are actually giving it a go and, you know, looking to ask someone rather than come to me. So, I feel like a lot of that, you know, like housekeeping stuff has been really beneficial and just pushing that as well so they can somewhat direct their own learning.
(Teacher 1)

They’re more engaged; so it’s not as if I’m trying to do a dance at the front of the room to keep them engaged. So they’re generally just more engaged. It’s more effort I think to make the unit in the first place, but I think it’s worth it for then the ease of running the unit.
(Teacher 3)

For the majority of them, they’re very excited to come in to class. So there’s no, ‘ugh it’s maths’. I’ve had a few students say to me that maths is their favourite subject. Which at the beginning of the year - before this, I actually polled them and it was no one’s favourite.
(Teacher 1)

…doing math I wasn’t that excited, but when we got into the classroom it was a lot more fun than it was last year.

But in maths everyone in our class pays attention.
Influences on Academic Achievement

Often when there are interventions to improve student engagement with mathematics it takes some time for evidence of improved academic outcomes to emerge. However, in the case of St Francis Catholic College, academic outcomes did show strong signs of improvement that were considered more significant than would normally be expected. Appendix 7 is a detailed report compiled by the Leader of Learning (Middle Years). The report includes evidence of the improved outcomes resulting from the Localised Numeracy Assessments (LNA) that were used each school term to assess numeracy across each of the syllabus strands.

The teachers made comment on the academic growth of the students:

The students are progressively improving and there’s been a number of students that have gotten into the band seven and eight towards the top end. (Teacher 1)

They had massive growth. So, I did the same pre-test and post-test. There was one kid who didn’t really – he wasn’t as low as the others to start off with but there was only one student who really didn’t – but there have been, there is like pastoral issues, so other teachers, we don’t know what is happening at home or anything like that and he is not normally like that. So, he is the only one who didn’t show growth. (Teacher 3)

So with our [LNA] results that we’ve done at the beginning of every term, we’ve gone from having a majority who were band four and five. So it’s like colour coded for us; so they were red. The rest were six and seven. We had no eights and nines for my class. Nearly every student has improved – there’s one student who’s just stayed the same the whole time, but I now have – I think three students who are a band eight and there’s only probably three that are left in the red. I think they’re fives. So they’ve all gone up one or two bands, with the exception of one. (Teacher 2)

The academic growth was also noted by the students:

...doing math I wasn’t that excited, but when we got into the classroom it was a lot more fun than it was last year. The teacher would just give us the work last year and we’d have to go do it. But this year Miss explains it to us, so it gives me a proper understanding of the work. (Year 7 student)

For other people in our class, they’re not the best at maths or anything but then once they go on, like they know what they’re doing, then they’re good. But then two terms ago in Term 2, other people were asking me or others, how do you do this? They were really unsure. So yeah, I think they improved. (Year 7 student)

So last – Term 2, so Semester 1 report I got a B on my grade and this year they said I was sitting on an A to B level, so I’m seeing it’s changing; maybe not my grade but my understanding of it is growing. So hopefully that impacts my grade in a positive way...

(Year 8 student)

Everyone is included in all the activities and no one argues, or no one’s bored in math. It’s a very fun classroom.
Action Research as Professional Development

The changes in the teachers’ practices and their positive influence on student engagement and achievement were the result of action research conducted under the guidance of the researcher, who facilitated professional development focusing on mathematics pedagogy and action research methodology. Action research is regarded as a ‘practice changing practice’ (Kemmis, 2009) and although there were clear changes made to each of the teachers’ practices within the mathematics classrooms, it is difficult to gauge at this stage whether action research itself has become an integral part of these teachers’ practices. During their final interview the teachers were asked to reflect on the process of action research as professional development. Each of the teachers were positive in their responses and articulated elements of the action research process that they felt were of benefit.

I definitely feel like it has been beneficial in order to focus on not only my pedagogical practices but to - how they’re implemented and how that affects the students’ learning. That’s the most important part of what we do. We need to look at is what we’re doing working and if it’s not how can we change it. Having that focus on a specific research question, it has actually improved other parts of the learning process. Specifically, I’m focusing on working mathematically and how students think about mathematical questions and breaking down barriers and all that kind of thing, which essentially has been really good in their confidence in how they approach a question and how they collaborate with others as well. (Teacher 1)

And finally, a quote that aligns with the intentions of this project within a school structure that is intended to provide the best possible outcomes for students:

It is important that I adapt my practices to the students, not the students adapting to my teaching style. I feel it has been a huge benefit in a beginning school to establish practices working in a learning team with other educators to ensure we are focusing on goals that can benefit all.

...having like the sub-questions, that kind of helped break it down further that you could focus on one bit at a time, if you needed to. (Teacher 2)
Summary
Summary

This research evaluation posed the following question: How does the implementation of participatory action research projects in one school site assist in the improvement of mathematics engagement and outcomes in the middle years?

Two sub-questions assisted in informing the research question:
• What are the benefits of having an academic partner to facilitate and support action research in a school?
• What are the perceived benefits to students?

The following summarises the data presented in the previous sections in response to the research questions.

How does the implementation of participatory action research projects in one school site assist in the improvement of mathematics engagement and outcomes in the middle years?

Evidence from teachers, students and assessment data revealed that the implementation of participatory action research across Years 5, 7 and 8 at St Francis Catholic College improved student engagement with and achievement in mathematics by:
• Increasing teachers’ awareness of their own practices and the effects of those practices on students’ perceptions of mathematics;
• Providing opportunities for the participating teachers to trial new practices;
• Providing opportunities for collaboration with other teachers across the various grades to deliver a more consistent approach to mathematics education across the middle years;
• Exposing students to more effective practices that, in turn, provided teachers with greater insights into student abilities; and
• Allowing teachers to trial differentiated practices to cater to the diverse range of abilities within their class cohorts.

What are the benefits of having an academic partner to facilitate and support action research in a school?

Having an academic partner to facilitate and support the action research at St Francis resulted in the following benefits:
• Targeted professional development that responded to the needs of individual teachers and their students;
• Provision of timely feedback and advice in regard to the process of action research and the delivery of effective mathematics pedagogy;
• Sharing of high-quality mathematics resources and academic readings in response to teachers’ needs; and
• Provision of a level of accountability through the requirement of meeting attendance, feedback sessions and the completion of a research report on conclusion of the project.

What are the perceived benefits to students?

The data collected through individual teacher and principal interviews, student focus groups and LNA assessments indicate the following benefits were experienced by students:
• Improved teacher practice that resulted in what students considered to be better explanations of mathematical concepts;
• A more hands-on approach to learning;
• More opportunities for substantive conversations with peers and teachers during mathematics lessons;
• More contextual mathematics lessons that highlighted the relevance of the curriculum beyond the walls of the classroom;
• Improved confidence through the development of growth mindsets;
• Improved academic outcomes;
• Improved perseverance and self-regulation; and
• Higher quality engagement at operative, cognitive and affective levels: students operating ‘in-task’ rather than ‘on-task’.
Recommendations
Recommendations

As a result of the data presented in this report, the following recommendations are made to the leadership team at Wollongong Catholic Education Diocese and St Francis Catholic College:

• Teachers participating in action research in 2018 should be encouraged to disseminate their work to colleagues to assist in the development of shared understandings in relation to effective mathematics pedagogy and action research methodology.

• Future professional learning opportunities in mathematics at St Francis Catholic College should focus on strengthening teachers’ understanding and implementation of the Working Mathematically strand to ensure it forms the core of mathematics teaching and learning.

• Given the nature of St Francis as a developing school with a new influx of teachers each year, it is imperative that those teachers who participated in action research in 2018 are encouraged to become mentors to incoming teachers within the mathematics faculty in order to promote the development of a positive culture in relation to mathematics education practices.

• Student voice in relation to mathematics teaching and learning should have prominence in relation to programming, planning, and pedagogy in mathematics.

• Further opportunities for collaboration amongst the middle years mathematics teachers is strongly encouraged to ensure alignment in pedagogical practices and to assist in the development of a community of practice where philosophies on mathematics education are in alignment.

• Support for participating teachers to continue developing the practice of action research as a ‘practice changing practice’ is strongly recommended to ensure action research is an ongoing aspect of practice rather than perceived as a finite project.
References
References


Board of Studies NSW. (2012). Mathematics K-10 Syllabus. Board of Studies NSW.


## Appendix 1: Teacher 1 Action Research Planning Template

### Action Learning

#### Part 1

1. **What is the nature of the problem/issue that you are trying to address?**
   - Communicating Mathematically.
   - Explaining the thought process behind the math involved in the solution.

2. **What data or evidence led to you to believe this is an issue?**
   - Students struggling to explain and justify what they did in a one-on-one conversation.
   - Taking risks with their learning to explain what they did.

3. **What have you tried to implement to address this issue that has not yet worked?**
   - Students present their working out to the class. Just explain answer not process.

#### Part 2

4. **Action learning research question**
   What pedagogies and practices can I implement to assist students in their mathematical thinking and reasoning when explaining the processes behind the final solution?

   **more transparent**

5. **Sub questions**
   - What is the student’s understanding of ‘thinking mathematically’?
   - What questions should I be asking to promote mathematical thinking and reasoning?
   - How can I modelled effective mathematical thinking verbally and in written form?
   - Should students be given more opportunities to be reflective within a class, group or one-on-one context?
   - How can I incorporate peer reflection?

   **prioritise sub questions 2–3**

6. **What have you tried that can be built on?**
   Each lesson is completed with a reflective where student’s answer a reflective question or students are asked to share their learning with the class to explain and justify their mathematical thinking.

7. **What are your main activities as part of this project? Remember, keep it concrete and specific.**
   - Modelling good mathematical thinking and reasoning
   - Scaffolds displayed of sentence starters to communicate mathematical thinking and reasoning.
   - Display REAL reflective questions in the room for students to actively view and choose to reflect on their lessons and activities.
   - Can I convince someone else to change their mind.
   - Introduce vocabulary for students to communicate mathematically.
Part 3

8. How could the success of your project be fairly judged? This is about what progress looks like. Paint a picture of what ‘success’ looks like. Identify 3-4 tangible, observable and meaningful signs that would lead an independent observer to conclude that your project is ‘on the right track’ or ‘succeeding’.

• Students demonstrate confidence in explaining their mathematical thinking and reasoning.
• Students can choose a reflection question to answer.
• Students are actively considering their mathematical thinking when completing a task. They are able to articulate their thinking.
• Students at all levels are able to explain their mathematical thinking appropriate to the task they are working on.

9. Is there anything else that you are hoping to learn along the way?

What strategies and practices can be implemented to design rich learning tasks to cater for a wide range of abilities, that provides opportunities for students to explore their individual mathematical thinking and reasoning?

10. What evidence/data are you going to use to judge the success of the project? This is about the tools you would use to identify progress

Existing evidence
• Students presented their work to the class about what they did and how they came to their solution.
• Select few students that are always willing to communicate their thinking with the class.

New Evidence
• Students can set goals that are specific to mathematical thinking and reasoning that ensures that are conscious about how they are thinking mathematically.

Action Learning Planning Template

<table>
<thead>
<tr>
<th>What</th>
<th>Who</th>
<th>When</th>
<th>Evidence</th>
</tr>
</thead>
<tbody>
<tr>
<td>Be specific about actions that need to be undertaken</td>
<td>Be clear about who has key responsibility for ensuring the task is completed</td>
<td>Be focussed on specific dates/weeks</td>
<td>Be clear about what evidence will be collected... and by whom</td>
</tr>
</tbody>
</table>

• Modelling of mathematical thinking and reasoning.
• Ensure mathematical thinking and reasoning is apart of the success criteria to ensure students are ensuring that is also a focus of any given open-ended task.
• Myself as the classroom teacher.
• Can share strategies and observations with the MYMT.
• Students are actively participating and demonstrating their abilities to work mathematically.
• Students can monitor their goals of working mathematically every lesson to ensure students are focusing on this aspect of the lesson.
• Students are given time within each lesson to reflect on their mathematically thinking and reasoning at the conclusion of each lesson. **MAKE A PRIORITY**
• Collect voice memos of spoken explanation of mathematical thinking and reasoning.
• What displays or modelling has happened in the classroom?
• Are there joint constructions have been completed to ensure students understand what mathematical thinking and reasoning is?
• Are there elements of working mathematically included within the success criteria?
Appendix 2: Teacher 1 Action Research Report

St Francis Middle Years Mathematics Action Research Report

**Name:** Teacher 1

**Grade:** Year 5, Stage 3

**Background**

St Francis Catholic College is a Diocesan P-12 Catholic school at Edmondson Park, in the Edmund Rice tradition in the Parish of Mary, Mother of the Church, Macquarie Fields. The College motto encourages all members of the community to grow and develop ‘open minds and open hearts’ through opening their minds to enriching, new learning experiences and through opening their hearts by being faith filled people of integrity, courage, compassion, inclusion and justice.

The CEDoW, as part of the *Lighting The Way* funding, has granted St Francis Catholic College additional funding to support the development of the Middle Years Learning program. As a result, we have developed two teams: Middle Years English Team (MYET) and Middle Years Maths Team (MYMT) to provide regular opportunities to collaborate, plan, assess and reflect on the teaching and learning experiences in years 5–8, specifically in English and Maths.

The MYET and MYMT have six periods allocated for collaboration, planning, team-teaching and to enhance the capacity of all staff.

The six periods will be used in the following ways:

- **Collaborative Meetings** – Three periods. All team members will be off class together.
- **Team teaching/Intervention** – Three periods. Some members of each team will be teaching to allow for team-teaching opportunities and specialist intervention.

A large portion of students were not able to independently work through tasks that involved the application of ‘working mathematically’ and work collaboratively to share their mathematically thinking. Students struggled to explain their mathematical thinking and justify why their solutions were accurate and what processes were used to reach a final answer.

I have tried to incorporate larger challenging tasks that involves students working on multi step problems over a larger period of time. There are a number of students who take the back seat in collaborative tasks due to a lack of confidence in their abilities and working mathematically skills that involve the application of skills to new contexts. This could definitely be built upon by giving students more practice with tasks like this and the opportunity to work with different people. Tasks need to be designed or chosen that have multiple entry levels rather than students partaking in different tasks. I believe this is important that allows students opportunities to uncover skills that give evidence of growth and development.

**Research Question:**

What pedagogies and practices can I implement to assist students in their mathematical thinking and reasoning?

**Sub Questions:**

- What is the student’s understanding of ‘thinking mathematically’?
- What questions should I be asking to promote mathematical thinking and reasoning?
- How can I model effective mathematical thinking verbally and in written form?
- Should students be given more opportunities to be reflective within a class, group or one-on-one context?
- How can I incorporate peer reflection?
The Research:

Methodology:
Reflecting on the background information and observations of the students, it was clear that there needed to be a focus on working mathematically that would then support student’s capabilities to apply skills to new contexts and topics.

Each lesson included a 5–10 minute reflection that involves students answer a thought out question relating to the task, lesson intention and success criteria/proficiency scales. The reflection question was a question the needed to answer in written form or a class discussion. Random students were selected to share their reflections. It became clear that a few students had not participated in mathematical reflection as they were unsure how to approach the task and how to write a response. Therefore, sentence starters and examples were provided to the students verbally and written to support their engagement and confidence in the task.

I have introduced a scaled level poster that was frequently used for students to determine how they were going with tasks and skills. The levels are 1-5 and detail, I don’t get it (level 1), I sort of get it (level 2), I mostly get it (level 3), I’ve got it and understand (level 4), and I can teach it (level 5).

I have given students the opportunity to reflect in groups to communicate their responses to a few people rather than the whole class to allow students to build confidence and gain insights about how others reflect on their learning. A poster was created with students allocated to a group with students taking turns at leading the discussion.

The questions used for the mathematical reflection are developed from the REAL Framework that are used for every mathematical reflection in order for students to reflect on unidimensional, multidimensional, relational and conceptual feelings, thought and actions about the learning processes.

In the warm up/introduction stage of the lesson where students are practicing a skill or introduced to new learning, I have asked students to complete their solutions and working out on a whiteboard to an open-ended task and then asked students to walk around the classroom to observe other student’s insights and working out to solve the question. Students are then to give constructive feedback about the ideas and problem-solving of others. This gives students a glimpse into how other’s think about a question which radiates confidence in their abilities, in addition to adapting other ideas to their own insights.
Data and Results:
Every term, students complete a Localised Numeracy Assessment (LNA) that monitors progress across the year over multiple sub-strands. This data has also been used to drive teaching and pin-point areas of focus amongst a group of students. Students results have demonstrated an adequate amount of growth across all sub-strands.

Students have improved their abilities to work independently with homework tasks. Homework tasks have been differentiated to suit the multiple levels of students, in addition to various modes of delivering homework. Parents have stated that their children have embedded mathematics homework into their routines and when supporting their child, their capabilities to understand questions, find a solution and confidence when approaching tasks has drastically developed.

Each sub-strand has been taught with links being made to other sub-strands to ensure students are making connections between mathematical concepts that improves their conceptual understanding. With this in mind, success criteria's have been introduced to students as 5-point rubrics or proficiency scales. This has allowed students to demonstrate their abilities across a scale and is a form of differentiation that allows students to monitor their success. Students use these independently and has been a great tool for students to drive their learning and seek challenges. Using the success criteria, students are then able to set realistic goals that are specific, measurable and directly relate to the success criteria.

I have placed a focus and emphasis of mathematical reflection and discussions; specifically focusing on how they use key terminology when discussing their mathematical thinking and processes. Students have therefore improved how they structure their working out and how they explain their solutions.

Overall, this has had a direct impact on student’s engagement in tasks. Having student directed tasks designed that follow a goal set by the students has allowed student to make meaningful decisions about their learning in mathematics.
Discussion:

- How to structure an effective mathematical reflection.
- Engage students in tasks that allow multiple entry.
- How to promote mathematical thinking through demonstration and reflection.
- Structuring warm up/number sense tasks that allow students to practice foundational skills in addition to expanding their horizons with worded problems to break down vocabulary.
- The importance of reflection and its connection to the ability of students’ skills.
- Giving students examples of how to set specific goals that directs to the own abilities.
- Students are capable of steady growth.
- How to design a success-criteria that supports student’s abilities to work independently and to direct their learning.
- Adapting tasks and resources to cater for all students.
- Reflective practices of the teacher.
- Student engagement reflects teacher enthusiasm and engagement.

Next Steps:

- Ensure continued collaboration in preparing and analysing students’ progress and data that focuses on their strengths and weaknesses to continue targeting.
- Using the REAL Framework reflection questions that stimulates critical thinking and allows students to set realistic goals based on their levels.
- Linking topics that incorporate and range of skills to support student’s capabilities to apply skills to a range of contexts.
- Working mathematically/challenging tasks that incorporate collaboration, communication and documentation of ideas.

Action Research as Professional Development:

I have thoroughly enjoyed being a part of the action research project as not only has it given me an opportunity to grow as a teacher, it has provided me with insights into how students learn. It is important that I adapt my practices to the students, not the students adapting to my teaching style. I feel it has been a huge benefit in a beginning school to establish practices working in a learning team with other educators to ensure we are focusing on goals that can benefit all. For example, it is important that all Mathematics educators ensure there is an emphasis on mathematical thinking and processes and there is an opportunity for students to reflect.

I have watched students to continue developing their abilities in mathematics that not only relate to data, but an improvement in their confidence, their capability to work collaboratively and how they reflect on their progressions.

Ensuring Sustainability:

Whilst this process has been rewarding and beneficial to the mathematical abilities of the students and teachers, St Francis Catholic College will continue to grow as it is a developing school with new students and teachers joining the Mathematics team for the next few years. This processes and practices that have been developed this year need to be explicitly demonstrated and discussed to the new educators joining the team to ensure we are working collaboratively to sustain what has been established this year whilst being a part of the action research project. Time needs to be spent discussing this process and the results that are evident due to the specific focus and goals we have worked towards with our students in mathematics.

I would also like to continue developing my own practice as a mathematics teacher and embed good mathematics pedagogy into the mathematics team.
## Part 1

1. **What is the nature of the problem/issue that you are trying to address?**
   Engaging students who don’t enjoy maths and who have a fixed mindset relating to their maths ability.

2. **What data or evidence led to you to believe this is an issue?**
   - Speaking to students one on one at the beginning of the year.
   - Students giving up easily.
   - Students working too far beyond their ability.

3. **What have you tried to implement to address this issue that has not yet worked?**
   Differentiated tasks – these didn’t work well with students choosing their level because they tried to work at a level which was too difficult – they thought they were ‘dumb’ if they worked at and ‘easy’ level.

## Part 2

4. **Action learning research question**
   How do high ceiling, low entry tasks influence student engagement and mindset in maths?

5. **Sub questions**
   - How can these tasks be used as an effective differentiation strategy to engage all students?
   - How can these tasks allow success in order to promote a growth mindset?
   - What are the successful strategies in moving from a fixed to growth mindset?

6. **What have you tried that can be built on?**
   Differentiated tasks where students choose their level. Some students use concrete materials whilst others don’t. I would like to try to keep materials used the same for all students so students still feel like they are doing the same task but at their own level.

7. **What are your main activities as part of this project? Remember, keep it concrete and specific.**
   Implement high ceiling, low entry tasks.
8. **How could the success of your project be fairly judged?**

- Students who don’t give up as soon as they are challenged.
- Students who recognise and work at their ability level rather than trying to work too far beyond it.
- Tasks used can be used for all students in the class but differentiated to meet individual student needs eg. all students can use the same materials but in a way which meets their needs.

9. **Is there anything else that you are hoping to learn along the way?**

More about fixed and growth mindsets.

10. **What evidence/data are you going to use to judge the success of the project? This is about the tools you would use to identify progress**

<table>
<thead>
<tr>
<th>Existing evidence</th>
<th>New Evidence</th>
</tr>
</thead>
</table>
| Anecdotal evidence from conversations with students relating to maths mindset and enjoyment of maths. | • Students who don’t give up as soon as they are challenged.  
• Students who recognise and work at their ability level rather than trying to work too far beyond it.  
• Tasks which can be used for all students in the class but differentiated to meet individual student needs eg. all students can use the same materials but in a way which meets their needs. |

### Action Learning Planning Template

<table>
<thead>
<tr>
<th>What</th>
<th>Who</th>
<th>When</th>
<th>Evidence</th>
</tr>
</thead>
<tbody>
<tr>
<td>Research into fixed and growth mindset.</td>
<td>Teacher 2</td>
<td>Term 2, 2018</td>
<td>Student reflection about what it means to have a growth mindset.</td>
</tr>
<tr>
<td>Talk to students about fixed vs growth mindset</td>
<td>Teacher 2</td>
<td>Term 2, 2018</td>
<td></td>
</tr>
<tr>
<td>Display unidimensional, multidimensional, relational and conceptual questions in classroom</td>
<td>Teacher 2</td>
<td>Term 2-4, 2018</td>
<td>Student reflection about tasks using unidimensional, multidimensional, relational and conceptual questions.</td>
</tr>
<tr>
<td>Implement high ceiling, low entry tasks relevant to unit content (Maths 300?)</td>
<td>Teacher 2</td>
<td>Term 2-4, 2018</td>
<td>Videos of students participating in tasks.</td>
</tr>
</tbody>
</table>
Appendix 4: Teacher 2 Action Research Report

Background

St Francis Catholic College is a Diocesan P-12 Catholic school at Edmondson Park, in the Edmund Rice tradition in the Parish of Mary, Mother of the Church, Macquarie Fields. The College motto encourages all members of the community to grow and develop ‘open minds and open hearts’ through opening their minds to enriching, new learning experiences and through opening their hearts by being faith filled people of integrity, courage, compassion, inclusion and justice.

The CEDoW, as part of the Lighting The Way funding, has granted St Francis Catholic College additional funding to support the development of the Middle Years Learning program. As a result, we have developed two teams: Middle Years English Team (MYET) and Middle Years Maths Team (MYMT) to provide regular opportunities to collaborate, plan, assess and reflect on the teaching and learning experiences in years 5-8, specifically in English and Maths.

The MYET and MYMT have six periods allocated for collaboration, planning, team-teaching and to enhance the capacity of all staff.

The six periods will be used in the following ways:

- Collaborative Meetings - Three periods. All team members will be off class together.
- Team teaching/Intervention - Three periods. Some members of each team will be teaching to allow for team-teaching opportunities and specialist intervention.

The nature of the problem addressed individually was how to engage students who don’t enjoy mathematics and who have a fixed mindset relating to their mathematics ability.

As a teacher, teaching outside of my trained subject areas, it was evident that in mathematics, students tended to give up much more easily when they found something challenging than occurs within the other subject areas I teach. In speaking to each student in my class individually, it became evident that many had a fixed mindset in relation to their mathematics ability. Those who thought they weren’t good at mathematics tended to give up if things were perceived to be too difficult, but those who thought they were good at maths tended to try to work too far beyond their ability or alternatively were quick to come up with an answer but couldn’t communicate how they got there.

In teaching mathematics last year, the College was part of the Diocesan Stage 4 “Every Student Counts” mathematics project. As part of this project we were required to implement challenging tasks which in themselves were useful when used in context, however these tasks at times needed to be used out of context which students found frustrating. A strategy which was used early this year that didn’t work very well with my class of students was differentiated tasks where students could choose their own level to start at. I found most students tried to work at a level which was too difficult because they thought they were ‘dumb’ if they worked at what was perceived to be the ‘easy’ level. After finding that this approach didn’t work, I went back to using challenging tasks, however ensuring they were used in context as I thought they could be beneficial if the way they were implemented was adjusted.

Research Question (and sub questions)

From looking at the background information I had gathered I came up with the research question “how can a focus on working mathematically through high ceiling, low entry tasks influence student engagement and mindset in mathematics?”. In order to make this question more manageable to focus on I broke it down into three sub questions:

1. What are the successful strategies in moving from a fixed to growth mindset?
2. How can high ceiling, low entry tasks be used as an effective differentiation strategy to engage all students?
3. How can high ceiling, low entry tasks allow success in order to promote a growth mindset?
The research (methodology, data and results)

To begin to address the research process, the first thing I needed to do was to increase my own knowledge of growth mindset. After increasing my own knowledge I was able to talk to my students about what it means to have a growth mindset and work with students to put some strategies in place to help move them from a fixed to growth mindset. Rather than giving up when a task was perceived to be too difficult, the class came up with a process that could be followed. This process encouraged students to persevere by re-reading the question, asking a partner for a suggested strategy to try and having another go before asking the teacher for assistance. I found by putting this process in place, students were less likely to give up straight away. This was particularly useful for high ceiling low entry tasks, as the open-ended nature of the tasks allowed students to share their thinking and success with others. These tasks also provided an inbuilt opportunity for differentiation through the use of enabling and extending prompts and consolidating tasks.

A Localised Numeracy Assessment was used at the beginning of each term to collect data, with the term one and four assessments being the same in order to assess student growth across the year. In term one, seven students in my year 7 class were in bands 4 or 5. By term four, only two students were in these bands, both being in band 5.

Anecdotal evidence collected throughout the year also suggests that students benefitted from the approach used. Some students in particular took the high ceiling low entry tasks beyond where they were expected, completing additional components at home, as they were engaged and keen to challenge themselves. This allowed opportunities for students to also seek additional feedback and demonstrate their mathematical thinking.

Discussion

As a result of this project I have learnt more about fixed and growth mindsets. This is something that is not only beneficial in mathematics, but also in my other subject areas and in pastoral care. I have also learnt how to use high ceiling low entry tasks as an effective strategy to differentiate and promote a growth mindset.

In completing this project I have a better understanding of my students and their thinking – those who are more likely to persist when challenged and those who need more encouragement in developing a growth mindset. In my teaching I have seen the importance of students having an ability to work mathematically, in order to be able to solve problems that are new to them, communicate and reason.

Next steps

As I won’t be teaching mathematics next year, the next step for me as a teacher would be to continue to emphasise the growth mindset component of this project in my other subject areas. This is sustainable by developing a culture within my classes that encourages persistence rather than giving up when something is challenging. This can also be incorporated within my pastoral class.

Action research as professional development

In completing action research, I found the project beneficial in terms of having a focus question and sub-questions to use as a guide for implementing new strategies within teaching and learning. The focus on developing a growth mindset linked in with a similar pastoral focus within the College. I found this was beneficial for students in making connections between what they were doing within mathematics and within the wider College pastoral focus.

Ensuring sustainability

In moving forward, as I will no longer be teaching mathematics, I will look to include a focus on growth mindset within the subject areas I am teaching.
Appendix 5: Teacher 3 Action Research Planning Template

Action Learning Planning Template

Part 1

1. What is the nature of the problem/issue that you are trying to address?
   • Maths in real life → real life applications → problem = relevance
   • Teaching of gaps in skills from primary
   • Differentiating across a wide variety of learners

2. What data or evidence led to you to believe this is an issue?
   • SENA (2, 3) LNA
   • ‘When will we use this?’, ‘What is the point?’
   • Class work - AFL, AAL, AOL (2, 3)

3. What have you tried to implement to address this issue that has not yet worked?
   • Some context based units – however, this needs to be done better
   • Challenging tasks – struggled with low ability students

Part 2

4. Action learning research question
   How will the use of differentiated context-based learning affect student engagement and achievement?

5. Sub questions
   • How did the tasks affect students understanding of the relevance of maths?
   • What are the elements of contextualised tasks that contribute to achievement and engagement?

6. What have you tried that can be built on?
   • Context based units
   • Challenging tasks

7. What are your main activities as part of this project? Remember, keep it concrete and specific.
   • Create contextualised units
   • Create surveys and pre/post tests.
## Part 3

8. **How could the success of your project be fairly judged?**
   - Student survey on relevance – Where could you use this strategy outside the classroom?
   - Pre and post tests (achievement).

9. **Is there anything else that you are hoping to learn along the way?**
   How to more efficiently and effectively differentiate for a wide variety of students?

10. **What evidence/data are you going to use to judge the success of the project? This is about the tools you would use to identify progress**

    | Existing evidence                          | New Evidence                           |
    |-------------------------------------------|----------------------------------------|
    | • Anecdotal evidence → student opinion and engagement in maths lessons. | • LNA                                   |
    | • LNA, SENA.                             | • Pre and post tests                   |
    | • Pre and post tests.                    | • AL, AFL, AOL                         |
    | • AAL, AFL, AOL.                         | • Surveys → relevance and engagement   |
Appendix 6: Teacher 3 Action Research Report

Background

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The six periods will be used in the following ways:
• Collaborative Meetings – Three periods. All team members will be off class together.
• Team teaching/Intervention – Three periods. Some members of each team will be teaching to allow for team-teaching opportunities and specialist intervention.

The nature of the problem addressed individually was how to engage students who don’t enjoy mathematics and who have a fixed mindset relating to their mathematics ability.

As a teacher, teaching outside of my trained subject areas, it was evident that in mathematics, students tended to give up much more easily when they found something challenging than occurs within the other subject areas I teach. In speaking to each student in my class individually, it became evident that many had a fixed mindset in relation to their mathematics ability. Those who thought they weren’t good at mathematics tended to give up if things were perceived to be too difficult, but those who thought they were good at maths tended to try to work too far beyond their ability or alternatively were quick to come up with an answer but couldn’t communicate how they got there.

In teaching mathematics last year, the College was part of the Diocesan Stage 4 “Every Student Counts” mathematics project. As part of this project we were required to implement challenging tasks which in themselves were useful when used in context, however these tasks at times needed to be used out of context which students found frustrating. A strategy which was used early this year that didn’t work very well with my class of students was differentiated tasks where students could choose their own level to start at. I found most students tried to work at a level which was too difficult because they thought they were ‘dumb’ if they worked at what was perceived to be the ‘easy’ level. After finding that this approach didn’t work, I went back to using challenging tasks, however ensuring they were used in context as I thought they could be beneficial if the way they were implemented was adjusted.

Research Question (and sub questions)

From looking at the background information I had gathered I came up with the research question “how can a focus on working mathematically through high ceiling, low entry tasks influence student engagement and mindset in mathematics?”. In order to make this question more manageable to focus on I broke it down into three sub questions:

1. What are the successful strategies in moving from a fixed to growth mindset?
2. How can high ceiling, low entry tasks be used as an effective differentiation strategy to engage all students?
3. How can high ceiling, low entry tasks allow success in order to promote a growth mindset?
The research (methodology, data and results)

To begin to address the research process, the first thing I needed to do was to increase my own knowledge of growth mindset. After increasing my own knowledge I was able to talk to my students about what it means to have a growth mindset and work with students to put some strategies in place to help move them from a fixed to growth mindset. Rather than giving up when a task was perceived to be too difficult, the class came up with a process that could be followed. This process encouraged students to persevere by re-reading the question, asking a partner for a suggested strategy to try and having another go before asking the teacher for assistance. I found by putting this process in place, students were less likely to give up straight away. This was particularly useful for high ceiling low entry tasks, as the open ended nature of the tasks allowed students to share their thinking and success with others. These tasks also provided an inbuilt opportunity for differentiation through the use of enabling and extending prompts and consolidating tasks.

A Localised Numeracy Assessment was used at the beginning of each term to collect data, with the term one and four assessments being the same in order to assess student growth across the year. In term one, seven students in my year 7 class were in bands 4 or 5. By term four, only two students were in these bands, both being in band 5.

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Discussion

As a result of this project I have learnt more about fixed and growth mindsets. This is something that is not only beneficial in mathematics, but also in my other subject areas and in pastoral care. I have also learnt how to use high ceiling low entry tasks as an effective strategy to differentiate and promote a growth mindset.

In completing this project I have a better understanding of my students and their thinking – those who are more likely to persist when challenged and those who need more encouragement in developing a growth mindset. In my teaching I have seen the importance of students having an ability to work mathematically, in order to be able to solve problems that are new to them, communicate and reason.

Next steps

As I won’t be teaching mathematics next year, the next step for me as a teacher would be to continue to emphasise the growth mindset component of this project in my other subject areas. This is sustainable by developing a culture within my classes that encourages persistence rather than giving up when something is challenging. This can also be incorporated within my pastoral class.

Action research as professional development

In completing action research, I found the project beneficial in terms of having a focus question and sub-questions to use as a guide for implementing new strategies within teaching and learning. The focus on developing a growth mindset linked in with a similar pastoral focus within the College. I found this was beneficial for students in making connections between what they were doing within mathematics and within the wider College pastoral focus.

Ensuring sustainability

In moving forward, as I will no longer be teaching mathematics, I will look to include a focus on growth mindset within the subject areas I am teaching.
Appendix 7: Report prepared by Shane Chapman, Leader of Learning (Middle Years)

St Francis Catholic College Report on Catherine Attard Action Research Project

Context
The CEDoW, as part of the Lighting The Way funding, granted St Francis Catholic College additional funding to support the development of the Middle Years Learning program. As a result, the College developed the Middle Years Maths Team (MYMT) to provide regular opportunities to collaborate, plan, assess and reflect on the teaching and learning experiences in years 5-8.

The MYMT had six periods a fortnight allocated for collaboration, planning, team-teaching and to enhance the capacity of all staff.

Dr Catherine Attard (Associate Professor of University of Western Sydney) conducted an action research project with members of the MYMT.

CEDoW Stage 4 Challenging Students Mathematics Project
The CEDoW Mathematics Think Tank Team developed the following project priorities:
- develop increased confidence and effectiveness in teachers
- create quality learning experiences that enable students to communicate their mathematical thinking and develop confidence, critical and creative thinking skills
- establish a growth mindset amongst our students and teachers
- create meaningful mathematical experiences that promote connections for students
- provide experiences to develop students’ conceptual understanding of mathematics for all students
- create student-centred experiences and environments that promote challenge and risk taking
- develop quality assessment and effective feedback.

These priorities were embedded in the MYMT teaching and learning programs and were thus a focus for the year during the Action Research Project.
Research Questions

Each member of the MYMT team developed a research question and sub-questions to guide their research.

Teacher 3

How will the use of differentiated context-based learning affect student engagement and achievement?
A. How did the tasks affect student understanding of the relevance of Maths?
B. What are the elements of contextualised tasks that contribute to achievement and engagement?

Teacher 1

What pedagogies and practices can I implement to assist students in their mathematical thinking and reasoning when explaining the processes behind the final solution?
A. What is the student’s understanding of ‘thinking mathematically’?
B. What questions should I be asking to promote mathematical thinking and reasoning?
C. How can I model effective mathematical thinking verbally and in written form?
D. Should students be given more opportunities to be reflective within a class, group or one-on-one context?
E. How can I incorporate peer reflection?

Teacher 2

How can a focus on working mathematically influence student engagement and mindset in maths?
A. How can these tasks be used as an effective differentiation strategy to engage all students?
B. How can these tasks allow success in order to promote a growth mindset?
C. What are the successful strategies in moving from a fixed to growth mindset?
D. Each team member was required to complete a report on their experience and action research. Please see Appendix A for the reports.

Process

Dr Catherine Attard developed and delivered professional development for the team which comprised of information to develop foundational knowledge of ‘Action Research’ and advice and support regarding quality mathematics pedagogy. This structure and support as a ‘critical friend’ was highly effective as the College did not have a trained Mathematics Coordinator/Leader.

Dr Attard attended the College eight times over the course of the year.
Results

At the beginning of each term, all students completed an online Localised Numeracy Assessment (LNA). The assessments were developed from previous NAPLAN Numeracy assessments and the Term 1 and Term 4 assessment were the same to enhance the reliability and validity of student data and growth.

The graphs below show the number of students ‘Below’, ‘At’ or ‘Above’ National averages in NAPLAN Numeracy for each term. Individual student results can be found in Appendix B.*

Year 5 Results

Year 5 Data

Year 7 Results

Year 7 Data
All grades showed significant growth in students performing ‘at’ or ‘above’ National minimum standards.

All grades showed a significant decrease in students performing ‘below’ National minimum standards over the course of the year.

* Results not included in this report