What happens when challenging tasks are used in mixed ability middle school mathematics classrooms?

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The topics of decimals and polygons were taught to two classes by using challenging tasks, rather than the more conventional textbook approach. Students were given a pre-test and a post-test. A comparison between the two classes on the pre- and post-test was made. Prior to teaching through challenging tasks, students were surveyed about their mindset in regards to mathematics and how they think they learn best. They were surveyed again at the completion of the project to see if there were any changes.

Mixed ability classes

As a practiced middle school mathematics teacher and a Mathematics Learning Area Leader, my experience supports the thought that mathematics is perhaps the most resistant teaching discipline to change (Zevenbergen, Mousley & Sullivan, 2001). At the college where I teach, there is debate amongst mathematics teachers as to how we can best cater for individual differences in the learning of mathematics in the middle school (Years 7 and 8).

Clarke and Clarke (2008) recommend that we should support students with different talent profiles in mixed classes, and should not group the pupils based on their mathematical talents, but deal with their individual needs. ACARA (2010) recommends that all students should experience a full mathematics curriculum until the end of Year 9, with mathematics still being compulsory in Year 10. This is in support of what Clarke and Clarke (2008) believe. They state that by Year 10, students should have made a choice about their mathematics course based on career prospects, capability and future study options. To make a suitable choice, they should have been exposed to a full mathematics program and not have been disadvantaged by organisational choices made for them in middle school. The document *Numeracy in practice: teaching, learning and using mathematics* (DEECD, 2009) states that catering for a wide range of confidence and mathematical understanding is seen as one of the biggest challenges in teaching mathematics. The report suggests that different strategies need to be employed so that students of all abilities are catered for. Clarke and Clarke (2008) indicate that it is impossible to teach every student on an individual basis. They report that the research evidence is clear that generally any benefits which accrue from ability grouping are only to very high achievers, with a negative impact on average and low-attaining students.

Some teachers consider the best way to cater for individual differences is to ability-group the students based on a pre-test at the start of each year. Low attaining students would be classified on the basis of competence on a single routine test of recall, basic skills and knowledge. I am concerned about how we measure which students should be placed in the appropriate group. It is rare for teachers to have time to search actively for the mathematical strengths of the low attaining students and their abilities may not be shown in the usual ways. My concern also encompasses that students who are not conventional mathematical thinkers may be limited from having further opportunities for undertaking high-level mathematics.

Zevenbergen (2005) investigated the effect of ability grouping in mathematics on Australian students. She spoke to students about how they felt about the work and the teachers. A student from the least able group commented that his teacher does not teach them much because they do not pay attention. Generating in-depth discussion about mathematics in such a group is very difficult. Students in the higher group comment that their class is always quiet and students are focused on the set task.

Anthony and Walshaw (2009) believe that communication about mathematics is essential and should be the central focus of classrooms. Discussion should be encouraged and it is the active engagement with mathematical ideas that leads students to develop competencies. If all the low achieving academic students are in the same group, they will not be exposed to the thought processes of the higher achieving students. Anthony and Walshaw (2009) also identify that low-track groups do not get the opportunity to do activities that require a great deal of thinking since the tasks they are given are often repetitive practice of algorithms.

Mixed abilities can be catered for by presenting challenging tasks where students have a different entry and exit level depending on their ability or are able to select their own task based on their interests. In this project, I established a variety of assessments including challenging tasks, concrete materials and a classroom with respectful discussion.

The project

I teach two Year 7 mathematics classes, 7B and 7C. Both classes are compliant, enthusiastic and want to do well, but they are dissimilar. There is a wide range of abilities in both classes. This study will observe the experiences and results of both classes as they do the topics of polygons, solids and transformations, and decimals. Both classes were taught incorporating challenging tasks into their curriculum. A control group was not used because I believed that the challenging tasks approach would be interesting for all students. In a small-scale pilot, I introduced some activities into the algebra and equations topic. The first involved giving small groups of students some 'Like terms' laminated cards and getting them to sort them into groups of like terms. The challenge was that they were doing questions well beyond what I would normally expect them to be able to do. By matching the easier cards first they would then be left with the harder ones that they would ordinarily not attempt.

The second activity involved giving each individual student a table that had an algebraic expression, a sentence describing an expression, and a substitution into an expression. They cut the table into cards, matched the three cards for each expression, and then glued them into their books. This style of activity means that the more difficult questions can be left until last and that there will be fewer choices to match them up with. The fact that all of the answers are there is also helpful, rather than searching for the 'back of the book' to check accuracy. It was interesting to note that when using the laminated cards, the students were more willing to try to get an answer than they were with the cards they had to glue into their books. By sticking the paper down, they were making a more definite decision. With the laminated cards, they were able to freely move the cards around with no real consequence if they got the wrong match.

The third activity was completed as a class group. The purpose of the activity was to teach the idea of 'equivalent expressions'. I showed them the expression $3x + 5$ and then demonstrated that this was the same as $x + 2x + 3 + 2$ or $x + x + x + 6 - 1$. They had a turn at writing their own equivalent expressions, to which there are infinitely many answers. In the end I was asking them to write me a 'silly' equivalent expression and they came up with things like $20000006x - 20000003x + (5000 \div 1000)$. This demonstrated an understanding of equivalent expressions and all students were able to follow the pattern to come up with a correct response. The challenge was in the level of sophistication, with some students using powers and square roots and starting interesting whole class discussion.

Prior to undertaking the challenging tasks approach the students were asked "If I could be granted one wish for my mathematics learning it would be…". Student responses included:

- To have more drive to succeed more.
- Do harder maths and get good at it.
- To understand what the teacher says in class.
- Sometimes I think one thing and write another.
- Not doing as much board writing.
- Doing it with a friend so I can study happily.
- Doing maths with a friend in a group.
- For things to stick in my brain and not forget information later that has been learnt.

This feedback sets the scene for implementation of challenging tasks. Students want to be able to collaborate with one another and they want to have the time to think about their work. Challenging tasks provide the opportunity to do harder mathematics, and to pursue answers that require a high level of thinking

Challenging polygon problems

In introducing the idea of challenging polygon problems, some informal tasks were set as introductory activities for the class. The following problem was written on the board and a discussion followed.

Introductory problem

> The four angles of a quadrilateral are labelled ***A, B, C, D.***
> Angle *A* is one third of angle *B*.
> Angle *D* is half of angle *B*.
> What might be the size of angle *C*?
> Draw what your quadrilateral might look like.

Students readily tackled this task, shared their answers in small groups and then with the entire class. They were able to draw their answers on the board and discuss their strategies. There were many correct responses.

The 'Polygons Challenge' task was done in a more formal manner, with a worksheet handed out to the class at the start of the lesson and collected at the completion of the exercise. Students were given a short survey after doing this activity.

This activity was initially conducted with 7*B*. The students incorrectly assumed that because there wasn't a lot of writing or a lengthy list of questions, that they would do the challenge quickly and without much thought. Many of the sheets were returned within 10 minutes, but were not correct. After 20 minutes, there were only four fully correct responses from the entire class. Figure 1 shows a typical student work sample for this activity.

Based on the regular topic tests, this student's results (refer sample in Figure 1) put her in the middle group of the class. She tends to want to look for short-cuts and gets work done quickly, without being concerned about the quality of the work.

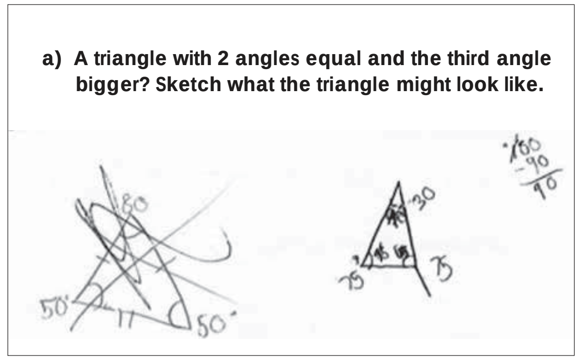


Figure 1. Typical student work sample.

This work sample is typical of her output. She had a try at the question and gave an initial answer. She crossed it out even though it was actually correct and her final response was incorrect. I would suspect that she found her work was different to the person next to her and then assumed that she was wrong. Having multiple acceptable responses is not something the class is used to, and it is interesting that she did not have the confidence to keep her original answer. I would have liked to see her explain the process she used, and in future I would get students to do three solutions and explain how they came up with each them. The next stage to engage students would be to then look for some sort of pattern, so they were able to get many responses quickly.

One of the 'high achievers', who also likes to get his work done quickly, produced the following work sample shown in Figure 2. It appears from this work sample that the student has tried to do the answer twice, and both times realised that he needs to think more carefully. Another consideration is that the 'high achiever' student realised that the problem was more difficult than he initially expected.

The same student produced the following for the final quadrilateral question given to the class to complete (Figure 3). This work sample showed the same type of pattern within a student response. This student assumed the question to be quite straightforward, so attempted to answer the question and tried a number of solutions.

Whilst he eventually obtained the correct answer, he became frustrated. He was quite aware that this task was not included on their reports and was happy to present it in this manner. I would suspect that if this were a task that was included in their final assessment, he would have done another neater and more accurate copy.

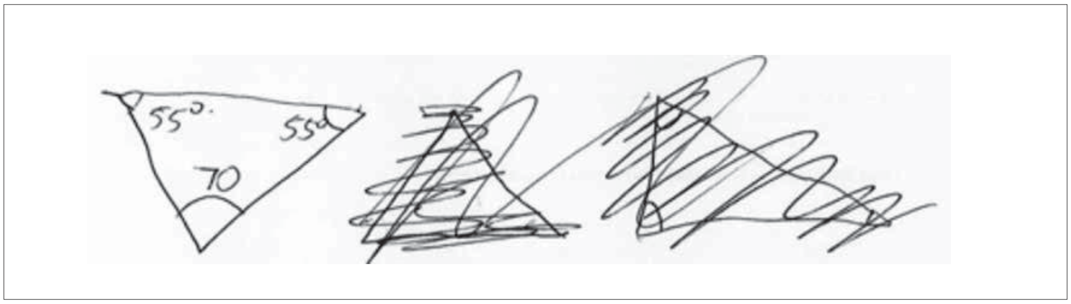


Figure 2. ‘High achiever’ student work sample for a triangle.

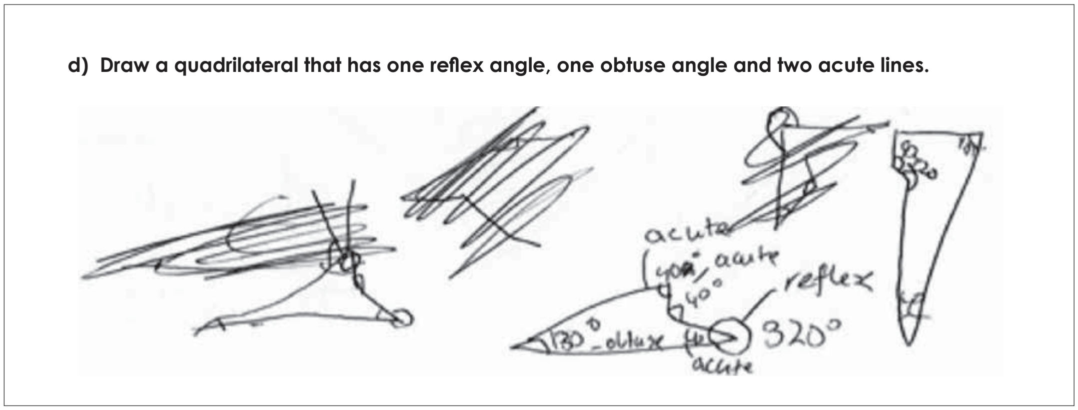


Figure 3. ‘High achiever’ student work sample for a quadrilateral.

Again, an explanation was not required and in future I would make the task more challenging by specifically asking for a written explanation of the process they used.

Not all students were able to make an immediate start on this task, even when being permitted to discuss their responses with one another. They were given the enabling prompt of “What do the angles in a triangle add up to?” to get them-started. I encouraged them to choose an angle to start with and see if it worked. If not, work out what a better guess might be.

Observations of the class indicated that students were engaged during the task, and having lots of conversations about what their triangles should look like. Students were using words like ‘isosceles’, and discussions around what their angles should add up to. There was a working atmosphere, and a general feel that this task was both enjoyable and challenging.

After they completed the activity students were asked to respond to the following question: “When I think about this task I prefer the questions we work on in class to be…”. Their responses are collated in Table 1.

Less than 10% of students across both classes reported that they would like their class work to be ‘much harder’, which is a little surprising since no students obtained the correct answer immediately.

Table 1: Student responses to the question ‘When I think about this task I prefer the questions we work on in class to be…’

Response Rating	Total number of students responding	Total (%)
Much harder	4	9
About the same	34	77
Much easier	6	14
Total Student responses	44	100

However, it is pleasing that 77% of students preferred questions to be at ‘about the same’ level of difficulty.

Student were also asked to complete the sentence “The best thing about this task was…” to which they responded:

- You still had to consider what each angle could be and work out if all angles added to 180.
- Thinking.
- You had to use your imagination.
- There were some easy questions.
- It was a challenge.
- There was more than one way to find the answer.
- Drawing and not writing.

- The questions were explained well.
- It didn't take long. It was fun.
- The difficulty wasn't too hard or too easy.

Students were also asked to complete the sentence "The worst thing about this task was…" to which they responded:

- That it was approximate.
- When you had trial and error.
- The many failed answers.
- I could not understand it at first.
- I couldn't find anything bad.
- The last one was hard.
- Nothing. I thought it was fun.

Other challenging tasks were set based on the use of *GeoGebra* (2016), an interactive dynamic mathematics software application that includes geometry, algebra, graphing and spreadsheets. Students downloaded this free software application, and used it on their laptops to complete the following geometry task:

Student geometry task

Draw the following shapes:

- a quadrilateral with no lines of symmetry;
- a hexagon with one line of symmetry; and,
- a shape with line symmetry of order 5 and rotational symmetry order 5.

The geometry task got students thinking around what the different shapes might look like, and the use of *GeoGebra* (2016) allowed them to draw accurate shapes quickly, any mistakes could be easily undone, and another attempt made. I witnessed extensive mathematical conversations in class around these questions with words like regular and irregular being used. There was a need for students to clarify with one another what rotational symmetry was.

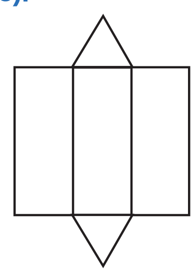
Discussion of the effect on learning through the use of challenging tasks

To observe how the teaching through challenging tasks affected the learning of students, I selected NAPLAN (National Assessment Program—Literacy and Numeracy) questions from the 2012 and 2013 papers that fitted in with the topics being studied. NAPLAN is an annual assessment for students in Years 3, 5, 7 and 9. The assessments are undertaken nationwide, every year, in the second week in May. These questions were used because they assess at a national standard. National testing should not drive what we teach, but if we are teaching the same work that is being assessed in NAPLAN, using the questions that have been developed by experts seems to be logical. I ensured that I planned the tasks prior to searching for NAPLAN questions. The questions matched what we had covered, rather than the other way around.

The same questions were used on both the pre-test and post-test and the responses recorded. A discussion around the responses to four of these questions follows respectively, in the sections on Polygon and Decimals results.

1. Polygon results

NAPLAN 2013 Question 4 Calculator active (ACARA, 2013).



This diagram is the net of a:

☐ **rectangular pyramid**
☐ **triangular pyramid**
☐ **triangular prism**
☐ **triangle.**

Table 2: Correct responses to NAPLAN 2013 Question 4 Calculator active pre-and post-test.

	Pre-test	Post-test
	n = 44	n = 45
Total	23 (52%)	32 (71%)

There was an improvement from 52% to 71% in correctly answering this question. This was a question that required the students to recall a name of a 3D shape. The only teaching addressing this area of content was an interactive website that was shown to the class, and a simple worksheet that involved drawing a line to match nets and their names. It was interesting to see that although none of the textbook work was done for this area, no homework was given and no formal notes were copied from the board, the results improved. This suggests that learning even basic recall of names of three-dimensional (3D) shapes does not require tedious 'drill and kill' teaching.

NAPLAN 2012 Question 19 Calculator active (ACARA, 2012)

Jason drew a shape that had six sides and exactly three lines of symmetry. Which of these could be Jason's shape?

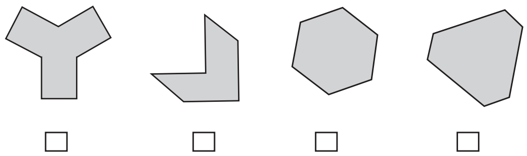


Table 4: Correct responses to NAPLAN 2012 Question 19, Calculator pre- and post-test.

	Pre-test	Post-test
	n = 44	n = 45
Total	16 (36%)	32 (71%)

There was improvement in this question from 36% to 71%. To support the learning of concepts connected with questions like this one, students were given a *GeoGebra* (2016) task where they had to draw lines with specified lines of symmetry. This was an open-ended approach. The most common incorrect response was where the students chose the shape with three lines of symmetry but with nine sides. Perhaps the hitch was with reading the question correctly rather than with the concept of lines of symmetry. We might expect that practice of reading of problems throughout the topic improved the students' ability to determine the important parts when reading a test question.

Challenging problems with decimals

I commenced the decimals topic with the following problem:

> I have $1 worth of coins in my pocket. I know that this can only be made up of 50 cent, 20 cent, 10 cent and 5 cent pieces. How many different ways could I make $1?

We then had a short class discussion about what any combination might be. For example, 2 × 50 cents or 3 × 10 cents, 1 × 20 cents and 1 × 50 cents. The real task for the weaker students was finding combinations that would give them $1, and for the more capable students, the challenge was to set up a methodical way of approaching the problem in order to get all of the combinations. Discussions emerged as students compared work to see which combinations they had got and which they had missed out on by comparing them. The level of decimals skills required for this was quite low. Recognising the importance of being able to use decimals correctly when dealing with money was valuable and no one was asking "when are we going to use this?", as so often is the question in middle school mathematics classrooms.

The first exercise in textbooks for Year 7 decimals is usually along the lines of "What is the place value of the 6 in the number 4.65". As an alternative to this, the students were posed the task of "Write a number that has a 6 in the tenths place". There are a number of responses they can have to this. The first response was 5.6, then students proceeded to give answers that just changed the whole number part at the start, until someone realised they could also give an answer with two decimal places, then three, then students were giving responses with an excessive number of decimal places, demonstrating a level of sophistication. By listening to each other students could develop their own correct response. The task developed further by asking "I am thinking of a number with a 7 in the hundredths place and a 6 in the units place. What might the number be?" Again, there are infinitely many answers, which was soon realised by the students. They progressed onto working with a partner and posing their own similar question to each other. This type of task responded to student feedback, where students indicated that they liked to work with a friend or group.

To further consolidate place value, students were asked to write down 10 numbers between 3.01 and 3.1 and we shared this with the class. Communication verbally, rather than in writing was enjoyed by the students and was a response to the opinions given in an earlier survey where students indicated that they did not enjoy the amount of written work in mathematics.

When teaching rounding of decimals, the usual process is to give the students a long list of numbers and get them to write them to specified number of decimal places. As an alternative to the textbook, I asked the class, "A number when rounded gives 5.8. What might the number be?". Again, there are infinitely many correct answers and as the discussion progressed, a wide variety of suitable responses were given.

As an alternative approach to teaching addition and subtraction of decimals, I set this type of problem:

> I did an addition of decimals question correctly, but my printer ran out of ink. I remember it looked like:
>
> 1 3 . 2 _
> 1 _ . _ 2
> 2 _ . 3 _
>
> What might the missing numbers be?

There are a variety of correct responses to this. Students ended up completing a number of calculations in the process of finding a correct response.

2. Decimals results

NAPLAN 2012 Question 6 Calculator (ACARA, 2012).

Casey had tests to check her vitamin and calcium levels. The table shows her test results.

Test	Normal range	Casey's result
Vitamin A	30 to 65	33
Vitamin C	0.4 to 1.5	0.6
Calcium	8.2 to 10.6	8.3

For which tests were Casey's results within the normal range?

- ☐ **Vitamin A,vitamin C and calcium.**
- ☐ **Vitamin A and vitamin C only.**
- ☐ **Vitamin A and calcium only.**
- ☐ **Vitamin C and calcium only.**

Table 6: Correct responses to NAPLAN 2012 Question 6 Calculator pre-and post-test.

	Pre-test	Post-test
	n = 41	n = 41
Total	32 (78%)	36 (88%)

This question tested whether the students had an idea of place value. We targeted place value in the challenging problems as discussed above and the percentage of correct responses increased from 78% to 88%. This improvement could be attributed to teaching through an effective method of developing a strong concept of the value of decimals.

NAPLAN 2012 Question 32 Calculator (ACARA, 2012)

Barney has a bag of $1 and $2 coins. The total mass of the coins is 71.4 grams. Barney knows that:

- **the mass of a $1 coin is 9 grams, and**
- **the mass of a $2 coin is 6.6 grams.**

What is the smallest mass of exactly $3 worth of coins?

grams

What is the total value of the coins in the bag?

$

Table 7: Correct responses to NAPLAN 2012 Question 32 Calculator pre- and post-test first question.

	Pre-test	Post-test
	n = 41	n = 35
Total	25 (61%)	24 (69%)

Table 8: Correct responses to NAPLAN 2012 Question 32 Calculator pre- and post-test second question.

	Pre-test	Post-test
	n = 41	n = 35
Total	25 (61%)	15 (43%)

The first question showed only a small change from 61% responding correctly in the pre-test and 69% in the post-test. However, the second question showed a greater improvement, from 15% in the pre-test to 43% in the post-test. The second question was more complex and required a higher level of thinking. More effort and persistence was needed and it may have been the challenging problems method of teaching that helped develop these skills, leading to improvement.

Mathematics self-efficacy

Whilst the responses to test questions show some promising results, investigation into the mindset around mathematics is also important. Dweck (2006) asked whether students viewed their intellectual ability as a gift or as something that could be developed. She found that students who considered themselves to be 'smart' lost motivation when they experienced setbacks. Students who considered that their high results were due to hard work and effort were more able to deal with challenges. She claims that an evolving difference in mathematical achievement is the difference in coping with setbacks and perplexity.

The students were asked pre- and post-test to respond to the following statements.

- Everyone has a certain amount of intelligence for doing mathematics and they can't really do much to change it.
- I can get smarter at maths by trying hard.
- Learning more than one way to solve a maths problem helps me to understand better.
- Seeing how other students solve a maths problem helps me learn.

Tables 9 through to 12 present the responses given by the students' pre- and post-test.

Table 9: Responses to "Everyone has a certain amount of intelligence for doing mathematics and they can't really do much to change it".

	Strongly disagree	Disagree	Un-decided	Agree	Strongly agree
Pre-test (n = 44)	10 (23%)	16 (23%)	7 (16%)	8 (18%)	3 (7%)
Post-test (n = 43)	9 (21%)	17 (40%)	8 (19%)	8 (19%)	1 (2%)

At the commencement of the challenging tasks approach, 7% of students strongly agreed and 18% agreed that they could not really change their mathematical understanding. After completing the tasks, only 2% strongly agreed with this and 19% agreed. This is only a small difference.

Table 10: Responses to "I can get smarter at maths by trying hard".

	Strongly disagree	Disagree	Un-decided	Agree	Strongly agree
Pre-test (n = 44)	1 (2%)	1 (2%)	4 (9%)	19 (43%)	19 (43%)
Post-test (n = 43)	0 (0%)	0 (0%)	4 (9%)	12 (28%)	27 (63%)

Even at the start of the program, most students believed that they would experience more success by working hard. This is something that is a constant theme in our class. They are repeatedly reminded that the result of hard work is improved understanding. Initially, 43% strongly agreed that they could get smarter at mathematics by trying hard and 43% agreed. After the program, 28% agreed and 63% strongly agreed. This illustrates that the challenging tasks approach contributed to the students seeing that if they persisted with tasks then they could get higher results.

Table 11: Responses to "Learning more than one way to solve a mathematics problem helps me to understand better".

	Strongly disagree	Disagree	Un-decided	Agree	Strongly agree
Pre-test (n = 44)	0 (0%)	5 (11%)	12 (27%)	16 (26%)	11 (25%)
Post-test (n = 43)	0 (0%)	1 (2%)	8 (19%)	19 (44%)	15 (35%)

In completing the challenging tasks, students were able to try different approaches. Traditionally, the teacher would give instructions to the class as a whole, showing only one method. With the challenging task approach they were able to see more than one method or try more than one approach themselves. The data collected showed that prior to the approach 11% disagreed with the statement "Learning more than one way to solve a maths problem helps me to understand better", and afterwards only 2% disagreed with this statement. To further support the use of challenging tasks and trying different methods of solving them, 36% agreed and 25% strongly agreed with the statement prior to the unit and this increased to 44% agreeing and 35% strongly agreeing at the completion of the unit.

Table 12: Responses to "Seeing how other students solve a maths problem helps me learn".

	Strongly disagree	Disagree	Un-decided	Agree	Strongly agree
Pre-test (n = 44)	4 (9%)	2 (4%)	13 (30%)	15 (34%)	10 (23%)
Post-test (n = 43)	3 (7%)	3 (7%)	7 (16%)	20 (47%)	10 (23%)

The students enjoyed sharing their work, listened to each other and were keen to be selected to demonstrate the way they approached the problems. The data collected shows that prior to the unit 34% agreed and 23% strongly agreed that seeing other students methods helped them. After the unit, when they had experienced seeing other students thinking processes, 47% agreed and 23% strongly agreed that this was a helpful way of learning maths. Part of the teaching of challenging tasks involved the students sharing their methods for solving the tasks. This is not a usual practice when teaching in a traditional manner. It is interesting that 30% were undecided in the pre-test and 16% undecided in the post-test, a drop of 14%. Once they had experienced seeing other students solve maths problems, it could be proposed that the 'undecided' group moved into the 'agree' group.

Limitations and improvements

Before discussing the implications of this work, the limitations must be acknowledged. It would be expected that teaching the units of polygons, solids and transformations and decimals in any way would result in an improvement on test questions. Whether the challenging problems approach has been more effective than the traditional approach was not measured.

I made the students aware that I was trying a new teaching approach and that I was analysing their results on the pre-test and post-test. They were quite pleased that this was happening and it could be argued that they worked harder as a response to being monitored. Their positive responses to the questions around 'trying harder' and 'understanding better', could be a reflection on knowing they were part of a study.

I did not focus enough on the explanation of solutions. When continuing teaching through challenging tasks, I will ensure the students give a written explanation that formalises their thoughts and what they have learnt through their conversations. This gives more depth into exactly what the students were thinking, rather than trying to guess how they got to their answers.

Summary and conclusion

Students were surveyed prior to teaching the unit and some of the responses were that they wanted to work with friends, do less 'chalk and talk' and not 'forget' information. Teaching through challenging tasks responds to these requests.

The tasks were initially introduced informally, and then became more formal with the *GeoGebr*a (2016) graphing program used on their laptops for one of the tasks. Discussions in groups and with the entire class were conducted. It was observed that the students became a bit surprised when problems that were as short as a few sentences took quite a bit of thinking to solve. They were used to having a long list of repetitive problems with only one correct answer. The challenging tasks often had a number of correct answers. The general response to the tasks was positive, with students believing the questions were at the right level of difficulty. They liked that there were some easy questions, they could draw and not write and that there was more than one way to find the answer. What they didn't like was that they recieved some 'failed' answers and that the 'last one was hard'. Even the negatives are what a teacher would consider a positive. None of the students found the tasks boring or tedious.

To see how their understanding of mathematics changed the students did a number of NAPLAN questions prior to the topic and again after we had completed the unit. Student results improved for all questions, with the most improvement being in the questions that involved a deeper level of thinking and perhaps some trial and error.

Before and after the study, students were surveyed about whether they believed they had fixed mathematical ability or if they could improve their understanding by working hard. After the challenging tasks approach, there was a small shift towards students believing that they could change their mathematical intelligence. There was a slightly larger positive shift in believing that if they try hard they can get smarter at mathematics.

By teaching through challenging tasks and sharing responses, they had the opportunity to see that there was more than one way to solve a mathematics problem. On the post-survey, students indicated that this was a good way of learning and that seeing other students solve problems helped them learn. Prior to the unit, they had generally not seen more than one way to solve a problem nor had they seen how other students solved problems, but after the unit they agreed that this was a good way of understanding better. Particularly interesting was that 30% of students were 'undecided' prior to the unit but only 16% after they had the opportunity to experience it.

The aim of this study was to observe what happens when challenging tasks are incorporated into a middle school, mixed ability mathematics classroom. It was observed that students experienced a more vibrant learning environment with mathematics that was both accessible and challenging. They had discussions, trialled lots of solutions and found multiple methods of solving the problems. They realised that sometimes there is more than one acceptable answer, they became more confident in sharing responses and were able to 'think outside the box' more readily. There was an improvement in the percentage of students that were able to respond correctly to NAPLAN test questions. Surveys indicated that they had more self belief in their ability and that by working hard they could become 'smarter'.

One of the measures of success is how the study impacts future teaching. Rather than getting students to do 'drill and kill' activity sheets that provide reinforcement of processes rather than understanding, we should be giving them a variety of tasks that are open-ended, challenging and engaging. It is my hope that teachers will re-engage and that the students will become enchanted rather than disillusioned by mathematics.

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