Accelerating Learning in Mathematics

RESOURCE 8: CREATING PURPOSEFUL INDEPENDENT ACTIVITIES

Students need time to develop or consolidate their understanding of key concepts or strategies. Independent activities can be used to reinforce the directed learning that takes place during ALiM group time.

This resource describes ways in which ALiM teachers can create or provide purposeful independent activities for the students they are working with.

Independent activities include practising a mathematical skill, working on an interesting problem, using manipulatives to make sense of a concept, playing a game, or doing an online activity.

Why is this important?

Well-designed independent activities allow students to consolidate, deepen, or apply their understanding of key concepts.

Vulnerable learners often believe that if they need to work hard to learn something, it means that they are not smart. However, with some exceptions, the way most people learn something is through repeated exposure or by effort. Practice, repetition, and feedback play an important role in transfering information to long-term memory. For practical reasons, not all of this can or should take place during ALiM sessions. Independent activities can be used to extend the time a student spends practising new skills.

During an ALiM session, a teacher may want to give students activities they can do without teacher input. If some students are working independently on tasks that are both engaging and meaningful, the ALiM teacher is freed up to give targeted support to other students in the group. Observing a student who is working independently can also provide the teacher with important information about what the student understands or can do.

Beliefs underpinning effective teaching of mathematics

- Every student's identity, language, and culture need to be respected and valued.
- Every student has the right to access effective mathematics education.
- Every student can become a successful learner of mathematics.

Ten principles of effective teaching of mathematics

1. An ethic of care
2. Arranging for learning
3. Building on students' thinking
4. Worthwhile mathematical tasks
5. Making connections
6. Assessment for learning
7. Mathematical communication
8. Mathematical language
9. Tools and representations
10. Teacher knowledge.

See *Effective Pedagogy in Mathematics* by G. Anthony and M. Walshaw, Educational Practices Series 19, International Bureau of Education, available at www.ibe.unesco.org

WORK WITH THE STUDENT'S CLASSROOM TEACHER

The work that a student is doing in an ALiM group should support the work that they are doing in class, and vice versa. For this to happen, the ALiM teacher and the classroom teacher need to collaborate to identify opportunities for the student to apply the skills they have been working on and for ways that the ALiM teacher can prepare the student for tasks that are introduced during class.

Research shows that students who are confident in mathematics are far more likely to be given exploratory problems that require deep thinking than students who struggle in mathematics. However, working on complex tasks "is crucial for stimulating their mathematical reasoning and building durable mathematical knowledge" (*Effective Pedagogy in Mathematics/Pāngarau BES*, page 118). It is important to support ALiM students so that they can participate in investigative tasks along with their peers.

An interesting task is usually intrinsically motivating provided that students have enough confidence to begin it and enough skills or knowledge to progress towards a solution. If the ALiM and classroom teachers work together, the ALiM teacher can help a student to develop the knowledge they will need to draw on in class.

Easing the access to more complex problems

Planning is important if ALiM students are not to be endlessly assigned simple, procedural-type mathematical "problems" or worksheets while their fellow students are engaged in interesting and challenging tasks.

By planning up-coming tasks with the teacher, the ALiM teacher can remove crucial barriers to understanding so that the students they are supporting can gain access to and engage with them.

Adaptations might include:

- providing a visual representation of the task
- reducing the language demands of the task
- making explicit the links between new concepts and what is already known
- reducing the size of numbers or the number of steps in the task
- providing materials for the students to use.

If suitable adaptations are planned in advance, the ALiM teacher can reasonably expect that their students will work without having them continually at their side. This is an essential first step in weaning them off dependence, and building their confidence that, like others, they can wrestle with a challenge and find a way through. Remind them that **the person who does the thinking does the learning**.

Opening up tasks

Planning adaptations presupposes a task that is rich enough to warrant exploration at a number of levels. A good problem should capture a student's interest and imagination. It should certainly involve more than simply choosing which mathematical operation to use.

Changing a closed question into an open question can make it both more real and more interesting. Using open questions increases the amount of time a student can spend exploring a problem and encourages flexibility in thinking.

For example:

> *Mere's mum has $10 to give her three kids as pocket money. Charlotte is five, Marcie is seven, and Mere is eight. What are some different ways that Mere's mum could divide the money? Explain which way you think is best and why.*

Wherever possible, choose contexts that interest students. For example, give students a toy catalogue and tell them they have won $120 worth of toys in a competition. Have them decide how they want to spend the money.

ONLINE ACTIVITIES

There are numerous online games and activities that are suitable for independent work. The best are those that provide students with feedback and are responsive to the student's decisions.

Online activities can be used for more than just building mathematical fluency. Some digital activities provide virtual manipulatives that students can use to consolidate their understanding of key concepts. Virtual manipulatives are most effective when they resemble the concrete materials that the student is familiar with.

Even if a student is using an online game or activity independently, the teacher can still be present as an observer. Watching a student make decisions can provide important information about their conceptual understanding.

The following questions can help you to evaluate the usefulness of an online game or activity:

- What is the key purpose of the activity? What skills will students build? What learning will it consolidate?
- Is the degree of challenge appropriate? Can the level be adjusted?
- What sort of feedback does it provide? What happens when a student makes a mistake?
- What support do I need to give students? Are the instructions easy to follow?
- What degree of thinking is required of the student?

ISBN 978 0 7903 4201 6

Digital learning objects (DLOs)

DLOs are interactive multimedia learning activities. Students enjoy their entertaining graphics and carefully structured challenges. The concepts they support are those identified as the most difficult for students to learn and for teachers to teach. See http://www.nzmaths.co.nz/digital-learning-objects

The DLOs are organised by strand and curriculum level.

Links for virtual manipulatives include:

- http://nlvm.usu.edu
- http://illuminations.nctm.org

e-ako

e-ako maths, a resource on the NZ Maths website, has been designed to help students develop their understanding of place value, basic facts, and fractions. Students can log in to their own account and explore the material at their own pace. The basic facts learning objects allow students to keep track of which facts they have memorised.

GAMES

Good games promote great thinking. They can also be fun and motivating. Students are often less concerned about making mistakes when playing a game, and a teacher can gain useful information on students' thinking by observing their actions and decisions.

Group games encourage students to interact, allowing them to observe and learn from the strategies used by their peers. Games can also help ELLs to interact more easily because language comprehension is usually less of a barrier once the rules of a game are clear.

Strategy games require students to apply logic, make predictions, and adapt their decisions in response to new circumstances or information. All of these are important mathematical processes. See Gordon Hamilton's video on the benefits of using board games on the "math pickle" website (www.mathpickle.com/Videos.html).

Refraction (http://games.cs.washington.edu/refraction) is an excellent example of a thinking game that is designed to support and develop students' understandings of fractions.

LOGIC PUZZLES

Logic problems are a useful way for students to engage in independent work. Working methodically through a series of steps to reach a tidy solution can be inherently satisfying, as evidenced by the widespread popularity of Sudoku puzzles. Logic puzzles usually have a single solution, and students can check back through the clues to ascertain whether their answer is correct.

A simple logic puzzle that requires deductive reasoning is "What's My Number?", in which students work out a mystery number by crossing out unsuitable digits in a table:

For example:

It's a three-digit number.

The number is even.

The number is a multiple of 5.

The tens digit is an odd number.

The number is less than 500.

The hundreds digit is two more than the tens digit.

3	1	0
~~0~~	~~0~~	(0)
~~1~~	(1)	~~1~~
~~2~~	~~2~~	~~2~~
(3)	~~3~~	~~3~~
~~4~~	~~4~~	~~4~~
~~5~~	~~5~~	~~5~~
~~6~~	~~6~~	~~6~~
~~7~~	~~7~~	~~7~~
~~8~~	~~8~~	~~8~~
~~9~~	~~9~~	~~9~~

Students could also write their own set of clues for a partner, checking that they are sufficient to identify a single number before handing over their puzzle.

For a range of logic problems and other challenging tasks, see http://mathwire.com

For a list of other sites offering problem-solving challenges, see http://mathwire.com/problemsolving/pslinks.html

For Sudokus specifically designed for students, see http://www.dailysudoku.co.uk/sudoku/kids/

SUPPORT LEARNING AT HOME

Blogs are a useful way to inform parents what their child is learning about and how they can support them at home. See Resource 9 for more information.

Games can be used to help learning continue at home. Consider setting up a family game kit for students to take home, along with the rules of the game. Have students teach a family member how to play.

NZ Maths provides a list of games and activities at www.nzmaths.co.nz/node/1390

Additional games that can be used to support numeracy at home can be found in the Families section of the NZ Maths website (http://nzmaths.co.nz/families?parent_node=).

REFERENCES AND FURTHER READING

Anthony, G. and Walshaw, M. (2007). *Effective Pedagogy in Mathematics/Pāngarau: Best Evidence Synthesis Iteration [BES]*. Wellington: Ministry of Education.

Sullivan, P., Mousley, J., and Zevenbergen, R. (2006). "Developing Guidelines for Teachers Helping Students Experiencing Difficulty in Learning Mathematics". Conference paper published by MERGA: www.merga.net.au/documents/RP572006.pdf

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