Learning & Teaching with the Modules

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1. The Three Stages in the Learning Cycle

In writing the modules with three stages - Exploration - Formalisation - Application - the intention was for students to progress through the materials in this order (although I am sure some teachers will use the materials very successfully in their own way).

Completing the materials section by section gives better continuity. All done together, the Activities create that sense of involvement, interest and purpose in the mathematics before the formalisation. On their own, each one may not be enough to motivate and connect students prior to them "getting into the heavier maths".

This method is also better for class management. It allows students to work at their own pace within each stage. If you set the first six periods in a topic for Activities then all students are going to be able to get a reasonable amount done and start making their own connections to the subject matter. The other way, if you want them to do an activity then move on, you will need them all to do it at the same speed and be ready to move together much more often. Hence, it will be much less driven by the students. It will also create a class that is much more "controlled and owned" by the teacher. With the three stage teaching you only need to bring them together at two points - only "manage them" twice - that leaves more time to be out among them involved in the learning.

On another point, it will be difficult for people to find; an activity - an exercise - an application, that are directly related. The modules focus on extended learning of a few major outcomes rather than teaching a series of objectives one by one.

2. Constructivism

The Integrated Maths Modules are designed to support a learning environment that is Constructivist, Student Centred and Cooperative. In the presentation I have given and which is available from the website, "Focussing on Learning in the Classroom", I have discussed a classroom that is based on these three principles. A classroom that is more in line with current Curriculum Framework requirements and that better reflects what has been discovered in recent years about how we learn.

The principle that learning should be Constructivist in its nature is certainly not new. In both Australia's "National Statement on Mathematics for Australian Schools (1990)" and a similar NCTM (US) document of the early 1990's maths teachers were encouraged to make their classrooms constructivist in nature.

Maths Forum defines constructivism in the following way:

> *"Students need to construct their own understanding of each mathematical concept, so that the primary role of teaching is not to lecture, explain, or otherwise attempt to "transfer" mathematical knowledge, but to create situations for students that will foster their making the necessary mental constructions."*

If this is the case then the classroom teacher's role is to set up an environment where students can explore mathematical concepts, be challenged in their understandings, and hence construct meaning for the concepts that they need to learn. This environment requires resources that do more than just demonstrate algorithms and provide for their practice. This is one of the underlying reasons for the Exploration and Application stages of the modules.

3. Student (Learner) Centred Learning

The Integrated Maths Modules support a student centred classroom - what does this mean and how does it work?

In many areas student centred is referred to as learner centred in that the focus is on developing in each student, a sense of responsibility for their learning. By empowering students with the skills and enthusiasm to learn for themselves as they mature the learning that can take place in a classroom is accelerated. A well planned student centred learning environment will have the student group surging ahead and the teacher facilitator moving along with them. A teacher centred classroom however, usually involves quite a bit of "pushing" from the teacher to keep the learning process moving.

By providing students with learning experiences that they tackle with a degree of independence and with a less stringent timeline, each student's needs and abilities are better met. In a classroom where the teacher directs the learning a significant proportion of students are not going to match the pace of the learning or fit in with the style of instruction.

To achieve this style of learning each module is written as a collection of learning experiences for students to engage in over a period of about two to four weeks. Students will vary in how much of the work they cover, but as each module aims to expose students continuously to a set of key outcomes all will move their level of understanding on from its previous point. The teacher's role in this classroom will be to encourage, stimulate and support the learning. In a practical role, the teacher will manage progress of the class so that they move through the learning cycle as a group.

4. Cooperative Learning

The Integrated Maths Modules provide the opportunity for students to work cooperatively - what does this mean and how does it work?

Because of the student centred nature of the modules the learning environment is suited to grouping students in threes or fours and allowing them to work cooperatively or independently as the need arises. This provides the opportunity for discussion and peer mentoring to take place between students which improves understanding and the development of appropriate language. In a teacher centred classroom it can be difficult to allow students to work together and move freely between independent and cooperative work, as this can interrupt the teacher's control of the lesson.

The five key elements of effective cooperative learning and how we can facilitate these are:

- Positive interdependence - make the common goal that of all group members learning as much as possible from their time together - reinforce the benefits of this happening and demonstrate how they can make it work for them.
- Individual accountability - all members must complete all tasks and develop their own understandings - ensure that students check their understandings with other group members as they proceed.
- Face to face interaction - by sitting students in groups you are providing them the opportunity to work with other students in learning.
- Social skills - although it is natural for humans to learn in a social environment the skills required to do this effectively must be taught. Take on this responsibility, hopefully with the rest of the school, to teach students how to work in groups - taking turns, encouraging, checking understanding etc.
- Processing – ensue you and your students reflect on the progress and achievement of the group as a whole - reward groups functioning well and demonstrate the value of working together.

In learning mathematics there are not too many opportunities for collaboration with students taking on roles such as recorder etc. (Chance & Data dos provide the best of these). Other aspects of Cooperative Learning are also not totally suited to our learning environment and content. However, it is important for us to take from what is known about Cooperative Learning, the parts that suit our teaching and learning. It is this adaptation of aspects of modern learning theory to our mathematics classroom, by mathematics teachers, that will ensure the learning environment we create maximises student learning.

Some hints about setting up groups from what I have experienced and read are:

- Set up groups of three or four for maximum benefit
- Choose group members yourself to optimise the learning
- Reform your groups about every five weeks based on what you have seen
- Teach students the "group skills" necessary for this to succeed

5. Assessment

The Integrated Maths Modules are designed to develop understanding of the processes of mathematics and the ability for students to connect and apply their learning to the solution of non routine problems. Because of this, the principal assesment tool for the modules is the Sample Application found in each teachers' module.

This sample application, like those found within the student modules, gives students an opportunity to demonstrate that they can selectively apply concepts and understandings they have learnt during the module to a new situation**.** Sample Applications are not a summative assessment - they should be seen as a "sampling" of a students understanding and any determination of a student's level of achievement must include further opportunities for them to demonstrate outcomes.

A practical and appropriate assessment method to add to the Sample Application is observation by teachers during ongoing class lessons. As we become more familiar with the outcomes we want to observe from students, it is possible for teachers who are working with students facilitating their learning to make judgments based on what they hear, what they are asked and what they see during lessons.

Another assessment tool is the collection of student work. Modules often contain Applications which, despite the lack of test conditions during lessons, result in each child demonstrating their individual achievement. An example that comes to mind is Application B of the Mapping module, C03. I have collected this scale drawing exercise from students after observing their work on it during class time and been able to level their achievement based on what they produced without feeling the result was compromised by the fact they completed it in class. This type of course based assignment clearly meets the "Valid" and "Educative" aspects of assessment.

The use of these three assessment tools, along with others you may devise, means that your assessment package is "Comprehensive" and more likely to be "Fair", two further key aspects of assessment. If you can devise other types of tools that suit you and your students all the better.

So what of the "traditional maths test"? An assessment item that monitors students mastery of skills and algorithms should still be part of your programme. It is important for teachers and students to continually check whether progress is being made in this area and it is useful to diagnose areas in which further "Formalisation and Consolidation" may be required. As far as using it to assess students' level of achievement of outcomes, it is difficult and probably not the best type of tool to use. With this type of assessment item, I have found that I had to change the type of questions I used to write to ones that give students more opportunity to demonstrate what they can do, rather than ones which produce a wide range of results from my class suitable for grading.

6. Web Based TLR Pages

The Integrated Maths Modules each has a Teaching & Learning Resource (TLR) page available on the web which contains further resources to support the learning programme.

These TLR pages contain links to:

- pdf files of worksheets used in the modules
- web sites that give background, run applets or contain lessons that support a particular topic
- Excel spreadsheet files that support Activities or Applications from the modules

The TLR pages are freely available to teachers and students and can be used as a reference for any topic you are teaching, with or without the modules.

You can download a booklet in pdf format from our presentations page titled "Online Resources For The Integrated Maths Modules" that you can sit down and work through to learn about these resources in more depth. The presentations page is at this address:
http://www.otrnet.com.au/Presentations/presentations.html

7. Classroom Management

The classroom structure that the modules were developed to support can be a significant change from a traditional maths classroom and teachers often ask how to manage the day to day running of the lessons. My first comment is always to point out to people that the lessons are not meant to be self-paced. Although students will work at differing rates and teachers may allow them to change the sequencing of activities or applications it is important to always maintain a "class atmosphere". This will facilitate the cooperative learning aspects, allow teachers to talk generally to the whole class when consolidating concepts or discussing ideas, and make the general management of learning easier.

I try to always have classes move from Exploration to Formalisation and from Formalisation to Application altogether. This can be achieved by having different expectations of what each child will cover, setting different targets for different children, and by setting work goals regularly for the whole class. Remember that the aim is to provide students with learning experiences that will develop certain key outcomes. Not every child has to complete exactly the same amount of material in the set timeframe. Advice from the teacher to individual students as to how many and which, Activities, Exercises and questions they should complete, can help keep classes “together”.

Where activities or applications involve direct group work these should be programmed for certain days in the learning cycle and all students should complete them at the same time. On careful analysis of the activities and applications teachers may notice that the last of each are usually significantly longer items requiring a greater depth of thought and a longer period of time.

This feature has been designed into the modules to help with the concept of all students changing stages together.

Finally, the issue of feedback on activities and applications. At appropriate times during lessons it is important to stop the class and go over the "solutions" and "key outcomes" of each activity or application. This is best done when all have finished the item although this may not be possible with later items. This phase is important for both teacher and student as the feedback that both get will allow reflection on what was learned and what remains to be fully understood.

8. Homework

Regular practice of skills, algorithms, procedures, tools etc is a necessary part of learning mathematics. Homework is a good place to do this regular practice because it is not too demanding and the increase in the number of exposures students have to skills helps with their retention.

The learning experiences from the modules help to develop concepts and understandings, make connections, and develop mathematical thinking - something homework is not as well suited to. Traditional texts and classroom structures spend considerable amounts of classroom time on just the skills, algorithms, procedures, tools etc. Often homework set is just more of this. If teachers combine the modules rich learning experiences in the classroom, with a programme of regular practice through the Exercises in the Formalisation stage and homework, it will enable students to develop both understandings and skills.

The type of resource required for setting homework is readily available with many books offering series of graded practice questions. Perhaps old texts still held by the school could become homework resource books.

Obviously the best homework for each student would be tailored to their specific needs and support the learning taking place in the classroom.

9. Algebra

The modules were written with a view to be relevant today and in the coming years. In terms of algebra, the requirement for manipulation skills is decreasing every year. With the advent of graphic calculators across our courses already and CAS soon to be "available" as well, the need for students to be able to manipulate variables is becoming less.

What this does is move the emphasis from Algebra as manipulation of variables to Algebra as Functions that model situations. You will find that our modules take students deep into this aspect of algebra, giving them a better understanding of algebra's real purpose. In the process of learning about functions, the manipulative algebra that is actually required can be acquired.

I first became aware of this view of algebra when WA schools took up the "Journey Into Mathematics" series from the Shell Centre in Britain in the 1980's. It is clearly reinforced in the series "Access to Algebra" written here in Australia and used by many schools.
In a crowded school curriculum with a greater need to develop processes and understandings with students, the reduced need for manipulative skills in algebra frees up some learning time. Its reduction, and the move to a functional approach, makes it much easier for students to see, and teachers to demonstrate, the purpose of algebra. This helps student motivation and hence learning.

There is also support in maths education circles for introducing the abstract components of algebra later in their schooling and teaching skills to students as required rather than in a "preparatory" form. These are views the modules have supported.

What we have kept in the modules, within the functional approach, is the solving of equations and the recognition of equivalent algebraic expressions. However, rather than solving equations by manipulation or factorisation a graphical approach is encouraged. As for equivalent expressions the modules would support students seeing that tables of values or graphs were identical rather than being able to expand or simplify. If these more formal methods are important, they should come later, when students understand what they are doing.

Having said all of this I know that there are schools who are adding some manipulative algebra to a modules based course. Personally I don't think it is necessary in the middle years having experienced teaching without it. If you decide to continue with some there is obviously a huge bank of this sort of material in traditional textbooks.

10. Revision

There is evidence to suggest that a lot of Australian maths classes spend too much time on revision lessons. Repeating lessons on earlier work in a similar format to the way they were presented in the first instance probably not only reduces student interest but also is very inefficient as a tool for learning.

While recognising the importance of building on prior knowledge, what we have tried to do with the modules is revisit outcomes throughout the modules so that early learning can be reinforced and extended. This is done in new contexts and situations and is a more efficient use of learning time and one that is more motivating for students. Hence, I see little purpose in students re-accessing old modules with previously used learning experiences. If they haven't developed to the level required on an outcome, provide some new learning experiences on that outcome rather than revisiting earlier ones.

This issue is blurred a bit when we consider the learning of skills or techniques rather than understandings or processes. In that case consistent practice is important and I have discussed that in part 8 under the heading of Homework.

11. Resourcing

I am often asked by schools interested in implementing the modules what the cost will be and how they can finance the purchases.

As for the cost of the modules there is no simple answer. The individual prices of each module are listed at this web page and on our order form:
http://www.otrnet.com.au/IntegratedMathsModules/immorderinginfo.html

The plan for the modules when the printing was set up was to keep costs per year to about $40, similar to what text books were. This is still the pricing structure but the cost of use will vary depending on your choices. A top class could complete up to 13 modules per year at up to $45. A middle class may only complete 10 modules at around $35. The modules are designed in the flexible format they are to allow teachers and schools to design their programme around the modules each group needs, so based on this, costs will vary.

As to financing the modules this is not an issue we can be involved in but I can suggest some of the methods used by schools who have purchased modules.

- Booklist schools can booklist the modules through their usual book supplier so that students get the set needed for the year.
- Schools can set a fee to be paid by students for purchasing the modules. They can then purchase the modules from a bookseller or direct from us, all at once or as needed, and distribute them to students as required.
- Schools can use a fee system but to keep this fee low they can retain ownership of the modules and loan them to students as required. By not allowing students to "consume" the modules they can be reused. I am aware of a school that has already had 7 or 8 uses of purchased sets.
- Schools can use surplus funds or seek special funding to purchase sets of modules for loan to students to cover certain topics. A significant number of schools use only a subset of the modules to support the courses they have designed.

On the issue of loaning school sets to students, experience has shown that the modules are very cost effective. As they are retained for only a few weeks by students they tend to not get lost. As they are thin schools can punch copies and get students to keep them in files. This also reduces losses and protects the module from damage to increase the number of re-uses.