Introduction

Patrick Griffin

CASE STUDY: DIFFERENTIATED AND DEVELOPMENTAL TEACHING IN MATHEMATICS AT SEA LAKE HIGH SCHOOL

This historical case study, first documented in 1970, describes an early practical application of some of the key ideas of this book. It shows what dramatic results can be obtained by the practical use of assessment for teaching. A more recent case study is provided in Chapter 12 to illustrate the application of the approach as it is now practised.

Teachers often avoid ability-based grouping because of both the classroom organisation required and the belief that there is a stigma attached to lower-ability group formation. This case study illustrates an approach used by Patrick Griffin, the lead author of this book. It is a description of the method of teaching mathematics put into practice by him as a new teacher at Sea Lake High School in Victoria. Using this method, the mathematics teachers of the school succeeded in overcoming problems of student apathy and poor performance.

THE PROGRAM

The teaching program was developed over four years of secondary mathematics and focused on three levels of competence. Failure in mathematics was eradicated. A primary goal was to target instruction at a level where students would be challenged but could experience success. The three levels were:

1. fundamentals
2. practice involving use of these fundamentals and some theoretical work
3. advanced work involving some research for better students.

The students advanced at their own rate, depending on sub-test results for each section of the work. Testing was carried out at three levels targeted at the student ability level.

Initially, the students were apathetic towards the discipline, and their abilities varied enormously; there were no Year 12 mathematics students in the school, and only correspondence classes at Year 11. The teaching team decided to set down overall aims for mathematics in this school.

AIMS OF THE PROGRAM

The teaching method grew from the following aims:

1. To offer a common course for all, but to cater for different levels of ability within it, regarding no level as closed to higher studies.
2. To enable the students to be independent, so that they might be able to read and learn from a text and not rely solely on 'spoon-feeding'.
3. To form an attitude that mathematics is an enjoyable subject and is meaningful, and by doing so to stimulate interest in the subject.
4. To give all students experience of success in the subject, as a lack of success traditionally accounts for many chronic failures.
5. To enable the low achievers to work more slowly and to grasp the necessary skills, rather than be relegated to a remedial class where time does not permit them to learn with their peers.
6. To enable the high achievers to:
   a. study each topic in depth
   b. advance to a higher level than their year indicates (the goal: to have the higher achievers studying Year 11 mathematics by the time they finished Year 10).

LESSON STRUCTURE

In each class, each student had a textbook and an assignment slip or worksheet for a particular chapter. The assignment sheets were printed on coloured paper: pink, yellow and blue. The pink assignment sheet directed the lower-ability students to learn the fundamentals of each section of their text. The yellow sheets directed the middle-ability students to learn fundamentals and perform standard application tasks included in the text. The blue sheets directed the high-achieving students to:

- learn the fundamentals of numeracy
- perform standard applications
- study each topic in depth and carry out research assignments relevant to the topic.

The assignment sheets contained:

- exercises to be done
- aids to use
- references from the library
- difficult sections of work and programmed instructions for these sections
- pronunciations of words
- directions for each student, depending on the level at which they were working.

The students were required to find the solutions to their own difficulties in the following manner:

- Read the relevant instruction in the textbook and, if this is not understood, read again and again.
- If this is unsuccessful, discuss quietly with neighbouring students, or other students who are more advanced in their work.
- If both the above strategies are unsuccessful, resort to the teacher, who can then determine why the student is having difficulty with the particular section, and take appropriate action.

As can be inferred from the above, the classes employing these methods could be rather noisy and, for effective work to be done, the cooperation of all students was required. Students were free to wander around the class discussing their work with others, and at times small-group instruction was carried out by the teacher if more than one student was unable to make progress on the same section of the work. As students advanced at their own rate, the teacher often needed to help individual students or small groups at different levels, with a possibility of up to six or seven different topics being taught within one 50-minute period. Some work was initiated by the students, who were given the opportunity to pursue their own ideas.

The facilitating role of the teacher in this class structure was to:

- guide each student at their own rate of learning (the essential thing was the learning of the pupil, not the teaching of the teacher)
- become a guide showing the student what to do, rather than solving the problem for the student
- ensure that all students were working at their best rate (which may not be their fastest rate, or their own chosen rate)
- ensure that cooperation between students existed at all times, so that the maximum could be achieved by all students
- give individual instruction to those students who had tried all means at their disposal and failed to discover solutions for themselves
- discover by testing (which will be explained later) whether a student had progressed to an understanding of sufficient depth (depending on the student's level) to proceed to the next section of the course
- ensure that all materials were provided for the spectrum of work being covered by the class at any one time

- instill enthusiasm and appropriate aspirations in each student, and give each student confidence that mathematics is something that can be learned by everyone.

CORRECTION OF WORK

Because students were left largely to themselves, they were taught the habits of correcting their own work and deciding for themselves whether or not they had understood a particular section of an exercise. No student was allowed to proceed from one exercise to another until each exercise was corrected, so that students could see for themselves whether or not they had understood the materials. If a student chose to continue and take a test when the work was not understood, there had to be an understanding that the unit or exercise would be repeated after the test result was known. It did not take long for all students to realise this. It was part of the process of developing their skills in learning how to learn and taking responsibility for their own learning.

HOMEWORK

Because students were spread over a wide range of ability groupings and worked on different topics, it was not possible to set any particular homework for the entire class. However, this did not mean that none should be done. On the contrary, all students were encouraged to study at home for the following reasons (reinforced in the students' understanding of the process):

- If students fell behind, then they needed to use homework to catch up.
- If students were up to date, then home study was a means of getting ahead and achieving promotion before the year ended.

ORGANISING THE PROGRAM

Students were allocated to one of three instructional groups in each class. These were identified as Levels A, B and C. Allocation to groups was determined by test results in basic mathematics. Students in the lower level (Level A) developed basic numeracy skills in the first two years (Years 7 and 8), then proceeded in their third and fourth years to basic arithmetic and commercial skills. The official curriculum was not followed for these students because the foundation skills had not been developed. It was regarded as inappropriate to try teaching skills to these students that they were not ready to learn. Instead, the emphasis was placed on the four operations within whole numbers, fractions and decimals. It was more important that these students developed foundation numeracy skills.

The middle group, Level B, had to cope with the basics (as for Level A students) as well as undertaking fundamental algebra, geometry, solid geometry and trigonometry from Years 7 to 10. The highest group, Level C, had to cope with the basics and the standard Level B program as well as directed research from references. These students were also expected to cover the work at a faster pace than those working at lower levels, and to move ahead of the rest while also working on higher-order development. Their advanced program followed the official curriculum in preparation for external examinations in

Year 12. While this could be argued to be undesirable, we could not reasonably argue that the program was a success if, at the end of six years, the students were unsuccessful at Year 12. This was the evidence of success expected by the local community.

The middle-ability group (Level B) was divided into two sub-groups. One group followed the formal curriculum and the work of these students differed from the advanced students' work only in its depth and the time taken to cover it. The other sub-group followed a commercial or terminal mathematics course, which was designed to finish at the end of Year 10. These students identified themselves during Year 9. The decision was essentially theirs, though it was made in consultation with their teacher and their parents during the parent–teacher interview. By Year 9, the students were considered capable of deciding whether they should continue to study mathematics at the senior levels of high school or attempt other courses.

The lowest ability group (Level A) was different in nature. The students entered Year 7 at levels ranging from Year 2 upwards, and had to be developed to a basic level before they could begin to cope with a full Year 7 course of mathematics. As a rule, they began at below Year 7 standard and concentrated on developing basic numeracy skills. Their progress was closely linked to their reading ability, so close liaison was maintained between the English and mathematics teaching teams. Level A material contained more explanation and more worked examples, and the students were encouraged to seek as much help from their classmates as they could muster. The work in their text was linked to a programmed unit of work cards in the areas of addition, subtraction, multiplication and division for positive whole numbers, fractions, decimals and percentages. These were obtained from a commercial series (SRA). Added to these were a unit on measurement and some work on number facts.

These topics were given only an introductory treatment in the students' first year, and followed in some depth in their second year. The students were assessed at the end of their second year to determine whether they were capable of coping with work similar to that undertaken by the Level B students in the commercially oriented course. Their mathematics program then became a preparation for a non-mathematics-based program, but it was designed to ensure that on leaving school they had sufficient numeracy skills to cope as citizens.

MOBILITY

No student was permanently placed within any specific level. If students coped adequately with the work for Level A, for example, they were given the opportunity to try Level B, and likewise for the next level. On the other hand, if a student was continually struggling, a lower level could be attempted. In this way, the ability groupings were dynamic and there was considerable mobility in the early stages – especially in Years 7 and 8.

There was no stigma attached to Level A. The students were pleased to be working at a level at which they could cope and experience success. If a Level B student experienced difficulty with the work and was regularly submitting poor work, morale was affected and the work rate decreased further. If the work was reduced in difficulty so that there was success at a lower level, confidence was restored through the

experience of success and the work improved correspondingly. As is now evident, the whole scheme was based on giving the students experience of success and adjusting their work difficulty by allowing mobility between levels. No level was closed to higher-order skills, although it was unlikely that many students working on Level A would achieve higher-order skills in mathematics.

TESTING

Where possible, Level C tests assessed students for application of the skills they learned in a particular area. The emphasis in their tests was on application, analysis and synthesis, as well as on lower-order skills in recall and understanding. The Level B tests emphasised learning of mathematics skills, and the ability to demonstrate skills in problems similar to those in the set textbook. These students were also expected to demonstrate that they could recall words and ideas learned in their work and apply these to authentic contexts. The Level A tests were not rigid mathematical tests. These students were the low achievers, and the tests were designed to find out only what had been learned by them. The problems were objective and simple, and focused on their ability to demonstrate the basic skills listed above.

A test was set for every topic for every student at the relevant level. Consequently, some students in Level C who had worked faster than others could complete over 20 tests, while others in Level A may have covered only seven topics and completed only seven tests for the year.

FEEDBACK

The teacher marked the test as follows.

- 'C' – Continue to the next section. If the teacher was satisfied that the student had understood a section of the work sufficiently to answer correctly the majority of the questions at that level, 'C' was used to indicate that the student was ready to continue to the next section.
- 'R' – Repeat the section. If the teacher was not satisfied that the student had grasped all or some of the more important sections of the work, then the student was required to repeat those sections. At times this decision was reached by discussion between the teacher and student, particularly if the problem was due to a lack of understanding. Initially, the teachers had difficulty in explaining that 'R' did not mean fail. The students had been conditioned to regard every grade as a pass or fail, and some time elapsed before the students would believe that nobody could fail mathematics in their first four years of high school.

Students who successfully completed a year's work before the end of the school year were immediately given the next in the series of texts, along with the appropriate assignment sheets, and allowed to continue. As a consequence, all grade structure – that is, Year 7, Year 8 and so on – was broken down, but teachers had to be wary of the students' enthusiasm for this improved rate of progress, so that the slower students were not embarrassed and the better students were not progressing before comprehending the subject-matter. As soon as one student finished a year's work and started

on the next book, a snowball effect emerged. Everyone wanted to do the same. This made the real meaning of individual work clear to the students, and the amount of work done almost had to be seen to be believed. The prize of early promotion was there for all who wanted to work.

In marking a student's work, no percentages were used but instead a series of letters and dates applied, giving the teacher an idea of the rate and depth at which the student had worked.

PROGRESS AND REPORTS

A student's progress was not assessed by tests alone, but from the following process. Both objective and subjective judgements were used, taking into account the amount of work covered and the ability of the pupil.

Mobility

Mobility between levels was taken into account. A good student on Level B was invariably slowed when upgraded, as there was more work to be done.

Workbook

Workbooks were collected from time to time and records kept on:

- the setting out of the work
- the correction of the work
- homework (frequency or lack of it)
- improvement – changes from A to B to C (the classes steadied after some time and an objective judgement was possible after early fluctuations ceased)
- class cooperation – class behaviour and the amount of help sought and given between members of the class.

At the end of the program's first year of implementation, an attempt was made to evaluate the scheme. The Year 7 students were retested with the same intake test and statistical methods were employed to establish the significance of the results.

FINDINGS

It was found that:

- significant learning had taken place overall
- boys improved more than girls
- low achievers showed a far greater percentage improvement than high achievers.

This last result was gratifying, but the positive effects of the scheme were also clear among the high achievers. It was found that the Level C group had finished Year 11 by the end of four years. After five years, all students who enrolled in Year 12 mathematics (85 per cent of the year cohort) were successful. There was no failure.

Source: Adapted from Griffin (1970).

Postscript to the case study

After more than 45 years I attended a reunion with the students featured in this story. Every one of the 32 (of the original 50 who started this with me) remembered the maths teacher who learned how to teach through them. Some of them became math teachers! Some even continued to differentiate in the classroom. All of them enjoyed the experience of learning mathematics. It was fun and rewarding to see them all again. They demonstrated to me that success in mathematics is about making progress and growth for everyone, not about getting the right answer. None of them felt they were a failure at maths.

But I have since learned about self-regulated learning – see Chapter 7. Had I known about learning to learn through self-regulation, even more could have been achieved. Had I known about Vygotsky, Glaser and Rasch (see Chapter 3), Guttman (see Chapter 9), or Krathwohl to supplement my meagre understanding of Bloom (see Chapters 3, 6 and 7 especially), maybe we could have achieved even more. But then, perhaps I may have needed this book to show me how to put it all together. At the time, it just seemed to be common sense. Now, in retrospect, it is a model of developmental teaching, learning and assessment.

One thing it convinced me was that assessment in the classroom, if focused on learning, helped the teacher, who in many cases was the student. Assessment information could be used to promote learning and to inform teaching.

Many years later all this came together in the Literacy Assessment Project, an initiative commenced in 2004 by the Catholic Education Office Melbourne in partnership with the Assessment Research Centre (ARC) in the Graduate School of Education at the University of Melbourne, for the benefit of Catholic primary school students. This 10-year project formed the basis of the ARC's Assessment and Learning Project, and is briefly discussed in Chapter 1.

Assessment information for teaching

It is common to hear assessment described as being *for* learning, *of* learning or simply *as* learning. Our stance in this book is that assessment is for *teaching*. This view underpins the Assessment and Learning Partnerships Project, which provides much of the evidence for the theory developed in the chapters of this book. This research project is run by the ARC, and is ongoing. It has had demonstrated success in raising levels of student literacy, numeracy and problem-solving, and has been implemented in over 400 schools.

The message of this book is that if assessment information is used appropriately, students will learn, teachers will be able to monitor learning and students will have the chance to engage with relevant learning opportunities. To reach this point, several key conditions must be in place.

Criterion-referenced frameworks

There is no best way to assess learning. Perhaps the most powerful approach is the continuous observation of student activities, and interpretation within a relevant frame of reference. For example, the frame of reference for young children's acquisition of reading comprehension skill would reside in understanding the skill's developmental sequence, and the contribution of phonological awareness and phonics, fluency and vocabulary to skill development. Our view is that the framework must be criterion-referenced (that is, referred to a defined progression of developmental outcomes) so that the growth and development of the student can be monitored through successive levels of increasing competence.

Our approach thus rests on criterion-referenced frameworks that are used to develop profiles of student development. These frameworks describe the increasing stages of competence defined by tasks or behaviours that are increasingly sophisticated. They are achievement-based rather than curriculum-based. They are not standards – they emphasise what a student is ready to learn and not what an external body argues they should be learning. Curriculum standards indicate what should be taught and expected at specific grades; achievement frameworks indicate what has been learned and what the student is ready to learn. There are no year-level expectations in a series of criterion-referenced frameworks. No one is at, on, above or below expectations. Every student is simply at a level of development defined by what learning is developmentally appropriate. This approach enables and requires differentiated and targeted teaching.

Teacher knowledge and pedagogical skills

It is essential that teachers understand the discipline they are teaching. Understanding implies knowledge of both the content area and the developmental progression, or the hierarchical nature of learning, in the area. For example, in the cases of literacy and numeracy, it is necessary that the expert teacher be literate and numerate as well as understand the components of literacy and numeracy, and how they aggregate and combine to generate expertise.

Different subjects and levels of development call for different pedagogical approaches. The teacher needs to be flexible to ensure that teaching method and resource allocation match individual students' learning needs. Therefore, the teacher must have a large repertoire of skills known to be linked to specific learning needs in the targeted subject area. For this reason, specific professional development is often needed to maintain and enhance developing teachers' skills in discipline-specific teaching.

Student learning

An essential component of our approach is that assessment data are not used to identify problems as they would be in a deficit model; instead, we use a

developmental model, in which assessment is used to identify the zone of proximal development (ZPD) (Vygotsky 1986). This is the point at which the student is most ready to learn, and where intervention will have the greatest impact on them.

If the point of intervention for each student is identified, then it is not necessary to fix problems, deficits or misconceptions. Instead, the teacher builds bridges, or scaffolds, to those things the student is ready to learn. The student will learn at this point; however, if there is intervention or help based around the ZPD, then it is possible that the student will learn faster than they would on their own.

Collaborative teams

Our approach depends upon teachers working collaboratively. Collaboration is not synonymous with sharing, acknowledging and supporting; it requires challenge, and confirmation should occur only when supported by evidence of success. Challenge does not have to be offensive – teachers need the language of challenge, based on evidence, not inference. Those who learn to focus on what students do, say, make or write find it easier to challenge ideas and suggested strategies.

Teachers need to observe and encourage each other to use mutually agreed solutions and strategies. This means that teachers work in teams and do not isolate themselves within closed rooms. The fact that the team owns the ideas, strategies, applications and solutions means that all members need to share in interventions and to observe the effects. Procedures that do not work need to be investigated as much as those that do work. This builds experience.

If a teacher is advised, encouraged and supported by team members to take a particular approach and use specific resources, and if team members do not have the opportunity to observe outcomes directly, it is natural and appropriate that they ask what happens when these measures are implemented. This is accountability – but it is accountability without threat, fear of exposure or the heavy hand of a top-down model.

Evidence

One of the most important elements of this approach to assessment is the use of evidence. Evidence is directly observable: it is not evidence if you cannot see it, touch it or hear it. Evidence is what people do, say, make or write. There are no other forms of observable evidence that we can use in the classroom.

Discussion among the team members must focus on this evidence, which in turn drives observation and teaching in the classroom. Teachers teach explicitly at the level of evidence so that they can identify change. Where there is change in what students do, say, make or write, we can infer change in what they understand, know, feel or think. These latent processes cannot be measured directly, nor can they be influenced directly. To achieve these changes, we must work with the observables. Hence we focus on the operation of team members at the level of evidence rather than inference.