

An Attempt to Integrate Mathematics Across Different Curriculum Areas at Lower Secondary Level

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Abstract

This paper describes the use of an innovative Learning Centre for Year 8 secondary students at Koonung Secondary College, a public coeducational secondary school in the eastern suburbs of Melbourne Australia, with about 860 students enrolled in years 7 to 12. In 2005 funding was granted to the school by the government education authority to establish an innovative learning centre for use by Year 8 students. The idea was that the delivery of the educational program would be made in a refurbished purpose-built open-plan centre equipped with state-of-the-art information and communication technology facilities. The learning model would be one of inquiry and investigation, with the three subject areas of English, Studies of Society and Environment, and Mathematics covered together in an integrated manner by two teams of three teachers, each team containing a specialist in each of the three areas.

Beginning of project

The Flexicentre began at Koonung Secondary College at the beginning of the school year in January 2006. The 150 Year 8 students were divided into two groups of approximately 75, each group looked after by one of two teams of three teachers in a special part of their program to occupy a little over one-third of each week's lessons. For the first half of the school year (late January to June) rooms were still under construction; for the last half (July to December) the finished centre was used. It was only in this latter part of the year that full implementation was possible.

What the school documents say

Annual School Report to the School Community 2005

This was presented at the school's Presentation Night, at the end of the school year in December 2005.

Student Engagement and Wellbeing

Professional development of teachers has emphasised approaches to pedagogy which increase student engagement without sacrificing academic rigour. Funding through the innovation and Excellence Cluster and the Leading Schools Fund project has allowed teachers to explore an inquiry-based curriculum at Years 7 and 8. This is in line with the Victorian Essential Learning Standards which emphasises interdisciplinary learning, the building of self awareness in learners, the delivery of a technology-rich curriculum and deep learning. In addition, programs such as LiveLife in Year 9 engender community mindedness and independence.

From the Opening Invitation, October 2006

The Koonung Secondary College Flexible Learning Centre, or Flexicentre, was funded through the Department of Education and Training initiative, the Leading Schools Fund. The project included a \$650,000 refurbishment and extension of existing buildings, provision of a range of learning technologies and extra teaching staff. The aim of the project is to create an environment in which the constraints of the factory model of education no longer stand in the way of innovative practice. Students in the middle years engage in hands-on activities, working in groups and with teams of teachers who are available to advise on a range of disciplines. State of the art technology provides support for a range of research and presentation purposes. The aim is to develop autonomous and

life-long learners who have acquired skills which are transferable to a range of academic and non-academic areas. Emphasis is on group work, research with presentation skills, with a major focus on creative problem solving. Art Costa's Habits of Mind are an integral component of the programs.

In a world of changing expectations, the Flexicentre is about going some way towards meeting the challenge for change for Koonung students. It is utilised at Years 7, 8 and 9 (mostly at Year 8) and provides a facility for students to learn in ways which will help them to become independent thinkers and workers.

What is happening now

If you were to visit the school now and walk into the Flexicentre whilst the Year 8 students are present (on 2007 for 15 teaching periods out of a total of 60 for the two-week cycle the school timetable operates on) you would see about 75 students seated in groups of four around a pair of tables pushed together (some semi-circular, some rectangular). They would have a small pile of books in front of them, brought from their lockers (they don't bring carry bags or backpacks to class) for use in the double period, either Maths, English or Studies of Society and Environment. Three teachers would be present, the specialist for the subject being delivered leading.

There is an electronic whiteboard in one corner of the room, available as a screen to a data projector, all connected to a desktop computer. Users would use either the desktop or their own laptop if required. All teachers in the school are provided with a laptop computer (currently an IBM ThinkPad R52 or similar), leased from the state education authority, for which they pay about AU\$12 per fortnight, deducted from their salary. Students do not have their own laptops; in the Flexicentre there are two trolleys of 18 ACER laptops each for use by them. They are charged (or powered) in the trolleys, removed for use by students at their own tables, wirelessly connected to the school's network and to the Internet.

The teacher might be presenting something to the whole group, or to a smaller group of students, or the students might all be engaged in their own work. The three teachers are all involved, and if it is Maths, for example, the other two would be moving amongst the students providing whatever help and support they are able to. Whilst neither of the two non-Maths teachers feel particularly confident about the Maths content they have enthusiastically embraced the opportunity to learn, share and support students. The students themselves are in the second year of secondary education, aged somewhere between 13 and 14.

What is the content?

There is a fairly prescriptive content for Maths, part of a Year 7–10 sequential program in the school based on the Victorian Essential Learning Standards (VELS) and on a text book Maths Zone 8 (written for VELS) students all purchase from the publisher Heinemann. For the year the topics are: Directed number, Measurement, Geometry, Algebra, Percentages, Equations, Chance and Data. Problem solving is an important ongoing activity. In Studies of Society and Environment (Geography and History) students investigate medieval history over the millennium from 500 to 1500 CE, covering areas such as the Celts, the Vikings, and feudal England. The study focuses on key aspects of daily life of the various social groups as well as the political organisation of society. Special emphasis is placed on the foundations of democracy.

In English, students develop their language and writing skills through activities in speaking and listening, reading and writing. Students are asked to respond to texts and write effectively for a range of purposes and audiences, in a variety of ways.

Habits of Mind

In addition to the standard subject content there has been considerable effort made to incorporate Habits of Mind into students' thinking and practice. These are the practices identified by Art Costa in 1995, in his book *Teaching for Intelligent Behaviour*, and generalised by him as *Intelligent Behaviour*, or intelligent thought transposed into action which he defined as "knowing what to do when you don't know what to do." We've been using the package provided by The Australian National Schools Network, a not-for-profit organisation, helping schools to develop a culture of student, teacher and leadership learning success. They actively promote the ideas and have established a Habits of Mind Hub, representing several hundred schools across Australia. You can find out more about ANSN at www.ansn.edu.au.

What are the 16 habits?

The sixteen habits are: persisting, managing impulsivity, listening to others—with understanding and empathy, thinking flexibly, thinking about our thinking (metacognition), striving for accuracy and precision, questioning and posing problems, applying past knowledge to new situations, thinking and communicating with clarity and precision, gathering data through all senses, creating, imagining and innovating, responding with wonderment and awe, taking responsible risks, finding humour, thinking interdependently, and learning continuously.

What have we achieved

The idea has been to build a Flexicentre in which groups of students would be engaged in self-directed activities of investigation and inquiry, answering questions they had helped formulate, across the three subject disciplines. Maths would be integrated and provide a means to think, discover, describe, organise, analyse and present information and ideas. Students would have at least some understanding and appreciation of its power and utility as both a tool and intellectual activity in its own right.

If you walked into our centre now the chances are that you would indeed see students busy, focused and productive. We have lots of visitors coming through: teachers, parents and students from surrounding primary schools, for example, who come to look at the school in their quest to make an informed choice about the secondary school for the student for Year 7, local politicians, and personnel from the regional educational authority.

Pictures will be shown in presentation.

How do the staff feel about what we have achieved?

At this stage, really only twelve months after full implementation of the initiative, the six staff are somewhat mixed in their views. To the extent that all are delighted to have been a part of it, and are still fully committed, there are grounds for considerable satisfaction. (Only one of the original six from 2006 chose not to continue.) There is still a way to go to reach acceptable levels of self-direction and autonomy. Much of what happens is still teacher-directed and traditional, practice transferred from the conventional single-room classrooms that predominate in the school to the bigger new space. We're not always confident or successful in building more openness and freedom for students. There is apprehension that students will 'waste time; not learn enough.'

A diversion to the broader scene

Our state education system wants to promote more open settings that promote collaboration, cooperation and problem solving skills; they make it clear that funding

support for buildings and resources is more likely to be provided where there is clear evidence of innovation. Some secondary schools in Victoria have made great progress, and funds and buildings have been provided from the Leading Schools Fund.

Mordialloc College

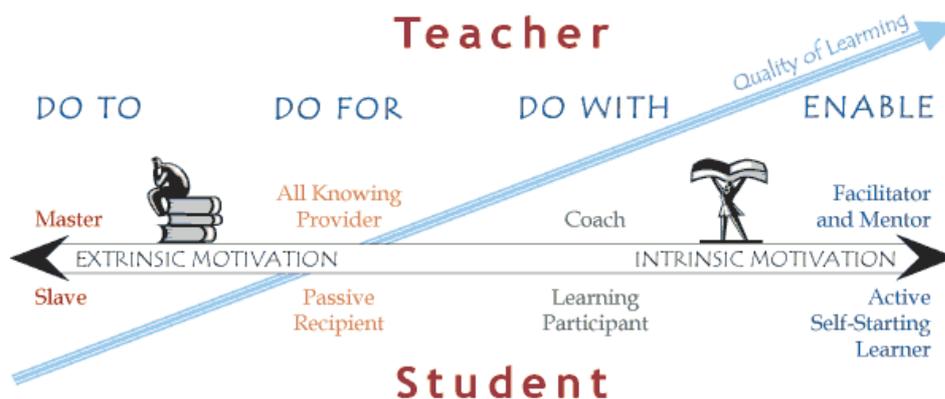
Mordialloc College is another Melbourne coeducational secondary school, situated on the Mornington Peninsula skirting the eastern boundary of Port Phillip Bay. Their 2007 prospectus states: “Mordialloc College continues its innovative approach to student learning with the extension of its Quality e-Learning Centre program to incorporate both Year 7 and Year 8. The Centre provides an area for students and staff to work together in an inter-connected learning space, with a clear emphasis on student-directed learning.” It’s been remarkably successful and runs a visiting program for those from other schools wanting guidelines. Our staff have been, and come away hugely impressed. We saw about 150 Year 7 students in their own centre all busy, positive and focused, in groups of four or more, all able to tell us exactly what they were doing, where it fitted in to the bigger scheme of things, and the tools and processes they were using. In a long teaching career, in a very wide range of settings, I’d not seen anything quite as inspiring. Pictures will be shown in presentation.

How the students describe what’s going on

They told us that what they liked most were the planning tools, something used before they starting every new task. Things like GANTT charts, brainstorming, fishbone diagrams, P3T (past three times) and flowcharts. The teachers too used tools for everything. No assessment was done without a quality rubric, to discover not what marks to award students, but what still had to be done to complete quality work.

Enabling Learning Model of David Langford

More advanced than we are, they’ve acknowledged another source of support that’s been crucial to their success. In 2000, as part of Quality in Schools activities supported by Business Learning Australia, they had come away from visits to their local primary schools astonished at how well students could articulate what they were doing, and determined to do something of their own. After some initial despair they sought help from Quality Learning Australia, who provided help through David Langford, a school development consultant from Canada. He worked with the school for several years, using his Enabling Learning Model.



Reference: Quality Learning Australia, www.qla.com.au/pages/QLS.html, and David Langford, Langford International, Inc, www.langfordlearning.com.

Langford has been a continual source of inspiration in matters to do with engaging the students and giving confidence to teachers to develop materials, procedures and tools that bring people together in a shared sense of learning, achievement and purpose. Those involved credit him with a huge part of their success.

What has this got to do with Koonung

General

It has helped us see clearly what we want to achieve in bringing Maths, SOSE and English together in a big open space, where teachers could build a coherent and workable structure that engaged students a whole lot better than the traditional classroom. As one of those trying to make it happen, I often think about the Italian immigrants to New York in the late nineteenth century, who had been promised a magical place where the streets were paved with gold. They would later often ruefully remark: “Not only was there no gold paving, the streets were not paved at all. And then, if that wasn’t enough, we soon realised we were there to do the paving.”

Mathematics at Koonung

The idea was that many important Maths skills and concepts could be developed in the context of learning in other areas. Geometry, for example, and the ideas of symmetry, to understand some of the elements required in the construction of medieval heraldic shields and coats of armour. Mensuration and measurement principles when considering how arable land would be subdivided amongst feudal serfs and peasants. The use of directed numbers on a number line to help understand historical timelines.

The dozen or so Maths staff at Koonung were none too impressed. A typical remark would go something like this: “Oh yeah, Integrated Studies! It’s all right for SOSE, History and Geography. Works fine, anything goes! But no way for Maths! We’re the ones who miss out.” And our Faculty manager was strongly opposed. She was bypassed by the Principal and Curriculum Manager, in their keen desire to get the project up and running.

Some of us believe in the idea of teachers working together across different disciplines to build more holistic and nurturing school structures. It wasn’t so much a matter of necessarily integrating Maths, which could assume a parallel but independent role, but more a way of making sure a vital thinking tool and unique intellectual discipline was included, in an initiative attracting resources and energy.

It has meant an additional layer of difficulty in delivering Maths to our students.

Following are some comments about what we have been able to achieve.

Maths and ICT

How do we use ICT tools and resources to enhance student learning in Maths. Of what value is a laptop computer?

The Internet

Barry Kissane is from the School of Education at Murdoch University in Western Australia, and a former President of the Australian Association of Maths Teacher. If you go to one of his Web pages at wwwstaff.murdoch.edu.au/~kissane/pd/javamaths.htm you’ll find a delightful example of the summaries he’s compiled to help teachers discover what is available. He proclaims too that if you haven’t seen the Fibonacci resources at the University of Surrey site www.mcs.surrey.ac.uk/Personal/R.Knott/Fibonacci/fib.html, you haven’t lived yet.” There are of course a great many other similar resources. Try something else Australian, from my home state of Victoria, by following the Maths links at www.education.vic.gov.au/schools.

Early days

We've tapped into very few of these so far. Despite the quality of so much that is available, it remains at this stage a professional frontier. Quite apart from the crippling technical difficulties we've experienced with the wireless connectivity of the laptops, sustained effort and building of familiarity over time with the resources available is necessary before they become an integral part of our program.

Our main activities

Animated presentations using PowerPoint or Easiteach

Developing lots of supporting files containing worked and often animated solutions to the text book exercises. Students pay about AUD\$50 for their text and an accompanying student CD with additional worksheets, some simulations (built usually with Excel) and a series of animations (built usually with Flash). It is still unusual for students to find them appealing; we believe that in their current form they can be enhanced with our own efforts, the PowerPoint presentations saved as .pps files, able to be played without the authoring structures evident. Students do make extensive use of them, and they provide one answer to the question: "Why a computer?" They get posted on to our school Intranet site and can be accessed from home.

Using a spreadsheet to show patterns and discover relationships

For use, for example, in establishing the relationship between the diameter and circumference of a circle from a series of empirical values, so that an idea of π emerges, and in discovering the Golden Ratio from the Fibonacci sequence.

Graphmatica

This is a program students use very easily to graph linear (and other) relationships, to experiment and discover things, for example, about the gradient and axis intercepts on the Cartesian plane.

Logo

We use Terrapin Logo to draw and discover properties of polygons. The size of interior and exterior angles, for example, and the fact that the sum of the exterior angles is always 360° (the total turtle trip).

Problem solving

This is a true inquiry realm, and one of course into which Maths comes into its own. We are fortunate to have a very rich source of examples available and build these into lessons usually as warmup activities. The Australian Curriculum Corporation's Working Mathematically document, provides a working structure, in terms of both problem solving strategies and the necessary steps involved in the plan to successfully address a problem in any area. The Australian Mathematics Trust is another quality provider of activities, and is best known for the Australian Mathematics Competition for the Westpac Awards, sponsored by the Westpac Banking Corporation since 1978 and attracting something like half a million entries annually, from Australia and overseas.

Examples will be available.

Some evaluation of our efforts

That the team, with constant encouragement and support from its leader, is still resolute and committed to the goal of student self-direction and inquiry is one measure of the value of the project, and a real pointer to the likelihood of longer term and lasting change. Planning is currently underway for implementation of a new series of integrated activities and accompanying progress markers and guidelines for students in Term 3, starting mid-July. There is to be a renewed emphasis on the idea of quality work, and a commitment to cut down considerably the amount of instruction to the whole group by introducing purpose-built workshop groups. A progress report will be made in the presentation.