

YEAR 9 ENRICHED

Rennae Miszkurka

Lisa Saffin

Caulfield Grammar School

Engaging and motivating Year 9 students to develop deeper mathematical thinking and understanding is not a new goal for teachers. Allowing students at this level the opportunity to become active participants in their learning, developing their own connections through, not only discussion, but also new and varied experiences, enables this type of learning to occur naturally within a classroom setting. Both CAS and non-CAS activities are introduced to enrich the students' mathematical experiences.

Introduction

Being teachers of co-educational, mixed ability Year 9 classes we decided to develop activities which we believed enriched students' learning experiences. The title "Year 9 Enriched" is not to focus on advancing students vertically through the curriculum, but rather introducing activities at appropriate stages that allow students to experience mathematics in new ways. Activities have been structured to open up, encourage and support enquiry through opportunities that allow students to discuss and develop concepts on their own in a variety of ways. Through such an approach, encompassing various modes of learning, students are constantly asked to make their own connections and hence move away from the compartmentalization of Mathematics and thus deepening their understanding.

Students at Caulfield Grammar School are introduced to CAS calculators for the first time in Year 9, and hence a large focus of this year is to not only equip students with the confidence in utilizing the new tool, but also to allow students to discover mathematics, to

lead discussions and learn through the use of CAS. It is through CAS's unexpected output that students are constantly being challenged to discuss and reflect on the mathematics occurring and "allowing students to construct their own knowledge in this way leads to greater interest in the course and, we all hope, greater long-term understanding of the mathematics" Buescher (2007). Through the structured activities, we hold firm to the belief that CAS can become "a partner in the learning process" as students become "active participants in their learning experience" Leinbach (2002).

Students are now being given the opportunity to look at almost all mathematics in different ways and in real world contexts, no longer using the textbook as the only source of questions but as simply another source for learning.

CAS learning activities

Activities in the CAS section are divided into the following different types:

- 1) Pedagogical activities through which learning of a new concept is the desired outcome, focusing on exploration of patterns and discussion to develop rules
- 2) Visually stimulating activities to observe patterns and analyze results
- 3) Application use to explore mathematics, previously only available on a computer, and to make the mathematics studied more relevant to the real world.

Exploration of patterns to develop rules:

The Surds and indices worksheets were structured to provide calculator inputs for the students. This allowed the students to practice using, and gaining confidence with, the calculator by entering these inputs. They then made observations of the outputs, had opportunities to discuss various outputs, and were given further outputs and asked to predict the inputs. These examples began at a simple level, and, using the same patterning structure, were extended to include pronumerals rather than numerical examples. In the case of the indices worksheet, several different inputs were asked for, to produce the same output, to make students aware of different possibilities. In this way it was hoped that an understanding of multiple representations of the same expression could reinforce the patterns and more easily develop not only the rules, but also a deeper understanding of the mathematics underlying these rules.

These worksheets replaced work from the textbook in the appropriate lessons within the topic. They were not "added on" to the already crowded curriculum. It was found it was not necessary to complete the basic index laws exercises or basic surd simplification exercises, but rather move straight into the more complex questions and problems.

Analysis using eActivities

e-Activities were used to ask “what if...” style questions and hence get the students to analyze what effects changes in different formulae had on the results.

In the case of the Measurement e-activity, which was simply an e-activity that calculated several measurement formulae, we asked the students to explore what would happen if one of the variables was changed. For example, what happens to the area of a circle if the radius is doubled? OR What happens to the volume of a rectangular prism if the length is halved? The students were then asked to explain in their own way, with diagrams and algebra, their findings. This particularly allowed weaker students to have an opportunity to construct their own knowledge at their own level.

Similar questions were asked when using the Pythagoras e-activity, although this was mainly targeted at the more able students as the algebra was more difficult.

Dynamic Graphing

Dynamic Graphing on the Casio Classpad is very simple. It was used to investigate the parameters a and b in the linear function $y=ax + b$ and similarly a , b , and k in the quadratic function $y=a(x - h)^2 + k$. This style of graphing is commonly used to investigate functions such as these. However, we used it in a slightly different fashion, where we began with a graph of data in the quadratics unit, and used the dynamic graphing capability to explore the function that would best fit the data. Effects of parameters were able to be shown and discussed as a group allowing students to guide and participate in their own learning.

Applications

The in-built spreadsheet has been used to explore a curriculum unit focusing on the mathematics involved in our student café. Using a self-guided booklet the students were exposed to an area of the calculator they will need to utilize in later years.

Hands On Activities

Although many of these activities are not in any way new, or developed originally, included below are a variety of different types of activities that have worked well within the Year 9 curriculum and are simple to set up and use, and target a different mode of learning.

We began the year with a numberline activity in which each student was given a card (integer or integer equivalent, fraction, decimal, surd) and they were required to think about the number they were given and place it where they believed it would be on a numberline.

This gave the students a great insight into different types of numbers, and the value of these numbers on a numberline. The “human” numberline generated much passionate discussion about the value of numbers as they took real ownership of “their” number. It was particularly evident that they were then able to estimate surd values accurately and have a really good understanding of the spacing between the perfect squares, and the surd values between them.

A Pythagoras rope activity was used to develop an understanding of Pythagorean triads. A rope of length 12 meters was divided by tying a knot at the end of each meter. The students had to make triangles with sides of integer lengths. This served to explore the types of triangles that could be made (isosceles, right-angled, equilateral, scalene) with the rope. We then asked the students to focus on the right-angled triangle and discuss what lengths of sides would be needed if the rope was doubled in length, halved, etc. The students particularly enjoyed the opportunity to get out into some open space and work as a team to make the triangles. Lots of discussion was heard regarding the nature of right-angled triangles such as: Can they be scalene, equilateral or isosceles? Other activities then followed on from this to cut out the triangles and squares to prove Pythagoras’ theorem, but the rope activity was used as a reminder throughout the unit when solving worded problems and isolating the right-angled triangles.

A Mats activity for linear equations worked as a form of Musical Chairs. The concept was again to have a physically active group of students focused on trying to stand on a remaining mat when the question was called out. The mats were a variety of linear functions, with a few non-linear functions. Questions ranged from “stand on the mat that represents a linear equation”, to: stand on the mat with a gradient of -2 ” towards the end when only a couple of students remained. The task was designed to focus the students on the language of linear functions and also on thinking quickly, completing simple transpositions without paper, and experiencing mathematics in a new way. The role of the non-participants was to check that the students did indeed stand on the correct mat. This could easily be utilized in other areas of mathematics at any year level.

An Indices dice game was used in much the same way as a game of Yahtzee. Initially the game was played with the students entering their rolled number on a die into a list of index expressions in order and calculating their result. In the second round, students were given the option of selecting which expressions would be the best option to place the number they rolled on the die, attempting to obtain the highest total and win the game. This encouraged the students to think about which of the index expressions would result

in small numbers (fractions, negatives) and which would result in high values. Students were then asked to analyze the game and consider what the optimum rolls would be for a game and to consider the likelihood of such outcomes, to tie in with their understanding of probability concepts.

3-dimensional trigonometry and measurement can often be “brought to life” by using models in the classroom. But getting the students to make the models using Blu-tac and bamboo skewers, or Geoshapes, gave the students an even more powerful experience to develop an understanding of dimensions, and isolation of right-angled triangles within these shapes.

Play dough 3-dimensional models were also used in measurement to identify the cross-sectional areas to be used to find volumes. Their understanding of the definition of “cross-sectional area” was greatly enhanced by the visualization of the different shapes obtained by cutting the play dough “solids” in different directions with plastic knives! Making the solid from the Play dough also enhanced the students’ understanding of total surface area and allowed them to make a much easier transition to the formulae involved.

Utilizing cut-outs of 2-D shapes and constructing new shapes enabled the students to gain a much better insight into composite shapes. This was particularly evident when they could glue shapes inside other shapes, and cut them out to identify the new areas created, as well as finding the remaining area once a shape was cut out.

Internet

nRich (HREF1)

This site has many wonderful problems, and, more importantly, a great searching tool to easily find curriculum related resources. We used this site largely for our extension students and for the technology active “thinking” activities.

Mathletics (HREF2)

We introduced Mathletics as our homework program this year. It is useful for skills practice, though has its technical and cost limitations.

National Library of Virtual Manipulatives (HREF3)

This site has a number of common problems represented as interactive visuals the students always enjoy using to explore problems such as Tower of Hanoi problem, but also includes Turtle LOGO, Algebra tiles and balances, a function grapher, a function machine, etc.

Wolfram Demonstrations (HREF4)

Provide an extensive list of animations on just about any mathematical topic.

Conclusion

Year 9 Enriched is merely the beginning of a more engaging, accessible curriculum for our students at this level. It is hoped that it will not only be interesting, but will empower the students to be better enquiry-based learners and risk-takers in their mathematics studies in the future.

References

- Buescher, M. (2007). CAS for the “average” student. *Computer Algebra in Mathematics Education Conference, CAME5, Theme2*, 1 – 14.
- Leinbach, C., Pountney, D., Etchells, T. (2002). Appropriate use of a CAS in the teaching and learning of Mathematics, *International Journal of Mathematical Education in Science and Technology*, 1 – 14.

Websites

- HREF1: <http://nrich.maths.org/public/index.php>, Problem-solving activities, University of Cambridge.
- HREF 2: <http://www.mathletics.com.au/>, Graded skills exercises and teacher assessment, 3P Learning
- HREF 3: <http://nlvm.usu.edu/>, Animations of mathematics problems, Utah State University
- HREF 4: <http://demonstrations.wolfram.com/>, Animations to demonstrate a large number of mathematical concepts and principles, Wolfram Demonstrations Project