CELEBRITY *function* HEAD

Putting the fun back into functions

Michaela Inglis & Will Caldwell
The Armidale School, NSW
<minglis@as.edu.au>

As part of the New South Wales Stage 5 Mathematics Syllabus (Years 9–10, ages 14–16), students are expected to identify and draw graphs of functions.

The course is structured hierarchically, and skills specifically move from graphing "linear and simple non-linear relationships from equations" (NSW Board of Studies, 2002 p. 97), to drawing and interpreting "a variety of graphs including parabolas, cubics, exponentials and circles" (p. 103). More able students (Stage 5.3) are expected eventually to cover more complicated polynomial functions, where vertical and horizontal transformations need to be identified, as well as being adept at sketching. Other state syllabus materials would probably have similar requirements.

Traditional ways of teaching curve sketching involve tables-of values, and pen-and-pencil plotting. Such methods can be laborious, particularly as the focus of the learning episode is to develop concepts relating to attributes of the various functions. For example, for $y = ax^n + k$, the effect of altering a, n or k can be quickly identified by the students through immediate plotting of the curve using a graphing program. Families of functions can be plotted quickly, colour-coded where necessary, and zoom capabilities allow for close investigation of roots and intercepts.

For mathematics teachers who are continually looking for ways in which to engage their students in the learning process, the capabilities offered by technology answer the call. Whether the technology comprises computer-based applications or graphics calculators, often boring aspects can be bypassed so that students can work on the "good bits" and build understanding. These tools, when used effectively, have been a great benefit to improving the cognitive development of many mathematical concepts. The advent of calculators in

mathematics classrooms did not negate the need to understand the basics; similarly, graphics programs do not replace the need for simple experiences such as point-plotting and a table-of-values.

While students' skills and understanding of graphing and algebraic manipulation is developing, reflective practice is necessary for them to clarify their ideas. Consolidation of concepts and skills is also achieved when the ideas are applied to alternative examples and new contexts. As an addition to more traditional textbook and worksheet activities, the game of "Celebrity Function Head" was devised as a fun ending to the topic of curve sketching, and primarily as a way to practise and consolidate the key concepts.

The seven functions

The Armidale School is a day and boarding school for boys in the northern tablelands of New South Wales. The co-educational Junior School caters for students from Transition (4 years old) to Year 5 and the Middle School provides a unique pathway for boys in Year 6 to Year 8. The Senior School consists entirely of boys from Year 9 to Year 12 (18 years old), where students have the opportunity to achieve through the School Certificate and Higher School Certificate curriculum.

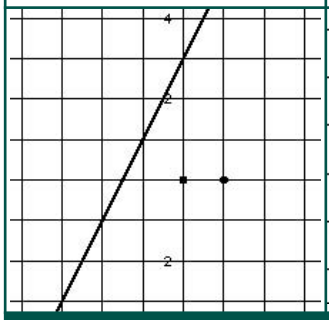
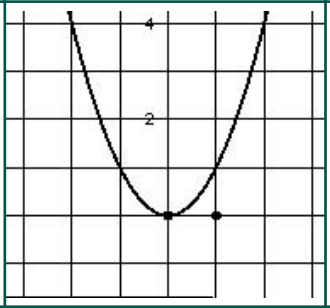
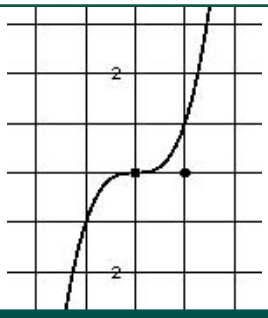
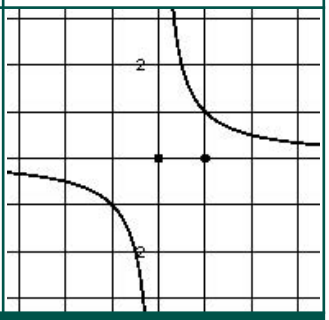
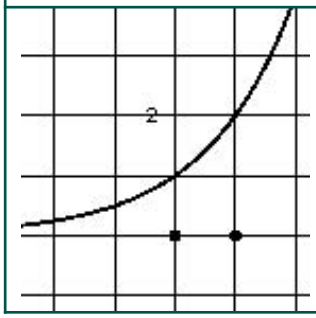
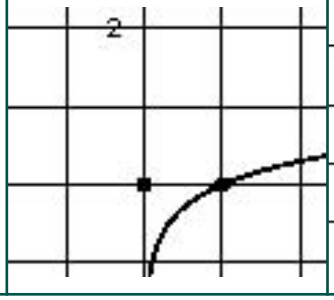
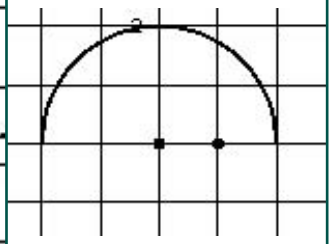
Within the topic of curve sketching for the more able mathematics students in Year 10, The Armidale School covers a sub-section called the "seven functions." In this sub-section, the difference between functions and relations is examined, together with discontinuous functions. With regard to curve sketching, students need to be familiar with the fundamental shape of particular functions, as well as being able to identify numerous characteristics such as odd and even properties, concavity, and the relevant features of different curves (i.e., vertices/turning points, y- and x-intercepts).

The family of the seven functions is loosely defined as: straight line, parabola, cubic, hyperbola, exponential, logarithm and circle. The circle is used initially, but as it is not a function, it is split into two semicircles: one above and one below the x-axis. Other polynomial functions are covered briefly, but as they are rarely treated in the Stage 5 NSW syllabus, they are not included formally in this family. Table 1 provides a summary of the seven functions.

Celebrity Function Head

The purpose of Celebrity Function Head is to identify the equation of a curve by asking questions relating to the features of those curves. A modification to the game may be to also produce a sketch of the function, which fits the syllabus requirements of sketching "a particular curve by determining its features from the equation" (NSW Board of Studies, 2002, p. 107). The following discussion provides the set-up, rules and scoring of the game.

Table 1

1. Straight line	2. Parabola	3. Cubic	4. Hyperbola
$y = mx + b$	$(y-m) = (x-n)^2$	$(y-m) = (x-n)^3$	$(y-m) = \frac{1}{x-n}$
			
5. Exponential	**6. Logarithm**	**7. Semi-circle**	
$(y-m) = a^{(x-n)}$	$(y-m) = \log_a(x-n)$	$(y-m) = \pm\sqrt{r^2-(x-n)^2}$	
			

Set-up

Students are divided into three teams. Each team sends one student to sit at the front of the classroom. The students at the front of the classroom are provided with a note pad and pencil to sketch the function or just keep track of questions asked. Although headbands were used, the game is just as effective writing the functions on the board behind the students.

A function is then chosen and placed on the head of the player. The player at the front of the room may not look at their own function.

Each student at the front of the class takes a turn at asking a question of his/her team regarding the function. If the answer is "Yes," then he/she gets another turn. If the answer is "No," then the turn passes to the next student at the front. To win, a student must be the first person to guess this/her own function correctly.

Once a function has been correctly identified, all labels are removed and the set-up process repeated for a new set of functions.

New players may be chosen from the teams, or the old player (who did not win) may remain.

Rules

1. Teams, and not the player, elect a level of function difficulty. The first member of the team to nominate a level determines that level; this decision cannot then be changed.
2. Students can ask questions to which the answer is either "Yes" or "No".
3. Team members may only provide "Yes" or "No" answers to their player's question.
4. Negative questions are not allowed. For example: "Am I not a parabola?" Such questions potentially allow for a team to have an exhaustive series of turns at the expense of others.

Scoring

Scoring is done by having a winning response (i.e., correctly identifying a function). The functions score points according to the degree of difficulty of that curve. There are six levels of difficulty, determined by which of the seven functions is used and the number of "changes" that are made to the basic function (see Table 2).

The point system was devised by a group of Year 10 students who determined that there were two aspects to the difficulty of identifying the functions in the game. Firstly, they perceived straight lines, parabolas, cubics, and hyperbolas as being easier to identify than exponentials, logarithms and semicircles. Secondly, the number of changes applied to each function also made that function harder to guess. There were four changes: (i) negative, (ii) shift left/right, (iii) shift up/down, and (iv) steeper/flatter.

Any combination of changes can be incorporated to make the function worth more points. For example, the 4-point question illus-

Table 2. Scoring rubric

Level of difficulty	**straight line, parabola, cubic, hyperbola**		**exponential, logarithm, semicircle**	
No change*	1 point	e.g., $y = 2^x$	2 points	e.g., $y = 2^x$
1 change	2 points	e.g., $y = (x - 2)^2$	3 points	e.g., $y = -2^x$
2 changes	3 points	e.g., $(y + 1) = (x - 2)^2$	4 points	e.g., $y = 3 \times 2^{(x+3)}$
3 changes	4 points	e.g., $(y + 1) = -(x - 2)^2$	5 points	e.g., $y = -3 \times 2^{(x+3)}$
4. changes	5 points	e.g., $(y + 1) = 3(x - 2)^2$	6 points	e.g., $(y + 1) = -3 \times 2^{(x+3)}$

* changes are (i) negative, (ii) shift left/right, (iii) shift up/down, (iv) steeper/flatter

trated by $(y + 1) = -(x - 2)^2$ has three changes: it is negative, has a horizontal shift of 2, and a vertical shift of –1. The function $y = -3 \times 2^{(x+3)}$ also shows three changes: it is negative, is steeper by using a multiple of 3, and has a horizontal shift of –3. This function is worth more points as the students perceived an exponential equation as being more difficult than a parabola.

By following the scaffold provided in the table above, teachers can devise their own set of functions for their classes. Students chose their level of difficulty (e.g., 3 points) and a function from this group is then placed on their heads. The list of potential functions is infinite and students can also be encouraged to contribute to this process. However, in addition to gaining points, teams may lose points for breaking any of the rules. The penalty for breaking a rule is three points.

Conclusion

Celebrity Function Head was trialled with a class of Year 11 boys. It was uplifting to see the fun they had in playing the game. Comments made by the boys included:

"Celebrity Function Head was a good game. I recommend a daily dose of celebrity function head. It is good to work and think outside the $x^2 + y^2 = r^2$."

"Fun and interactive. Also challenging."

"It helps make us think very carefully about functions and stuff."

One student asked for more difficult functions and another mentioned that they really began to understand how all the different aspects of a function fit together.

Although this game was devised for the top set of students, the function list could be modified to suit students of lower ability. This modification could be done by either limiting the number of base functions (e.g, straight lines and parabolas), or by reducing the number of changes.

Acknowledgement

Celebrity Function Head is modelled on the television version of Celebrity Head as it appeared on *Hey Hey It's Saturday*.

Reference

Board of Studies NSW [BOSNSW] (2002). *Mathematics 7–10 Syllabus*. Sydney: Author.