The graphical work required in our present examination system consists mostly of plotting points and drawing the curves of graphs corresponding to algebraic equations such as for example,

\[ y = x^2 - 2x - 2, \quad -2 \leq x \leq 5; \]

there is often a request to read values off the graph and sometimes a line has to be drawn and the points of intersection identified. However, the most widespread use of graphs in the outside world is to illustrate the variation of some aspect of a real situation arising in medical studies, physics, or elsewhere.

Three secondary four pupils of school X in the Express stream who had done Graphs and Graphical Solutions six months ago while preparing for the GCE 'O' level mathematics examination were given the following question on interpreting graphs of practical situations.
The hurdles race

The rough sketch graph shown here describes what happens when three athletes A, B and C enter a 400 metres hurdles race.

Imagine that you are the race commentator. Describe what is happening as carefully as you can. You do not need to measure anything accurately.

A
B
C

Examples of students' work

Student A:

C was leading at first but later fell down. A and B overtake him. Now A was leading but near the finishing point B. overtook him and got first. A became second and C keep running and got last.

Student B:

Athlete C take a longer time to finish the distance because he rest in between the distance.

Athlete A increases his speed during the running.

Athlete B decreases his speed during the running.
Student C:

At starting point, athlete A sped off and accelerated faster than the other 2 athletes. Athlete A maintained its speed to the finishing point, thus taking little time to finish the race. Athlete C, stops halfway of the race and later continue to finish the race. Athlete B, is similar to athlete A; maintained its speed to the finishing point but take less time to finish than A.

The Hurdles Race . . . Marking Scheme
(suggested by the Joint Matriculation Board Examinations Council)

Interpreting a mathematical representation using words.

1 mark for 'C takes the lead'

1 mark for 'C stops running'

1 mark for 'B overtakes A'

1 mark for 'B wins'

2 marks for any four of the following:
A and B pass C
C starts running again
C runs at a slower pace
A slows down (or B speeds up)
A finishes 2nd (or C finishes last)

Part mark: 1 mark if any two (or three) of the above points are mentioned
2 marks for a lively commentary which mentions hurdles.

Part mark: 1 mark for a lively commentary which does not mention hurdles, or for a 'report' which mentions hurdles.

A total of 8 marks are available for this question.

Marking The Descriptions

*Student A* has mentioned all of the first four factors and also three of the additional ones. For this he scored 5 marks. Student A's commentary reads more like a report than a commentary, and since he does not mention the hurdles he is not awarded any 'commentary' marks. Therefore, he obtained a total of 5 marks out of the possible 8.

*Student B* has not mentioned any of the first four factors. Only 1 of the additional factors is implied, thus scoring no marks. As the commentary reads like a report not mentioning the hurdles no 'commentary' marks are awarded. Hence student B obtained no or zero marks out of the possible 8.

*Student C* has only mentioned one of the first four factors and implied three of the additional ones, thus scoring 2 marks. Student C has failed to score any 'commentary' marks and therefore obtained a total of 2 marks out of the possible 8.

It appears that the three students who attempted the 'Hurdles Race' question are not proficient in the language of Graphs, although they are able to work typical examination questions on graphs and graphical solutions confidently. Could it be that while we attempt to make our students "numerate" we are content merely with the skills of computation and fail to pay attention to the wider aspects of graphical numeracy which are absent in most school textbooks?

Furthermore, many, if not all, approaches to the teaching of graphs in our schools focus mainly on technical issues – for example, algebraic manipulation, point plotting and reading, filling in entries in tables – at the expense of the meaning which is to be conveyed.
Like any language which is learned for a particular purpose – namely to communicate with other human beings – the same is true of mathematics. The purpose of the representations which mathematicians have invented and used is to facilitate communication between human beings and also to provide an internal language to facilitate thinking.

References
