

TECHNOLOGY ENHANCED LEARNING tel.ac.uk

MiGen a world where algebra makes sense

TEL stories

EVIDENCE from
the TEL research
programme

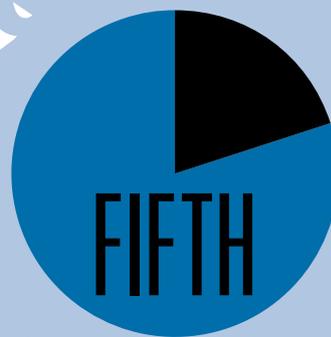




MiGen is not an attempt to replace algebra, but to create a bridge to understanding this powerful means of thinking about the unknown, making generalisations, and testing conjectures.

Professor Richard Noss, principal investigator, MiGen project.

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MiGen... the challenge

Just over a fifth of young people leave school in England without the maths they need to cope with the challenges of contemporary life.¹ Despite many examples of rising standards in education, this proportion has remained unchanged for 30 years. So just when and why does maths stop adding up?

A key sticking point is when 1, 2, 3 turns in x, y, z. Young teenagers are at their mathematically weakest when it comes to algebra.² Trying to teach this beautiful, but complex language to a secondary class is akin to supervising 30 games of chess being played by people who don't understand the rules and don't see the point of playing.

But without an understanding of algebra, students are like pianists who only ever play the scales and never the tune.

Mathematics is the science of patterns. Identifying, analysing, and predicting patterns is the source of the power of mathematics – whether it's a sequence of numbers, the structure of shapes, the change in the climate, the spread of a virus. But finding patterns in a few cases is not enough for mathematicians: the trick is to express the pattern so that it's true for all cases – to generalise it.

In 2007 the MiGen research team was funded jointly by the ESRC and the EPSRC to build a computer system and activities that would encourage 11 to 14-year-olds to develop algebraic habits of mind. Crucially it would help them learn how to recognise and articulate generalisations.

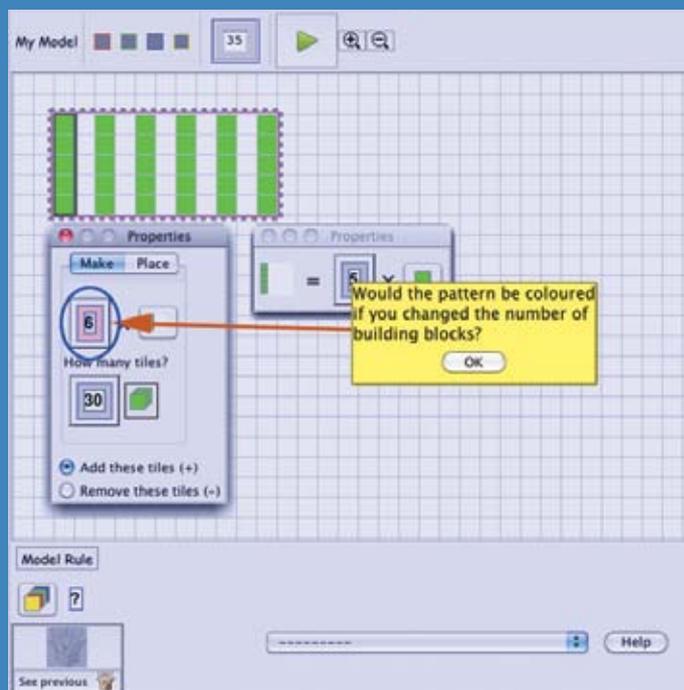
¹The levels of attainment in literacy and numeracy of 13 to 19-year-olds in England, 1948-2009, Rashid, S., and Brooks, G., 2010. ²TIMSS, 2007.

MiGen...

MiGen... the technology

MiGen is an intelligent, computer-based support system. Young people enter a 'microworld' that presents algebra in a colourful, dynamic and visual format. They are nudged to explore the nature of relationships and uncover rules for themselves. And they are empowered to present their answers creatively, using simple sequences of coloured tiles.

In the MiGen microworld, students bump into powerful ideas. They learn to move from the specific to the general – an essential mathematical skill whether you are tiling a bathroom or working out what happened two seconds after the Big Bang.



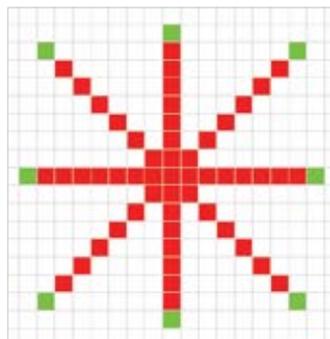
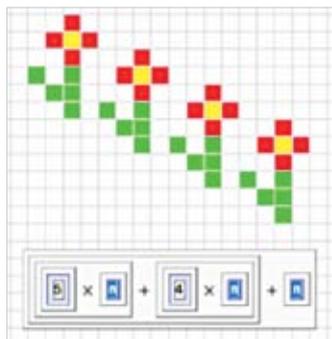
In the MiGen system

The eXpresser microworld: allows students to construct patterns from tiles, express the structure within the patterns and the relationships that underpin them. eXpresser is designed so that students can 'keep an eye on the general' which helps their understanding of what the general case is, why it is important, and how to express it.

The eGeneraliser: offers intelligent, personalised support to students as they use the eXpresser, giving them hints and clues as to what to do next.

The eCollaborator: allows students to reflect, share and discuss their patterns with others, compare approaches and refine their work.

The Teacher Assistance Tools: provide data on students' progress, suggesting ways to help students interact with the eXpresser.



MiGen...

The team gathered data from more than 300 hours of interaction by 11 to 14-year-olds at four secondary schools in England.

MiGen... in action

The MiGen team gathered data from more than 300 hours of interaction by 11 to 14-year-olds at four secondary schools in England. The data showed that MiGen helped them become aware of a pattern, construct it and use it as a basis for building symbolic rules. Students were also able to exploit their experience of building patterns to express structural rules, rather than merely counting or spotting numerical patterns.

After three or four lessons using MiGen, studies showed that students were able to apply their knowledge to conventional generalisation tasks.

MiGen comes with built-in help for teachers. Intelligent systems that focus only on the students can end up marginalising teachers. But MiGen keeps them in the picture by providing a suite of tools to monitor students' progress and to view and compare their

constructions. Two students may, for example, see a pattern in two different ways, both of which are correct. They may both arrive at an algebraic expression for their pattern. But unless they know what the other has done they will not realise that rules that look completely different can in some sense be the same. MiGen can spot the potential benefit of their collaboration and help teachers group them together.

MiGen can give feedback to teachers in sophisticated ways. As well as spotting fruitful collaborations, it can help teachers gauge students' progress, and highlight those in need of assistance.



After three or four lessons using MiGen, studies in five schools showed that students were able to apply their knowledge to conventional generalisation tasks.

MiGen... find out more

More information about MiGen, including its final report, is available at www.tel.ac.uk. The project is part of the Technology Enhanced Learning (TEL) Research programme, based at the London Knowledge Lab. This is...

- a £12m programme funded by the UK ESRC and EPSRC from 2007-2012;
- designing and evaluating systems to advance our understanding of learning and teaching in a technological context;
- supporting eight large interdisciplinary projects;
- working to achieve impact for emerging research results;
- mapping progress on key themes.

