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Using Spreadsheets in the Teaching and Learning of Mathematics: a research bibliography

Keith Jones

Spreadsheets have been around since the early 1980s and, although not designed as an educational tool, have been used in mathematics classrooms since they first became available. Over the years, one important area of research has been exploring how using spreadsheets can assist pupils to learn critical aspects of algebra more effectively. Pupil difficulties in algebra are long-standing, with teaching approaches that tend towards the imposition of the algebraic method, and accompanied by an over-emphasis on the manipulation of symbols, appearing to be only successful for the minority of pupils. One way that seems to help pupils move from a non-algebraic to an algebraic approach is through work with spreadsheets. This is because, in using such a tool, compared to using paper and pencil, pupils appear to be able to learn more readily to express general mathematical relationships using the symbolic language in the spreadsheet environment. This is a key to making progress in algebra.

Another area of research, though less developed than that relating to algebra, is examining how a spreadsheet might provide a useful educational environment in which to teach statistics, primarily because statistical concepts and procedures using a spreadsheet may be more transparent to pupils, allowing them to look inside the "black box" of statistical techniques.

Other teaching advantages of spreadsheets are that pupils are likely to relatively familiar with them as these are used in other lessons in school. Pupils are also likely to have access to spreadsheet software outside of school, including at home.

The publications listed below are in chronological order of publication.

Capponi, N., & Balacheff, N. (1989), Tableur et calcul algebrique [spreadsheet and algebra], *Educational Studies in Mathematics*, **20**, 179-210.
Pioneering study showing that while the use of a spreadsheet requires manipulation of formulas, there is no easy transfer of pupils' algebraic knowledge into the spreadsheet context.

Sutherland, R. and Rojano, T. (1993), A Spreadsheet Approach to Solving Algebra Problems, *Journal of Mathematical Behaviour*, **12**(4), 351-383.
Classic study demonstrating how judicious use of spreadsheets can lead to algebraic understanding.

Ainley, J. (1996), Purposeful Contexts for Formal Notation in a Spreadsheet Environment, *Journal of Mathematical Behavior*, **15**(4), 405-422.
Suggests that teaching that utilises spreadsheets can assist the early stages of children's introduction to the use of variables in formal algebraic notation.

Nash, J.C., and Quon, T.K. (1996), Issues in Teaching Statistical Thinking with Spreadsheets, *Journal of Statistics Education*, **4**(1) – online journal, no page numbers.
Discusses a number of advantages and deficiencies of using spreadsheets in the teaching of statistics, including the difficulty in keeping track of what calculations have actually been carried out in a spreadsheet and issues to do with the range of graphing options available.

Rojano, T. (1996), Developing Algebraic Aspects of Problem Solving within a Spreadsheet Environment. In: N. Bednarz, C. Kieran, & L. Lee (Eds.), *Approaches to Algebra: perspectives for research and teaching* (pp. 137-145). Dordrecht: Kluwer Academic Publishers.
More evidence of how the judicious use of spreadsheets can lead to algebraic understanding.

Abramovich, S. & Nabors, W. (1997), Spreadsheets as Generators of New Meanings in Middle School Algebra, *Computers in the Schools*, **13**, 13-25.
Building on the research of Rojano and Sutherland, shows that 12-13 year old pupils, using a combination of manipulative and numeric approaches to a variety of algebraic word

problems in a spreadsheet environment, can develop new understandings of algebraic relationships.

Dettori, G., Garuti, R. & Lemut, E. (2001), From Arithmetic to Algebraic Thinking by Using a Spreadsheet. In: R. Sutherland, T. Rojano, A. Bell & R. Lins (eds), *Perspectives on School Algebra*. Dordrecht, The Netherlands: Kluwer.
Suggests that while using a spreadsheet may lead pupils to solve problems using "trial and improvement", under the guidance of the teacher they can come to understand what it means to solve an equation, even before being able to handle equations.

Healy, L., Pozzi, S. & Sutherland, R. (2001), Reflecting on the Role of the Computer in Developing Algebraic Understanding. In: R. Sutherland, T. Rojano, A. Bell & R. Lins (eds), *Perspectives on School Algebra*. Dordrecht, The Netherlands: Kluwer.
Prominent researchers reflect on the role of the computer in teaching algebra.

Baker, J. E. & Sugden, S. J. (2003), Spreadsheets in Education: the first 25 Years, *Spreadsheets in Education*, **1**(1), 18-43.
Brief survey the history of the spreadsheet, followed by a survey of the major publications over the past 25 years in the area of educational applications of spreadsheets, including the teaching and learning of mathematics.

Kieran, C. & Yerushalmy, M. (2004), Research on the Role of Technological Environments in Algebra Learning and Teaching. In: K. Stacey & H. Chick (Eds.), *The Future of the Teaching and Learning of Algebra: an ICMI study*. Dordrecht, The Netherlands: Kluwer.
Reviews a range of research, placing work with spreadsheets alongside other computer applications.

Sutherland, R. (to appear), A Dramatic Shift of Attention: from arithmetic to algebraic thinking. In; J. Kaput, D. Carraher, & M. Blanton (Eds.), *Algebra in the Early Grades*. Mahwah, NJ: Lawrence Erlbaum Associates.
Suggests that the "algebra-like" spreadsheet code can be learned relatively effortlessly by pupils without explicit teaching and that, in this way, it can help to establish the all-important link between symbols and general numbers.

MircoMath *Research Bibliographies*

Every year hundreds of teachers engage in classroom-based research for a variety of purposes. As more and more opportunities arise for teachers to get support for engaging with research, *MicroMath* is devoting a section to a series of *research bibliographies* designed to provide details of the most pertinent research on using particular ICT applications in the teaching and learning of mathematics.

Previous bibliographies are:

Using Interactive Whiteboards in the Teaching and Learning of Mathematics: a research bibliography, *MicroMath*, **20**(2), 5-6.

Celebrating 20 Years of Computers in Mathematics Education: a research bibliography, *MicroMath*, **20**(1), 29-30.

Using the Internet in the Teaching and Learning of Mathematics: a research bibliography, *MicroMath*, 2003, **19**(2), 43-44.

Research Bibliography: Four-function Calculators, *MicroMath*, 2003, **19**(1), 33-34.

Research Bibliography: Dynamic Geometry Software, *MicroMath*, **18**(3), 44-45.

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