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Guest Editorial

Learning number and algebra in computer-based environments: Selected papers from ICTMT-7

Keith Jones and Federica Olivero

This issue of IJTME represents the second set of paper originally presented to the 7th International Conference on Technology and Mathematics Teaching (ICTMT-7) which took place in Bristol (England) in July 2005. While, as with earlier events in the series, the conference brought together educators, researchers, and developers all with a common interest in enhancing the teaching and learning mathematics (at any level) through the use of Information and Communications Technology (ICT), there were a number of unique features to ICTMT-7. First, the conference was the result of a pioneering collaboration between the conference organisers and a school in Bristol, John Cabot City Technology College (www.cabot.ac.uk), an ultra-modern state comprehensive school for pupils ages 11 – 19 and superbly equipped with ICT resources that became the wonderful venue for the conference. Secondly, contributors to ICTMT-7 had the opportunity to submit a full version of their contribution for inclusion, following peer review, in special issues of this journal, again a pioneering collaboration between the journal editorial board and the ICTMT-7 organisers.

The papers contained in this special issue explore a number of issues related to the use of software in the teaching and learning of aspects of number and algebra. Throughout the set of papers the authors explore, in particular, how new technological tools permit access to representations of mathematics that might otherwise be out of reach of the learner.

In their paper *Exploring Links across Representations of Numbers with Young Children*, Harries and Suggate report on their experiments with designing and using a computer environment (a suite of programmes) within which various representations of number could be created and manipulated. Their report focuses on one of the programmes within which activities were developed for pupils aged 5 to 8 years. The authors found that not all representations were equally well understood by the children. For example, they found that reading figures accurately could come before a full understanding of place value (though an ability to count in tens and ones was associated with greater understanding of many representations). Overall, the authors found that it is not clear which comes first, the facility to count in tens and ones, or the facility to use many different number representations. Yet, the authors conclude, it does appear that an awareness of the nature of groupings (that is, the structure of number) is the central feature of place value.

Mor, Noss, Hoyles, Kahn and Simpson, in their paper *Designing to See and Share Structure in Number Sequences*, also report on a teaching experiment, this time on iteratively designing and testing a set of computer-based activities and tools in which 10-14 year old students used the *ToonTalk* programming environment to construct models of number sequences and series, and then shared their models and their observations about them utilising a web-based collaboration system. What the authors found was that there evolved a design pattern (or programming method which they called 'Streams') which supported the students in engaging in the process of summing and 'holding the series in their hand'. As a consequence, the author argue, the students were able to make sophisticated arguments regarding the mathematical structures of the sequences without requiring the use of algebraic notation that may have been beyond their means. Their illustrative examples provide an idea of the potential of the computer-based activities and tools for enabling learners to express, and reflect on, deep mathematical ideas.

That reaching a facility with algebra is difficult for many pupils is well-established. In this context, the paper by Nicaud, Bittar, Chaachoua, Inamdar and Maffei, Experiments with *Aplusix* in Four Countries, illustrates the use of a computer-based system (the *Aplusix* system) that has been designed to help students to learn algebra. The system, with its capacity to tell students whether or not their calculations are correct, to provide families of exercises at a chosen level, and to give scores after tests, allows it to be integrated into the regular work of the class. In their paper, the authors describe four experiments conducted in four different countries with different goals: remediation piloted by researchers in Italy; remediation integrated into the regular functioning of classes in Brazil, collaborative learning in India, and learning and use during the entire school year in France. In each case, *Aplusix* was shown to be a usable computer program (in that it is easy for the student to use and is very 'user friendly') that was useful in supporting the students' learning of the algebra curriculum (shown by comparing pre- and post-tests on paper).

Student difficulty with algebra is also the focus on the paper by Issakova, Lepp and Prank, *T-algebra: Adding Input Stage to Rule-Based Interface for Expression Manipulation*. The *T-algebra* project has created an interactive learning environment for manipulating algebraic expressions. As the authors explain, the main didactical principle driving the project has been that all the necessary decisions and calculations at each solution step should be made by the student, and that the computer-based system should be able to understand student mistakes (something not common is other computer-based environments). While the *T-algebra* project is focusing on four areas of school mathematics (calculation of the values of numerical expressions; operations with fractions; solving of linear equations, inequalities and systems of linear equation; operations with polynomials), this paper, in particular, describes the design of an Action-Object-Input dialogue and different input modes as an instrument to communicate three natural attributes of the steps: choice of conversion rule, operands and result. The

findings, though tentative at this stage of the project, suggest that the error messages shown by the program were clear enough for the students to correct the mistakes and that the different input modes of different rules that were tested during the research were all useful.

In the Ideas for Teaching and Learning section, it is fitting to return to the idea of representations of number and, in particular, the number line. In her paper New Tools for Mathematical Learning: Dynamic Number Lines, Clark-Wilson describes the development of a number line tool which could be web-based, free for educational use, and not require the user to have particular software (beyond the freely available Macromedia Flash) installed on their computer.

Overall, this set of papers provides a wealth of evidence about the potential of computer-based systems to support learner access to representations of mathematics. That new learner understandings might emerge (and that new forms of knowledge might be needed) when interacting with technological tools indicates that further research is required in order to gain better insight into the potential of technological tools in the teaching and learning of mathematics. Further examples of such approaches are invited for submission to this journal.

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