Literature Review of the use of Video as a resource for professional development of mathematics teachers

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Contents

Background ................................................................................................................................3
Literature Search .......................................................................................................................... 3
Literature Review ....................................................................................................................... 4
A brief history of video use in teacher education ..................................................................... 6
Content, quality and duration of video resources .................................................................. 6
Potentially positive aspects of using video for mathematics CPD ............................................ 7
Problematical aspects of using video for mathematics CPD ..................................................... 8
Gaps in the research about using video for mathematics CPD ................................................ 9
Mathematics video resources ................................................................................................. 9
Conclusions ............................................................................................................................. 11
References ............................................................................................................................... 13
Appendix One: Academic Journals ....................................................................................... 16
Background

The National Centre for Excellence in the Teaching of Mathematics (NCETM) commissioned, in July 2007, the Research Centre for Learning and Teaching (RCfLaT), based in the School of Education, Communication and Language Sciences at Newcastle University, to conduct a search and review of the literature pertaining to the use of video resources in the Continuing Professional Development (CPD) of mathematics teachers. Additionally, RCfLaT was requested to identify sources and locations of mathematics video CPD resources in order that NCETM could develop a central access point for parties interested in using these resources for their own CPD needs.

Literature Search

Preliminary searches for resources, reports, articles etc were conducted on the Internet and a number of academic databases. The Internet was searched for CPD and mathematics related video limited to the UK only. A number of key sites in England, Northern Ireland, Wales and Scotland were identified. The resources available on these sites have been outlined in the Excel database that accompanies this literature review.

Academic databases, listed in table one below, were searched using the main search terms: Mathematics, Video and CPD and variations on these terms identified in each of the academic databases. Searches were limited to articles etc published in the English language (including British, European, American and Australian publications) between the years 2000–2007. Searches of the Internet and academic databases yielded 261 references potentially relevant to the NCETM research. References have been stored in an Endnote database. Where articles were available for download these have been added to the Endnote database. After reviewing these references, a smaller number were identified as particularly relevant to the NCETM research and consequently form the core of the review.

Table 1: Academic databases used for the literature search

<table>
<thead>
<tr>
<th>Academic databases</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Academic Search Premier</td>
<td>Full text for nearly 4,000 scholarly publications, including more than 3,100 peer-reviewed journals. Coverage spans virtually every area of academic study and offers information dating as far back as 1975.</td>
</tr>
<tr>
<td>Australian education index</td>
<td>Indexes over 200 Australian journals covering educational research and policy from 1976 to the present day, also includes conference proceedings and papers, research and technical reports.</td>
</tr>
<tr>
<td>British education index</td>
<td>Indexes over 300 English language European journals in education. 1976 onwards.</td>
</tr>
<tr>
<td>Educational research abstracts</td>
<td>ERA is a comprehensive database comprising specially selected high-quality abstracts which cover the current international research in education, from seven leading abstracting journals in the field of education. Includes abstracts from over 500 journal titles. Links to full text where available. 1995 onwards.</td>
</tr>
<tr>
<td>ERIC</td>
<td>1 million references to journal articles, books, theses, conference papers, research reports; online thesaurus. 1966 onwards.</td>
</tr>
<tr>
<td>OCLC First Search</td>
<td>Access to ArticleFirst, ATLAReligion, ContentsFirst, ERIC, GeoRefS, GPO, MEDLINE, MLA, PapersFirst, ProceedingsFirst, WorldAlmanac and WorldCat.</td>
</tr>
<tr>
<td>Science Direct</td>
<td>The full texts of over 1000 scientific, technical, medical, mathematical, management and social science journals. 1995 onwards. Provides e-mail 'alerts' to update searches and announce the arrival of latest journal issues.</td>
</tr>
<tr>
<td>Social sciences citation index</td>
<td>Title, keyword and citation searching of 1,400 journals, 1956 onwards. Available within the ISI Web of Science database. Citation searching allows the user to find articles that have cited key papers and authors in their bibliographies.</td>
</tr>
</tbody>
</table>
Literature Review

The importance of long-term and continuing professional development of mathematics teachers has been highlighted over a number of years particularly in the USA e.g. The TIMSS studies 1999 and 2003 (J. Hiebert et al., 2003; NCES, 2003, 2004). Within the UK context reports spanning a number of years e.g. Cockcroft (1982), looking specifically at mathematics, have made repeated recommendations concerning the professional development of mathematics teachers.

With concerns that UK productivity and innovation may be in decline, the UK government commissioned a review into supply of people with science, technology, engineering and mathematical skills in 2001, with a view to improving the UK’s productivity and innovation performance. The findings and recommendations of the review, conducted by Sir Gareth Roberts, were published in April 2002 (Roberts, 2002, p. 189: Annex A). The report made a number of important recommendations about mathematics and science teaching at primary level in the UK:

“The Review recommends that the Government ensure that primary school teachers receive greater subject-specific training (in particular, in relation to the physical sciences and mathematics) both in their initial training and through Continuing Professional Development to enable primary teachers to build on the progress they have made so far. Furthermore, the Government should review, in three years’ time, the progress made in improving primary school teachers’ confidence in teaching all areas of the mathematics and science curricula, and take further action as necessary.”

Following the Roberts review, the Advisory Committee on Mathematics Education (ACME, 2002) recommended the:

“Initiation of a sustained and developmental programme of CPD for all teachers of mathematics, across all phases and at all stages of their careers, to be provided through a National Academy for Teachers of Mathematics and local mathematics centres”.

Professor Adrian Smith’s inquiry into post-14 mathematics education (Smith, 2004, p. 9), recommended that:

“Formal responsibility for and entitlement to fully funded CPD be introduced as soon as possible into the professional terms and conditions of service of teachers of mathematics in schools and colleges in England, Wales and Northern Ireland. The Inquiry further recommends that additional remuneration be linked to successful completion of accredited CPD activities”.

The Primary and Secondary frameworks for literacy and mathematics are also significant influences in this area. The aim of the Primary Framework for literacy and mathematics:

“Is to support and increase all children's access to excellent teaching, leading to exciting and successful learning. The renewed Framework forms a significant development that builds on the learning that has taken place since the original Frameworks for teaching literacy and mathematics were introduced in 1998 and 1999. The renewal marks an important step and brings new impetus and new structures that are a significant development in teaching and learning in literacy and mathematics, rather than a repackaging of guidance that is already in place. Changes in the structure and content of objectives, along with core guidance are
significant, and schools and settings are encouraged to understand the changes and to move towards implementation rather than to rely upon the original Framework. The structure of the electronic version of the Primary Framework for literacy and mathematics aims to provide practitioners with ready access to a broad range of appropriate guidance and resources to support planning and greater personalisation to ensure that the needs of all children are met”. http://www.standards.dfes.gov.uk/primaryframeworks/introduction/

The Secondary National Strategy for school improvement (DiES, 2006),

Is part of the Government’s major reform programme for transforming secondary education to enable children and young people to attend and enjoy school, achieve personal and social development and raise educational standards in line with the Every Child Matters agenda. The aim is to create a dynamic and diverse education system built on high expectations and a commitment to the needs of every child, underpinned by a new teacher professionalism. Within this context the New relationship with schools supports schools in maintaining a focus on their priorities through sharper self-evaluation, simplified data and information systems and a new inspection regime. The Secondary National Strategy has the following overall key strategic aim:

To raise standards of achievement for children and young people in all phases and settings. Specifically this involves:

- Improving the quality of teaching and learning in all schools;
- Improving the effectiveness of the management and leadership of schools
- In order to deliver the best possible outcomes for learners.

Within the context of these aims, the Secondary National Strategy has a number of overarching priorities for 2006–07. These are:

- To maximise the engagement of practitioners;
- To extend opportunities to learn from and with the Strategy through a more blended and personalised approach to continuing professional development (CPD);
- To build greater coherence at a local level by linking the support and challenge offered by School Improvement Partners (SIPs) with that provided by the Strategy.

The 2006–07 programmes have been significantly influenced by the most recent White Paper Higher Standards, Better Schools for All. In particular, there are a number of priority areas relating to improving personalisation:

- Exciting whole-class teaching, which gets the best from every child;
- Extra small-group or one-to-one tuition for those who need it, not as a substitute for excellent whole-class teaching, but as an integral part of the child’s learning;
- Innovative use of ICT, both in the classroom and linking the classroom and home.

The influence of these reports and policy developments has been and will be considerable in terms of the ways that mathematics is taught and will be taught in UK schools. The reports and policies emphasise the importance of high quality mathematics teachers and the creation of a framework for Continuing Professional Development. As part of this developmental process, The National Centre for Excellence in the Teaching of Mathematics (NCETM http://www.ncetm.org.uk/) is a:

“Major initiative funded by the Department for Children, Schools and Families (formerly the DfES) to enhance professional development for mathematics teachers, established in response to the recommendations of the Advisory Committee on Mathematics Education (ACME, 2002)
NCETM’s overarching strategy is to work with the wider mathematics community to:

“Facilitate, enhance and provide strategic direction and leadership for all aspects of continuing professional development in mathematics. http://www.ncetm.org.uk/about

As part of their strategy, NCETM commissioned this review with a specific focus on the potential use of video resources e.g. recordings of mathematics lessons, for mathematics’ teachers continuing professional development.

A brief history of video use in teacher education

Interest in the use of video recordings for the purpose of CPD for teachers has a long history going back to the 1960s. Sharpe et al (2003) provide something of a brief history beginning in the 1960s with Allen and Ryan’s use of video for the purposes of microteaching (1969); Greenburg’s (1971) use of video recordings in conjunction with instructor supervision to improve physical education teachers’ teaching; Koorland et al (1985) use of videotaping and telephone conferences to improve teaching practice. Jaworski (1990) raises a number of key points not only about the use of video in the professional development of teachers but also in regard to producing such videos in the first place. Modern technologies e.g. videoconferencing facilities, offer, according to Admiraal et al. (1999), another opportunity to enhance and improve teaching training and CPD.

The idea of a knowledge base to store the accumulated knowledge of teachers in order that it can act as a resource for new and experienced teachers was proposed by Hiebert et al (2002, p. 4). They argue that professional knowledge must be publicly available for teachers to share to encourage the use of different and innovative ways of teaching. The Internet has made possible the creation of web based video libraries of lessons that teachers can access and use for their own professional development. They argue, in particular, that:

“Videos provide concrete examples of instructional practices that avoid much of the ambiguity of written descriptions [and that] videotapes of lessons can illustrate concretely what a teacher has in mind” (2002, p. 8)

Although there is still scanty research evidence, there appears to be a growing consensus that using video recordings of lessons for the purposes of professional development may be useful for teachers in at least two main respects. Firstly, it allows them to see their own teaching and secondly it allows them to see the behaviours of their pupils (Jaworski, 1990, p. 60). However, while video clips may be a useful tool in teacher education and CPD, it is clear that there are a number of important factors to consider if they are to be used effectively. It is not simply a case of recording a lesson and using it for professional development. Hiebert et al (2002) suggest that some sort of verification process is required to determine the quality, accuracy and reliability of professional knowledge as shown in videos, for example. Borko et al (2007) argue that there is little agreement as to what actually constitutes high quality professional development.

Content, quality and duration of video resources

There is currently little research available about the optimum length of video clips. Jaworski (1990) argued that clips should not be too long in duration since long clips may cause
attention to wander. Sharpe et al (2003) found that three-quarters of their sample of teachers felt that video clips should be longer than 3 minutes. Video clip information stored in the video resources database shows that clips can be as short as 27 seconds and as long as 28 minutes in some cases. Videos on the Teacher TV site are all in the 10-15 minute range but do apparently have pause sections built in to allow for reflection on the material. What may be more important is the content of the video clips viewed in conjunction with experienced mathematics teachers, teacher trainers and any accompanying explanatory materials.

**Potentially positive aspects of using video for mathematics CPD**

Jaworski (1990, p. 63) argues that the use of video tape as an in-service education tool has a number of potential roles to play including:

- To offset the isolation of teachers who rarely see beyond their own classrooms, by providing glimpses of other teachers at work.
- To provide opportunities for viewing other teaching styles and observing other teachers' strategies in the classroom.
- To provide a medium for recording and reviewing a teacher's own classroom as an aid to reflection on teaching.
- To provide a shared experience which can form a starting point for discussion of teaching, leading to identification of important issues and the possibility of working on these issues in the classroom.

Current evidence (Borko et al., 2007) suggests that lesson video clips produced and used by teachers within their own schools are effective means to encourage reflective practice. The development of a community of trust within which trainee teachers feel comfortable and supported to view videos of themselves and their colleagues may be another important factor in the effective use of video for CPD.

McGraw (2007) argue that the use of cases in teacher education can:

- Enhance the content and pedagogical content knowledge of practicing teachers
- Assist pre-service teachers in identifying and thinking critically about issues related to their own emerging practices
- Engage in-service teachers and pre-service teachers in considering multiple perspectives and comparing alternative courses of action

Certainly, there seems to be some consensus around the notion of video clips of lessons or teaching episodes as powerful media for provoking discussion and reflection among teachers (Borko et al., 2007; Sharpe et al., 2003). McGraw et al (2007, p. 118) concluded from their study that:

"With respect to implications for teacher education and professional development, results from this study suggest that pre-service teachers benefit, in terms of opportunities to learn, from engaging in case discussions with more knowledgeable others. Further, the mixture of mathematicians, mathematics teacher educators, and pre-service and in-service teachers has potential for stimulating discussion about a range of important issues related to teaching and learning; thus, such groups may be a particularly useful site for learning”.

Santagata et al (2007, p. 125) argue that:

"Because video can be played over and over and accessed digitally, it allows for a depth of reflection and analysis not possible during live observations. Teaching is a cultural activity,
and cultural routines are more easily unveiled when the teaching process is slowed down and critically analyzed.”

Lin (2005, p. 351) inquired into the effect of research-based video-cases on pre-service teachers understanding of contemporary mathematics and concluded that:

The video-cases improved their construction of pedagogical representation and their ability to identify a problematic situation with multiple perspectives. These effects appeared to be influenced by the scaffold of three factors: vicarious experience to complement personal experience, watching and discussing video-cases enriched by the developers, and journal writing to foster deeper reflections.

Hu et al (2000, p. 377) argued that new technologies, particularly video conferencing, can aid teachers’ reflective practice. His research, conducted in Singapore, suggests that streamed lesson video clips:

“Provided opportunities for the professional development of the student teachers by allowing them to share ideas, experiences and teaching resources in real time with an audience wider than the schools where they taught.”

The utility of using video for professional development in familiar surroundings and with trusted colleagues is, again, emphasised in Sherin and Han (2004, p. 163). Their research focused on video clubs for teachers where they could watch videotapes of their own classrooms. They concluded that:

“Over time, discourse in the video clubs shifted from a primary focus on the teacher to increased attention to students’ actions and ideas. In addition, discussions of student thinking moved from simple restatements of students’ ideas to detailed analyses of student thinking. Furthermore, teachers began to reframe their discussions of pedagogical issues in terms of student thinking.”

The same message emerges from the work of (Boling, 2007; Dalgarno & Colgan, 2007; Nemirovsky & Galvis, 2004; Sztajn, Hackenberg, White, & Allexsaht-Snider, 2007; Van Es & Sherin, 2006).

Problematical aspects of using video for mathematics CPD

Evidence suggests that there are socio-cultural differences on global and local levels when it comes to mathematics teaching (NCES, 2003, 2004) and that, consequently, there is not any one best way to teach mathematics. Santagata and Barbieri (2005) argue in their research that:

“Italian teachers prefer whole-class instruction to individual seatwork; they engage in teacher talk/demonstration to transmit information; and they often call on students to solve problems at the board before the rest of the class. Italian lessons are characterized by the inclusion of a large number of mathematical principles and properties”.

It might be argued that if there are contextual and situational factors in the way that mathematics is taught, the creation of generic and standardised videos for universal use may have limited utility.

Fong and Woodruff (2003, p. 195) highlighted some difficulties about teachers successfully identifying exemplary practice in video clips. They used video vignettes as a tool for teacher professional development. They concluded that:
“Teachers’ professional frames prime them to view vignettes through multiple “lenses,” and that teachers may not recognize exemplary practice when presented with it [and that] Quantitative analyses suggest that teachers rarely recognized the exemplary qualities of practice presented to them. Furthermore, teaching experience significantly influences the type of lens through which a teacher will observe exemplary practice vignettes. There is also some evidence to suggest that priming teachers with instructions may be helpful.”

This research could be interpreted as showing that experienced teachers can react adversely to being shown ‘how to do it’. Thus an issue to be considered is whether clips which are ‘framed’ as showing teaching that could be ‘improved’, rather than ‘exemplary’ episodes, would be more valuable in order to provoke discussion in the context of professional development.

Gaps in the research about using video for mathematics CPD

Much of the available research focuses on the use of video clips in the training of pre-service teachers. Using video clips for the professional development of in-service teachers is under researched. There appears to be little research about the content of videos, their optimal duration, visual and sound quality.

Mathematics video resources

As part of the NCETM review, a search for websites containing videos of mathematics teaching an professional development was undertaken. Metasearch engines such as Dogpile were used and then individual searches of separate search engines e.g. Google, Yahoo, were undertaken. Our focus was UK websites only. Thirty-nine websites that looked of potential value in regard to mathematics, video clips and CPD were located. After reviewing these systematically, the list was reduced to 5 websites. Many of the sites that were rejected provided an incredible range and variety of mathematics and CPD resources. However, these sites had few, if any, mathematics video clips. Their website details have, nevertheless, been stored in the video resources database for future reference. The video resources database contains information (where this is available) under the following main headings:

resource provider,
country of origin,
primary/secondary,
year group,
key stage,
whole class,
group, pairs,
one to one,
lesson focus,
resources available,
visual quality,
sound quality,
duration of video clips,
software required,
downloadable resources,
copyright issues,
main website,
video clip locations,
lesson outlines
notes.
Sample clips from relevant websites have been downloaded. Links to video resources can be found in the video resources database. It appears that a standardised database of resources will be difficult to develop since the same information is not available on all websites. There are also variations in the type and quality of information available. However, it should be possible to use auto filter in Excel to filter data by the various column headings in the supplied file.

The top 5 websites for video clips that could be used or adapted for mathematics CPD purposes are as follows:

Teacher TV (150 mathematics videos)
Mathcentre (Loughborough University 89 mathematics videos)
Teacher net (18 mathematics videos in the form of case studies)
Curriculum Online (12 mathematics videos)
Scottish Interactive Technology Centre (SITC: 37 lesson videos and 56 calculator key press videos)

The top 2 sites are Teacher TV and Mathcentre located at Loughborough University. Teacher TV has approximately 150 mathematics related clips viewable online and downloadable after joining the site. The video clips are high quality in terms of sound and vision. Most of the clips range from 10 to 15 minutes. They cover all key stages and appear to be geared more to school based learning.

Similarly, Mathcentre offers a range of video clips covering all key stages up to FE. The clips are streamed for online viewing and it is uncertain if they can be downloaded. The sound and visual quality are excellent and the videos fill a PC screen. Clips are much longer than the Teacher TV clips e.g. 22 minutes and more in some cases and seem to be more for individual use by teachers and students.

Video resources from the American TIMSS studies are not available online but can be purchased from www.lessonlab.com. Video clips are taken from lessons in a range of countries including Australia, the Czech Republic, Hong Kong SAR, Japan, the Netherlands, Switzerland, and the United States and consequently may be useful as a means to identify common practices in mathematics teaching and cultural differences.

While the visual and sound quality of clips from Teacher net and Curriculum Online are good, they have limited video clips available for viewing and/or download.

Scottish Interactive Technology Centre (SITC) offers video clips related to the use of calculators. There are clips from primary and secondary lessons and some clips from CPD workshops too.

CUREE, too, offers video resources for CPD purposes. These can be accessed after joining the site:

“The TDA are Mentoring and Coaching Library is a new TDA extranet that has been created to provide information on materials and resources developed across the education sector to support the development of mentoring and coaching programmes in schools. At this stage the content comprises the national framework for mentoring and coaching that was developed by CUREE and a range of resources, including video clips illustrating key skills and principles, all designed by CUREE to support the framework. The site also includes activities you can undertake with colleagues to raise interest and awareness and start to build skills, plus case studies of how six different schools have developed an effective mentoring and coaching culture. If you are interested in gaining access to this library please email...
coachingandmentoring@tda.gov.uk with your details and request a user name and password. It can take 10 days for your password to come through so please be patient! Then visit http://mclibrary.tda.gov.uk and use the log in details you are given”.

While the Open University produces a range of mathematics videos and DVDs, we were unable to obtain any of these. The Open University has a range of websites which may allow access to video resources but it is necessary to join these websites. Many of these resources can be purchased online from Open University Worldwide. The Centre for Mathematics Education at the Open University http://cme.open.ac.uk/ have been contacted about this project and are willing to discuss how they might help. Our view is that Open University resources are top quality and are worth collecting.

Conclusions

While the use of videos in the CPD of mathematics teachers looks attractive and is supported to a certain extent by a number of reports and articles, there are a number of issues that need to be carefully considered.

A number of messages seem to emerge from the literature on the use of video in the continuing professional development of teachers generally and mathematics teachers specifically. If video clips are to be used effectively, it seems that they must take into account local contextual/situational factors i.e. videos produced by teachers themselves for use in their own schools seems to be more important than so called ‘universal’ or standardised video recordings for general consumption. The TIMSS (NCES, 2003, 2004, 2006) studies suggest that there is no one best way to teach mathematics and that there are in fact cultural differences, which may prevent such an approach.

It is not enough to simply take video recordings and use them for CPD purposes. Video recordings need to go through a screening process in order that their ‘fitness for purpose’ can be assessed. The context in which the video is ‘framed’ can also have implications for its value as a learning resource.

Videos have been shown to be useful for generating discussions and reflections on teacher practice especially where groups are composed of teacher trainers, pre-service teachers and in-service teachers. There is much to be gained from ‘conversations’ between such groups of teachers and videos may act as a catalyst in generating such discussions and reflections.

Resources

There are a number of video clips available on the Internet but widely dispersed on a number of sites in the UK. Would it be desirable or even possible to bring these resources into one easily accessible site? Perhaps it might be more practical to create a portal of mathematics resources with clickable links?

Quality

Most of the video clips viewed online are good in terms of sound and visual quality. One issue that needs to be carefully considered is the quality of the actual content. Who decides what constitutes a quality lesson? It might be the case that videos demonstrating teaching which could be improved would be more valuable as a stimulus for discussion. It is concluded that determining the quality of a video recorded lesson may need to be a socially constructed activity involving highly qualified and respected mathematics teachers and advisors.
Accessibility

It is anticipated that attempting to create a flow of expertise and exchange that mathematics teachers can gain access to may be a long-term process requiring the engagement of a diverse body of resource providers. The possibility of free exchange of information and resources may be hindered by ownership/copyright issues. Firstly, legal agreements may have to be established between NCETM and providers of research e.g. academic journals, in order that this research can be made available to teachers in electronic and/or hard copy format. Secondly, legally binding agreements may have to be established between NCETM and producers of electronic media e.g. video, streamed content etc, in order that practitioners are able to legally and easily access such content.
References


Appendix One: Academic Journals

Australian Senior Mathematics Journal
British Journal of Educational Technology
Cambridge Journal of Education
Chronicle of Higher Education
Communication Education
Community Mental Health Journal
Compare - a Journal of Comparative Education
Computer Applications in Engineering Education
Computers and Education
Contemporary Family Therapy
Contemporary Issues in Early Childhood
Distance Education
Early Child Development and Care
Education
Educational Research
Educational Researcher
Educational Technology
E-Learning
Electronic Education Report
European Early Childhood Education Research Journal
European Journal of Special Needs Education
Family Practice - Oxford
Innovations in Education & Teaching International
Instructional Science
International Journal of Early Years Education
International Journal of Educational Research
International Journal of Nursing Studies
International Journal of Science and Mathematics Education
International Journal of Science Education
International Journal of Technology and Design Education
Intervention in School & Clinic
Journal for Research in Mathematics Education
Journal of Advanced Nursing
Journal of Educational Media
Journal of Experimental Education
Journal of Health, Physical Education Recreation
Journal of Information Technology for Teacher Education
Journal of In-Service Education
Journal of Mathematics Teacher Education
Journal of Nursing Management
Journal of Research in Science Teaching
Journal of Science Education and Technology
Journal of Science Teacher Education
Language and Education
Learning in Health and Social Care
Learning Media and Technology
Mathematics Teaching in the Middle School
Medical Education - Oxford
MT: Mathematics Teaching
Nurse Education in Practice
Phi Delta Kappan
Radiotherapy and Oncology
School Science & Mathematics
Science Teacher
Support for Learning
Teachers and Teaching - Theory and Practice
Teaching and Teacher Education
Teaching Children Mathematics
Technology Pedagogy and Education