
PRESERVICE TEACHERS LEARNING MATHEMATICS FROM THE INTERNET



TROELS LANGE

Charles Sturt University and
Malmö University

Troels.Lange@mah.se

TAMSIN MEANEY

Charles Sturt University and
Malmö University

Tamsin.Meaney@mah.se

Although preservice primary teachers' limited mathematical knowledge has been well documented, little research has been conducted on programs to improve it. We report on first-year, teacher education students' use of recommended internet resources on different mathematics topics. Our findings suggest that many of our preservice teachers had not previously used internet resources for learning, except to do research. They also saw mathematics learning as occurring only when they are taught by a teacher and so internet resources were of limited value. Ultimately these beliefs, if left unchanged, will have an impact on their teaching of mathematics to primary school students.

Background

In this paper, we evaluate a resource for supporting preservice teachers' learning of primary school mathematics. It was a CD with links to websites and references to the textbook on the different topics covered in a test that preservice teachers had to pass in their first mathematics education subject. Although some students made use of the CD, many expected to have a teacher teach them how to answer each question. This research has implications not just for improving preservice teachers' mathematical knowledge but also for their pedagogical understandings about how mathematics is learnt.

In recent years, many preservice primary teachers' (PPTs) limited mathematical knowledge has been acknowledged. In Australia, the Senate Standing Committee on Workplace Relations and Education (2007) stated "early tests of numeracy conducted by education faculties showed that a very large proportion of [teacher education] students cannot do grade 5 maths because they never learned a lot of maths at school" (p. 58-59). Consequently, government regulatory agencies such as the Office for Standards in Education [OFSTED] (1994) in the UK and more locally the NSW Institute of Teachers (2006) instituted mathematical requirements for entry into primary teacher education courses.

However, requirements for PPTs to have high school mathematics qualifications may not provide them with the necessary knowledge to teach primary school mathematics (Tobias & Itter, 2007; Goulding, Rowland, & Barber, 2002). At Charles Sturt University (CSU), a concern about ensuring that PPTs had appropriate mathematics for primary school teaching resulted in an assessment being a mathematics test in the first mathematics education subject. However, research from 2008 suggested that studying

for this test confirmed PPTs valuing of procedural rather than conceptual mathematical understandings (Meaneay & Lange, 2010). The test reinforced the PPTs' identities as students rather than becoming teachers, so learning was focused on passing the test rather than on being able to provide learning opportunities for children. Subsequently, the test was changed in 2009. At the beginning of semester, PPTs were given 50 short-answer questions based on children's responses to mathematical problems, inspired by Hill, Schilling, and Ball (2004). About two thirds of the way through the semester, they had to respond to ten of these questions in a formal test environment. PPTs who failed this test had a second chance to pass, several months later after they paid a \$100 fee. If they failed the second test or did not take up this option, they had to re-enrol in the subject the following year.

Morris (2001) had found that the fail rates of PPTs, taking an audit of their mathematical understandings, had reduced significantly in the year when they had been provided with a specimen paper at the beginning of their course. Given that we knew from our previous research that many students had very spiky knowledge background (Meaneay & Lange, 2010), in that they knew some things but did not know others, we anticipated that giving the students the set of 50 potential questions would help them to tailor their learning to the areas that they identified as being difficult. Self-auditing of mathematical knowledge for a similar test had been used in other research (Goulding et al., 2002; Corcoran, 2005). Nevertheless, we were also aware that preservice students could be overly optimistic about their mathematical capabilities, simply because they were unaware of the misconceptions that they had (Morris, 2001). Therefore, lectures were provided for one hour a week that specifically covered the topics in the test but did not provide answers to the specific questions. In a similar vein to Ryan and McCrae (2006), we wanted students to use the test questions as a catalyst for learning the mathematics that they would be required to teach, rather than seeing the test questions as the only mathematical knowledge that they would need.

Resourcing preservice teachers learning

We knew that for some students, the lectures would not be sufficient to overcome the gaps in their mathematical knowledge. Consequently in 2010, following a model similar to that of Lin (2010, see Figure 1), we collated websites for the relevant mathematics topics, where the emphasis was on the mathematical concepts, rather than on simply learning how to use a procedure. The websites varied from providing text-based material on children's common misconceptions, to videos on YouTube about operations with fractions, to simulations/animations to games. Most links had been trialled in the lectures for this subject in 2009. Links to these websites were sorted according to topic, provided with references to the relevant section of the textbook and organised as a website on a CD (see Figure 2, next page). Every student was provided with a CD.

We decided to present support material in this way for several reasons. As part of a wider initiative to support PPTs gaining knowledge of how to integrate ICT into their classrooms, all first-year, primary teacher education subjects at CSU included ICT requirements, including engaging with a range of web resources. Although some students arrive at university with significantly more ICT skills than their lecturers (Barnes, Marateo, & Ferris, 2007), it has been found that graduating teachers feel apprehensive about using ICT in teaching (Lin, 2008).

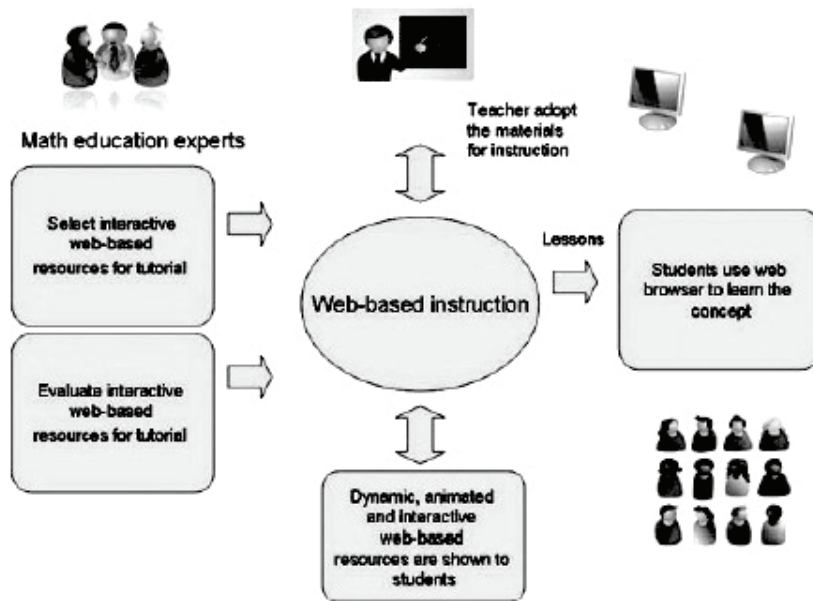


Figure 1. Web-based instruction model from Lin (2010, p. 63).

Recent research suggested that mathematics teachers, when they used the internet, predominantly used it for planning and made limited use of learning activities designed for students (Moore-Russo, Viglietti, & Bateman, 2009) resulting in a well-funded initiative being implemented in Australian universities to improve graduating teachers' "effective and innovative use of ICT in education to improve student learning" (Australian Learning and Teaching Council [ALTC] & Australian Council of Deans of Education [ACDE], 2011, p. 4).

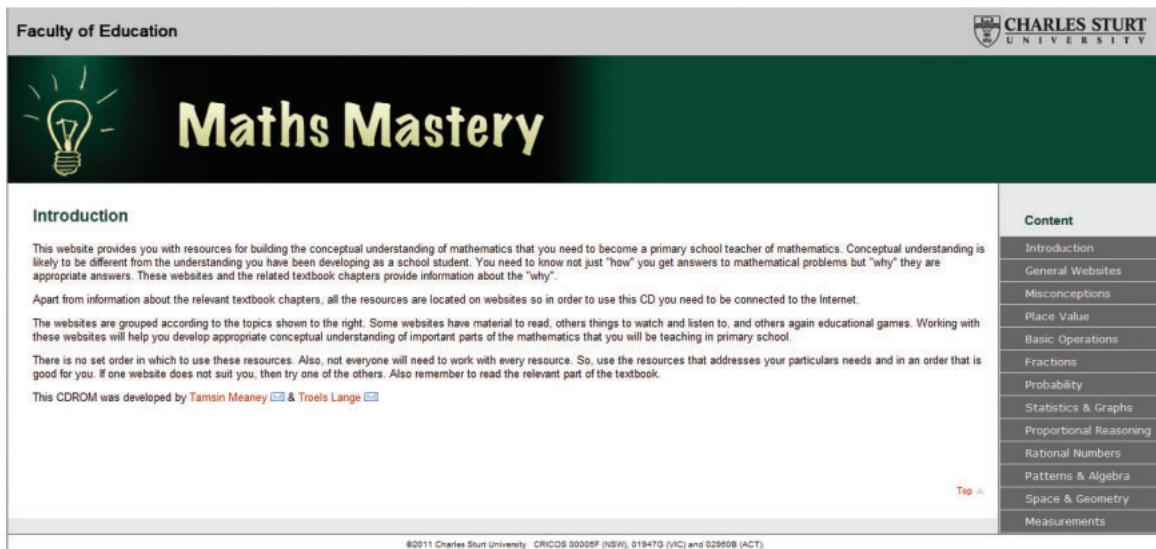


Figure 2. Front page of the CD resource.

There was also some evidence that suggested that having preservice teachers engage with ICT not only made them more enthusiastic about teaching with ICT (Lin, 2008) but also was more valuable for supporting their learning than traditional lectures (Lin,

2010). Although Lin's studies were done with small numbers of students, the findings were encouraging. However, almost no other studies have investigated PPTs' use of web-based resources for improving mathematical knowledge. It was important to us to discover how the CSU PPTs used the CD and how we could improve it so that it was of most benefit to our students. Therefore, we wanted to find out what supported and what hindered PPTs' use of the CD to improve their mathematical knowledge.

Methodology

In this paper, we concentrate on information provided by the PPTs. At the beginning of the semester 190 PPTs completed a survey about their previous use of web-based resources as well as their preferred way of learning for the test. The PPTs were also asked to keep a diary of web links from the CD that they used and how useful they found them. Only twelve preservice teachers, across the two campuses, handed in these diaries after the test was graded and the marks handed out. Of these, only five recorded that they used the CD more than once. Following the test, focus group interviews were held with a small sample of students. These interviews were not carried out by lecturers.

Results and discussion

In this section, we summarise the results from the data. A chi-square test on the numerical data suggested that previous experiences of using web-based resources of the two cohorts were different. This suggests that even within CSU, PPTs bring a large variety of experiences to their university studies. Consequently in Table 1, we have provided numbers of responses from student teachers from both campuses (Bath for Bathurst, or WW for West Wyalong). Our data collection methods did not enable us to match the surveys to the PPTs involved in the interviews so the differences between the cohorts is not explored. Although 190 surveys were collected, some questions were not answered by everyone.

The results show that most PPTs had some previous experience with using web-based resources. Nevertheless, at both campuses at least 15 percent of PPTs had never used these resources. One comment from the survey exemplified some PPTs' lack of experience with computers. It came in relation to a question on whether they would use the CD to study for the test:

If it works in a DVD player because I don't really know what else it will work in. (Bath)

Answers to the open-ended questions also suggested that many preservice teachers felt that the internet was expensive and computers were difficult to use. In responding to a question on what they did not like about using web-based resources, PPTs wrote:

Money to download, speed of net. I don't like reading off screen. (Bath)

Involves you to be around computers etc which are not always easy to access. (WW)

Table 1. Preservice teachers' previous use of web-based resources.

Have you used web-based resources for learning before?	Yes		No					
	WW	Bath	WW	Bath				
	86	65	15	18				
a. If yes, how often did you use these resources?	All the time		Quite a lot		Occasionally		Very Rarely	
	WW	Bath	WW	Bath	WW	Bath	WW	Bath
	13	4	32	15	33	33	10	17
b. What sort of resources did you use?	Video from sites such as You Tube		Text-based material such as explanations		Animations of experiments, etc.		Games for testing skills	
	WW	Bath	WW	Bath	WW	Bath	WW	Bath
	38	31	79	62	17	12	18	36

Note: Numbers represent PPTs.

At both campuses, the most common previous use of web-base resources was reading text-based explanations. As well, about a third of preservice teachers had used videos from the web and at the Bathurst campus, a similar proportion had used games. A relatively small proportion had used animations. These results suggest that even if preservice teachers have had experience of web-based resources then it was likely that these resources were conceptualised as being similar to book resources. Thus, learning through web-based resources was conceived as finding and reading information that was laid out in a step-by-step manner. Comments about the advantages of using web-based resources reflected these beliefs.

They step things out for you. (Bath)

There is such a wide variety of resources you can nearly always find relevant information. (WW)

At times, this wealth of information was perceived as being overwhelming and difficult to handle because they could not judge its validity.

Get lost. Too much info. Not easy to direct around Internet. (WW)

By providing them with the web-links and a short description of what was on each website, we had hoped to overcome the difficulties of students finding appropriate sites.

Although some PPTs felt that web-based resources allowed them to learn at their own pace, there were differences of opinion in whether websites provided the interactivity that many viewed as important for their learning. Comments about not getting individual help from websites came almost exclusively from Bathurst students.

Can access them at home, and can target the area I feel I need to work on. (Bath)

Because it will be like having someone there, I think I will use it all the time. Need a lot of help in maths. (WW)

If you don't understand, you can't get instant support. (Bath)

However, for some PPTs, their nervousness about having to sit a mathematics test meant that any help was welcome.

All the help I can get. Maths is one of my weakest subjects. (Bath)

In answering a question about the support that they needed for studying for the Mastery Test, some PPTs at both campuses valued support from lecturers or other PPTs. More comments of this kind came from Wagga Wagga based PPTs.

Teacher support, when I get a clear explanation of a problem. (Bath)

One-on-one, go through questions in-depth and show me how to get the answer, group work. (WW)

In responses about the support they needed, previous experiences of learning for mathematics tests was evident in how they felt they should learn for this test. Although the preservice teachers had been provided with the 50 questions, 27 PPTs at Bathurst and 11 at Wagga Wagga requested practice question and previous test papers. The test was the focus for preservice teachers and at the beginning of the semester, they did not see the need to know material because they would be teachers.

Need to go over the exam; have someone explain so I understand; write notes over it. (Bath)

Explaining in depth how these questions really need to be answered. (WW)

Although almost all students in the initial survey stated they would at least try out the CD, in fact very few PPTs used it. Of the comments in the diaries, most indicated that PPTs looked for information on specific topics. The following comment about the Maths for Kids website illustrates this:

Didn't understand long division. So helped lots. (WW)

For one preservice teacher, there were indications that she saw herself as learning because she was to become a teacher, not just to pass a test.

Helpful in my understanding & a way of teaching it, too. (Bath)

After the test, the focus group interviews suggested that more PPTs could see links to being a teacher and this may well have been connected to another assessment where they had to work with primary school children.

I used that [the CD] for one bit of it, for decimals and how to explain that, but, we actually used it for another assignment, the next assignment, for a problem solving exercise. (WW)

However, the availability of a computer and ICT skills continued to be a reason given by students for not using the CD.

I was sweating a bit just to get a pass, I took the CD home and had a look and had a look at the links on it and I said you've got to be kidding me, I had very little amount of internet usage at home, so I wasn't going to go through all this at home. (Bath)

For some preservice teachers the CD was useless because it was not how they expected to learn.

Like even having a teacher sitting there drawing on the whiteboard or something and showing, and then break it down into stages, because that's the way I learn, when it's broken down, if it's just given to me and I see there's the answer and you've got to figure

it out, I'm completely lost, but if it's broken down into different stages and I can see the logic, oh okay, so if I was given a similar one, I can probably work that out too. (Bath)

Even after completing the test and commenting on the importance of explaining the mathematical concepts to their potential students, these preservice teachers still seemed to see mathematics learning as involving an expert, such as a teacher, showing a novice, such as a student, how to do the problem by breaking it down into stages, in other words as procedural understandings of mathematics. In commenting on the test, one student said:

I think it was worse than an HSC [High School Certificate] exam because teachers prepare you for HSC. Well the HSC you've got questions and teachers like they work over the whole broad and we weren't told really how they wanted us to explain it. (WW)

These comments, and there were many, showed not just how hard it is to ensure that preservice teachers value conceptual understandings of mathematics (Meaney & Lange, 2010) but that procedural understanding ingrains in them a particular view of what learning involves. This has implications for how they see their role as a teacher and what they expect from the students who will learn from them:

Could someone just come up with some sort of handbook or even a CD or something, that says, okay, if you are teaching fractions, this is what you say, this is what you write on the board? (Bath)

Although these PPTs had two further semesters of mathematics education subjects to complete their degrees, there is an issue about overturning these ideas about mathematics and how it is taught. If this is not recognised and addressed specifically, it is likely that even with our best intentions, these preservice teachers will teach procedural mathematics from the whiteboard once they have graduated.

Conclusion

From this research, it is clear that PPTs arrive at university with a range of different ICT experiences, few of which seem to make them inclined to use ICT in their own learning. Partly, this has to do with their beliefs about how they learn mathematics.

In recent years, the idea of pedagogical content knowledge (Shulman, 1986) has enabled PPTs' lack of content knowledge to be researched in isolation from pedagogical knowledge. If pedagogical knowledge is mentioned then it is in relationship to mathematically-competent PPTs gaining the most from their mathematics pedagogical subjects (Capraro, Capraro, Parker, Kulm, & Raulerson, 2005). Our research suggests that this separation is unhelpful. Unless, we as teacher educators recognise that preservice teachers expect to learn in the way that their previous experiences suggest mathematics must be learnt, then we will struggle to convince them of the need for conceptual understanding and that it needs to be gained through active engagement. Like the mismatch that Skemp (1976) described between some teachers and their students on what 'understanding' was, we will continue to work together in our mathematics education subjects from non-intersecting views about what mathematics is and how it can be learnt.

References

- Australian Learning and Teaching Council [ALTC] & Australian Council of Deans of Education [ACDE] (2011). *Teaching teachers for the future: Institutional guide*. Canberra: Author.
- Barnes, K., Marateo, R. C., & Ferris, S. P. (2007). Teaching and learning with the net generation. *Innovate Journal of Online Education*, 3(4). Retrieved March 1, 2011, from <http://www.innovateonline.info/index.php?view=article&id=382>.
- Capraro, R. M., Capraro, M. M., Parker, D., Kulm, G., & Raulerson, T. (2005). The mathematics content knowledge role in developing preservice teachers' pedagogical content knowledge. *Journal of Research in Childhood Education*, 20(2), 102–118.
- Corcoran, D. (2005, September). *Mathematics subject knowledge of Irish primary preservice teachers*. Paper presented at European Conference of Educational Research, UCD, Dublin. Retrieved March 15, 2011, from <http://hdl.handle.net/2428/7880>.
- Goulding, M., Rowland, T., & Barber, P. (2002). Does it matter? Primary teacher trainees' subject knowledge in mathematics. *British Educational Research Journal*, 28(5), 689–704.
- Hill, H. C., Schilling, S. G., & Ball, D. L. (2004). Developing measures of teachers' mathematics knowledge for teaching. *Elementary School Journal*, 105(1), 11–30.
- Lin, C.-Y. (2008). A study of pre-service teachers' attitudes about computers and mathematics teaching: The impact of web-based instruction. *International Journal for Technology in Mathematics Education*, 15(2), 45–57.
- Lin, C-Y. (2010). Web based Instruction on preservice teachers' knowledge of fraction operations. *School Science and Mathematics*, 110(2), 59–70.
- Marszalek, J. (2009, May 1). Queensland teachers face competency exam before teaching. *Courier Mail*. Retrieved March 31, 2011, from <http://www.couriermail.com.au/news/teachers-face-ability-exam/story-e6freon6-1225705759755>.
- Meaney, T. & Lange, T. (2010). Preservice students' responses to being tested on their primary school mathematical knowledge. In L. Sparrow, B. Kissane, & C. Hurst (Eds.), *Proceedings of the 33th annual conference of the Mathematics Education Research Group of Australia* (pp. 415–422). Freemantle, WA: MERGA.
- Moore-Russo, D. A., Viglietti, J. M., & Bateman, S. M. (2009, September). *Teachers' use of online mathematics education resources: Insights on digital natives and proficient digital immigrants*. Paper presented at the annual meeting of the North American Chapter of the International Group for the Psychology of Mathematics Education, OMNI Hotel, Atlanta, GA.
- Morris, H. (2001). Issues raised by testing trainee primary teachers' mathematical knowledge. *Mathematics Education Research Journal*, 3, 37–47.
- NSW Institute of Teachers (2006). *What qualifications are required for teaching?* Retrieved March 15, 2011, from <http://www.nswteachers.nsw.edu.au/What-qualifications-are-required-to-teach-in-NSW.html>.
- Office For Standards in Education [OFSTED] (1994). *Science and mathematics in schools: A review*. London: HMSO.
- Ryan, J. & McCrae, B. (2006). Assessing pre-service teachers' mathematics subject knowledge. *Mathematics Teacher Education and Development*, 7, 72–89.
- Senate Standing Committee on Employment Workplace Relations and Education (2007). *Quality of school education*. Canberra: Commonwealth of Australia.
- Shulman, L. S. (1986). Those who understand: Knowledge growth in teaching. *Educational Researcher*, 15(2), 4–14.
- Skemp, R. (1976). Relational and instrumental understanding. *Mathematics Teaching*, 77, 20–26.
- Tobias, S. & Itter, D. (2007). *Mathematical backgrounds of preservice teachers in rural Australia: A comparative study*. Paper presented to the 2007 annual conference of the Australian Association for Research in Education. Retrieved September 15, 2008, from <http://www.aare.edu.au/07pap/tob07424.htm>.