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# Teaching mathematics at a distance – trialling a wiki community to focus reflection and share resources

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## Abstract

Professional development for academic staff in Higher Education is always more interesting and inspiring if good practice can be embedded in a way which is meaningful and relevant to the individual. The current project focuses on raising awareness of significant or difficult parts of a course, and promoting the exchange of good practice using a wiki environment. Our findings suggest that this methodology has promise, and is particularly valuable to new tutors, or at the start of a new course. The wiki can be used to host a repository of teaching materials and we illustrate a number of examples. We have also learnt a number of useful lessons on the ways in which a wiki might be used to support a staff community in the future, and offer a list of recommendations.

## 1. Introduction

Professional development for academic staff in Higher Education is always more useful if good practice can be embedded in a way which is meaningful and relevant to the individual. There is scope for the sharing of good practice between staff at the point of need, or between new and experienced staff, and communities of practice can enhance practice through contact with peers. Using online media the community can operate regardless of time and place, of particular relevance to part-time teachers, or for any group of staff who are not regularly co-located [1].

We describe a project which assesses the potential for enhancing the teaching practice of part-time mathematics tutors in the Open University, using a wiki to support an online community and to allow the sharing and development of resources.

## 2. Professional development at the Open University

Professional development is challenging in a distance environment, where face to face events are expensive and difficult to organise. Opportunities for the exchange of good practice on course teaching commonly take place in an initial face-to-face briefing for tutors at the outset of a new course; on some courses a debriefing happens after the first year. Tutors are also encouraged to attend professional development events which provide both subject specific and generic sessions. Such events are supported by a range of online resources for distance study.

Online communities using forums are already enthusiastically embraced by tutors on some courses. These forums are particularly useful during assignment marking, when tutors may use the online group to discuss their understanding of question requirements, or of marking criteria. Not surprisingly, such groups are particularly successful where forums are in habitual use for core tutoring duties [2]. The mathematics course involved in this study is an example: it has enjoyed an active online tutor community for several years. The current project builds on this work with its focus on raising awareness of significant or difficult parts of a course, and promoting the exchange of good practice in teaching, using a wiki.

### 3. Methodology

Open Mathematics (MU120) is a 30-credit point level 1 course which runs over nine months, starting twice a year. The course provides an introduction to studying mathematics within real world contexts and typically attracts around 3000 students a year, supported by around 150 tutors.

Ten tutors (labelled M1-M10) were recruited for the project, ranging from tutors newly appointed to tutors who have taught the course since its first presentation in 1996. The tutors are scattered throughout Scotland. In terms of other commitments: 3 tutors are employed with other HE/FE providers; 3 have retired from their day job; for 3 tutors the OU is their main source of income and one is a freelance science communicator.

In a full day workshop tutors discussed significant or difficult points of the course and then activities which could help students with these parts of the course. They were introduced to current thinking on Threshold Concepts and Troublesome Knowledge [3] in the hope that these ideas might help them to talk about their subject and the difficulties they encounter in teaching.

A wiki "book of course teaching" was set up for the project, in which the workshop output was included. The wiki used is a new tool which has been introduced as part of the University's Moodle VLE. It has as yet fairly basic functionality, including the ability to create and edit new web pages, but no facility to attach files or to alert subscribers to new entries. Tutors were asked to visit the wiki monthly during the course to reflect on current experiences and to share teaching material with fellow tutors. A wiki moderator reminded participants once a month that their contributions were due, and organised the wiki as it grew.

The project concluded with a reflective exercise, in which participants were asked to visit the wiki and assess the extent to which they agreed with the significant or problem areas identified, and to consider whether the material deposited there could be relevant to their tutoring practice. A questionnaire was circulated by email.

The following account draws on two sets of notes from different participants on the initial workshop together with examples from the wiki and short qualitative responses from the questionnaire.

### 4. Issues in the teaching of mathematics

In identifying significant or problematic areas in the course there was much discussion on algebra and the difficulties experienced by students in working with algebraic ideas and seeing the relationship between geometry and algebra.

*"..the difficulty that students have in understanding what is meant by solving an equation...: many students confuse this with rearranging an equation." M7*

*"multiplication of brackets of form  $(ax+b)(cx+d)$ ,  $(ax+b)^2$  and even  $a(b+c)$  where some of values are negative." M8*

Tutors also discussed the issue of communicating mathematics effectively. They noted that students often do not realise that communicating mathematics involves more than simply writing down the answer or writing only in symbolic language and that a combination of words and mathematical notation expressing their reasoning process is required. It was also noted that students need support and encouragement to appreciate why using notation and terminology correctly is important.

*"Lack of experience of writing for other people to read. Not understanding that a mathematical solution is a form of communication from one person to another... Writing their solutions out properly." M2*

Other discussion focussed on conceptually difficult areas for novice mathematicians such as percentages, ratios, negative numbers or scientific notation.

“Conversion of units: I think that students concentrate too much on the numbers, instead of trying to visualise the situation.” M7

“...if students perceive that something is difficult then they will lose themselves in the detail and not see the big picture. If something is difficult then it must take a complicated process to solve it.” M4

Finally, tutors discussed how students’ difficulties might not be absolutely tied to an identifiable part of the course, year after year. For example knowledge might be troublesome as a result of students’ varied backgrounds (e.g. previous courses, school). Alternative notation in use, for example for writing numbers in scientific notation, can also be an obstacle for new learners in mathematics. Moreover, the approach in the course teaching and assessment material may suit some learners more than others.

## 5. Wiki contributions

The wiki contains some excellent new material of interest for current tutors and for staff designing future courses. This account concentrates on: developing communication skills in mathematics, relating mathematics to everyday life, and helping students to understand difficult concepts.

As noted, learning to communicate mathematics effectively was a major issue: the following handout makes use of a model answer to illustrate good practice.

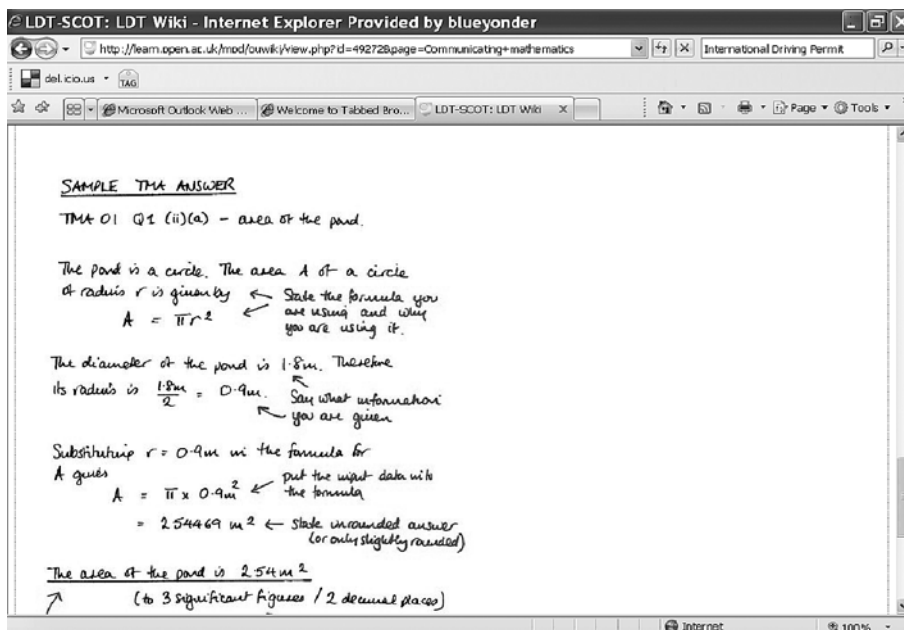
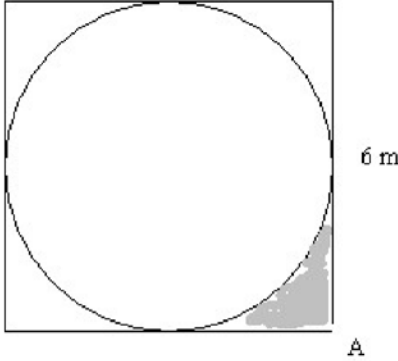


Figure 1: A screenshot from the wiki showing part of a ‘communicatingmathematics’ worksheet

Figure 2 (opposite) is another example of encouraging good communication in mathematics, by engaging students in a dialogue with an exercise.

Relating mathematics to everyday knowledge was another popular theme, important for helping students to understand abstract concepts, and also applicability. Quirky and interesting examples, such as in Figure 3 (opposite), were added to address the age-old question of WHY we study mathematics – to enable us to solve problems and answer questions.

A flowerbed in a park is a square with sides 6m long. A circle is set inside, as shown in the diagram.



(i) Find the area of the square flowerbed.

(ii) Find the area of the circular bed in the centre. Give your answer correct to one decimal place.

(iii) Find the area of the shaded area at corner A.

Here is a student's answer to this question. How could it be improved?

(i) 36

(ii) Area =  $\pi r^2 = 3.14 \times 9 = 28 \text{ m}^2$

(iii) Area =  $36 - 28 = 8 / 4 = 2 \text{ m}^2$

[...]  
**Notes:**  
 Add some words to explain what you are calculating;  
 Be careful not to misuse the equals sign. The student wrote  $36 - 28 = 8 / 4 = 2$  which just isn't true! Can you see why? The expressions on either side of the equals sign must be equal and  $36 - 28$  is not equal to  $8 / 4$ .  
 Remember appropriate units.  
 [...]

(M3)

Figure 2: An example that engages students in a dialogue with an exercise.

### What have an elephant's ears got to do with mathematics?

Students are calculating volumes and areas at an early stage in MU120. As a group exercise I ask them to calculate areas and volumes of cubes of side 1, 2, 4, and 8 metres, and see if they can spot a pattern in the results.

With each doubling of the side of the cube, the area goes up fourfold but the volume goes up eightfold. I assure the students that this applies to any shape, elephants included.

An elephant's body generates heat, which it mostly loses through its skin. The amount of heat that it generates is going to be (roughly) in proportion to the amount of elephant (its volume), but its heat-losing capacity is going to be roughly in proportion to its surface area.

If you have two elephants, one twice as tall as the other, the taller elephant will generate about 8 times as much heat but will only have four times as much skin to lose it through. As a general rule, large animals therefore have a heat-loss problem.

An elephant's huge ear flaps are richly supplied with blood and are used as radiators - extra surface area to make up for its relative shortage of area compared with smaller animals.

Figure 3: A real life example on the wiki of mathematics in action.

## 5.1 Reflections on the wiki community

Most participants were positive about the benefits of sharing experience and resources; it was of particular value to those who were less experienced.

*"Sharing difficulties, teaching practice and resources is very helpful, especially to new and perhaps inexperienced [tutors]. I fit into this category ..."* M6

*"Good to get reassurance that other tutors encounter the same kind of problems that I experience and how these are tackled by them."* M8

Participants were asked to visit the wiki and identify an entry which was of particular relevance to them. It was clear that the benefit was marginal for some: three out of seven said there was nothing of particular use to them, possibly because the course has been running for some years, and many staff have considerable experience.

*"Many of the examples were interesting, but mostly just described what I have been trying to do for years ..."* M5

Others appreciated the sharing of resources and techniques, and identified specific examples:

*"I found this very useful as it gave a different approach to those I have used – it was a very full, detailed and cohesive explanation of the teaching technique used."* M6

*"I like this idea: but haven't quite got around to preparing one myself. To have the prepared resources already available is great."* M4

However, the wiki contributions were irregular and somewhat reluctant. There may be several reasons, providing useful lessons for future good practice.

Since the wiki was an unfamiliar tool, the tutors struggled to remember how to use it each time they joined. They were not just coping with new functionality, but also with navigating and deciding where to post contributions, or whether they should be posted as comments or main text, or indeed posted at all.

*"Is this a useful place to share resources? I have a worksheet on mathematical communication, but if I copy it in, the wiki could become unmanageable ..."* M7

As shown in Figure 4, in order to distinguish their input from earlier contributions, some participants wanted to use coloured text, while others wanted to identify themselves as the author.

**Ideas from the workshop**

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**\*\* Sally here again\*\***

A very sticky area is the notion of 'two minuses make a plus' when multiplying numbers. The **real** reason for this is that it has to be so - otherwise all fundamental notions fall down. (Russell et al). I have seen many different motivations for this, however none seem to work terribly well for students.

(I'm not sure if I'm writing this in the correct place – if someone can advise me how to write in a different colour, then that would be great.)

Sally's comment: can anyone think of a real life need for negative numbers other than debt and temperature, (both of which I feel acutely after dog walking and in process of moving house.)

Bill says: Perhaps we could introduce the concept of deviations as in deviations from the mean in a statistical sense .... also the concept of variance or variation from a target or plan

Figure 4: Deciding how to use the wiki

This may be related to more familiar practice with forums and email. There are also particular difficulties in communicating mathematics using print media.

*"Explaining in print can be time consuming, especially if mathematical formulae etc need to be inserted. The wiki also appears to get messy as comments are added, making it difficult to follow just one entry...I hadn't used a wiki before and sometimes felt hesitant that I may 'spoil' the page. Although this worry has lessened somewhat during the year, perhaps the different skill levels throughout the group have hindered participation." M6*

There were usability issues, for example files could not be attached and there was no notification of changes to participants' email boxes, so it was effectively out of sight and mind until participants were reminded of its existence every month. The wiki was not in a place which tutors would pass on their way to core duties; they required to follow a separate link, so serendipitous visits were unlikely. These comments are reminiscent of the lessons we have observed from participation in other online groups, particularly online forums [4].

The wiki was chosen because of the potential to organise contributions and make them available for easy searching and retrieval. However these objectives were not realised in this pilot. A lack of consistency in the places where new entries were posted and a proliferation of new pages required moderator input to link them to the home page. There was no obvious distinction between entries posted as comments and those posted on the main part of the page. Future wiki communities need better guidance on good wiki practice, and a protocol for identifying new material.

Finally, the small group size (10) combined with the fact that activity was expected only monthly meant that the wiki did not have much "buzz". This was coupled with tutors' lack of time, demands from other online groups and a certain lack of motivation to contribute.

*"Why don't people contribute? I suspect that the basic issue is: what's in it for them? To act in a spirit of reciprocal altruism requires that a contributor expects to get something useful out of the wiki. However there is a fairly well established body of ways of explaining maths, that tutors are going to be largely familiar with. The odds of seeing something really new are quite small." M2*

It is difficult to write material for teaching mathematics at this level which is truly innovative and useful. A few contributors did provide such material; however, we should not have expected everyone to do this and perhaps asking more specific questions for tutors to answer might have provoked a higher level of participation. This said, the issues associated with teaching these ticklish topics in mathematics remain vibrant and open.

## **6. Discussion**

Our findings suggest that this methodology for professional development has potential, and is particularly valuable for new tutors, or at the start of a new course. The workshop was effective in identifying 'troublesome' areas for the teaching of this course, and stimulated some fascinating discussion into the nature of mathematics and its teaching.

The wiki potentially provided a repository of teaching materials, which some tutors found helpful. However for various reasons it was not particularly successful as an online community; the following useful lessons have been learnt for further practice.

### **Contributing to a wiki**

- Participants need guidance on where to post, and which types of material are appropriate.
- They need a protocol for amending or commenting on the work of other contributors, and how to acknowledge authorship if that is considered important.



- The moderator needs to move and organise content to improve usability.

### Participation

- There has to be a good reason for tutors to participate!
- An initial face to face meeting can help to initiate the community and allows discussion of its focus and purpose.
- The use of near-synchronous or synchronous sessions can revive interest.
- Introducing structured tasks may encourage participation.
- If participation is optional, then a large group is preferable, allowing for contributions by an active minority and passive access by others.
- Membership of the wiki community should be integrated into the workload of tutors.

### Usability

- The tool should alert participants to new material.
- Use of the tool should be integrated with the use of other communication tools by the group.
- If the tool is used in other contexts then this is likely to increase its acceptability.

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