Mathematics in a connected world

Anne Porter

University of Wollongong, alp@uow.edu.au
Mathematics in a connected world

Abstract
The issues confronting mathematics teachers remain as they have been for many years. How do you engage students who do not want to learn mathematics? How do you teach to students with varying abilities? How do you convey the relevance of mathematics? How do you engage students from different socioeconomic and ethnic groups? The questions all present as challenges. In a connected world there are many more options for addressing such challenges. The ease of creating and/or accessing learning resources in a connected world has enabled possibilities such as MOOCs, flipped classrooms, online learning, learning support programs and headstart programs. With such opportunities other issues arise, such as how to develop appropriate learning designs that minimize cognitive load and optimize learning, how to provide feedback and how to provide for deep and meaningful learning.

Keywords
mathematics, world, connected

Disciplines
Engineering | Science and Technology Studies

Publication Details

This conference paper is available at Research Online: http://ro.uow.edu.au/eispapers/3484
Mathematics in a Connected World

Anne Porter

Abstract
The issues confronting mathematics teachers remain as they have been for many years. How do you engage students who do not want to learn mathematics? How do you teach to students with varying abilities? How do you convey the relevance of mathematics? How do you engage students from different socioeconomic and ethnic groups? The questions all present as challenges. In a connected world there are many more options for addressing such challenges. The ease of creating and/or accessing learning resources in a connected world has enabled possibilities such as MOOCs, flipped classrooms, online learning, learning support programs and headstart programs. With such opportunities other issues arise, such as how to develop appropriate learning designs that minimize cognitive load and optimize learning, how to provide feedback and how to provide for deep and meaningful learning.

Introduction
Mathematics in a connected world still faces the same issues that plague mathematics educators in traditional classrooms. How for example to engage students in learning mathematics, how to teach at the tertiary level to students who are ill-prepared for higher mathematics, and how to engender deep thinking and learning rather than relying on rote learning.
Teaching and learning in a connected world offers new possibilities to address many of these issues. Possibilities include access to repositories of learning resources, assessment systems, communication tools, peer review systems, learning support, and remote laboratory connection providing students access to software.

Resources
In a connected world teachers and students of mathematics have access to a wealth of learning resources. For students who respond to a variety of input auditory and visual multimedia, in addition to traditional print, offers alternatives, particularly for the struggling student. Video resources may focus on demonstrations, worked examples with the steps articulated, theory refreshers, orientation clips as a means of introducing students to the challenges they may encounter, or chapter and subject overviews. Addressing the ever-present issue of relevance, multimedia clips may address mathematics in context. Stimulus clips can be used to provoke thought, whether it is how to collect data on bushfires or demonstrating teaching techniques to students. For students with hearing challenges captions can be used.
In recent years there has been a shift from the creation of multimedia resources to the sharing of resources. Unlike the early years when resources appeared and disappeared from the web, making their incorporation into learning programs tenuous, these days there are many reliable sources. One of the most notable in mathematics is the Khan Academy (www.khanacademy.org). Thousands of resources are also available through Content Without Borders, including Australian, UOW mathematics collection (oer.equella.com/access/home.do). Others are available through YouTube, Reteachers and TeacherTube. Resources are also made available for teaching by package creators such as Wolfram Mathematica Resources (http://demonstrations.wolfram.com/) and sites such as MyCsula provide, for example, IBM SPSS training videos.
Just as videos can be created to address a number of issues, the way in which they can be used also opens up opportunities. Three such possibilities include the use of online learning support - MOOCs, flipped classrooms and Headstart programs.

Combining resources to support learning

How to combine such multimedia elements or resources may take a variety of forms. The way in which resources are combined has an impact on student learning and care needs to be taken to keep the number of web page levels to a minimum when accessing resources (Bukhatwa, 2013). Cognitive load theory (Sweller, 2006) would also suggest simplicity in approach, particularly when teaching subjects such as mathematics (Algarni, 2012). Learning designs can be used to focus lectures and students on the task, activities and supports that are available for learning, such as that used by Baharun and Porter (2011) (refer Figure 2).

Figure 2. An extract of a learning design visual sequence for a week of STAT (Porter & Baharun, 2010)
In developing countries and in poorer areas of developed countries, or even those with geographical impediments to accessing the internet, html and html browsers can provide for sophisticated organisation of resources for students. Access may be via a variety of storage devices such as CD or USB drive, or available from a server over an intranet.

For students and staff in developing countries a PC application Learning Links has been developed which is based on links to resources available on the web, aligned with subject topics, which is searchable and modifiable (available through Content Without Borders, Australian Collection).

Figure 3. Web page organisation of resources

Figure 4. Learning Links and example learning resources aligned to curriculum
Learning platforms such as Moodle offer another way of providing resources to students. Students can receive a book of learning resources in addition to the primary resources made available to students.

Figure 5. Use of the Moodle Book to collate learning multimedia resources

**MOOCs**

With an emphasis on sharing good quality resources, the possibilities for creating programs of study has emerged with large scale Massive Open Online Courses (MOOCs) and flipped classrooms. Two early MOOC providers were Coursera and Udacity. Such courses depend upon the organisation of multimedia and communications. Interaction often involves the answering of embedded questions in lectures. With respect to MOOCs there are many issues: sustainability, online pedagogy, lack of social learning experience or of being dealt with personally, quality and low completion rates, and the awarding of higher education credit (Yuan and Powell, 2013).

It’s one thing to expect brilliant teens or medical students to be self-starters. It’s another to teach students who are in need of close guidance. A recent report ... finds that underprepared students taking online courses are, according to one of the authors, “falling farther behind than if they were taking face-to-face courses.” (Delbanco, 2013).

For those who want to learn MOOCs can provide powerful approach to learning. MOOCs are growing in number and variety, with a list of such courses at http://www.mooc-list.com/.

**Flipped Classrooms**

The flipped classroom is also an approach that makes use of multimedia materials.

While there is no one model, the core idea is to flip the common instructional approach: With teacher-created videos and interactive lessons, instruction that used to occur in class is now accessed at home, in advance of class. Class becomes the place to work through problems, advance concepts, and engage in collaborative learning. Most importantly,
all aspects of instruction can be rethought to best maximize the scarcest learning resource—time. (Tucker, 2012).
The flipped classroom is a means of engaging students in activity, rather than being lectured at. There is still discussion as to its effectiveness, particularly for those who do not do the preparatory work at home.

**Headstart programs**
Headstart programs providing students with a module or two of work and assessment ahead of the formal start to classes. With a wide range of resources available online or purposively created it is now possible to create self paced learning modules relatively easily which have been found effective in reducing failure rates in disciplines such as mathematics and engineering (Porter & Denny, 2011).

**Communication**
In a connected world, communication is also important to maintain that connection. Communication may occur through design, often with the provisions of content and assessment requirements online. Forums may be used to raise issues, answer questions with both lecturers and students providing input. Students can be required to engage with other students through peer review of students publically available assessment (posted to a forum), thus facilitating learning through critique and modelling of others work. Team projects can be facilitated by simultaneous access and sharing via the Cloud. Missed assessment often can provoke communication as lecturers attempt to elicit from students if they are experiencing difficulties and need help. With numerous forms of communication (see for example, Solis, 2008) can come difficulties such as how to connect - through telephone, email, skype, viber, messaging systems, through the student administrative system, a twitter account or social media. It is often difficult to know whether a student receives or remembers such contact or its content, while for those engaged there may be use of multiple systems. Contact with many struggling students as they disengage from learning can be difficult when all attempts at communication by any method remain unanswered.

**Conclusion**
When we head down the path of using the internet and rich multimedia input and resources, we need to be aware sometimes that the best mathematics students only need a printed version of the content as it is often quicker for them to read than watch a multimedia presentation. My focus is on the struggling student, who may need richer resources, simple design and time to learn.
Whatever we do needs to be evaluated, evidence gathered and the bottom line, successful completions, however defined, examined.

**References**
Bukhatwa, B (2013). Improving mathematics education in the Middle East: A focus on technology, learning design and professional development. PhD, University of Wollongong.


