DISTRIBUTION AND USE OF DIGITAL LEARNING MATERIALS: AN EVALUATION OF A VIRTUAL MATHS WEBSITE AND SURROUNDING ACTIVITIES

Christopher Gorse[1], Ian Dickinson, Isfahan Ashraf, Paul Whitehead, Tony Shepherd, Martin Smith and Andrew Platten

Leeds Metropolitan University, School of the Built Environment, Leeds LS2 8AG

The next generation of construction professionals are IT literate; they surf the web, access the latest news from multiple sources and use social networking websites to connect with their peers around the globe. The skills of the construction knowledge worker are changing and while IT skills for many are second nature, the standard of maths has been questioned. Many learning providers are using websites to deliver information and improve various skills, yet there is little knowledge on how to use web applications to help ensure potentially interested parties are exposed to the material. The construction industry is mathematically demanding and construction workers need relevant skills. In an attempt to tackle this, construction based maths resources were created in an interactive web environment. However, while the web resource exists, it does not mean that it will be found nor used. Research was undertaken to determine how the website applications and surrounding activities impacted on the use of the website and ultimately provided exposure to the maths tools. The use of the Virtualmaths website has been monitored with Google Analytics. The results have proved interesting in terms of the activities undertaken to promote the site and comparisons with the website hits. While the maths website ranks well in search engine results, much of the traffic to the site is by direct access, through social media and networking sites such as Twitter and YouTube. However, face to face workshops that were used to showcase the web resources were found to produce a significant impact with regard to direct access and user registrations. It is clear that the quality of the materials is important as is the promotion of open access web materials if they are to be used.

Keywords: functional skills, mathematics, teaching and learning, Google Analytics, open access, learning resources.

INTRODUCTION

The provision of open educational content, or open educational resources (OER) is increasing (Attwood 2009) and while the IT movement is embedded within modern culture there is little research on the impact and use of web based learning materials. As online materials are developed it is important to ensure that the content is applicable and that the tools are used, otherwise academia is embarking on an unprecedented level of expenditure which may have a limited shelf life.

There is an assumption that once content is placed on the web then people will find it and use it. Although students have grown up as part of the 'net generation' and are

[1] c.gorse@leedsmet.ac.uk

Gorse, C, Dickinson, I, Ashraf, I, Whitehead, P, Shepherd, T, Smith, M and Platten, A (2010) Distribution and use of digital learning materials: an evaluation of a virtual maths website and surrounding activities. *In:* Egbu, C. (Ed) *Procs 26th Annual ARCOM Conference,* 6-8 September 2010, Leeds, UK, Association of Researchers in Construction Management, 133-142.

skilled in searching and locating websites, many teachers, trainers and lecturers are constantly learning and adapting their e-skills to keep pace with new developments. Currently, our understanding of how teachers and trainers locate websites and whether they decide the content is sufficiently relevant to adopt and use the resources is largely anecdotal. Sites may need to be promoted through reliable channels or be introduced by accepted and more traditional approaches, such as presentations, workshops and seminars as well as promotion through modern methods of communication. Research is required to understand how construction based education resources should be promoted.

Expansion and distribution of web based learning resources

The expansion of the web is without question; however, the limited control mechanisms which assist web growth results in both benefits and drawbacks. Even with the disadvantages, the ability to produce materials that are increasingly accessible is important for education (Hodges 2009; JISC 2009). As a medium, the web can be used to distribute resources easily across the country, thus e-learning platforms are often seen as 'the answer', used to cure nationally recognized problems. Indeed, there are a number of programmes underway to expand and release open education material with the aim of reducing duplication, reducing the cost of producing materials and improving quality (Attwood 2009; JISC 2009). Although such resources exist and are being developed it is of interest to learn the extent to which the learning materials are being found and used. Much of the current open resource development is broad without a specific focus. At this stage the aim seems to be to promote the development of the open access resource. It is also important to understand how different materials sit within web environments and the extent that users in specific fields make use of the resources. Developing resources to improve practical maths in construction is a quite a specific topic and one which is worthy of research to help understand the best way of achieving relevant impact.

Standards of mathematics: a national challenge

There is growing concern that students, teachers and practitioners are not sufficiently prepared in the areas of science, technology, engineering and mathematics (STEM) (Kuenzi 2008). Furthermore, employers, for many years now, have noted that there has been a steady decline in the standards of maths and science knowledge (Lowry 2009). Lord Drayson, in his address at the start of the National Science and Engineering week, stated that "as we enter tough economic times and look to boost British expertise in areas such as high tech manufacturing, the foundation for which is Science, Technology, Engineering and Maths skills, it is more crucial than ever that employers join the drive to inspire young people…" (STEMNET 2009). The common desire to improve the standard of maths education is supported by government ministers whom have advocated a need to develop open, universally accessible, educational resources that are both engaging and stimulating (BECTA 2008a). Unfortunately, even with the expansion of the web and e-learning, high tech functional resources are still relatively scarce and the task of improving the standard of maths still evades most educators (Lowry 2009).

In recent years the application of mathematics to real world context has become a national agenda with the introduction of functional mathematics into the national curriculum (QCA 2006). Web technology has assisted this movement by offering a medium for contextualizing problems and presenting them in multiple delivery formats. With interactive websites, it is possible to explain and present theories in various ways, helping to accommodate different learning styles. Modern methods of

delivery and feedback have achieved significant results improving skills development and knowledge transfer, with some lecturers embracing the technology and many students responding well to the new methods (Hodges 2009). Different and integrated delivery formats have been identified as an important benefit of e-learning (BECTA 2008a), with 'learning by doing' offering one proven method of developing key skills (National Statistics Office 2007). There are critics of functional approaches to mathematics, for example, du Sautoy (2008) is of the opinion that attempts to make learning relevant can reduce the rigor and making the subject less interesting. Gorse *et al.* (2009) also found that some teachers are resistant to contextualized learning or methods that coach students through problems. Those against coaching or contextualized learning prefer to use pure maths theory believing that such approaches are uncluttered with surrounding information and enable the maths to be applied to any situation (Gorse *et al.* 2009). One advantage of web platforms is that they can offer both contextualized problems and the maths theory next to each other, enabling the learner and teacher to select the most suitable learning style for the session. The term recently coined for mixing and matching resources to suit the style of learning and teaching is 'blended learning'; regardless of terminology, it has always made sense to use the appropriate mix of resources for the situation and the learner. Bringing two subjects, such as construction and mathematics together does not on its own make maths more meaningful and engaging. Thought needs to be given to the method of presenting and delivering the material.

Although interactive online activities can capture interest, the downloadable tools, worksheets, group tasks and games are beneficial in skills development (Gorse *et al.* 2009). Not all of the successful web based tools are interactive; they may be paper based tools, activities and games that can be downloaded from the web. Websites may simply offer the repository and medium by which the tools are stored and made openly available; for example, the Open Education Resource Programme offered by JISC does just that (JISC 2009).

Tackling the maths skills gap requires a varied approach (QCA 2008a) and, although there is debate over which teaching and learning styles have the greatest impact (Bose and Bahr 2008), it is obvious that a greater range of resources increases the ability to accommodate the learning styles and needs (Clausen-May 2005). Even with the increased use of ICT in the classroom, the potential of the technology to assist teaching and learning has not been harnessed. The web is world wide, yet there are few sites that offer open access interactive maths resources (Gorse 2008; 2009). While other developed countries are also experiencing problems in the standard of maths education (Kuenzi 2008), the presence of good open access resources on the internet is thin. Open technology repositories are being created for research and education through JISC funds (JISC 2010). In areas such as research, the savings and efficiencies gained through the development of open access resources are claimed to be in the region of £172 million (JISC 2010; Houghton *et al.* 2009). If such efficiency gains can be achieved then, it is worthwhile exploring the development of relevant teaching and training resources in construction; however, thought needs to be given to resources that already exist and whether the resources created are effective.

Some functional maths resources do already exist offering exemplar products rather than providing a comprehensive range of subject matter (for example, National Centre for Excellence in the Teaching of Mathematics 2009; Centre for Innovation in Mathematics Teaching 2009; Proskills 2009; Cre8ate maths 2009; Bowland Maths 2008). Currently, the development of maths resources is sporadic and there is little

information on how the materials are being accessed and used. Our knowledge of online maths materials and their ability to assist teachers still seem woefully insufficient to address current concerns.

Distributing information through web media is part of a developed culture. It is now the norm for children to grow up with information technology, with an estimated 18.5 million households having access to broadband (BECTA 2008b). However, even in the 'net generation' consideration needs to be given to those without internet access. In 2007 1.4 million children did not have access to the internet at home (BESA 2007), two years later it was also noted that over 10 million people in the UK had not gone online (Adams 2009). Although initiatives are underway to develop access in learning centres, schools and through mobile technologies, interim measures ensuring students can take away resources and learn without a computer are still necessary. When developing online material there is a need to discover how the information is found, used and distributed, and how it is used beyond internet connectivity.

RESEARCH METHOD: ITERATIVE DEVELOPMENT AND EVALUATION OF SITE USE

The aim of the project was to produce an open access web based maths resource that would be used by teachers to engage students. The Virtual Maths project uses Flash technology to create functional contexts for maths learning tools (http://www.virtualmaths.org). While the Flash technology enables highly interactive maths problems to be set in construction contexts, for more comprehensive understanding, downloadable tools are made available and can be used as part of classroom activity, for training or self study. Previous studies found downloadable resources to be useful for classroom activities (Gorse 2008; 2009). The site is open access and can be used by all education and training establishments.

Each maths problem developed was created iteratively and sequentially with feedback from users to help inform the development of the learning objects. The iterative development enabled the designers to experiment with different tools and environments.

While the prior research shows that the maths tools have been useful (Gorse *et al.* 2008; 2009), the way people are finding, accessing and using the site was identified as an area for further investigation. Initially, the site received few unsolicited hits and it was felt that it was underused. Using the descriptive statistics and data produced by Google Analytics, the site's use was monitored; the number of hits and registered users were noted against time. Events and workshops used by the team were also recorded to observe potential links between the site's use and promotion events. Feedback on site use and areas for further development was also collected at two workshops. In total 52 forms were received from 62 delegates.

The development and research has been undertaken using action research methods. Action research is interpretative where the researcher is involved in the research setting and, to some extent, the experience itself (Nunes and McPherson, 2002). The cyclic approach to action research is often described as plan, act, observe and reflect. Action research involves learning through action and reflection is undertaken while the work is taking place (McNiff and Whitehead, 2002). Initially, examples of a contextualized maths project were developed by a team of academics, web designers, construction professionals and maths specialists. The team put forward their ideas to create a scenario that would capture the interests of students. Once developed, the

ideas were presented at colleges and feedback was sought. During this period the use of the site was also monitored. The focus of this research was on the activities that took place and subsequent use of the site. If the site is not being used then there is no potential benefit of the open access resource.

RESULTS

Having monitored the Virtualmaths website over the seven months that it has been online, the results show a steady growth in user visits (hits) and registered users. Immediately after launching Virtualmaths, the site was submitted to be indexed by the major online search engines such as Google, Yahoo, Microsoft Bing and AOL. The basic information about the site, its content and related keywords were also submitted to each of these search engines and after two months the website ranked high on the listing for virtual functional maths resources. Currently, traffic from these search engines makes up 22% of total visits. 60% of the website traffic is represented by users accessing the site directly; these users are inputting the web address directly in to their browsers. To access the site directly the user must have the URL (universal resource locator – commonly known as a web address). The address could be gained by recommendation, from a handout, poster, through a search engine, from an event or previous visit to the site. The remainder of the total traffic is made up from other websites linking to Virtualmaths, as well as the Social Networking profiles such as Twitter, which are used to promote and distribute the resources.

The Virtualmaths website has currently been accessed by 1090 individual visitors, 73 of whom have registered to become members. The pages on the website have a combined visit total of 10,101 hits and with user exploring the content for an average of between 5 and 6 minutes.

Figure 2 shows the user hits between the website launch on the 14th October 2009 and the time of writing, 12th April 2010.

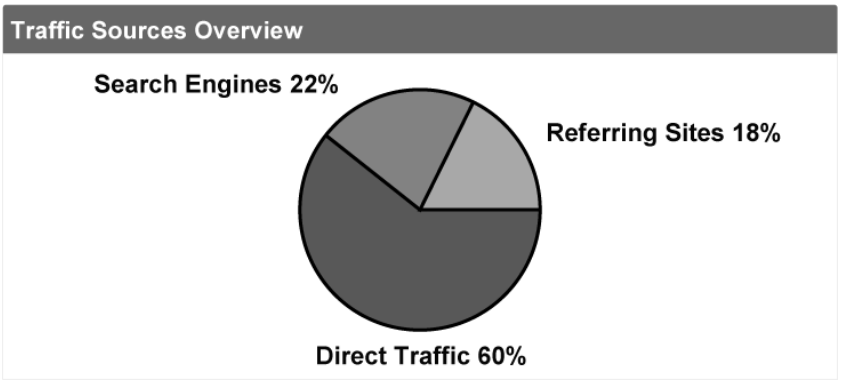

Figure 1: Virtualmaths website traffic: Google Analytics for Virtualmaths.org (12 April 2010)

At each event the teachers and lecturers present were introduced to the site, after which the use of the site dramatically grew. For several days after the maths events, hits from new users were high and exceeded the number of people attending the event, which suggests that the delegates were recommending the website to others. On the feedback questionnaires collected at the events, many attendees noted that they would be passing the information about the Virtualmaths project on to others.

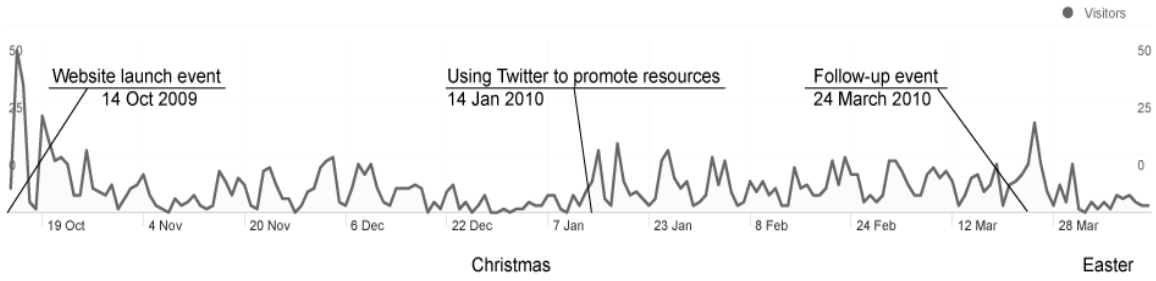

Figure 2: Virtualmaths site use against time and promotion events – Google Analytics for Virtualmaths.org (12 April 2010)

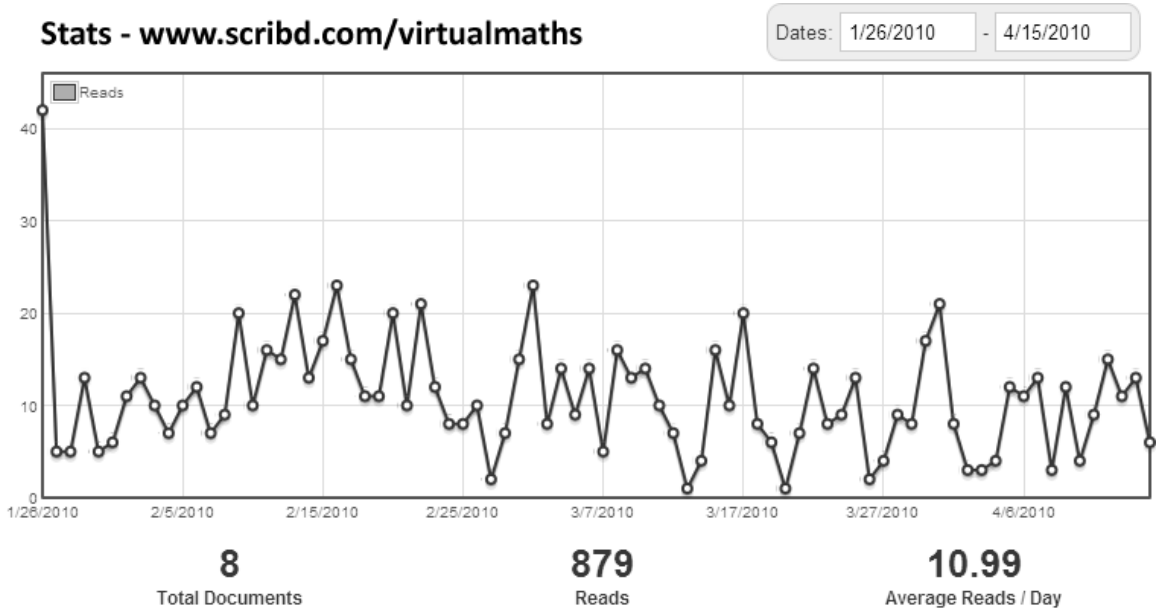

Figure 3: Virtualmaths paper-based resource usage on Scribd.com (16 April 2010)

The Virtualmaths team began using the social networking website Twitter (www.twitter.com/virtualmaths) on January 12th 2010 in order to network with maths teachers and engage with people interested in the project from around the world. The Twitter account has 55 "followers", who are people who actively show an interest in the project and want to be notified of updates.

Twitter was continually being used to promote the maths resources on the Virtualmaths project as well as workshops and events. There are large maths communities who actively interact on Twitter, and use it as a service for sharing information. Each time the Virtualmaths website was updated with a new activity or resource, a "Tweet" including relevant information and web link was sent to the Virtualmaths followers on Twitter and there was an immediate increase in web traffic following. The graph (Figure 2) shows that after the team started using Twitter, there was a steady and continuous flow of new visits to the site.

The rapid response capability of the Twitter platform has led to an unprecedented growth in the viral marketing capability of most e-marketing services. Twitter user's "re-tweet" capability allows a message to potentially spread across the entire user base. Tweets can also be identified through the use of "hashtags" (#VirtualMaths for example); this allows a greater flexibility in searches as all tweets with that hashtag will be automatically linked. Twitter has become a powerful tool for not only interacting with friends, but also for marketing products, services and websites. Companies like Pepsi, Levi's, Dell Computers, Best Buy and The North Face use it as

an integral part of their online marketing schemes and have recorded increases in sales from promotions and deals posted on Twitter. (Twitter Business Report 2010).

Since January 12th 2010, the Virtualmaths team also used a document sharing community Scribd (www.scribd.com/virtualmaths), which has a large database of maths worksheets and other resources, as an alternative host for the paper-based resources from the website. Each document on Scribd was read on average 11 times per day (Figure 3).

EVALUATION: CAPTURING INTEREST

Before trying to understand the site traffic, it was necessary to determine if the resources were considered to be worth accessing. The feedback from the workshops was positive. Those attending the events were enthusiastic about the quality of the materials. Although the hits on the site are the best indication that the resources demonstrated encouraged repeat visit to the site, some of the qualitative feedback included:

- " Very usable and relevant resources".
- "A lot of extremely interesting and helpful information".
- "Very practical, all of the examples can be used in many different ways".
- "Activities which I will share with other staff".
- "An absolute winner – lots of lessons to try out".
- "All of the resources can be implemented into teaching immediately".
- "Activities can go straight into classes".
- "INTERACTIVE, kinaesthetic and visual activities especially suit construction students".

While it is clear that the materials are being used and downloaded, the degree of use is not as extensive as expected. The promotional activities through the web tools such as Twitter are making an impact; however, the use of face-to-face training events, where various uses of the resources can be demonstrated, makes the greatest impact.

CONCLUSIONS

The resources are well received by those that have had an opportunity to work through them, but the locating and use of the site through unsolicited searches is relatively low. Even where the resources are well received and the quality confirmed it is important to identify methods of effectively promoting resources. For open access resources to be effective they need to be used. There is clearly a ripple effect when people find resources and recommend them to others; however, in specific subject areas such as construction related maths the community interested in such subjects within local schools and colleges is relatively small. The disparate nature of teaching groups and the physical distance between them may provide barriers to the transfer of information, even when contained within open access platforms. Currently, face to face events, such as workshops, that expose the resources to those that could benefit from them are important for the adoption and use of open access web based resources. Social media also has an impact on the distribution of information. While many benefit from website resources, the learning providers have preferred and different methods for discovering and learning about such content. Thus, as well as considering the learner needs when developing web resources, some attention needs to be given to how such resources are exposed and introduced to the learning provider.

There is a need to undertake further investigation using inferential statistics to determine the significance of each intervention and promotion event and the related increase in site traffic and use.

REFERENCES

Adams, T (2009) The internet and the 'e-solated', The Observer, Sunday 25th October, www.guardian.co.uk/culture/2009/oct/25/internet-uk-martha-lane-fox [accessed 7/4/10].

Attwood, R (2009) Get it out in the open, The Times Higher Education, 24th September 2009 www.timeshighereducation.co.uk/story.asp?sectioncode=26andstorycode=408300 [accessed 6/4/10].

BECTA (2008a) Universal access / parental engagement – A guide for school leaders. BEC1-15520, January 2008, BECTA,Coventry. www.becta.co.uk [accessed 15/12/08].

BECTA (2008b) Exemplary Progress: A network to share best practice. BEC1-15520, 26 November 2008, BECTA,Coventry www.becta.co.uk [accessed 16/12/08].

BECTA (2009) 82% of parents left 'in the dark' when it comes to their child's schooling. http://news.becta.org.uk [accessed 24/3/08].

BESA (2007) Personalized Learning in Schools – 2007 edition. 'ICT in Schools' series in association with National Educational Research Panel (NERP).

Bossé, MJ and Bahr, DL (2008) The State of Balance Between Procedural Knowledge and Conceptual Understanding. In Mathematics Teacher Education. International Journal for Mathematics Teaching and Learning, 25th Nov 2008, Centre for Innovation in the Teaching of Mathematics www.cimt.plymouth.ac.uk/journal [access 11/1/08].

Bowland (2008) Bowland Maths: An imaginative resource for teaching mathematics Key Stage 3, Bowland Charitable Trust DVD learning package www.bowlandmaths.org.uk [Accessed 10/11/08].

Boston, K (2006) Speech to the advisory committee on Maths Education, Qualifications and Curriculum Authority 8th March 2006 www.qca.org.uk/qca_8579.aspx [accessed 14 12 2008).

Business Twitter (2010) @DellOutlet: Raising awareness increasing sales, measuring results, Twitter 101 http://business.twitter.com/twitter101/case_dell [accessed 12/4/10].

Byron, T (2009) Oh Nothing Much Report: The value of after School conversation. BECTA, www.nextgenerationlearning.org.uk/ohnothingmuch [accessed 24/3/08].

Centre for Innovation in Mathematics Teaching (2009) www.cimt.plymouth.ac.uk [accessed 12/1/09].

Clausen-May, T (2005) Teaching Maths to pupils with different Learning Styles Paul Chapman Publishing, London.

Cre8ate Maths (2009) Mathematics motivational and memorable www.cre8atemaths.cseprojects.org [accessed 2/2/09].

du Sautoy, M. (2008) Without big maths stories our numbers are plummeting, The Guardian, Tuesday 3/6/08 www.guardian.co.uk/commentisfree/2008/jun/03/maths.education [accessed 9/6/08].

Gorse, C, Dickinson, I, Bown, A and Shepherd, T (2008) Developing maths skills in a virtual construction context: benefits and challenges.. In: Dainty, A R J (Ed.), 24th Annual ARCOM Conference, 1-3 September 2008, Cardiff, UK. Association of Researchers in Construction Management, Vol. 2, 963-72.

Gorse, C, Dickinson, I, Walker, C, Whitehead, P and Shepherd, T (2009) Virtual maths: Contextualized learning with new and emerging technologies. In: Dainty, A R J (Ed.), 25th Annual ARCOM Conference, 7-9 September 2009, Albert Hall, Nottingham. Association of Researchers in Construction Management, Vol. 1, 495-504.

Hodges, L. (2009) Time to wave goodbye to old fashioned lecture note, The Independent: Education. 19th November 2009, www.independent.co.uk/news/education/higher/time-to-wave-goodbye-to-oldfashioned-lecture-notes-1822851.html [accessed 3/4/10].

Houghton, J (2009) Economic implications of alternative scholarly publishing models: Ecploring the cost and benefits, JISC EI-ASPM Project. A report to the Joint Informations Systems Committee, January 2009, www.jisc.ac.uk/publications/reports/2009/economicpublishingmodelsfinalreport.aspx [accessed 5/4/10].

Jaggar, D and Ross, A (2003) A survey into the effectiveness of web-based teaching of building design cost management. In: Greenwood, D J (Ed.), 19th Annual ARCOM Conference, 3-5 September 2003, University of Brighton. Association of Researchers in Construction Management, Vol. 2, 633-42.

JISC (2009) Open educational resource programme. Joint Information Systems Committee. www.jisc.ac.uk/oer [accessed 5/3/10].

JISC (2010) Open access for UK research JISC's contributions – Summary of achievements. Joint Information Systems Committee. www.jisc.ac.uk/publications/programmerelated/2009/openaccesscontributions.aspx [accessed 3/4/10].

Kuenzi, JJ (2008) Science, Technology, Engineering, and Mathematics (STEM) Education: Background, Federal Policy, and Legislative Action, CRS Report for Congress, Congress Research Service. March 21 2008 www.fas.org [accessed 2/2/09].

Lowry, M (2009) Inspire Scholarship Work placement award launch. The ICE QUEST Undergraduate Scholarship, Ormeau Baths Gallery, ICE Northern Ireland – Speech, ConstructionSkills www.cskills.org [accessed 20/3/09].

Mathematics Network www.stemnet.org.uk [accessed 23/3/09].

National Statistics Office (2007) Digital age: e-Education – 48% gain skills through learnin-by-doing,15 March 2007, www.statistics.gov.uk/cci/nugget.asp?id=1712 [Accessed 14/12/08].

NCETM (2009) Parent power to improve pupils' potential. National Centre for Excellence in the Teaching of Mathematics www.ncetm.org.uk [accessed 19/3/09].

McNiff, J and Whitehead, J (2002) Action Research Principles and Practice, 2nd Ed,Routledge Farmer.

Nunes, MB and McPherson, M (2003) Action research in continuing professional education, Journal of Computer Assisted Learning, Vol. 19, pp 429-437.

Proskills (2009) Making skills work www.proskills.co.uk [accessed 3/2/09].

QCA (2006) Annual review 2006: quality, Confidence and Aspiration. Qualification and Curriculum Authority. Great Britain. www.qca.org.uk [Accessed 9/12/08].

QCA (2008a) National Curriculum, Functional Skills in the Mathematics programme of study; QCA http://curriculum.qca.org.uk [Accessed 12/1/09].

QCA (2008b) National Curriculum, Mathematics, Key Stages 3 and 4 programme of study QCA http://curriculum.qca.org.uk [Accessed 12/1/09].

Ofsted (2008) Mathematics: Understanding the scores – messages from inspection evidence. September 2008 London, www.ofsted.gov.uk [Accessed 12/1/08].

STEMNET (2009) Minister leads call for industry backing of national Science and Engineering programme. March 2009, Science, Technology, Engineering and Mathematics Network www.stemnet.org.uk [accessed 23/3/09].