Researching STEM?

Dr David Spendlove, University of Manchester
Dr David Barlex, Curriculum Adviser to the Design and Technology Association

When we suggested, almost two years ago, the idea of a special edition of this journal related to STEM (Science, Technology, Engineering, Maths) we could never have imagined the way world and political landscape was about to change. Whilst the ability to predict the future has always been a hit and miss affair, the extent of the financial crisis and the subsequent political and economic impact could not have been foreseen. Within this context education has become a key barometer as to the extent of the crisis and it is clear that existing models of funding for schools and higher education, particularly in the UK education system have become unsustainable.

However whilst cuts of around 50% to universities budgets and increased student fees have been indicated, the UK Treasury has indicated that the Department for Business, Innovation and Skills, will "continue to fund teaching for science, technology, engineering and mathematics (STEM) subjects" (NDS, 2010). As always the devil is in the detail but this might mean that STEM activities may not be hit as badly as other areas of Higher Education. Given the perilous state and the potential lifeline that STEM subjects have been given, two immediate questions arise for those involved in Design and Technology Education:

Firstly, given the financial crisis why has the UK government decided to protect and give priority to the STEM subjects?

Secondly, what is the position of Design and Technology based activities within the STEM agenda?

To take the second question first, this was what drove our interest in having this special edition and why the title of the call for papers, 'Researching STEM?' was posed as a question. The researching and defining of STEM appears to be ill informed and to this end the discussion papers and research papers in this Journal are an early attempt in the evolution of STEM to attempt to identify both the broader nature of STEM and the contribution that Design and Technology can or cannot make.

Returning back to the first question, clearly given such significant spending cuts, various governments around the world see STEM developments as an opportunity to secure future economic prosperity. This poses an interesting challenge and opportunity for the design and technology community as the economic trump card is not one that has been regularly played by the subject. Whilst a utilitarian view of the subject as an essential part of general education has often offered a sufficiently challenging and engaging narrative for the subject it appears that such arguments may now be insufficient. It would appear that with the exception of a privileged selection of subjects', those that in England will be part of the English Baccalaureate[1] (covering achievement in English, Mathematics, Sciences, a Language and a Humanities subject), places on the curriculum will have to be earned. As such the value of design and technology may be judged not against its worth in general education terms but by its contribution both to STEM and the future economy.

Therefore a paradox exists in terms of academic versus vocational worth. Science and Mathematics are seen as subjects worthy of inclusion in the English Baccalaureate, as they are established academic subjects, and whilst they are necessary they are not sufficient (by themselves) for economic recovery. Yet those subjects that directly relate to economic prosperity and provide opportunities for authentic and contextualised learning experiences (notably Design, Engineering and Technology) as part of the development of an emerging 'STEM identity' (inevitably not so well established as they are recent arrivals in the school curriculum) are at best marginalised and at worst ignored in celebrating and recognising notional educational achievement.

To help us untangle these complex arguments, within this special edition, we have invited a 'foreword' and 'reflection' by two influential thinkers, Professor Sir John Holman and Professor Richard Kimbell, who each offer a unique perspective on STEM. We have also invited a 'synopsis paper' from Alice Onion and Sir Brian Follett (Chair of the Government STEM Advisory Forum) to provide an overview of the UK Governments 'STEM agenda'.

Matthew Harrisons paper offers a further unique insight into Engineering and Technology, the two areas most closely aligned to Design and Technology education. Matthew argues for increased clarity and definition of the 'E' and 'T' in STEM accompanied by the development of an 'engineering pedagogy'. This is in a context, as already alluded to, where engineering as a school activity remains

[1] *Statement of intent 2010 – Addendum*
(the English Baccalaureate with individual students' future achievements marked through a certificate).

relatively small whilst in economic terms a strong engineering community would appear vital for the future prosperity of the UK. Therefore such calls, politically, may be timely.

The distinction between being radical and reckless with curriculum reform is however probably defined by the degree of reflection and discussion that takes place prior to, rather than after such reform. Therefore John Williams's paper is timely in suggesting that the Design and Technology community should 'proceed with caution'. John's paper echoes Richard Kimbell's reflection piece and places his argument in a world context arguing that a lack of clarity combined with political expediency and unfounded rhetoric suggests a reckless rather than radical approach by governments looking for quick solutions. The lack of a clear educational rationale within the STEM agenda would appear sufficiently convincing to 'proceed with caution' and the danger is that the overwhelming economic arguments may surpass any educational debate.

It would however appear to be unwise for the Design and Technology community to completely ignore the STEM agenda, therefore an obvious question is how can initial teacher education prepare future teachers to be open to such an agenda and to the possibilities of interdisciplinary activity that such openness might afford? Lindsay Brears, Bill MacIntyre and Garry O'Sullivan argue that problem based learning (PBL) provides an environment for pre-adolescent pupils (aged 10-14 years) that can be used to 'integrate' Science and Technology education and their research describes the responses of New Zealand teachers in training to their own experience of such PBL. The responses show a high level of reflection and evaluation and indicate that the trainees have strong intentions to build this approach into their future practice as middle school teachers. This is encouraging and echoes John Holman's point in his foreword that there are benefits when 'teachers move, however cautiously, out of their subject silos'.

The influence of the 'subject silo' is also evident in Joël Lebeaume's highly informative account of attempts to integrate the STEM subjects in France. To say that there has been resistance to this would be an understatement and although the situation in France is decidedly different to that in England Joël captures nicely the inertia that resists such change and the time likely to be taken for a new curriculum to emerge "when it takes half a century to stabilise a curricular structure change requires probably the same amount of time…where change is seen as a break and a revolution". As the Science, Technology, Engineering and Mathematics (STEM) Programme Report (DFES & DTI, 2006) is only four years old Joël's analysis indicates that it is very early days to be considering anything significant in the way of change in the relationship between the contributing subjects.

Textiles as a subject remains an underrepresented area within STEM discussions. Using a grounded theory approach Chris Hughes, Dawne Bell and David Wooff examine both teacher's practice and perceptions of the place of Design and Technology in STEM. Through semi-structured interviews, focus group dialogue and email conversations the importance of a dynamic relationship between Design and Technology and Mathematics and Science emerges. From their research the question emerges of how such a relationship between subjects can become more transparently incorporated into mainstream curriculum lessons and they identify how teachers need to be aware of the contribution they can make to the emerging agenda.

So, where does this leave STEM as we await the forthcoming review of the English National Curriculum? The UK coalition Government appears committed to the idea of rigorous academic subjects as the basis for school education (The Importance of Teaching, Schools White Paper) and whilst this may be good news for Science and Mathematics it immediately puts Design and Technology on 'the back foot' as it has always resisted such pigeon-holing insisting on "being neither a specialist art nor a specialist science. It is deliberately and actively interdisciplinary. It is creative, restive, itinerant, non-discipline" (Kimbell and Perry 2001).

Such a position, which resists definition, may now be less tenable and in the new 'subject orientated' environment it will become more important for Design and Technology to define itself rigorously as a subject in its own right so that it can maintain its place in the school curriculum. Whether or not, to quote John Holman, STEM signals a profound shift in the way schools think about the relationships between subjects or proves to be 'a passing fashion' in education, Design and Technology remains a subject that offers opportunities that other subjects cannot provide. The defining of Design and Technology as a subject does not therefore need to be seen as compromising the uniqueness of the subject and may be a small price to pay for ensuring the future of Design and Technology.

The forthcoming review of vocational education by Professor Alison Wolf will also offer further implications and opportunities for both Design and Technology and STEM and whilst a strong presence in vocational education offers obvious benefits this will not be without

consequences for the subject in the school curriculum. The need for clear thinking and discussion, informed wherever possible by research, has therefore never been more important.

Finally, It is unusual to comment on book reviews in the editorial to a special edition. However the nature of the books under review and the quality of reviews warrant breaking with tradition. The first book, Sustainable Energy – without the hot air (Author: David MacKay), deals with the validity of various responses to climate change. Deciding what is best to do about the way we utilise available energy sources is surely a STEM activity of epic proportions and importance. So the book sets an interesting agenda for the way the school curriculum, particularly subjects such as Design and Technology, Science and Mathematics should respond. The review is equally impressive in that it not only summarises the book well including citing those who might not agree with MacKay's position but also describes how it might be useful across a range of curriculum development activities highly relevant to STEM.

The second book, Creativity: A handbook for Teachers (Editor: Ai-Girl Tan) discusses a breadth of issues that those interested in creativity will find useful. However whilst 'STEM' and 'creativity' seems to be an area waiting to be researched, the area of 'ethics' and 'creativity' is highlighted as an area of interest in Professor Stephanie Atkinson's review. The issue of ethics being not simply related to creative processes, "but more importantly to the applications of creativity, with the creative products themselves". This is an important point that we shouldn't forget, as whilst in this special edition we have discussed the many benefits of STEM, the misuse of interdisciplinary and creative approaches to achieve unethical objectives must also be a consideration.

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david.barlex@btinternet.com
david.spendlove@manchester.ac.uk