Linking Lessons learnt from the Classroom with Research Findings on Pedagogies with GIS.

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Abstract
When used effectively, GIS are powerful purveyors of information where maps, photographs, satellite images and other spatial data can be generated together. However, this potential is yet to be fully recognised in geography education in UK schools. The associated challenges with implementing such technologies are not unique to GIS. In this paper, research evidence suggesting connections between successful implementation of a technological innovation and developing effective pedagogies is explored. Research also suggests that teachers respond particularly well to peer-professional development. Two such professional development networks are considered, here.

Key Words: GIS, effective pedagogies, professional development networks.

Introduction

The challenges presented to teachers attempting to develop effective pedagogic practices around geo-technologies such as GIS can be daunting (Kankaanranta, 2004). Evidence suggests that only the very best classroom practitioners are using technologies such as GIS successfully (Hay McBer cited in Web and Cox, 2004, p.278).

A range of effective pedagogical practices with ICT have been identified in the literature including emphasis on collaborative and scaffolded learning. However, getting teachers to a stage where they can instigate successful and productive group activities with ICT in the classroom and select appropriate opportunities for student's individual use of ICT is a potentially complex and challenging task (Web and Cox, 2004).

At a time when significant curriculum change is again being implemented in geography education in UK schools, this is a timely opportunity to engage in debate about how we can develop these pedagogies with GIS further.

Research findings on pedagogy and GIS

'It is important to understand what is stopping us and what is helping us to develop the subject' (Kirkham cited in Kent, 2006)

Research suggests that connections between successful implementation of a technological innovation such as GIS and the role of teachers has not been fully explored or understood. It is true that very little guidance exists for teachers wishing to develop pedagogies involving GIS. It is also clear that already over-stretched teachers, including a large minority of non-geography specialists are unlikely to embrace GIS without a considerable amount of sustained support. Some researcher suggests that difficulties experienced by some teachers confronted by the spatial querying that is an inherent aspect of using GIS is a specific area of teacher training that needs to be more specifically provided for (Bednarz & van der Schee (2006).

Other evidence also suggests that all ICT-related curriculum innovation requires teachers to develop their pedagogic strategies in considerably more complex ways than they may have

done before. They need to be cognisant with a range of areas of knowledge: their own subject content knowledge, knowledge about how students think and learn and increasingly in the twenty-first century classroom, knowledge about how to use technology.

Recently, Mishra & Koehler (2006) have adapted this concept into a broader pedagogical framework to include a specifically technological dimension.

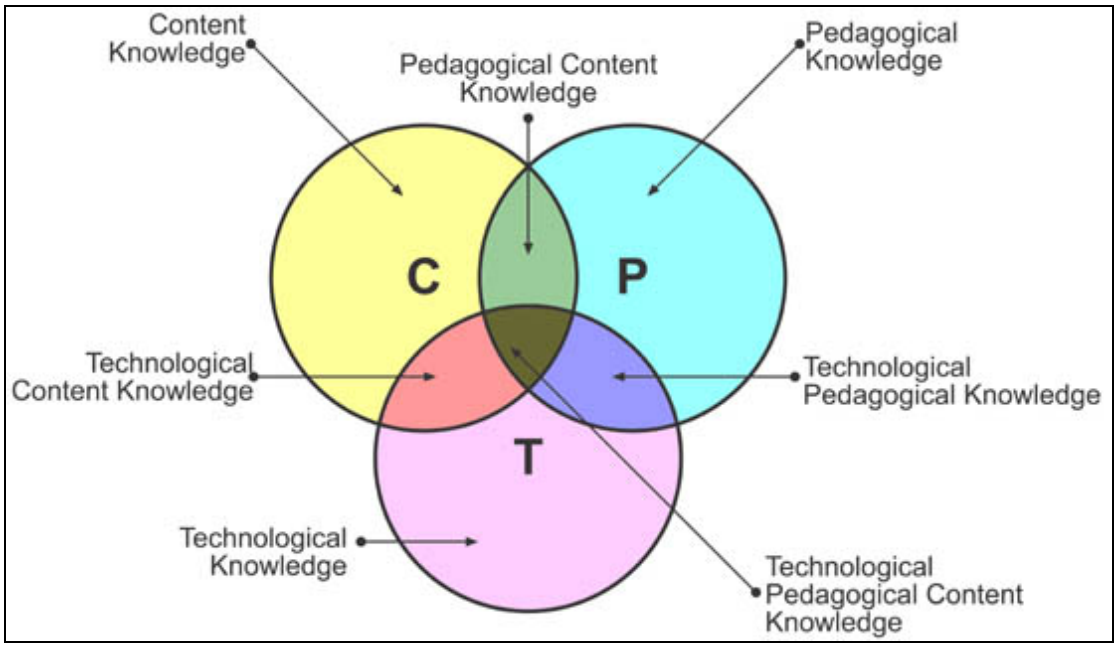

Figure 1 The Technological Pedagogical Content Knowledge (TPCK) framework (Mishra & Koehler, 2006) http://tpck.pbwiki.com/

Mishra & Koehler's *TPCK framework* brings together knowledge about Content (C), Pedagogy (P) and Technology (T) as important inter-relating factors affecting the development of effective teaching with technology.

Content Knowledge (*CK*) is subject-based knowledge. Every subject has a specific core of central ideas and concepts that teachers need to be fluent with if they are to present accurate accounts of key content knowledge to their students (Shulman, 1986).

Pedagogical Knowledge (PK) has a broader significance including the elements of the art of teaching and theories about how individuals learn.
The intersection between content knowledge and pedagogical knowledge encompasses

Pedagogical Content Knowledge (*PCK*) (Shulman, 1987). *PCK* is a more applied knowledge. When a teacher applies *PCK*, they are making qualitative decisions about effective teaching and learning *within their subject.*

Technological Knowledge (*TK*) involves the ability and competence to operate both simple and more advanced technologies. With specific reference to a more advanced digital technology such as a geographic information system, *TK* could involve navigating between raster layers or importing geo-referenced data from a website.

Technological Content Knowledge (*TCK*) requires teachers to be conversant with the ways in which technology can be applied to their subject matter. For example, a basic understanding

of how geographical information (GI) is stored in vector, raster or hybrid GIS greatly facilitates clarity of a user's understanding about how data can be digitally manipulated.

Technological Pedagogical Knowledge (*TPK*) involves knowledge about how the use of specific technologies can be used to enhance particular types of teaching and learning. For example, a geography teacher with proficient *TPK* would be familiar with the pedagogical benefits of using Google Earth (the web-based earth viewer) for manipulating global images when teaching scale. Other teachers with different training or experience may be familiar with ArcGLOBE (an industrial strength GIS).

Technological Pedagogical Content Knowledge (*TPCK*) lies at the core of Mishra & Koehler's framework. *TPCK* requires technological competency, pedagogical skills and firm foundations in subject knowledge. But even more than this they suggest that:
'TPCK is a form of knowledge that expert teachers bring to play anytime they teach.'
(Mishra & Koehler, 2006, pp.15)

Successful GIS-supported pedagogies in geography education are more likely to occur through careful consideration of a framework such as Mishra & Koehler's *TPCK*. However, if we are to develop support for teachers using GIS further, consideration of a theoretical framework is likely to be only the beginning of the process.

'The need for teachers' professional development is clear but enabling teachers to adapt their pedagogical reasoning and practices in response to learning opportunities provided by ICT is likely to be a very difficult and complex process.'
(Webb and Cox, 2004, p.278)

Professional Development Networks
Many teachers like to learn from other teachers (Crandall et al 1982). Indeed the benefits of school-based geography curriculum development through CPD are well-documented (Kent 1996; Rawling 2001). The acts of sharing new strategies at peer level can be powerful if complex processes contributing to professional learning (Groundwater Smith 2001). In particular, the intimacy of shared goals can help to overcome the well-documented phenomenon of individual teachers feeling geographically and philosophically isolated (Hargreaves 1998). When teachers are pivotal, the processes of setting a collective agenda often become more readily transformative (Sachs 2003). However, the success of teacher collaboration in curriculum innovation is dependent on a range of challenging and complex factors not solely restricted to the innovation itself.

'Teachers today are having to learn to teach in ways in which they have not been taught themselves' (Hargreaves et al 2001, p197).

There are a wide range of other factors at work which contribute to these challenges. The recent and continuing rapid rate of technological change can be hugely problematic in itself. Even when teachers are trained to use particular software packages, familiarise themselves with the intricacies of new or adapted hardware or painstakingly learn associated terminologies, their training can become swiftly out of date (Mishra & Koehler, 2006). Added to this, several software packages currently in use in schools were not designed with education in mind. This is particularly true of GIS packages (Bednarz & van der Schee, 2006). Bednarz and van der Schee identify external and internal factors which may affect teachers' decisions to become involved in curriculum innovation (Bednarz and van der Schee, 2006). They identify the influence of both external and internal factors in this process.

Authority, power, manageability and consistency are as important external influences. For example, seminal texts may sway teachers' attitudes towards and not away from innovation. Power can be directly linked to authority too – compulsory status for fieldwork in the geography curriculum empowers the subject as a whole. Manageability is also seen as a vital factor, with teachers less likely to adopt innovations which are difficult to master. Consistency is cited as an attractive feature too – if an innovation 'fits in' with current practice and systems easily it becomes a more attractive proposition. Important internal factors include previous experience and learning goals.

Proactive approaches towards developing successful pedagogies with GIS

In their recent examination of twenty-six cases of good practice across Europe, North America and Australia, Kirschner & Davis (2003) have addressed this difficulty. They identified six significant benchmarks of teacher professional development programmes where teachers are trained to:

- 'become competent personal users
- become competent to make use of the ICT to organise data for students (e.g. via a GIS database)
- master a range of educational paradigms (models) using the ICT;
- competent in their use of ICT as a tool for teaching;
- master a range of assessment paradigms which make use of ICT;
- understand the policy dimension of the use of ICT for teaching and learning.'

(Kirschner & Davis, 2003)

Their large-scale study suggests the need for a considerable deepening of teachers understanding and application of ICT before progress with pedagogy can be made.

Spatially Speaking

'Spatially Speaking' is a 'Local Solutions' (LS) project developed by the Geographical Association and supported by ESRI UK and the British Educational Communications and Technology Agency (BECTA). The project currently involves a team of GIS teacher innovators and beginners from several different schools working together on developing pedagogical strategies around the use of the newest geo-technologies in the classroom. The 'Spatially Speaking' membership also draws on expertise and experience from other representatives of the GIS industry, teacher educators and educational researchers. A central aim of the project is to give the team time and space to work together to provide tried and tested pedagogical guidance that will be made available to other UK teachers via the Geographical Association's website.

Advancing Geospatial Skills in Science and Social Science (AGSSS)

One recent project which aims to address this need more comprehensively is the Advancing Geospatial Skills in Science and Social Science (AGSSS) scheme run by the Geography Department at Texas A & M University, USA. This support network aims to enhance the development of spatial skills in local schools. As part of this support, graduate students are invited to work as Advancing geospatial Skills in Science and Social Studies Fellows with teachers and students in the local community. AGSSS fellows are employed to undertake responsibilities which include regular and wide-ranging commitment to their partner schools. Their training includes guidance on effective mentoring in spatial thinking and induction course on school systems. Fellows become involved in curriculum development and evaluation as part of this shared learning. Teachers and fellows work together to design and implement research to evaluate the project and make recommendations for future curriculum development involving spatial thinking.

Conclusion

'A classroom that uses GIS as a problem-solving tool is a classroom in which the walls are invisible and the teacher and student assume roles that are non-traditional….Adopting this technology is not for the fainthearted. But integrating GIS into the curriculum rewards teachers by creating intellectually challenging and demanding learning opportunities.' (Audet & Ludwig 2000).

Sustained success with the introduction of any ICT in education depends on a complex range of internal and external factors including: training, resources and issues around organisational methods and technical support (Minaidi & Hlapanis, 2005).

'Above all, planning must consider the pre-implementation issues of whether and how to start, and what readiness conditions might be essential prior to commencing. Implementation planning is not a matter of establishing a logical sequence of steps deriving from the innovation or reform at hand.' (Fullan, 1991)

There is growing evidence that harnessing the full potential of digital technologies such as GIS in schools may require more effective partnerships between industry and education. Increased uptake of GIS use in geography school education is likely to require development of a 'shared vision' with proven practices established for supporting innovators and beginners (Becta, 2006). Sustained success with introduction of ICT in education depends on a complex range of internal and external factors including: training, resources and issues around organisational methods and technical support (Minaidi & Hlapanis, 2005). Integrated strategies at both a local and national level which recognise and address the complexities of these inter-related factors will be required if we are to *finally* fully realise the potential of GIS for geography education.

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