Teaching GIS in International Development as an Employability Skill

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(Received 1 June 2013; final version received 16 January 2015)

Abstract:

The importance of developing employability skills of graduates has become a strategic priority in higher education. Knowledge of Geographic Information Systems (GIS) tools is a valuable skill for graduates both in terms of the specific skillset it provides and the wider transferable skills. This paper discusses the importance of GIS as an interdisciplinary and employability skill within the setting of a weeklong intensive GIS course taught in the School of International Development at UEA. GIS as an employability skill within a commercial setting is also discussed, with the focus on how to teach GIS most effectively in this setting.

Keywords:

GIS, teaching, employability, interdisciplinary, international development

1. GIS as an Employability Skill within International Development

The application of Geographic Information Systems (GIS) has been taught as part of geography degrees for many years and is often considered to be a key employability skill unique to geography graduates (Whyatt, Clark, & Davies, 2011). In addition, learning GIS enables graduates to develop many transferable skills that are desired by UK employers, such as spatial thinking, spatial statistics, planning and environmental awareness (Institute of Directors, 2007; Solem, Cheung, & Schlemper, 2008). The School of International Development (DEV) at the University of East Anglia has a strong focus on employability, which it defines (after Yorke, 2005) as:

> "…a set of skills, knowledge and personal attributes that make an individual more likely to secure and be successful in their chosen occupation(s) to the benefit of themselves, the workforce, the community and the economy."

The importance of employability skills has come to the fore in all degrees and it is now much more common for graduates to question what specific roles or jobs are available to them (Dowling & Ruming, 2012). Learning to use GIS provides an important technical skill both for those who go on to use GIS in industry and those who do not directly make use of it on a regular basis, but may utilise GIS approaches in decision-making (Whyatt et al., 2011). With that in mind, it is concerning that a recent ESRC report (ESRC, 2012) on Human Geography in the UK states that there are relatively few human geographers taking up GIS skills and there are diminished departmental priorities in this research area. They say that this is "most surprising in light of the growth of … GIS in the US. If the current trend continues, UK geographers may soon lack the skills necessary to analyse and interpret the large (geographic) data sets ... although several of the methods have been developed in the UK"

(ESRC, 2012, p. 12). This is also acknowledged within the geography discipline; Longley (2000) and Singleton (2014) highlight the trend within human geography for geographers to use GIS tools but not to be involved in the development of new GIS techniques. If this trend continues then human geographers will find themselves using GIS tools created by non-geographers, which may not be appropriate for the tasks they are completing.

GIS is a key employability skill for students undertaking studies in International Development and across many other subjects that make use of spatial data (Dunn, Atkins, & Townsend, 1997; ESRC, 2012; Silvey, 2002). Managing and understanding spatial and/or complex data, in combination with associated numeracy and ICT skills are valued by businesses, and GIS allows graduates to develop and demonstrate these skills (Institute of Directors, 2007). The wider application of benefits associated with GIS has resulted in it being taught across a much broader range of subjects than previously, when GIS was traditionally limited to Geography or Environmental Sciences. Transferring GIS courses to a different department has its own specific challenges depending on the approach used (Shepherd, 2009). This paper presents a case study of two environmental science GIS professionals teaching GIS as an employability skill to Masters students in the School of International Development (DEV), University of East Anglia. We discuss the changes and adaptions we had to make from teaching GIS as an academic skill to teaching it as a employability skill, as well as discussing how our experience of GIS training and use in a commercial setting helped us make this transition.

2. GIS in International Development

The main case study presented in this paper describes how an environmental science GIS course was developed for Masters students within an International Development department. The UEA has a strong GIS group in the School of Environmental Sciences (ENV) and the Norwich Medical School but use of GIS in other schools is limited. DEV had relatively limited experience in the use of GIS in research or teaching, which was one of the driving factors behind the development of this course.

International ‘development’ is traditionally understood as short and long-term global processes of structural and societal transformation (Sumner & Tribe, 2008). The study of international development is inherently multidisciplinary and considers a diverse range of topics including poverty reduction, improving levels of health and education, the development or maintenance of ecologically sustainable livelihoods in the context of rapid rural and urban transformation and the influence of gender, power and governance structures on these processes. Traditionally international development was concerned with the transfer of knowledge and resources from the ‘North’ to the ‘South’ or from the ‘West’ to the ‘Rest’. While the increased affluence and influence of countries such as India, China, Brazil and the Gulf states in both aid and trade now makes such distinctions problematic, nevertheless, development theory and practice remains intrinsically concerned with notions of space and location. Skills and knowledge to use tools such as GIS, which enable analysis and understanding spatial effects and relationships, thus have wide application in international development ranging from mapping the utilisation of ecosystem services from conservation areas by society (Willemen, Drakou, Dunbar, Mayaux, & Egoh, 2013) to assessing and responding to humanitarian needs following natural disasters (Verjee, 2010).

Graduates from DEV face a competitive employment environment and employers highlight the importance of practical skills and experience as major factors in deciding whom to recruit (Lowden, Hall, Elliot, & Lewin, 2011). In recognition of the need to continue to enhance the practical skills and employability of DEV Masters and Undergraduate students the School has invested in developing a programme of optional practical and professional skills workshops. GIS skills were recognized by DEV faculty as a relevant technical skillset with strong potential to help students to stand out from the crowd in a competitive jobs market. Notably, students who registered to attend the course also identified enhancing their employability as the key motivation for acquiring GIS skills:

> "I want to attend the GIS course as I think it will really help me in my area of work, … environmental health and decision-support technologies."
> (MSc Climate Change and International Development student, 2012).

As DEV lacked staff with specific GIS teaching experience, the authors were commissioned to design and run a one-week intensive course for DEV Masters students, to develop their skills for using GIS in their dissertations and as an employability skill. The course is now in its fourth year and is revised on an annual basis in response to student feedback, software updates, the availability of new technologies and approaches. Anecdotal evidence from students who have taken the course indicates that some have found GIS skills relevant in their employment following graduation.

2.1 Overview of DEV GIS Course

The course was designed to be an introduction to GIS for Masters level students in DEV, with an emphasis on practical skills for employability. The intended learning outcomes were:

- To improve understanding of mapping tools and their applications in natural resources and environmental research, management and development (the areas GIS is most used within international development).
- To develop practical skills, specifically in GPS use and GIS software.

This was an optional course, with GIS advertised as an employability skill with the material having a practical focus. The students each paid £50 to attend, and the course focused on practical skill development, underpinned with the principles of GIS theory. The course has a greater focus on practical skill development (compared with other academic courses on GIS) because it focuses on GIS as an employability skill rather than an academic skill.

Due to timetabling limitations, the course ran as an intensive training course over five days. The course covered three different levels of spatial tools - Participatory Rural Appraisal (PRA), geobrowsers (Google Earth) and GIS software (ArcGIS[1] and QGIS[2]). PRA is similar to a number of techniques used in participatory GIS and is something many DEV students are already familiar with. This technique is often used in the field, to gather the local population's view of their surrounding area or to map villages and their local resources (e.g. Chambers & Kumar, 2003; Wates, 1999). The course then focused upon the use of Google Earth, GPS units, ArcGIS and QGIS. The inclusion of PRA and Google Earth emphasised that GIS is merely an extension of the students existing skillset, as they are already familiar with many of the concepts of 'space' from their previous studies. In addition, we asked a

[1] ArcGIS 10.0, http://www.esri.com/software/arcgis
[2] QGIS 2.0.1, http://www.qgis.org/

number of DEV lecturers to talk to the students about how they used GIS in their work. Topics included using GIS as a tool for understanding lake area fluctuations, mapping seed flows through informal markets and livelihood and resource mapping in Asia. The final section of the course was dedicated to student projects, where the students were able to apply the GIS skills that they had learnt to create a publication-quality map in an area of interest to them (e.g. a Masters dissertation or field work).

The course comprised of lectures and self-led practical sessions. The practical sessions (nine in total) ran in a supervised computer lab, which allowed the students to work through the material at their own pace and to seek help when necessary. The topics began at a basic level (e.g. importing GPS points in to Google Earth) and developed into intermediate (e.g. creating a publication quality map) and advanced topics (e.g. site selection and remote sensing). The GIS tools and techniques the students covered included: georeferencing, joining data, map design and basic analysis (including buffers, point-in-polygon analysis, dissolving and unions).

ArcGIS is widely recognised as one of the most commonly used GIS, with market share estimates varying from 40% to 70% (Directions Mag, 2011; GIS Lounge, 2011). Based on an informal review of current job descriptions, it is experience in this platform that is important to employers recruiting from an environmental science background. However, students across all subjects go on to work for a variety of organisations including non-governmental, governmental and commercial companies. ArcGIS is relatively expensive to buy on a commercial basis (between £1,545 and £14,425 + VAT depending on features for an individual commercial license, ESRI, 2014, pers. comm.), and many organisations that students might go on to work for are likely not have the resources to procure ArcGIS licenses. QGIS is included in the course as it is a free, open source alternative to ArcGIS and is a piece of software that is often adopted by organisations with limited resources. Open source GIS is increasingly being adopted in academic research to enable and support reproducible research (Brunsdon, 2011). With the increasing adoption of open source GIS, having GIS skills in multiple GIS software packages is an important employability factor for students applying to GIS related positions who can better distinguish themselves from other candidates.

2.2 Developments to the DEV GIS Course

The GIS course undergoes continuous improvement, with course updates based on our experiences as tutors, feedback from the students and changes in the technology and software that is available. The focus on self-led practicals works very well as the students indicate that they like the flexibility to work at their own pace. Some of the stronger students commented that they would “like more exercises”, so a range of optional exercises were added to each practical which allowed the stronger students to further develop their understanding while ensuring the weaker students did not miss out on any fundamental concepts. One of the students in the feedback form said they would like a list of the technical GIS terms we used, so we created a glossary of GIS terms and definitions. The students enjoy the opportunity to spend some time dedicated to a project of their choice, and often students have requested more time for the project, but unfortunately this is limited by timetabling. A number of students highlighted the importance of the employability aspect of GIS, and recommended the course for other students by saying they found GIS “a very helpful tool for their future work.”

The level of computer literacy of the students varies considerably and this is something that we take into account in the practicals. For example, some of them do not understand the concept of folders or folder structures, downloading files from the Internet or extracting files from zip files. The issue of technical skills is one that there is wide anecdotal evidence of within GIS teaching, but little formal evaluation (Jones, 2011, pers. comm.; Ellul, 2011, pers. comm.; Appleton, 2012, pers. comm.). A study from computer science (McLennan & Gibbs, 2008) found that students who graduated more recently had higher online computer skills than those from a decade earlier, but lower offline computer skills such as file management, which are some of the skills required for GIS. In our own experience, it is common for students to be able to search the Internet for information using Google or to be able to update their Facebook status, but to be unable to recognise folders or know what a URL is[3]. Occasionally we have some students who are very technically strong and a few years ago we had a student who created a series of cartograms for their individual project (using the ArcScript addin for ArcGIS[4]), which was far above the level that we expected.

The method of teaching over a one-week intensive period is in contrast to many other GIS teaching across different universities, which tend to adopt a modular approach, either teaching GIS as a stand alone module across a semester, or integrating it within existing modules. The teaching as a stand-alone course originated from a desire to make a variety of professional skills courses available to students across all Masters programmes. Students from a variety of disciplinary areas can thus elect to develop GIS skills, while others pursue other areas of professional interest. While this has some advantages there are potentially some costs. For example students are not formally assessed on their assignments which may affect motivation and performance. Anecdotal evidence from students supports an intensive approach with students expressing that they felt the intensive approach was more effective, compared to their previous GIS teaching experiences. Additionally, DEV lecturers consistently suggest that they find the intensive method suits their typical patterns of working with GIS (Springate-Baginski, 2014, pers. comm.). In GIS there is very little research on comparing these two teaching methods, (Chen, 1998; Keiper, 1999, Rickles, 2013, pers. comm.), with findings from non-GIS teaching inconclusive (Kucsera & Zimmaro, 2010; Lawton, Rankin, & Elliott, 2013). Some of the students will go on to use GIS in a commercial setting and it is important to consider how they are likely to use GIS in a commercial setting and how this differs from using GIS in a academic setting.

3. GIS in a Commercial Setting

The use of and training in GIS in a commercial environment is markedly different to that of academia. These differences need to be considered when designing teaching material at Masters level, as many students will go on to use GIS in a commercial or NGO setting rather than an academic setting. This is particularly relevant when the course presents GIS as an employability skill rather than as an academic skill. The differences include the types of analysis undertaken, the tools available to achieve outputs and the time available to produce the desired results.

[3] Students go to Facebook without knowing that the URL for Facebook is http://www.facebook.com by searching Google for 'Facebook' and clicking on the first search result.
[4] Cartogram Geoprocessing Tool 2, http://arcscripts.esri.com/details.asp?dbid=15638.

The range, number and proficiency of GIS users vary across business sectors in a commercial setting as a response to business requirements and the availability of skilled personnel. Whilst there are many hundreds of GIS users in a typical large consultancy, the vast majority use GIS as a tool for querying and displaying spatial data, while a small contingent of 'super users' use GIS for more advanced analysis and programming / development. Typically, the utility of GIS analysis tools within the business environment focuses upon service or process automation, spatial analyses and map production. Therefore, training requirements typically centre on these needs whereby colleagues often require advice on automation or batch processing of large datasets (e.g. ArcGIS ModelBuilder utility or bespoke software or tool development). Training requirements also include the appropriate use of different types of spatial analyses at different spatial scales and the production of similar maps for multiple study sites or areas (e.g. the ArcGIS Data Driven Pages tool). As a result, there is often a distinction between the types of analyses undertaken in the business context and those in academia, although the principles used to undertake either type of analyses often overlap. The skills regularly used in a commercial setting have been incorporated into the training material to familiarise students with the common tasks they may be asked to perform if the go on to use GIS in a commercial setting. This includes digitising hand drawn annotations, as well as locating and importing data from a variety of sources for the project section.

Alongside the different types of analysis undertaken on a day-to-day basis within the business environment, the varying use of GIS software and tools is also apparent. For example, whilst the associated costs of software and licences might be covered by academic discounts in universities, the costs associated with commercial software licensing can be upwards of tens of thousands of pounds per business for technical software like ArcGIS. These costs may be charged to individuals who install and use the GIS software, as a business overhead per user per month. The result can be a smaller contingent of users with access to GIS software (i.e. only where there is a business case for doing so); for example, a particular project that requires some spatial analyses that the individual is working on. This is in stark contrast to the 'all-access' model in the academic world.

Over the last few years, rapid improvements to open source GIS (for example, QGIS) has opened the eyes of many businesses seeking to take advantage of spatial software/technologies who are also looking to improve their competitiveness, by reducing costs in times of austerity and to broaden their technical skill base. The latest version of QGIS has been instrumental in facilitating improved uptake of GIS software amongst colleagues, diversification of workforce skill sets and in reducing business costs. Crucially, the software is able to be delivered to users at zero-cost which has resulted in greater uptake of the software by low-level users for whom complex spatial analyses are not required. In addition, the wider roll-out of QGIS has facilitated the development of bespoke tool development for clients who are in turn also able to use the tools without the need to purchase additional add-ins or expensive licences. Moreover, the use of open source GIS has expanded market capabilities in terms of the types of services that a commercial organisation could offer their clients such as software training and for future proofing the business to changing technologies.

These advantages mean that open source software like QGIS are here to stay and are very much welcome in the business environment. This increased use of basic level GIS has resulted in a different training requirement, and existing skills in GIS are therefore more

important than ever to a business in this situation. Moreover, the GIS skills taught to new graduates are crucial to improving the UK's technical capability and the competitiveness of UK businesses as a whole.

4. Conclusion

GIS has been acknowledged as a key employability skill (Solem et al., 2008) and GIS is now an interdisciplinary subject, taught across a much broader range of subjects than even five years ago (ESRC, 2012). It is important to be able to give students a comprehensive idea of how GIS is used both in academia and in commercial organisations as well as making the GIS material used appropriate for a wide range of disciplines. Therefore a number of important ideas, concepts and practical applications highlighted in this paper have been included in the course based on the authors varied commercial and academic experiences. This is in addition to the inclusion of open source GIS software in the course, which is increasingly being adopted across the range of organisations that use GIS.

We presented a review of the GIS course taught in the School of International Development at the UEA, emphasising the reasons for the importance of GIS as an employability skill and the need for students to be familiar with a variety of software packages. This is important because GIS is increasingly considered to be an important key employability skill, with the wider benefit of GIS evidenced through improved strategic thinking and environmental awareness. The range of users is widening and teaching GIS courses with an employability focus outside of traditional Geography departments is key to ensuring that the next generation of scholars are suitably equipped to deal with new technologies and increasingly competitive markets.

Acknowledgements

We would like to thank the four cohorts of students who have taken part in the course and given us very valuable feedback. We would also like to thank Oliver Springate-Baginski who has helped us run and develop the course within DEV, as well as Patrick Rickels, Claire Ellul and two anonymous reviewers for their assistance and comments. The European Centre for Environment and Human Health (part of the University of Exeter Medical School) is part financed by the European Regional Development Fund Programme 2007 to 2013 and European Social Fund Convergence Programme for Cornwall and the Isles of Scilly.

References

Brunsdon, C. (2011). Reproducible Research: What Can Geocomputation Achieve? Presented at the GISRUK2011, University of Portsmouth, UK.

Chambers, R., & Kumar, S. (2003). *Methods for Community Participation: A Complete Guide for Practitioners*. London: ITDG Publishing.

Chen, X. M. (1998). Integrating GIS Education with Training: A Project-Oriented Approach. *Journal of Geography*, *97*(6), 261–268. doi:10.1080/00221349808978843

Directions Mag. (2011). *Update: Esri has 40+% of GIS Marketshare - All Points Blog*. Retrieved July 14, 2014, from http://apb.directionsmag.com/entry/esri-has-40-of-gis-marketshare/215188

Dowling, R., & Ruming, K. (2012). Synergies between geography, planning and vocationalism in curriculum development and implementation. *Journal of Geography in Higher Education*, *37*(2), 1–16. doi:10.1080/03098265.2012.730507

Dunn, C. E., Atkins, P. J., & Townsend, J. G. (1997). GIS for development: a contradiction in terms? *Area*, *29*(2), 151–159. doi:10.1111/j.1475-4762.1997.tb00017.x

ESRC. (2012). *International Benchmarking Review of UK Human Geography*. Economic and Social Research Council. Retrieved from http://www.esrc.ac.uk/funding-and-guidance/tools-and-resources/impact-evaluation/UK-human-geography.aspx

GIS Lounge. (2011). Commercial GIS Software Applications. *GIS Lounge*. Retrieved from http://www.gislounge.com/gis-software-applications/

Institute of Directors. (2007). *Graduates' employability skills*. Retrieved from http://www.iod.com/influencing/policy-papers/education-and-skills/graduates-employability-skills

Keiper, T. A. (1999). GIS for Elementary Students: An Inquiry Into a New Approach to Learning Geography. *Journal of Geography*, *98*(2), 47–59. doi:10.1080/00221349908978860

Kucsera, J. V., & Zimmaro, D. M. (2010). Comparing the Effectiveness of Intensive and Traditional Courses. *College Teaching*, *58*(2), 62–68. doi:10.1080/87567550903583769

Lawton, J., Rankin, D., & Elliott, J. (2013). Is Consulting Patients About Their Health Service Preferences a Useful Exercise? *Qualitative Health Research*, *23*(7), 876–886. doi:10.1177/1049732313485161

Longley, P. A. (2000). The academic success of GIS in geography: Problems and prospects. *Journal of Geographical Systems*, *2*, 37–42. doi:10.1007/s101090050027

Lowden, K., Hall, S., Elliot, D., & Lewin, J. (2011). *Employers' perceptions of the employability skills of new graduates*. Edge Foundation, University of Glasgow, SCRE Center. Retrieved from http://www.edge.co.uk/media/63412/employability_skills_as_pdf_-_final_online_version.pdf

McLennan, T., & Gibbs, S. (2008). Has the computing competence of first year university students increased during the last decade? In *Proceedings ascilite Melbourne 2008*. Melbourne,. Retrieved from http://www.ascilite.org.au/conferences/melbourne08/procs/mclennan.pdf

Shepherd, I. D. H. (2009). From Geography Department to Business School: Strategies for Transplanting GIS Courses between Disciplines. *Journal of Geography in Higher Education*, *33*(sup1), S28–S45. doi:10.1080/03098260903034038

Silvey, R. (2002). Teaching Postgraduate Development Studies: Possibilities within geography. *Journal of Geography in Higher Education*, *26*(3), 345–353. doi:10.1080/0309826022000019918

Singleton, A. (2014). Why Geographers Should Learn to Code. *Geographical Magazine, Royal Geographical Society (with the IBG)*, 77.

Solem, M., Cheung, I., & Schlemper, M. B. (2008). Skills in Professional Geography: An Assessment of Workforce Needs and Expectations. *The Professional Geographer*, *60*(3), 356–373. doi:10.1080/00330120802013620

Sumner, A., & Tribe, M. A. (2008). *International Development Studies: Theories and Methods in Research and Practice*. Los Angeles ; London: SAGE Publications Ltd.

Verjee, F. (2010). *GIS Tutorial for Humanitarian Assistance* (Pap/DVD edition.). Redlands, Calif: Esri Press.

Wates, N. (1999). *The Community Planning Handbook: "How People Can Shape Their Cities, Towns and Villages in Any Part of the World."* London: Routledge.

Whyatt, D., Clark, G., & Davies, G. (2011). Teaching Geographical Information Systems in Geography Degrees: A Critical Reassessment of Vocationalism. *Journal of Geography in Higher Education*, *35*(2), 233–244. doi:10.1080/03098265.2010.524198

Willemen, L., Drakou, E. G., Dunbar, M. B., Mayaux, P., & Egoh, B. N. (2013). Safeguarding ecosystem services and livelihoods: Understanding the impact of conservation strategies on benefit flows to society. *Ecosystem Services*, *4*, 95–103. doi:10.1016/j.ecoser.2013.02.004

Yorke, M. (2005). *Employability in higher education: what it is - what it is not* (resources). York: UK: Higher Education Academy. Retrieved from http://www.heacademy.ac.uk/resources/detail/employability/employability336