Innovative Pedagogy for Geospatial Lifelong Learning

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SUMMARY

The core geospatial surveying body of knowledge that must be taught to students is generally well understood. As a vocational subject the focus on teaching has usually been on the student obtaining the core specialist knowledge via transmission from teacher centered activities. Students prove attainment of learning through traditional assessment methods such as: reports, calculations, field class results and exams.

These assessment methods can demonstrate attainment of subject matter however students should graduate from a University with more than just text book knowledge and competence at operating instruments and software. They should develop higher order skills as well as transferable skills, often called 'graduate attributes'.

Pedagogy used to develop these skills typically receive less attention in geospatial literature.

There have been calls for a broader development of a Surveyor's education, acknowledging the importance of lifelong learning. In order to be a lifelong learner certain skills and values must be developed. Development of these skills may be improved with pedagogic techniques that move towards student centered learning strategies.

This paper will outline two such techniques that have been introduced by the author on the professionally accredited, post graduate taught programmes in the School of Geographical and Earth Sciences, University of Glasgow.

Firstly, peer assessment, which can help students adopt deep learning strategies. It will be shown how online peer assessments are used as part of student's summative coursework.

Secondly, students write a personal reflective diary during a week-long land surveying field class. In this they track their own development of the Glasgow Graduate Attributes (GGA). Personal reflection allows students to take ownership of their own learning, vital for continued professional development (CPD) beyond University.

The relevancy of these techniques in professional practice and one's own CPD is explored.

With the introduction of pertinent educational literature and practical examples of implementations of these techniques it is hoped that others responsible for geospatial education may consider implementing these techniques.

Inclusion of a 'Geospatial Learning and Teaching' component (covering pedagogy and development of graduate attributes and lifelong learning) should be considered in any profile or model for geospatial education.

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1. INTRODUCTION

The core geospatial knowledge of traditional surveying that should be taught to students is generally well understood. FIG and accreditation bodies give recommendations on what should be taught. It has been observed that geospatial professionals require additional knowledge and skills as their role develops, particularly later in their careers. Previous work has identified subject areas that should be included in a geospatial curriculum (Enemark, 2004). There has been an acknowledgement that new teaching approaches are required with a shift in focus from 'teaching' to 'learning' (Masum et al., 2017) and that professionals will have to be 'lifelong learners' (Hannah et al., 2009) to succeed in their field. This may require innovative pedagogy and fundamentally rethinking what kind of education we should provide geospatial professionals. Students in higher education should develop more than subject specific knowledge and proficiency with instrumentation and software. They should, for example, develop higher order thinking skills (Bloom, 1956) as well as transferrable skills, sometimes called 'graduate attributes'. Development of these skills, important to lifelong learning (Knapper and Cropley, 2000), may be improved with pedagogic techniques that move towards student centered learning (Biggs et al., 2007), where students take responsibility for their own learning.

Pedagogy to develop these skills in geospatial education does not often feature in academic literature. This paper will outline two practical implementations introduced by the author at the University of Glasgow. These are: online peer assessments and personal reflective diaries. Pedagogical literature and relevancy of these techniques will be explored.

The University of Glasgow has offered geospatial qualifications for over fifty years, with surveying and cartography featuring in its Geography degree as far back as 1909 (Forrest, 2015). It currently offers several Post Graduate Taught (PGT) degrees covering varying aspects of 'Geospatial Science'. These are one-year Master of Science (MSc) programmes that are accredited by the Chartered Institute of Civil Engineering Surveyors (CICES) and Royal Institute of Chartered Surveyors (RICS).

2. FROM TEACHING TO LEARNING

Previous work has called for a shift from 'teaching to learning' (Masum et al., 2017). The teaching aspect will be considered first. The teaching of surveying, like many other vocational subjects, has long been modelled on the student obtaining core specialist knowledge via transmission from an instructor or lecturer. This may be achieved through activities such as lectures, practical work and virtual learning environments. Students prove attainment of learning mainly through traditional assessment methods such as reports, calculations, field class results and exams.

This general concept could be described as teaching at 'level 1' (Biggs et al., 2007). That is, the one way transmission of information from lecturer to the student. This teacher focused method is concerned with transmitting the required technical detail in the alloted time. Most education approaches have historically used this approach and could be termed traditional 'teaching'. Aspects of this are highlighted by (Young et al., 2012) from a UK perspective where there is a reluctance to move away from traditional education with regards to content and pedagogy.

Whilst perhaps this approach to teaching may seem sensible it can be problematic for several reasons. It may encourage students to adopt a 'surface approach' to learning where they are not engaging meaningfully and exercise only low level skills (Bloom, 1956). For example with instructors only assessing for 'independent facts' (Biggs et al., 2007, p. 23), particularly when there is a lot of content to cover in a short space of time.
It can also lead to the student becoming dependent on the lecturer for their learning. When the student graduates they may struggle to learn independently. This is a concern if we are wanting to establish a profession of lifelong learners. This potential barrier is highlighted by Knapper and Cropley (2000) who state that such techniques may 'encourage learners to see themselves as incapable of learning, except perhaps under close supervision' (Knapper and Cropley, 2000, p. 186).

An improvement to the 'level 1' approach above is coined 'level 2' by Biggs (2007) where the focus is still on the teacher, but they are aware of and use different teaching techniques.

With a conscious move towards 'learning' we should aim to address some of the concerns outlined previously. We should discourage surface approaches to learning as they infer 'low level' skills e.g. identification or memorization. Instead encouraging higher order skills e.g. reflection, application. This deeper and more meaningful engagement with tasks can only occur if students are given the time, space and assessment methods that enable them to do so. These

assessments should be constructively aligned to learning outcomes that are identified as being vital for the 'transdisciplinary' (Masum et al., 2017) working of geospatial professionals.

This focus on the student is what Biggs (2007) calls 'level 3' teaching which is a 'student-centered' model. This may be a target for surveying education to move towards as has been done elsewhere with problem-based learning (Enemark, 2009).

3. LIFELONG LEARNING

Lifelong learning has been identified as essential for geospatial surveyors (Hannah et al., 2009; Masum et al., 2017) due not only to changes in technology but of roles and responsibilities as one advances through their career. Lifelong learning is the deliberate learning that occurs throughout a person's life (Knapper and Cropley, 2000). There is an emphasis on the deliberate aspect with learners aware that they are learning. There should be specific desired outcomes that are useful for 'a considerable period of time' (Knapper and Cropley, 2000, p. 12).

However there are challenges to being an effective lifelong learner and higher education is ideally placed to develop the ethos and provide the 'organizational framework' (Knapper and Cropley, 2000, p. 3) to succeed. Students first need to have the necessary skills and 'learn how to learn' (Enemark, 2009) that is, acquire the prerequisite skills for lifelong learning. Having the motivation alone is not enough. Students must be able plan ahead and have competance in the evaluation of their own learning needs. They must have the self awareness to inspect what skills and knowledge they already have to be able to 'perceive shortcomings or see ways in which improvements could be made' (Knapper and Cropley, 2000, p. 9).

Key skills that geospatial surveyors need to develop in order to become effective lifelong learners can therefore be identified as self-assessment, self-regulation of learning and critical reflection.

A geospatial curriculum should therefore have opportunities for students to develop these skills. Appropriate assessment methods must also be used to allow these skills to be demonstrated. The challenge for educators is that it may require innovative applications of different pedagogical approaches.

4. GLASGOW GRADUATE ATTRIBUTES

Transferrable skills are often termed 'graduate attributes' for those moving through Higher Education. These are the skills that are gained from the complete University experience (Biggs et al., 2007). Within the geospatial profession they are becoming increasingly important. In part this is due to having to provide 'extra value' beyond the traditional surveying tasks e.g. taking measurements. The ease of mass data collection may (and in some cases already has) result in non subject experts performing the task (Olaleye et al., 2010). The geospatial professional will have to find roles that utilise additional knowledge in related fields but also these graduate attributes. The skills that are required have considered briefly in previous literature (Hannah et al., 2009; Young et al., 2012). At the University of Glasgow these are

called the 'Glasgow Graduate Attributes' (GGA). An adapted version of the skills matrix is given in Table 1.

Table 1 - Glasgow Graduate Attributes (adapted)

Graduate Attribute	Description
Subject Specialist	Breadth and Depth of knowledge. Professional competency.
Investigative	Intellectual curiosity, analyse variety of information to provide solutions.
Independent and Critical Thinkers	Assess complex issues, critical judgement of data, innovative thinking.
Resourceful and Responsible	Self-directed learner. Capable of substantial independent work.
Effective Communicators	Articulate complex ideas in quality written and spoken English. Listen and negotiate effectively with others.
Confident	Defend ideas amongst peers. Possess excellent interpersonal and social skills within an international community.
Adaptable	Flexible, adapt skills and knowledge in unfamiliar situations. Demonstrate resilience in dealing with change.
Experience Collaborators	Engage in scholarship. Positive contribution when working in groups.
Ethically and Socially Aware	Social and Global responsibilities. Open to multicultural and international experiences. Knowledge of professional, ethical frameworks
Reflective Learners	Use feedback for self-reflection. Set aspirational goals. Self-assess their skills, knowledge and understanding in a variety of contexts.

Many of these attributes are similar to other descriptions of transferrable skills that are useful in the work place. However, the recognition of the importance of Glasgow graduates being 'reflective learners' is of particular interest. It is important that this attribute is developed for successful lifelong learning.

5. PEER ASSESSMENT EXAMPLE

Peer assessment is where students are given a piece of work from one of their peers, they assess it and issue a grade with feedback. This is a pedagogical technique that is recognised as being a key aspect of the enhancement of assessment and feedback practice in the UK (Nicol, 2009). It is commonly used in teaching of other professions e.g. accountancy (Malan and Stegmann, 2018), engineering (Hersam et al., 2004) and many others (Purchase and Hamer, 2018). Peer assessment is noted for maintaining standards of excellence amongst academics and that similar benefits can be achieved for students (Knapper and Cropley, 2000). Peer assessment can be an 'enabling condition'(Nicol, 2010, p. 4) for self assessment which is required for students to take ownership of their own learning (Nicol and Macfarlane-Dick, 2006). This is turn will enable then to critically assess their own development and plan accordingly e.g. with targetted CPD courses.

The author has introduced a series of online peer assessment exercises in an attempt to develop these skills for lifelong learning.

A typical Glasgow PGT student cohort will have a wide range of mathematical and statistical skills when arriving at the University. These skills are developed throughout the first semester

in a variety of ways in several courses. Early in semester 1, students perform basic plane geometry calculations in their Principles and Practice of Land Surveying course. These are basic polar to rectangular conversions etc. They perform two assessments under exam conditions. Student develop their answers on paper and can use a calculator.
After the test, exam scripts are scanned to create a digital copy. A peer assessment is then performed using AROPA. AROPA is an online system specifically developed for peer review (for feedback, not specifically grading) where students can review or comment on the submitted electronic works of other students. It is a free system and has been online since 2009. It has been used by 24 universities in 10 countries for 1103 peer review exercises (Purchase and Hamer, 2018).

Students then perform a peer assessment. The student marks a randomly assigned paper from a fellow student. Identities are made anonymous. Students are provided with an extended 'model answer' document (separate from AROPA). Students then compare the issued paper against the model solution whilst answering a guided questionnaire designed to analyse the various quality aspects of the paper. They are also asked to consider their own submission (i.e. self-assessment) considering the model solution and their peer's work. After completing the questionnaire students then consult a detailed grade rubric (separate from AROPA) to decide a final grade.

A student's overall grade includes elements from how well they performed the calculation but also for how well they have performed the peer assessment. For example, was the assigned grade justified? Have they had identified any maximum grade or limiting criteria for the assigned submission?

Whilst the notion of students marking each other's work may initially seem alarming the authors experience of this over the past two years has been mainly positive. A moderation process is performed for quality control. Anecdotally most grade adjustments performed by the author are relatively minor, between 1 and 2 grade points (the University uses a 22-grade point scale system). Occasionally a larger change is required however it is most often a case of a fellow student being too harsh rather than lenient. This agrees with other literature showing that students tend to be very strict when marking their peers (Boud,1990.)
Another factor that makes this task reduces risk (from a quality perspective) is that the weighting of any individual peer assessment is very small, 2% of a 10-credit course.

Whilst the academic benefits for the student have been outlined, it is important to identify how this might be relevant for the student when in industry. Assessment is an important part of any Surveyors practice. Surveyors should, where possible, check calculations or work obtained from other team members or other specialists. Comparing a peer's calculation against specified criteria can be compared to the checking of survey results against a client specification and evaluating how well it meets the requirements.

Whilst this implementaion of peer assessment is based on a calculation, the AROPA system lends itself well to any digital submission so could be used for a variety of geospatial

submissions for summative assessment or formative feedback e.g. cartographic maps, essay drafts.

6. REFLECTIVE DIARY EXAMPLE

Reflection is where students explore their experiences in ways that 'lead to new understandings' (Boud, 1985, p. 19). Again reflection is regarded as a valuable tool (Nicol, 2009) in UK higher education. If we are attempting to encourage deeper learning approaches, then the ability to reflect is a 'meta cognitive aspect of learning' (Knapper and Cropley, 2000, p. 46) necessary for higher order thinking.

Guidance on the identification of levels of reflection: important for guidance to students and for marking by academics can be found in the works of (Hill et al., 2012; Plack et al., 2007, 2005).

Outside academia and the geospatial field its usefulness to enhance ones practice is recognised in disciplines such as nursing (Finch, 2016) where multiple reflective accounts are a requirement of professional revalidation.

Reflective diaries have long been a part of the Geospatial programmes at the University of Glasgow. Students for example keep a diary throughout the year, critically reflecting on professional engagement (CPD events, workshops etc.)

However, students now also keep a reflective diary where they must align their experiences against a set of development criteria. This is done during their week-long residential land surveying field class. The field class requires that students: work closely in small groups, organise equipment, plan field observations, negotiate for land and station access with other groups, and issue key deliverables to tight deadlines. In short it provides a suitable environment for them to develop and demonstrate important transferrable skills i.e. their GGA.

The reflective diary is used for students to gauge their own development of the GGA. A diary is a suitable format for this kind of development work. There will likely be some automatic recognition of a diary being a place for more personal writing which is important for reflection. It can allow admission of struggles, mistakes and a freedom to work out issues and strategise.

This is a useful task for two practical reasons. Firstly, it enables students to assess their own development of these key skills. Ideally identifying areas of strength but also areas that need further development. They can then take the next step of articulating how they will develop identified gaps.

Secondly it gives the student practice in writing a narrative that is aligned to a set of requirements or competencies. Professional development programs often require a piece of writing where the applicant must demonstrate attainment of a competency to the required level. Applicants to the CICES for example will have to consider their own experience against specific

Geospatial Engineering competencies. A student aligning their own field work against the GGA will therefore develop some familiarity with this process.

Once a member of the institution, professionals need to not only continue with CPD but they need to articulate specific objectives, recognised learning outcomes and offer some reflection. Taking the opportunity to develop these skills before students enter the work force will mean they are better equipped to deal with professional development throughout their career.

7. CONCLUSIONS AND RECOMMENDATIONS

The need for educators to equip students for lifelong learning is well understood. This piece of work has outlined some of the skills that must be developed to make this possible. Practical examples of pedagogy that can be used to develop these have been outlined. Relevant educational literature showing the pedagogic context and rationale for these techniques has also been introduced. It is hoped that others responsible for geospatial learning and teaching will find value in these techniques and consider implementing aspects in their own practice.

As educators we should seek innovative pedagogical techniques and guidance from outside of our field and adapt as appropriate. Scholarly investigations into our geospatial teaching is required and a worthwhile endeavor. Dissemination of this scholarship in geospatial learning and teaching in academic literature is important for sharing of developments and good practice.

An effort should be made to increase awareness and promote use of such pedagogical techniques. Relevant bodies and accreditors should consider specific guidance for geospatial learning and teaching, particularly with regards to graduate attributes. Educational profiles, or models, of geospatial education may benefit from a ‘Geospatial Learning and Teaching’ component that guides pedagogy for required graduate attribute development.

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BIOGRAPHICAL NOTES

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