Making Surveying Education Relevant

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SUMMARY

Surveying education has been ‘playing’ catch up with changes in the surveying/geomatics industry and some individuals are of the opinion that the lag is substantial and demands immediate attention. Not only has technology impacted the surveying industry but the modernisation brought on by information and computer technologies has considerably impacted teaching and learning methods and the characteristics and expectations of students who access higher education. This paper examines how selected surveying programmes address the issue of making their courses relevant. The issue of relevance is explored at a number of levels using the common theme - change. In this regard change in technology, in professional expectations, in societal demands, in student characteristics and in the scholarship of teaching and learning will be discussed with a focus on how they impact surveying education. The discussion is based on empirical data from a research that involved fifteen surveying programmes from thirteen countries. The study investigates curriculum architecture and pedagogical alternatives in surveying education and the perceived impact these have on student preparedness for work.

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1. BRIEF HISTORICAL ACCOUNT OF SURVEYING

The importance of surveying activities to numerous human activities can be traced to ancient times. Knowledge of the shape and size of the planet we live on and the ability to measure and represent land features have been important to humans for millennia. Archeological artifacts continue to provide an increasing amount of evidence that surveyors (or whatever they were referred to in previous eras) have made their marks (pun intended) on the development of human societies. The Harpedonaptae (Rope Stretchers) were actively involved in replacing boundary marks destroyed by the waters of the flooding Nile in ancient Egypt (Kavanagh, 2006). We continue to be amazed not only by the technology that must have aided the construction of the Egyptian pyramids but also their precise layout. The geometrical layout of England's famous landmark Stonehenge demonstrates that many years ago humans had developed very precise surveying skills (Johnson, 2008). Surveying clearly has been around for a long time and its importance has not diminished.

Technological advancements and knowledge growth have propelled us into an age that is far different from the lived experiences of our ancestors. We have moved from a time when the earth was perceived to be a flat disk floating in an oceanic river to a time when we can have snapshots of the planet from satellites orbiting space revealing its 'true' shape. No longer do we measure land with knotted ropes, now we use far more sophisticated methods. This digital age has facilitated increased access to a wealth of spatial information. Now even our young children are able to see images of the earth, the continent they live on, their country, their neighbourhood or their house at the click of a button. We now use navigational tools in mobile devices and the concept of viewing land data in three-dimensional interactive formats is no longer a farfetched fantasy. The use of spatial information has virtually become second nature to humans in modern societies. Its use is predicted to grow even further.

2. RESPONDING TO CHANGE IN THE GEOSPATIAL INDUSTRY

Though some specialised surveying operations such as cadastral surveying are still protected activities for surveyors in some countries, generally land measurement and representation are no longer seen as exclusively the domain of surveyors. The geospatial industry continues to become more and more commercialized and caters to a growing market. In some contexts this is perceived by the surveying community as a threat and in others as an opportunity. Though these perspectives need to be taken in context, there is a growing awareness within the international surveying community that changes in the geospatial industry should be viewed as an opportunity for surveyors. Surveyors are now expected to adapt their systems of measuring, computing and representing land features to the ever changing technologies. Indeed, as it relates to this area of work and education the only constant is change (Enemark, 2005). Some argue that surveyors should not limit their roles and functions to doing only the things they used to do using new methods and new tools, but also embrace the new opportunities to use their expansive knowledge and skills to engage or rather lead the way in the commercialized geospatial industry. Surely surveyors are best placed to provide not only reliable data and processed information, but with appropriate education and training they can also provide leadership, advice and guidance in the vast array of areas where spatial information is used.

3. SURVEYING EDUCATION

The scenario described above brings to focus questions about the systems used to educate individuals for the surveying profession. In a number of countries the training and education of surveyors have been historically rooted in a system of apprenticeship. Young men (primarily) with a proclivity for mathematics and the outdoors were seen as prime candidates for surveying apprenticeship. They would be trained under the supervision of a professional surveyor and through some supporting arrangement exposed to theoretical and computational aspects of the discipline. After a period of ‘adequate’ development in surveying knowledge and skills, the apprentice could follow a legally prescribed process to obtain a license to practice as a professional surveyor. In a number of countries such as Britain, the military has also played an important role in the training and education of persons in surveying. Civil societies have benefitted from military trained surveyors who have worked, for example, in the primary surveys of numerous countries that were overseas territories of the former British Empire. Some of the earliest local surveyors in many of these former British colonies were apprenticed to European surveyors employed to the Directorate of Overseas Surveys (MacDonald, 1996). In Britain and other contexts, university graduates with academic degrees in fields such a geography and mathematics were also recruited to fill senior surveying positions within the civil service. With this latter group in-house training within the surveying establishment were provided since they had limited or no exposure to surveying knowledge and skills after graduation,

Formal surveying education in most of the countries looked at in the study, started in technical institutions such as the polytechnics in England and some Caribbean and African countries. These technical institutions provided vocational training offering certification to sub-degree levels. They trained both surveying technicians and diplomates who could follow on to become licensed or chartered surveyors. Many of these polytechnic institutions were upgraded to universities and their surveying courses upgraded to degree courses. Within this framework of development, surveying curricula maintained a strong focus on measurement and mapping. However, university requirements brought about a broadening of education for students in degree programmes. This, in many cases, meant a reduction in the concentration of specialised surveying and an increase in general education. However, this had to be balanced with demands from professional accrediting bodies to maintain certain specialised content if the courses were to maintain a strong surveying flavour. The study found that in all 15 programmes, the specialised core elements remain the major components of the surveying curricula.

An important difference in the educational approaches of the past and present is identified. The apprenticeship system had a primary focus on building practical competences through a process of scaffolding. This was supported by short, sometimes informally arranged sessions to teach relevant theoretical concepts. Most of the university-based courses in the study had a system that was the opposite of the previously described model. The educational model was primarily concerned with covering theoretical concepts along with simulated practical exercises that reinforce the theoretical concepts. Where work-related experience was included as part of the study, it was given secondary consideration relative to the more theoretical focus. Figures 1 and 2 illustrate the two models of surveying education described above.

Work-based skills development is the aspect that differentiates *Traditional Model I* from *Traditional Model II*. In those curricula that did not include work-based experiences, this was a decision based more on resource constraints rather than for philosophical reasons. Programme leaders generally expressed that because surveying education is profession-oriented, students would benefit from industry exposure during their studies. The ability to incorporate industry experience in surveying education, though not always a viable option for universities, is generally viewed as a learning activity that enhances students' readiness for work.

The models illustrate colour-coded boxes that highlight aspects of the educational models that seek to develop: Disciplinary knowledge and skills (blue); Work-based learning (dark green); Practical skills (light green); and professional competences (yellow). The upper levels indicate primary emphasis in the curriculum and the lower level secondary emphasis.

Figure 1: Apprenticeship Model

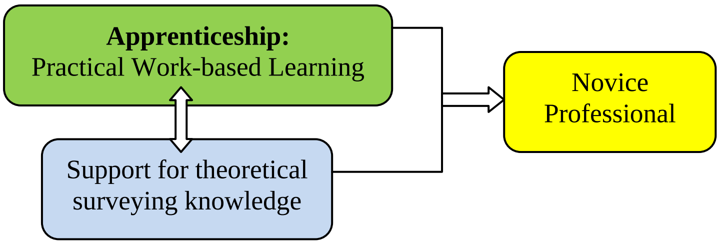


Figure 2: Traditional Education Model I

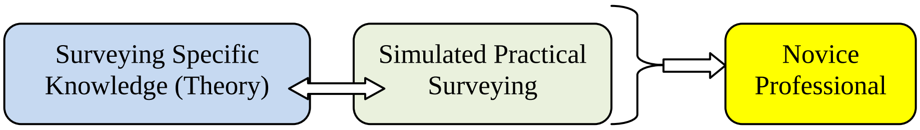
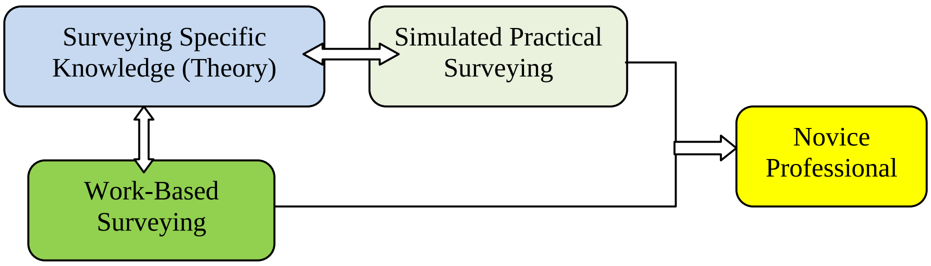


Figure 3: Traditional Education Model II



<u>Perceptions of models</u>

Apprenticeship Model
Produces highly technically skilled surveyors but lacking in more generalised knowledge base.

Traditional Education I
Produces graduates with good knowledge base but under-prepared for work as the technical abilities in an authentic context is under-developed.

Traditional Education II
Produces graduates with sound technical knowledge and higher work skills relative to the other models.

The study found that a contemporary model of education (Figure 4) is emerging based on how the surveying community perceives the modern context of surveying. This educational model seeks to incorporate the corpus of traditional surveying knowledge with knowledge of wider geomatics areas, along with other aspects of learning that are more related to developing in students the skills to function in a dynamic world where interests and methods are in a constant state of flux. Learning for the entire community of learners (not only the students) is at the centre of this model. With this model the disciplinary knowledge and skills may take on a generalist geomatics approach or it may offer narrow specialisations in areas such as Measurement Science, GIS, Remote Sensing, Photogrammetry, etc. Generic skills are those that are typically assumed to be developed during the normal course of knowledge growth and skills development. However, higher education programmes are now expected to explicitly incorporate systems that can develop generic transferable skills in students. Some examples of generic skills are: time management, teamwork, critical thinking and adaptability. These may be developed through increased group activities, student self-direction and opportunities to reflect on work. Allowing students to choose surveying methods in the execution of multiple tasks and to justify their choices in the context of economy and accuracy and other specifications has been identified as one way of building critical thinking skills in students. If then our educational efforts focus on learning rather than teaching, then we would be more inclined to try new methods and to adjust methods depending on our evaluation of students' needs and the needs of industry.

Figure 4: Contemporary Model of Surveying Education

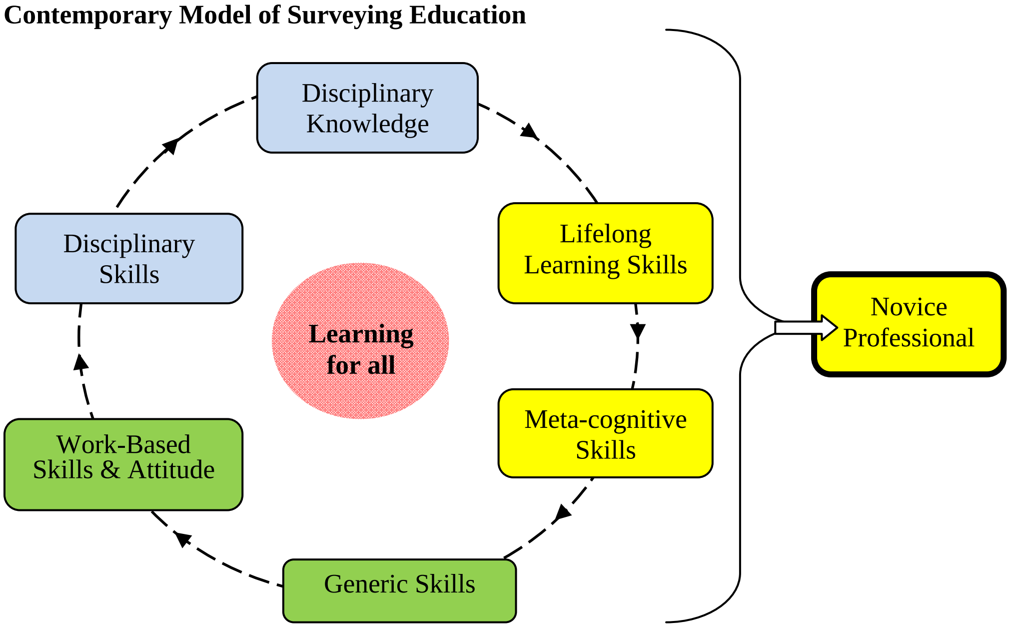


Table 1 explains each concept in this contemporary model and uses examples to illustrate how each aspect has been used to develop this holistic education in surveying students. The desired result from this educational model is a surveying graduate who has the knowledge, skills and confidence to successful engage in work as a novice professional within this modern context.

[See next page for table]

Table 1: Illustrating the Concepts in the Contemporary Education Model

Concepts	Definition	Concept application examples
Disciplinary Knowledge	Specialised knowledge that is contained within a defined disciplinary field.	Corpus of geomatics knowledge is typically covered in lectures. Core geomatics subjects form a major component of the curriculum. This is generally specialised in the latter parts of the course in narrow areas such as Measurement Science & Mapping, GIS, Remote Sensing, Land Management, etc.
Disciplinary Skills	Applications of the specialised knowledge in practical settings that may include fieldwork, lab work, computations, design, reporting, evaluating etc.	Practical exercises are organized around the teaching of theoretical concepts. These practical exercises in the field and in labs reinforce the theoretical concepts. The production of reports that justify choices and identify how challenges were overcome are also an important skill developed through project work.
Generic Skills	Skills that are not unique to surveying/geomatics but are relevant to the development of a professional.	Group work, though a natural modus operandi for surveyors, is embraced as a mechanism through which many generic skills can be developed. When assessment methods include peer evaluation for example, this reinforces the importance of each member actively participating in all aspects of the group project. The presentation of findings helps both oral and written communication skills. Working with stated deadlines with penalties for shortfalls is one way of reinforcing the principles of appropriate project planning and time management.
Work-based Skills & Attitude	Work-based skills are those kinesthetic and cognitive capabilities that are useful for work. Work-based attitudes are features of the affective domain that promote a healthy approach to work and coworkers.	Simulating a team of professionals from a variety of areas is developed, for example, in inter-disciplinary learning. In this context students learn to appreciate the functions of others they may have to work alongside in the real world. Making things like punctuality a component of assessment also encourages good work-based attitudes. The inclusion of industry-attachments for students opens up a world of opportunities for learning work-based skills and attitudes. A number of surveying courses involve members of the profession in aspects of the education.
Meta-Cognitive Skills	Those skills that foster reflecting on what one does and why it is being done. It is a reflexive way of being that allows a person to associate value with practice.	Students are required to openly explore the role of the surveyor in a wide spectrum of traditional and non-traditional areas. They are encouraged to consider innovative ways that the skill of the surveyor can be utilized and to explicitly state how these can be of benefit to the surveyors themselves and to others. As part of reporting on projects, students are required to comment on the relevance of the work done.
Lifelong Learning Skills	An approach to learning that assumes that learning is an ongoing process not limited to time inside the formal university setting.	The use of discovery learning activities in which students are given a problem, asked to deconstruct it in student groups and to proceed down a part of discovering workable solutions. Within this context the learning responsibility is primarily on the learner as they have to actively seek out the information and tools they need to come to solutions. The academic staff, in this context is seen as one of the resources that students can access but not as the primary source of knowledge as in a traditional didactic instructional setting.

3.1 Relevance of educational methods - Considering students' expectations and their changed characteristics

3.1.1 Student Expectations

Students' motivation for accessing higher education courses is primarily associated with career aspirations. Surveying students expect their university education to prepare them for work in the surveying industry and also to help in their preparation for professional certification. This fact has been overwhelmingly acknowledged by surveying students, surveying programme leaders, surveying academics and representatives of professional accrediting bodies interviewed in the study. The degree to which universities prepare students for the profession is a product of a number of factors. The knowledge content of the course is one of the more obvious factors as well as the degree to which students are able to apply theoretical concepts to practical work. However, the link between pedagogical approaches and learning is less frequently acknowledged. Certain approaches are better at promoting certain types of learning than do others. If, for example, students are expected to have a holistic appreciation of a particular surveying method, they should be able to engage with the theoretical concepts, the skills required for applying theory to practice, and the affective aspects of negotiating the problem in a relevant context. In other words, concepts are not taught as abstract ideas that are joined with related concepts and activities after graduation. Rather, the learning of theoretical concepts occurs in a setting where related activities are linked. This kind of learning arrangement is described by Kolb (1995) as experiential learning. In this context students are able to make meanings of the teaching and learning experiences.

The study found that sometimes experiential learning is hindered by lack of resources. For example, where three-dimensional laser scanning is presented in theory but the expensive equipment is not available for demonstration and hands-on applications to real surveying situations. Two universities in the study have demonstrated how 'virtual' experiences can be employed as an effective alternative. This refers to the use of multimedia, animation, video conferencing and other live links that allows students to at least see how concepts can be applied in real situations.

3.1.2 Student Characteristics

Additionally, educational literature has identified a set of changed characteristics of students who access higher education courses. The literature speaks of the emergence of student with characteristics vastly different from those of past students. Students born in the late 1980s and onward have been referred to as *Net Generation Learners* by Oblinger & Oblinger (2005) and as *New Millennium Learners* by Pedró (2006). These descriptors define the first generation of children to grow up surrounded by digital media, with most of their activities dealing with peer-to-peer communication and knowledge management mediated by these technologies (Pedro, 2006). These students are considered to be particularly adept with computers, creative with technology, highly skilled at multitasking, find interactivity engaging, and have a preference for experiential, hands-on learning.

How true are these descriptions of modern surveying students? How do we engage this breed of students in the surveying teaching and learning activities? Should we use traditional lecture-based methods or should we use more innovative methods? While observing surveying lectures and lab sessions, students from time to time switched to social networks to connect with friends, surfed the internet to look up new concepts being presented and used their personal computers to read the notes from the lecture and to augment the notes (not necessarily in that order). Computer technology seemed indispensible to the surveying students within both case study sites. Not only did they appear to be adept at the technology, it was integrally linked to their study programme. In one university students used a voting system to register their attendance in the class as well as to respond to questions posed by the lecturer. The lecturer was able to do quick evaluations of students' understanding during the lesson. Surveying students in these contexts were clearly oriented to the technology as part of their education as well as tools useful for instruction.

If we are to educate effectively, we need to consider the characteristics of those we teach. Frand's (2000) description of the higher education scenario is very telling:

> The outlook of those we teach has changed, and thus the way in which we teach must change. The world in which we all live has changed, and thus the content we teach must change. The industrial age has become the information age, and thus the way we organize our institutions must change, as must the meaning we attach to the terms "student,""teacher," and "alumni." The challenge will be for educators and higher education institutions to incorporate the information-age mindset of today's learners into our programs so as to create communities of lifelong learners (p. 24)

Redefining the roles of the stakeholders in the education system, and teaching students to become lifelong learners have been identified as the challenge facing higher education. Table 1 shows one way we can encourage the development of lifelong learning skills in our students. Education needs to be presented as more than knowledge transfer and the assessment of students' ability to memorize facts. Our pedagogical approaches need to elevate the learning responsibilities of the learners. Learners need to be supported but also made to understand that they must be actively engaged in seeking the knowledge and skills that will support their learning. This is important because what students learn in today's classrooms may be obsolete by the time they graduate. It is, therefore, important that teaching and learning be done with this understanding. Modern surveying students must be encouraged and supported in developing critical thinking skills, the skills to be able to deconstruct a problem and follow unpredictable paths to finding materials and tools to aid them in coming to decisions related to authentic surveying problems. Whether this is done through case study learning, group-based learning, project-based learning, problem-based learning, or other methods, the critical thing is that the learning needs to be oriented towards learning and not teaching. Within this modern paradigm, all stakeholders in the educational framework are learners (as illustrated in Figure 4).

4. CONCLUSION

Our current study gives consideration to the nature of the systems we have used to train and educate individuals for the modern surveying profession. How relevant are they to the modern context? Who are the individuals who typically access surveying courses or rather to whom do surveying courses appeal? The answers to these questions are fundamental to the development of surveying educational programmes. These are issues of relevance. Relevance of practice to societal needs, relevance of education to practice and relevance of educational methods to students needs and to industry needs. Exploring these issues involves: (1) an understanding of the nature of the profession in its modern context and also foresight into the likely path it will take in the near future; (2) an understanding of the characteristics of modern day school leavers and higher education students; and (3) an understanding of the teaching and learning strategies employed by a responsive and responsible higher education sector.

There is no doubt that the geospatial industry has changed. It has become far more commercialized than it was a few decades ago. Increasingly non-surveying organizations are making inroads into the geospatial market, grasping the opportunities that this modern context offers. The modus operandi of surveyors has also changed (more so in some countries than others). We can foresee that those countries that are lagging in the technologies will eventually see wide-scale modernization of the surveying processes. We believe that two things are crucial for moving forward for the community of surveyors and surveying educators: (1) surveyors need not only to adapt their operations to the changing technologies but also tap into new opportunities that their skills-set clearly makes them ideal for; and (2) universities and other educational institutions that offer surveying courses need to orient the education towards learning for all in a community of learners involving all stakeholders. The curriculum structure and pedagogical approaches employed must begin to manifest a degree of flexibility that allows for changes to ensure relevance. As a surveying community we can only respond to contemporary demands if our orientations and our education are relevant to the times.

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