Educating the next generation of geomatics professionals – A South African perspective

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Abstract

The lack of education research and innovation in Geomatics education programmes may imply doom for the traditional surveying professions in the next twenty years. ‘Teaching exactly as I was taught’ has been the traditional and remains the most applied manner of educating the next generation of Geomatics professionals. A professionally registered person with a higher qualification remains qualified to teach, assess and certify the next generation of Geomatics professionals, technologists and technicians. The teaching purpose originally directed at transfer of knowledge from the knower-to-the-learner through lectures, tutorials or practical and evaluating the extent of memorising that has occurred through examinations has changed. This paper presents results of the study to identify the modern purpose of teaching. This involves the transfer of knowledge from one person to the other through multiple pathways, originating from multiple sources and utilising “multiple intelligences” [1]. It discusses the teaching processes that contribute towards the growth of knowledge, improvement of knowledge, skills and competencies, using multiple sensory channels including hearing/listening, doing, reading, and participation, arguing and observing. The sources of the learning are also as diverse, and include social networks, publications, viewership and trial-and-error and each learner may prefer one or more of these channels [2]. Therefore, persons recognised in Geomatics categories must acknowledge that they cannot be specialists in all specialisations of the Geomatics profession. This entails that being a “jack of all trades” makes you a master of none. A “master of one discipline” is at most mediocre in all others. A meeting of masters of many disciplines are likely to make superior decisions on aspects linked to reality. This is the rationale of cooperative management as envisaged in the traditional African culture

Keywords
giomatics education, teaching and learning, geomatics professionals

Introduction

Geomatics is an age old profession that can be traced to the evolution of human life and the first organised settlements traced to Babylonia and Egypt [3]. Geomatics education emerged almost immediately as the profession become known, primarily to ensure replacement of skills and competences on retirement of those practicing. The reason for education has evolved, from the need to protect siblings from nature’s dangers (survival lessons of the Nile Valley) to facilitating of community progress and innovation (developmental lessons today). Assistants who were employed initially as trainees became qualified to take over the institutional functions of the profession. The premise was to induct the learner to become familiar with the fundamental theory, practice and applications at the same standard of competences and reliability of the teacher. The teaching purpose was directed at transfer of knowledge from the knower-to-the-unknowing (teacher-to-the-learner) through inductive approaches such as observations, demonstrations, doing and tutorials. Thereafter, subsequent evaluation of the extent of knowledge transfer and competencies was evaluated at higher applications levels to qualify the new professional as a teacher. These trained and highly qualified, trusted and respected members of the community were accredited to practice, judge and later teach, assess and qualify the next generation of professionals. The main disadvantage observed from this period up until about 40 years ago was the “law of the lid” as popularised by John Maxwell [4]. The learner focused on ensuring they master what the teacher knows and used mainly the recommended readings the teacher was familiar with, limiting their innovation and growth.

Through a continuum of changes, the purpose of education has today become growth of the learner to realise their full potential, using the teacher’s knowledge, skills and competencies only as the spring-board for further development. The teacher being the source or process of identifying sources of information is no longer a challenge. Most spatial information is free and at appropriate resolutions (spatial, temporal and spectral) traditionally only attainable by well trained and highly qualified professionals. Transfer of knowledge from one person to the other now occurs in multiple ways: listing, doing, reading, participation, arguing and even assisting. The greatest challenge for a teacher today is actually that the learner may be more knowledgeable that the teacher. However, at practice and competency levels, the learner is lacking. The teacher therefore does not need to emphasise knowledge acquisition by the learner, but rather to guide learners on the processes to identify sources and the applications in practice.

The problem statement

The widening of demands for knowledge, skills and competencies of the traditional surveyor (herewith, geomatics professional) to encompass information communication technology (ICT) hardware and software, and geographical information science and technology (GIsc & T) techniques in data acquisition, manipulations, and presentations means applications have become broader while techniques are easier to learn. Rüther [2] noted that changes have already
emerged in the geospatial professions in the final decade of the 20th century, either as natural evolution and progression of the discipline or imposed by those in authority. Hannah, Kavanagh, Mahoney and Plimmer [1] estimated that the evolution of the geomatics profession had broadened to include at least two hundred vital competencies. Educating knowledge of such a broad competences base is unattainable in 3 year diplomas or 4 year professional degrees.

In South Africa, education research and innovation in geomatics teaching and learning is limited and from a few dedicated academics. This lack of foresight from the geomatics professions on the need to educate replacement will contribute to the decline in the number of graduating geomatics professionals in the next twenty years. Further, the tendency to teach as taught by the education institutions, even when industrial trends seem to have progressed, appear to be condoned by accreditation authorities who grant accreditation certificates. The lack of alignment between the purposes of accreditation and accreditation process is demonstrated by continued emphasise for high numbers of professionally registered staff within an academic department, instead of advanced academic qualification coupled with additional qualifications in education and assessment. Advanced qualifications instil a culture of research that is essential to keep abreast with geomatics technology and technique developments. In the last half century, semi-automation and automated measurements such as global navigation satellite systems (GNSS) have become possible opening opportunities for high quality volunteer data at suitable spatial, temporal and spectral levels. To continue emphasising the teaching of theory, memorising or recall of such broad, diverse and multiple spatial data acquisition knowledge areas, widening skills and innumerable applications is no longer possible or essential.

Internet connectivity is now cheaply available to the general public with the increase in smart phones and reduced cost of data bundles. Barry and Whittal [3] argued that spatial, temporal and spectral theory lessons traditionally covered over many years can today be mastered easily and quickly. Because today’s generation is computer savvy, their conceptualisation of information technology literacy and internet accessibility is good. As a result, world-wide reports that other related professional can now measure for themselves results in reduced opportunities for employment of traditional surveyors, closures of geomatics programmes in response to low student intake/output numbers, and the growing irrelevance of traditionally taught geomatics professionals [1].

**The research methodology**

The purpose of the study is to explore causes for the changes that seem to threaten the geomatics profession for the last half century. Having explored various methodologies to study education and training in this scientific discipline of geomatics, it was difficult to identify a single method that accommodates all techniques applied to the study. The techniques adopted required to be dynamic, and the “bricolage” proved most appropriate. What Kincheloe and Berry’s [4] termed the “bricolage” as used by Denzin and Lincon [5] is an adaptation of the Lévi-Strauss (1966) French term *bricoleur*. In the *bricoleur*, a handyperson’s capacity to undertake and complete a construction by adapting locally obtainable supplies and equipment for all planning, building and completion of work is recognised [4, p. 1].

In this *bricolage* research, qualitative and quantitative paradigms are co-applied in the same research design using multiple and mixed methods. The most suitable candidate method in the study is adopted as and when best suited for that stage of research. The mixed methods involved applying qualitative and quantitative methods on the same phenomena and/or at the same time to solve the “what” research questions. This provided the required focus on geomatics education in its natural real-life setting, complete with multi-level complexities and cultural dynamics [10]. Multiple methods entailed differing methods following on each other such as interviews, questionnaire, intervention trial etc. Thorough evaluations of the dimension and frequency of occurrences in quantitative and exploratory search for meaning and understanding in qualitative perceptions were used concurrently, bridging the divide between post positivist and purely humanistic methodologies. Adoption of mixed and multiple methods in the study allowed for the shift between qualitative and quantitative without discrediting the rigor of study.

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Fig. 1: Illustrative diagram of the Bricolage method.

The added advantage of the *bricolage* approach is that it disregards *a priori* (before) stipulations in the research processes, with detailed stipulations of processes and arrangements dynamically generated as and when the unfolding conditions demanded [4]. With multiple interweaved methods occurring at the same time and with different methods to
the same participants, some specialist education researchers have argued this approach as chaos or complexity theory rather than “bricolage”. Data was collected through questionnaires, interviews and a review of publications over a period of three years (June 2010 - June 2013) although older datasets were used to define historical trends. The geographical footprint covered mainly Gauteng, North West, Limpopo, Mpumalanga and Western Cape. In addition, recent local and international publications were reviewed for indications of the health of the geomatics profession and suitability of the graduates from both universities and universities of technology. Perceptions and comments of employers and government departments were further sought for and integrated with research by Bachelor of Technology students. An understanding of the motives, actions and reactions as determined from participants responses were mapped into a subjective context with no a priori hypotheses. Based on personal knowledge of structuring positivist data sets, the results were grouped and coded using the primary distinction of traditional universities and Universities of technologies.

The results of the study

The study of the origins, trends and future of the geomatics profession shows clear distinctions between the traditional and the modern requirements for education. This section discusses the traditional and modern professionals and the distinction in the competences the industry demands of them.

History of geomatics teaching and learning approaches

South African universities and university of technologies and the geomatics programmes have not been an exception to the pressures for economies of scale demanded by university administrators with the restructuring [6]. Several institutions were merged and restructured in an effort to dilute the influences of South African’s history of inequality and accessibility disparity. Geomatics departments have faced pressures to increase enrolments while risking mergers or outright closure due to low viability. The competences have had to become accustomed to a more litigious and consumer-aware society [6]. The outcome has been a systematic altering of geomatics education through merging with related disciplines of civil engineering, architecture, planning etc. to remain viable. Some institutions have focused on adjusting the geomatics programmes to match the community needs, which ultimately drift the curriculum away from highly rigid core competencies as defined by the professional councils. Only two institutions, from the original list of two traditional universities and four universities of technologies have retained their existence as separate geomatics or survey departments after the “restructuring and rationalisation of programme development and delivery” [6] in South Africa.

Two strategies have contributed to the survival of the geomatics departments through major restructuring and mergers within their institutional structures. In the first, the department strived to ensure the traditional teaching and learning approaches are retained while supported by one or more statutory bodies that grant recognition based on the competences of previous graduates. There are indications that at least one institution has taken advantage of the discontinued geomatics programmes in other institutions to retain a monopoly of offering geomatics education in a specialised form targeted at a specific industrial sector in South Africa. The second approach involves the diversifying of the applications, skills and techniques of geomatics to the broader competencies (approximated at 200) identified by authors such as Hannah, Kavanagh, Mahoney and Plimmer [1]. The first approach faces tremendous challenges, unless strong research and innovation’s supported to promote the alignment of changing demands of geomatics education. The development and implementation of legislative changes assisted in coercing the community and public to maintain respect and recognition. This remains viable only until more innovative approaches are adopted with technology revolution against its irrelevance. The second requires that geomatics education adapt to the new technologies, new challenges and new applications as they emerge in the evolving societal challenges [1]. Again, this requires support and may benefit through sector recognition and professional accreditation, but research, innovation and adaptability to societal changing needs remain vital. The challenge of this option is that clear and definable international and national definitions of the recognised profession of geomatics and a supervisory body agile enough to keep pace with the changes has not been drafted.

The research results indicate that traditional geomatics education is strong in research into geomatics theory and principles, and reliant on strong professional body endorsement and legislative support from government (e.g. South African Geomatics Bill). This literally means the relevance has not been questioned by the public meant to benefit from the specialisation. Teaching and learning therefore had strong government and professional body influences with the norms and standards of the time adequate to graduate competent professionals to meet that day’s societal needs and challenges as perceived by the ruling party. However, the fact that these needs have remained in existence, though in their evolved form means education was not producing a perfect graduate or the improvements necessary.

Traditional assessment of geomatics competencies

Generally, all professionals educated in the last century ending 2010 were assessed through examinations mainly, and contributing not more than 40% of the final mark was for term tests, practical and assignments (see Table 1). While
some institutions included, in their rules, a requirement to achieve an aggregate pass to qualify for the examination this was not mandatory and enforced and some learners were admitted in error. The consequences were statements such as “we drink daily and pass annually” [7]. For highly gifted learners, there was no value in concentrating on the term assessments as swatting two weeks before the examination was adequate to pass with a distinction. Instead, the missed term assessment appeared more relevant and vital for competent performance at the work place.

1 Body of knowledge completed over a defined period e.g. ±75 hours (see Plato Academic Models for Professionals, Technologists and Technicians [13]) and a minimum of 60% assessed through examination and supplementary examinations.

2 Approximately 30 hours, of practical hours segmented through mandatory techniques as specified in the curriculum and stipulated in the body of knowledge by the professional body.

3 Assessment of individual assignments requiring reading of recommended texts, notes etc. and writing for summative marks.

4 Tests and examinations that encourage students to compete in attaining best grades [6, p. 86].

Table 1: Historical assessment techniques.

The above case demonstrated the lack of alignment between the geomatics education in traditional geomatics competencies with the required and vital competences at the work place. Firstly, a professional will on graduation have to consistently work on projects or tasks all working days (save for leave) and thus must adapt to consistent life of intense pressure of work. Instead, the education systems are inducting the learner to a culture of only two week intense study per semester, if not per year followed by a three hour examination. This symbolises the initial misalignment. Secondly, the theoretical 3 hour examination paper included recite of concepts and was weighed highest between 60% and 90% of final mark. Yet at work, there is no need to remember these concepts which are readily accessible using smart phones, books, reference notes and internet. In most cases, being readily available for quick reference is adequate to ensure efficient application of theory, principles and knowledge. The applied skills and competences become more vital, particularly when information and data are readily available, that what the learner remembers in short or long term memory. Finally, the assessment tends to include theory, principles and standard methods and on rare occasions balance with applications. Even these advanced applications remained divorced from the real-life setting, other than work done during survey camps. However, the costs of sustaining these camps became high and were excluded from some curriculum, another misalignment.

Even though major misalignment can be noted between the purpose of assessments and the assessment methods, the traditional approach remains adequate to accredit some geomatics programmes for modern geomatics. The justification which can be noted for the continued use of such misaligned assessment techniques is that they were acceptable practice and are easy to grade by the assessor. This presents a final misalignment as the purpose of assessment is not to ensure simplicity of grading but to ensure fair, reliable and consistent assessment of learning (not assessment of the learner).

Modern geomatics teaching and learning

Modern teaching approaches need not only acknowledge the over 200 [1] competences to which geomatics knowledge, skills and competences have been applied, but also must adapt to the changing techniques, technologies and competence requirements. South African provinces still have differing legislation resulting in minor evidence that the role of the practising geomatics professional differs within each authority. The need to maintain mobility of learners across provinces is essential. The skills and competencies are relevant to all locations and beyond borders. Thus, the geomatics education today must not only surpass the minimum stipulations from advisory and accrediting authorities [13], but also ensure the graduate can adapt to environments and cases indirectly taught.
The role of the professional and accreditation bodies then are transformed from prescriptive content and mandatory hours to stipulating of core relevant value systems, skills and competencies that must be achieved by qualified learners. Fig. 2 illustrates the comparison between learners of different abilities taught over two academic years. Graph G illustrates the outcome over 1 year (half the required) when a gifted learner is able to demonstrate all competencies well before the completion of the learning period. An average learner, represented by graph A, may acquire the same competencies over the two year learning period. Yet a challenged learner can complete the mandatory learning period but fail to demonstrate required competencies after the two year prescribed period and only show progress after 4 years. This places in question the reliance on tuition hours in the accreditation process instead on quantifiable competences.

The impact illustrated in Fig. 2 could be emanating from differences in teaching approaches on learners with the same capabilities. Adopting Howard Gardner’s “theory of multiple intelligences”, an instructor may adopt various instructional methods that stimulate most senses in learners resulting in an average learner demonstrating in G graph in Fig. 2 [7]. Impacting knowledge in an inappropriate instructional method such as using verbal approaches for learners with gifted spatial intelligences may result in them following the C graph. Teaching approaches differ in form as inductive and the traditional deductive learning approaches. The impact on learners also varies depending on the preferred learning approach. Content based assessment ends up failing good learners or passing hopeless workers.

The processes of accreditation of geomatics education grounded on completed mandatory hours and covered content syllabi becomes a mockery and irrelevant as indicators for accreditation. Some highly knowledgeable, skilled and competent learners may be inappropriately classified as inadequate, just because they crammed the basic theory before an examination, yet are unable to demonstrate competencies. This is because some learners may adequately prove the same competencies after completing half of the prescribed mandatory.

Modern geomatics assessment approaches

Assessments in modern day geomatics may vary for the key competencies in the broadly identified areas in cadastral surveying, geomatics engineering, GISc & T and satellite-based systems.

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<th>Set of outcomes in a programme e.g. demonstrate competencies in using the latest geomatics measurement technology (varies in time from theodolite in the 1980s, total stations 2000s, and GNSS today) and assessed by a minimum of ±60% application of technology in real or simulated environments called integrated task.</th>
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<td>Integrated task assessment of learning in-situ for both theoretical and practical skills and competencies that promoted life-long learning regardless of method, locality or length of time taken [6, p. 86] while targeted at solving current and future community problems. Lecturers act as facilitators of knowledge discovery, knowledge creation and specialist assessors of level of competencies.</td>
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<tr>
<td>Assessment of guided individual and group work targeted at not only assessing geomatics competencies, but also critical cross field outcomes essential in work environments. Learning is through recommended sources and other accessible sources such as internet.</td>
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<td>Assessments and projects that foster cooperation and teamwork, learning from peers than the teacher.</td>
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Table 2: Modern assessment alternatives.

The modern assessment of geomatics competencies have instead shifted from simplicity to assess, and become relevant or fit the purpose of evaluations. For the assessors, moderators and accrediting teams, training and refresher courses in assessment are mandatory periodically and the emphasis must be on assessing aspects relevant to everyday working environments. For example, a learner who attends tasks late would likely fail a course where punctuality is weighed high. Further, integrated assessments would incorporate traditionally omitted assessment aspects such as inter- and intra-personal skills, working as a member of a team, team organisation, team dynamics and skill for third party computations of tasks observed by teammates.

Professional alignment of demands to education in geomatics

The challenges facing the geomatics profession in the twentieth century are highlighted by Hannah, Kavanagh, Mahoney and Plimmer [5]. These include:

- Poor resources and pool of learners keen to consider Geomatics as first choice courses resulting in low student numbers and poor graduation rate. This is exacerbated, in the South African context, by extremely stringent academic entry and subsequent practice assessment for registration, making some successful professionals actively practicing the skills and competencies of geomatics ineligible to register regardless of years of proven competencies and track records.
Diversification of core competencies in geomatics identified as 104 by RICS [6] and estimated to be at least 200 by Hannah, Kavanagh, Mahoney and Plimmer [5]. This results in challenges to clearly define the modern geomatics profession of today.

Finally, South African geomatics professionals must respond to challenges of globalisation in re-shaping its roles to the community it serves.

Conclusions and recommendations

The dynamics of the geomatics profession, the growth of demands for geomatics knowledge skills and competences has resulted in increased demands for qualified and registered professionals, technologists and technicians. However, the widespread closure of universities in the last four decades and the mergers with other departments is likely to result in more demand for geomatics skills and competences in society. Most South African universities and universities of technology are struggling to compete with industry in attracting the few professionals into academia resulting in these institutions relying on foreign, migrant and expatriate labour. The task of drawing a vision for educating the next generation of South African geomatics professionals is then taken over by those temporarily or untrained in education studies. With few qualified in an education qualification, the competency of the professional accreditation authority in assessing the relevance becomes questionable. But the importance of the geomatics profession to re-design and evaluate its profession, how the members are educated and how the community perceives their service remains vital.

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References


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