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Assessing Senior Engineering Student's Ability to Identify Graduate Attributes

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Abstract
Universities around the world are responding to industry and accreditation body requests by embedding graduate attributes into their curricula. The Central University of Technology in South Africa has followed suit by stipulating 10 graduate attributes that academics need to cover in their curricula. It is important that engineering students be able to identify and understand these graduate attributes, as they need to demonstrate them through their entire educational career. The purpose of this paper is to demonstrate which graduate attributes senior engineering students can easily identify based on their understanding of the definition. A questionnaire was used as the data-collection instrument in a descriptive case study. Senior engineering students could easily identify 8 of the 10 graduate attributes that has a word that can be linked to the definition. The graduate attribute "communication" was identified by 92% of the students while 66% identified "entrepreneurship". However, the majority of students struggled to identify two graduate attributes, which are numeracy (6% identified it) and technical and conceptual competence (40% identified it). A possible reason for this could be that there are no words in the definition that may be linked to the name of the attribute. It is therefore recommended that all graduate attributes be defined is such a way that a synonym or antonym of the attribute be used in the actual definition. This may assist students to better identify and understand vital graduate attributes that they need to acquire before entering Industry.

Keywords: assessment, graduates, universities, curriculum.

Introduction

"At the heart of self-regulated formative assessment is the capability to critically self-reflect when utilising feedback for improving learning towards reaching desired standards," was noted by Sin & Mcguigan, (2013). Assessment of graduate attributes

reflects on student's capability to identify graduate attributes. Students should be able to identify graduate attributes in order to meet industry standards and attributes ensures students ability to be effective members of the industry.

Universities around the globe are responding to the call by industry and professional bodies that graduates attributes be embedded into the curriculum, so that students may be able to demonstrate them (Meda & Swart, 2017). Different authors agree that universities have to cultivate required skills and abilities amongst their graduates in order for them to meet the needs of industry. According to Hughes & Barrie (2010), universities must pay attention to the delivery and assessment of graduates attributes. Graduate's attributes have not been considered as learning outcomes that are integrated into the curriculum, but rather as a set of generic outcomes that need to be implemented outside of the learning environment. Furthermore, Green, Hammer & Star (2009), illustrate that global trends have prompted universities worldwide to do more for their students than just teaching disciplinary content. They emphasize that these trends have driven the agenda of developing personal, generic and transferable skills to improve the employability of graduates in different countries.

Herok, Chuck & Miller (2013), indicate that the assessment of graduates attributes is fraught with challenges. One stated challenge is that it may not always be open to an objective evaluation. This claims are based on outcomes which feature verbs that are difficult to quantify or measure, such as understand (Meda & Swart, 2017). Moreover, the number of years learning, rather than of weeks based on context-dependent. On the other hand, Sin & McGuigan (2013), relate that there are challenges associated with developing graduate attributes. They are limited to traditional assessment approaches for assessing the learning outcomes of modules and courses. In addition, this challenge is typically diverse, indeterminate and requires judgement of quality from multiple perspectives (Sin & McGuigan, 2013). This means that if it is difficult to assess graduate attributes, it may also be difficult to identify or understand them. This may be true for both academics and students in higher education.

The purpose of this paper is to determine which graduate attributes senior engineering students can easily identify based on their understanding of the definition. A descriptive case study is used where quantitative data was gathered from a pre-workshop questionnaire. The paper begins with defining graduate attributes as adopted by the Central University of Technology (CUT), followed by the context of the study. The research methodology, results and discussions then follow. Succinct conclusions are finally presented.

Graduate attributes adopted by CUT

The International Engineering Alliance (IEA) (Alliance, 2013) defines graduate attributes as clear, succinct statements of the expected capability, qualified, if necessary, by a range indication appropriate to the type of programme. These graduate attributes are stipulated for engineers (Washington Accord), engineering

technologists (Sydney Accord) and engineering technicians (Dublin Accord). These Accords list a number of graduate attribute profiles that engineering student must gain. The Washington Accord focuses on solving complex engineering problems and results in a professional engineering graduate. The Sydney Accord focuses on the application of engineering procedures, processes, systems or methodologies and results in an engineering technologist graduate. The Dublin Accord focuses on wide practical procedures and practices, resulting in an engineering technician graduate. Moreover, graduate attributes serve to identify the distinctive characteristics as well as the areas of commonality between the expected outcomes of different modules within a given curriculum.

CUT has responded to the needs of industry and professional bodies by trying to implement 10 graduate attributes into their curricula. According to CUT's strategic plan (often called Vision 2020 (Strategic Plan, 2016-20)), these 10 graduate attributes have been mandated for inclusion into all university curricula. Table 1 illustrates the 10 CUT graduate attributes, with their accepted definitions.

Table 1: Graduate attributes at CUT

Graduate Attribute	**Definition**
1. Numerate	Use basic mathematics, budgeting and financial management skills.
2. Teamwork	Work independently and in teams, to manage your own learning, work and take responsibility for self while contributing to teams such as learning communities.
3. Communication	Communicate proficiently, in oral, written, presentation, information searching and listening skills. Be assertive and articulate, be able to negotiate responsibly and persuade others.
4.Innovation and Problem Solving	Be innovative, think creatively and critically and apply a range of strategies to solve/find solutions for real world problems. Demonstrate the ability to apply theoretical knowledge that will lead to development of new ideas, methods, techniques, practices, products and services in a variety of contexts (technology, commerce, social systems).
5.Community Engagement	Be socially engaged in your communities.
6.Sustainable Development	Be environmentally sensitive and recognize your role as a socially responsible citizen who care for the common good of others, the country and environment.
7.Technologically Literacy	Use information and communication technologies effectively.
8.Citizenship and Global Leadership	Make a meaningful and positive contribution to society, be ethical and visionary leaders who can show leadership.

9. Entrepreneurship	Be entrepreneurial, industrious and be able to recognize opportunities; turn them into ideas for enterprises. You shall have business acumen and display basic business skills.
10.Technical and Conceptual Competence	Demonstrate depth of specialized disciplinary knowledge and skills and be able to apply them in different contexts to solve problems.

The implementation of graduate attributes commenced in January 2014, underpinning CUT's academic learning programmes. They have since been integrated into the teaching and learning process, into the curricula and into other activities, such as co-curricular, cultural and sporting activities and work-integrated learning (WIL). It is important to note that ALL these graduate attributes need to be demonstrated by ALL students over their entire educational career within one qualification or programme. This suggests that some graduate attributes would be found in the first year of study, with others in the second or third year of study. This means that the sum of ALL the graduate attributes would be assessed over the total period of the entire programme.

It is often said that engineering students must be able to solve problems and use technology effectively (Phang, et al., 2016). One could say that these graduate attributes should be found in every module within a given study programme or engineering qualification. They are listed as number 4 and 7 by CUT, and as number 2 and 5 by the IEA who use the terms Problem Analysis and Modern Tool Usage (Wendel, Minichiello, Graham, Graham, & Zundel, 2017). Other two graduate attributes that were easily identified by students are sustainable development and teamwork. Sustainable development features the word "environment" in its definition, while team work features the word "groups" in its definition. This makes it easier for student to identify the graduate attribute form a given definition.

Context of the study

CUT has four main faculties on its main campus in the Free State Province of South Africa. The four faculties cover Engineering and Information Technology, Health and Environmental Sciences, Humanities and Management Sciences. Table 2 presents the number of registered students in the four faculties for 2015 and the number of full time staff members working at CUT. This shows that Engineering and Information Technology has the highest number of students and staff members requiring more workshops to create awareness of the importance of graduate attributes.

A Student Peer Mentorship programme commenced in 2013 in order to better help first-year student's transition into higher education. This programme was initially funded by the Department of Higher Education to address low success rates, graduation rates and throughput rates in order to enhance student learning. This Student Peer Mentorship Programme was implemented in all four faculties at CUT, where senior engineering students were appointed as mentors to a group of 10 first-year students (mentees). These mentors are required to welcome first-year students

to the University, assisting them with orientation and information regarding basic student support and information about the faculty. All faculties have their own Student Peer Mentorship co-ordinator who is responsible for organizing workshops and training for their appointed mentors. However, the context of this study is limited to mentors who were appointed in 2017 in the Faculty of Engineering and Information Technology at CUT. The main reason for this is due to the fact that the authors only had access to these mentors.

Table 2: Number of registered students in the four faculties in 2015

Faculties	**Number of students registered**	**Number of full time staff members**
Faculty of Engineering and Information Technology	4213	88
Faculty of Health and Environmental Sciences	1642	54
Faculty of Humanities	2358	74
Faculty of Management Sciences	3390	80

There are five departments in this faculty, namely Electrical engineering, Mechanical engineering, Civil engineering, the Built environment and Information Technology. Senior students from second year to fourth year level who are performing well academically are appointed as mentors. These students must be able to work well with fellow students and academics, displaying good leadership, interpersonal and organisational skills. Mentors in the faculty were given training on graduate attributes in January of 2017, in order for them to better convey the meaning and importance of them to their mentees. Mentors should therefore be able to correctly identify the 10 graduate attributes of CUT.

Method

Participants

The target population for this study comprised all 72 mentors in the faculty, thereby negating a sampling technique. These mentors were invited to a follow-up workshop on how to assess graduate attributes, which was held in May 2017. However, only 51 attended the workshop, which becomes the sample size of this research. The sample size is acceptable as it represents 75% of all mentors in the faculty.

Design

A descriptive case study is used with quantitative data. Yin (2009), points out that a case study is an empirical inquiry that investigates a contemporary phenomenon in depth and within its real-life context, especially when the boundaries between phenomenon and context are not evident. Yin (2009), states that there are three types of case studies, which are exploratory, descriptive, and multiple case studies. A descriptive case study is used where a situation (identifying graduate attributes) is described within a real life context (mentors who are mentoring first-year students).

Data collection instrument

Data was collected through a questionnaire that was distributed to the participants before the workshop commenced. Mentors were asked to complete the questionnaire and return it to the facilitator. The questionnaire was anonymous, being compiled using the institutions strategic plan document and graduate attributes information brochure. The 10 graduate attributes and their definitions were extracted from the brochure and from the strategic plan document. This contributes to the content validity and reliability of the questionnaire. Content validity (McMillan & Schumarcher, 2010) refers to the study's aim, scope and relevance to the value being measured and the accuracy of the measurements to be made. The reliability of a research is related to the repeatability of measurements and the similarity of results for measurements at different times.

Descriptive statistics

Descriptive data is presented in bar graphs, where the demographics of the participants and the questionnaires results are shown. It is important to include participant's demographic information when presenting findings because they provide credible information of the study. According to Kohler, Londis, & Cortina, (2017), reviewers often rely on the demographics of the sample size. The researchers should collect and provide all the relevant information about the demographic attributes of the sample that may be related to how individuals might respond to the selected measures. These include, but are not limited to gender, age, nationality, and tenure in the organization and university programme. Furthermore, the purpose of the demographic information is to assist the reader to be able to assess the degree to which sample of the study may have driven the findings and limit potential of generalising (Kohler, Lundis & Cortina, 2017).

Results and discussions

The demographics of the mentors is shown in Figure 1. The findings show that most of the students are male (71%). The majority of students are aged between 21 and 25 years of age (male students comprise 80% of this group), with the dominant home language being Sesotho. The findings compare well with the national head count by Case, Marshall and Grayson (Case, Marshall, & Grayson, 2013) who found that the student population in South Africa are primarily between 20-24 years of age. Hodges and Park (Hodges & Park, 2013) research findings show that the majority of 77% of students in Engineering are male.

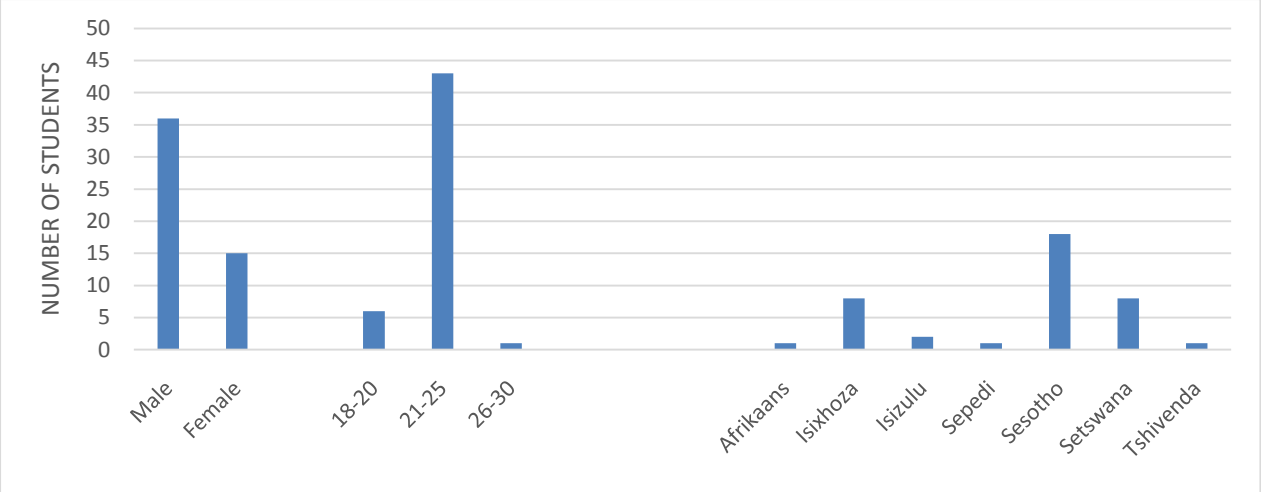

Figure 1: Demographic Information of students

The results of the graduate attributes assessment are illustrated in Figure 2. The results indicate two graduate attributes that the mentors struggled to identify correctly, namely technical and conceptual competency and numeracy. The other eight graduate attributes (teamwork, communication, problem solving, community engagement, sustainable development technological literacy, entrepreneurship, citizenship and global leadership) were correctly identified by more than 65% of the mentors. It is important to note that the correctly identified graduate attributes have a synonym in their definition that may be traced back to the attribute name. For example, problem-solving attributes is linked with challenges, communication is linked with the word talk and community engagement attribute is linked with the word communities.

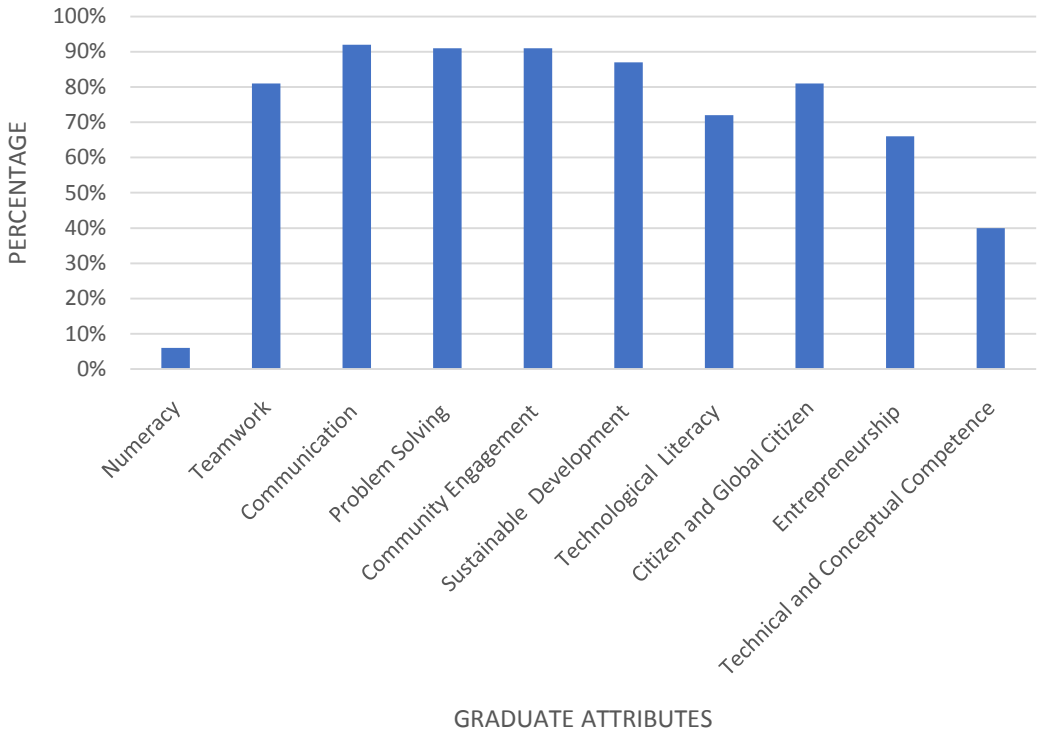

Figure 2: Results of Graduate Attributes Assessment

Conclusion

The purpose of this paper was to determine which graduate attribute senior engineering students can easily identify based on their understanding of the definition. Although the majority of the students who are mentors could identify most of graduate attributes, it was difficult for them to identify and understand two graduate attributes, being numeracy and technical and conceptual competency. Therefore, a lack of understanding of these graduate attributes may result from the inability to correctly identify them. When mentors are not able to understand and identify graduate attributes, it reinforces the need for more workshops to create awareness of what these attributes are and what they really entail. What is not known is whether all senior engineering students in the faculty can easily identify each graduate attributes based on their understanding of the definition. Further research is needed in this regard.

Mentors were assessed on graduate attributes in a form of a questionnaire. Results illustrates that the mentors could easily identify eight out of the ten attributes. However, they struggled to identify technical and conceptual competence and numeracy, as there is no word in the definition that may be linked (synonym or antonym) to the name of the attribute. It is recommended that the definitions of the graduate attribute include a synonym or antonym related to the name of the attribute, which may help students to better identify and understand them. This may also assist engineering students to better demonstrate these graduate attributes through their educational career, as they prepare for their work career in industry.

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