Expectations of and support for engineering graduates: A preliminary review of the industry perspective

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Structured abstract

BACKGROUND
The competencies that successful engineers should possess have been widely identified in the literature. So too has the need for change in the education context and much research is being conducted on methods by which these can be achieved. From another perspective, organisations assist their new graduates through development opportunities. Entry-level engineering positions are seen by employers to be a learning experience and industry spends significant amounts of time and resources with the aim of developing their new graduates to fit into their organisation and into the role of a professional engineer. Little literature exists, however, on the initiatives that are being taken by employers to develop their graduate engineers in the workplace, particularly in the engineering sector.

PURPOSE
This paper reviews the expectations placed on engineering graduates entering the workforce and outlines the early career development initiatives that are provided to them as part of a Graduate Program, drawing implications for the link between the two. It is a preliminary review, part of a larger investigation looking at the transition of engineering graduates into the workplace and into professional practice.

DESIGN/METHOD
This paper describes employer perceptions of the competencies of engineering graduates entering the workplace and the attributes expected of these graduates. Desktop research has been conducted using information obtained from the public domain. This method allows for thematic analysis of the opportunities made available through graduate programs. Outcomes from both methods are used to draw links about the initiatives taken by industry to develop engineering graduate attributes, beyond the tertiary educational context. Findings will form a new understanding of initiatives taken by employers. Attributes that should be better developed in the educational context are proposed.

RESULTS
'Career motivation' is one of the top two attributes that employers wish to see in graduates they employ, followed closely by interpersonal skills and initiative. Of the fourteen large engineering organisations reviewed using publically available information about the graduate programs they offer in Australia, rotations, orientation and induction programs, a strong support network, technical and professional development training, opportunities for further education, support for professional qualifications and individual support are the key opportunities offered to graduates as part of a graduate program. In general, these formal and informal methods are used to aid graduates to become 'well-rounded' professionals. Employee motivation and retention are also key aims.

CONCLUSIONS
The emphasis placed on 'career motivation' by industry cannot be ignored and is a key attribute that requires deeper insight at a research level and emphasis at an educational level. This paper gives insight into the entry-level environment that a graduate engineer generally occupies in a graduate program upon entry into the workplace – one which is different to that of an experienced engineer. It is anticipated that this distinction would have implications on the expectations placed on graduate engineers.

KEYWORDS
Graduate program, attribute development, professional engineer, industry, transition

Introduction

Engineers are expected to undertake a range of responsibilities and roles, to be leaders of engineering teams and effective project managers (King, 2008). They are required to go beyond scientific knowledge and problem solving (Kumar and Hsiao, 2007). Accordingly, in Australia, the Stage 1 Competency Standards for the Professional Engineer (Engineers Australia (EA), 2011) describe the competencies that must be demonstrated at the point of entry into the profession. They highlight not only the expectation but also the importance of, and value placed on, both the professional and personal attributes of engineers.

The range of competencies that engineering graduates should possess have been widely identified (Nguyen, 1998; Hadgraft and Muir, 2003; Barrie, 2006; Male, Bush and Chapman, 2010; Jollands, Jolly and Molyneaux, 2012) and the need for change in the engineering education context has been acknowledged (King, 2008; Sheppard, Macatangay, Colby, and Sullivan, 2009; Litzinger, Lattuca, Hadgraft and Newstetter, 2011). Several studies have also suggested methods by which change could be achieved in the educational context (Seat, Parsons and Poppen, 2001; Elshorbagy and Schonwetter, 2002; Treleaven and Voola, 2008; Maynard *et al.,* 2012). Nevertheless, change is slow and gaps are often highlighted by employers (Spinks, Silburn and Birchall, 2006; Katz, 2007; King, 2008; Jollands *et al.* 2012).

Employers, on the other hand, recognise that universities cannot teach students everything that is required to work and succeed in the workplace (Katz, 2007). Some organisations spend significant amounts of time and resources each year on formal Graduate Programs. Little literature exists, however, on the initiatives taken by employers and the training and development that occur in the workplace (Connor and Shaw, 2008). Little is known about the purpose of these programs and about how graduate engineers transition from the educational context into the workplace and into their professional careers.

This paper is a preliminary review that (i) looks at the attributes expected of engineering graduates from an industry perspective and (ii) outlines the early career development initiatives that are provided to engineering graduates as part of a formal graduate program. This paper goes beyond current literature by investigating how graduates are supported post tertiary education. It is intended that, by analysing the issue of engineering graduate attribute development from this perspective, greater understanding will be gained into the expectations of industry on graduate engineers. Further, greater insight is given on the role of engineers in their early careers in the workforce. Attributes that should be better developed in the educational context are proposed.

This paper is part of a larger investigation looking at the transition of engineering graduates into the workplace and into professional practice. The authors are currently conducting interviews with participants from organisations in Australia that offer graduate programs to engineering graduates.

Methodology

Desktop research was conducted using information about graduate programs collected from the public domain. Key methods used by employers to promote graduate programs are organisation websites and hardcopy and online graduate recruitment directories (Graduate Careers Australia (GCA), 2013). These were the key sources utilised in this study.

Recruitment directories for 2013 were used to shortlist organisations that offer a graduate program for which graduates of engineering disciplines are eligible. From this, 14 organisations were selected based on the availability, at the time of data collection, of adequate information to investigate the opportunities available to graduate engineers as part of a graduate program. All 14 organisations are considered large enterprises with locations in Australia; the majority also operate internationally. All organisations are in the private sector: Consulting (4), Minerals and Energy (4), Fast Moving Consumer Goods (e.g. food and beverage) (2), Accounting (1), Telecommunications (1), Transport/Infrastructure (1) and

Water (1). The graduate programs were not selected based on discipline, rather on the availability of data.

Due to lack of detailed information regarding selection criteria from three organisations, only 11 were analysed for the purpose of addressing the attributes expected of successful applicants into the graduate program; all 14 organisations were used to gain insight into the characteristics of the graduate program.

Online data was captured and imported using NCapture and managed using qualitative data management software NVivo 10. Text and visual data were then coded and analysed thematically in relation to the research aims.

Graduate Attributes

There are many stakeholders in the discussion of what attributes are required of engineering graduates. Education providers, industry, government, accreditation bodies, current and future students, graduate and experienced engineers are just a few. Each stakeholder has the potential to add their own layer of insight.

In Australia, 300 established engineers, with between 5 to 20 years of experience, placed greatest value on communication, working in diverse teams and self-management (Male, Bush and Chapman, 2011). Professionalism was also ranked highly, while technical items were ranked lower.

A study that considered three perspectives (industry, academics and students) (Nguyen, 1998) found that the relative value placed on certain attributes varied amongst the three groups. 'Attitude' was considered most significant by industry; 'technical knowledge and skills' by academics; and, students' perception overlapped with both of these areas. Considering all three stakeholders, the study concluded that engineers must have knowledge of engineering fundamentals and be able to apply theory to practice, must be skilful and practical, understand environmental constraints and quality control; and, understand technical terminology and economic and political issues. Effective communication skills were desirable, while competencies such as loyalty and honesty and an understanding of the engineer's role within society were considered advantageous (Nguyen, 1998). Teamwork was not directly referred to.

A more recent study (GCA, 2013) looked at the issue from an employer perspective by asking 102 employers which selection criteria they considered to be most important. The top three criteria were: interpersonal and communication skills; passion, knowledge of industry, drive, commitment and attitude; and, work experience. Leadership skills were ranked last, suggested to be a skill that could be developed once in the workplace.

The value placed on different competencies in these studies show the differences in perception between stakeholders. It is acknowledged that a lack of mention in any one study does not constitute that a particular attribute is not important for successful engineers. The studies used different participant groups and were conducted at different points in time, thus having implications on the findings. Nevertheless, these studies highlight that, even though there are some common understandings, there is considerable difference in the expectation of certain attributes, when considered from the perspective of different key stakeholders. An important point to note is that both Male *et al* (2011) and Nguyen (1998) highlighted that technical ability remains the number one criterion, even though other attributes were ranked higher; calibre of academic results was ranked 5 (out of 10) by employers (GCA, 2013). Here, it is important to consider the environment in which different stakeholders operate, as this would impact their priorities and values.

Another observation is the method by which these studies were administered, involving participants needing to respond to predetermined attributes. This eliminates the potential for participants to give due consideration to (or mention) certain attributes that are important from their particular perspective, but which may not have appeared on a survey or questionnaire provided to them.

As also suggested by Nguyen (1998), emphasis being placed on certain graduate attributes in tertiary education are different to what is sought after by employers. Hence, this paper looks at the issue of graduate attributes from the perspective of the employer by considering selection criteria for 11 separate organisations. This analysis is conducted taking into consideration the role that graduate engineers occupy as part of a graduate program. The characteristics of graduate programs at 14 organisations are provided. The perspective gained by using the current methodology is not one which has received consideration in past literature, though proves to give significant insight into the issue.

Results and Discussion

Figure 1 showcases certain attributes that were referred to in recruitment material published by 11 engineering organisations in information referring to the organisations graduate program. These attributes were thematically determined. The characteristics and the context of graduate programs will be discussed later in the paper.
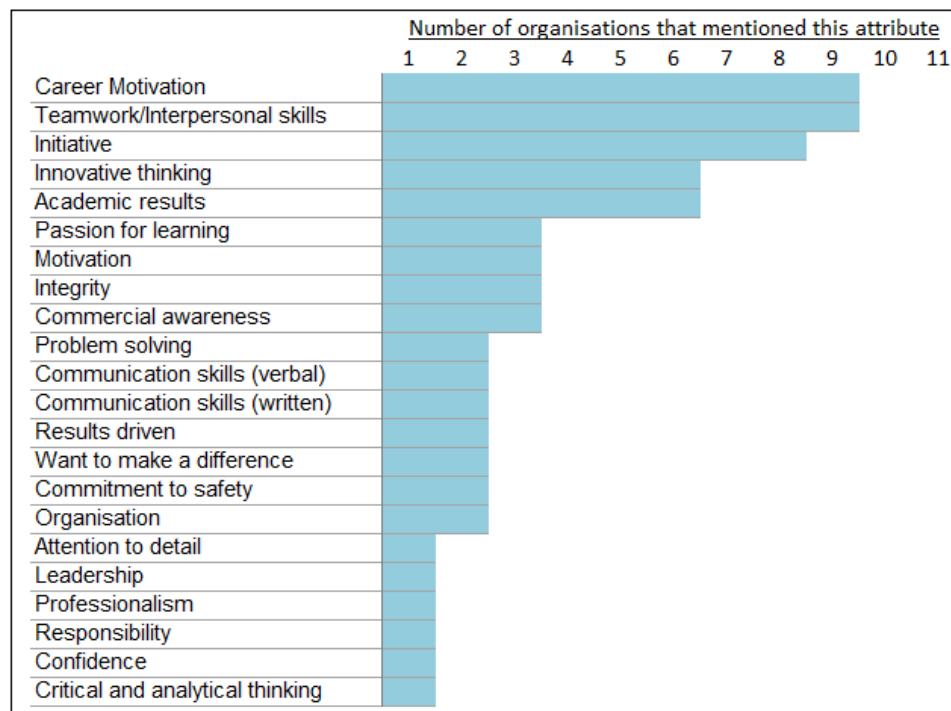

Figure 1: Most stated attributes in graduate recruitment material

The findings highlight that 'career motivation' is one of the top two attributes that employers wish to see in graduates they employ. This finding is in agreement with the earlier study that found drive and attitude to be the second most sought after criteria by employers (GCA, 2013). Of the other two studies mentioned earlier, Male *et al.* (2011) does refer to 'self-management', perhaps due to the participant group of the study being experienced engineers. However, in this instance, the 'self management' referred to is inclined towards being able to function as an individual, not the sense of knowing what career one wishes to pursue and making decisions based on that motivation, as is the case in the current findings. Nguyen (1998) also found 'attitudes' to be highly valued by industry, however, again, this did not encompass the significance placed on career motivation.

Career motivation (with this emphasis) is not mentioned in the earlier studies, though, promisingly, it does have a mention in the Stage 1 Competency Standards (EA, 2011) through a reference to 'self-management', but here with a connection to achieving career goals and objectives. Nevertheless, the significance of this characteristic, as shown in the current findings, calls for greater understanding and emphasis at the tertiary education level.

Teamwork and interpersonal skills were the second most mentioned attribute, in support of past studies. Interestingly, the concept of 'passion for learning' is another attribute mentioned by employers but not directly referred to in the past studies. What is interesting is that this attribute is, as is career motivation, more so a personal attitude and motivation than a skill that can be taught (though perhaps it can be nurtured and encouraged).

Past literature (Male *et al.* 2011) does acknowledge that non-technical and attitudinal competencies are as important as technical competencies, though the significance of the current findings are amplified when viewed with a perspective not before considered – Engineering graduates enter the workforce not as experienced and professional engineers, but as entry level engineering 'graduates'. Consideration of the early career role of engineering graduates upon entry into the profession is essential to understand the graduate attributes they require and the necessity and importance placed on 'career motivation, initiative and passion for learning'. It is here that consideration needs to be given to the path that graduates take after tertiary education.

The Graduate Program

Graduate programs are structured entry-level positions that are seen by employers to be a learning and development experience for new graduates entering the organisation and into the role of a professional engineer (Katz, 2007). They are designed for recent university graduates with a relevant Bachelor's (or sometimes Master's) degree, who are looking to enter the workforce. Generally, candidates become ineligible for a graduate program if they have worked in industry for more than 12 months or if they graduated from their degree more than two years before commencement in the program. Where graduates do have prior experience, they are recommended to apply for other professional positions within an organisation. A degree completed within two years of application is requested to ensure qualifications are relevant to current business practices.

Analysis of the 14 engineering organisations that offer graduate programs to engineering graduates revealed several common characteristics. Graduate salary is negotiated upon selection into the program. Salaries are noted to be competitive and dependent on the market rate, type of degree and whether or not the graduate has any prior professional work experience. Graduates are employed full-time on a permanent basis and the program generally lasts from 1.5 to 4 years. Upon completion of the program, the graduate is offered an ongoing role based on their preferences and business requirements; the employer aims to keep the engineer within the business. This is expected, given the time and resources invested in each graduate.

Table 1 presents the opportunities generally offered to engineering graduates as part of a graduate program. It is representative of the initiatives provided by 14 large organisations that offer a graduate program in Australia. It is acknowledged that not all organisations offer every one of these initiatives and some may not have been captured in the data collected, even though they are provided as part of the program. Overall, however, the key characteristics of graduate programs are: rotations, orientation and induction programs, a strong support network, technical and professional development training, opportunities for further education, support for professional qualifications and individual support.

Table 1: Characteristics of graduate programs offered at 14 organisations in Australia.

Characteristic	Number of graduate programs that offer the respective characteristic (out of 14)
Rotations	13
Orientation / Induction program	11
Support network	
Manager for each rotation	4
Mentoring	13
Buddy	2

HR contacts	3
Professional skills development	11
Technical training	7
Further education	7
Professional qualifications	8
Individual Support	6

Three organisations specifically mentioned that the graduate program would last 1 year longer for engineers compared to other professions, as the program was also available for applicants other than engineering graduates (e.g. science and commerce). Overall, only one program out of 14 lasts for less than 2 years and the majority (6) lasts for 2 years. Rotations (present in all but 1 program) involve working in different roles and on different projects; seen by employers as an opportunity to gain business awareness and experience.

Mentoring was offered to graduates (in all but one program) as a form of support and guidance. A support network consisting of access to mentors, a 'buddy', Human Resources (HR) contacts and a direct manager were also mentioned, though not by all organisations. It is likely that access to a manager and HR contacts were not as prevalent due to these not being considered relevant specifically to graduates alone.

In terms of training and development, 11 organisations mentioned the provision of either compulsory or optional opportunities for the development of professional skills e.g. project management, leadership, ethics, client relationships and business writing, to name a few. Technical training was mentioned in 7 programs, referring to both structured programmes and on the job training. Assistance for further education was mentioned by 50% of organisations, referring to financial and leave support for relevant qualifications. Eight organisations also support graduates to acquire professional qualifications e.g. Chartered Engineer status, this being seen as an important career milestone and the potential to being benefits to both the individual and the organisation.

As specifically mentioned by two organisations, employers aim to acquire personnel with different thoughts, opinions, fresh ideas and perspectives through the recruitment of graduate engineers. These qualities bring value to the organisation. The benefits available to graduates are also many, particularly considering their relative lack of work experience. Graduate programs provide support that is necessary in light of this inexperience, and perhaps due to the mismatch of competencies expected of engineering graduates and that which is displayed by them in the workplace. Hence, this further training and development is essential, to not only increase the benefits to be gained by the employing organisation, but also to aid the graduate in their transition to becoming a professional engineer.

Accordingly, employers, by offering particular opportunities, ensure their graduate employees are given the chance to become 'well-rounded' professionals, gain the skills and confidence needed to become future leaders of the organisation, and smooth the transition from the educational to the workplace context. The role of an engineer employed in a graduate program is significantly different to another engineering role, in the sense that graduates are generally required to undergo rotations across several roles within the organisation. This allows them to gain insight into the culture, structure and systems of the organisation and explore a variety of roles and projects. Even so, graduates are given the chance to put theory into practice while working on 'real', challenging projects. The opportunity and expectation to take on the responsibility of an engineering professional is also present. The difference, however, is that the graduate program aims to offer a supportive environment in this process, in the form of formal and informal opportunities.

Implications

Graduate programs are structured in such a way that they offer support for new engineers. In fact, six programs referred to individual support, highlighting the provision of assistance with

such things as setting objectives, career development pathways, consideration for personal ambitions and aspirations and long-term progression. Employers see graduates as being able to develop certain attributes during the program (supported by GCA (2013)) and, as shown here, they provide opportunities for development in the early years of employment and encourage on-the-job learning. Even though employers undoubtedly seek to hire the most competent of graduates, these findings show that, as a graduate progresses through the program, the necessity for 'career motivation' and 'initiative' (found earlier to be key attributes sought by employers) becomes understandable. It is this characteristic that will allow graduates to make the most of the opportunities provided to them by their employer, to become the future leaders that the organisation seeks.

These findings give insight into the entry-level environment that a graduate engineer occupies upon entry into the workplace and the expectations placed on them by their employer. It is clear that this role is different to that of a highly experienced professional engineer. It is hoped that these findings will aid in the distinction between the two and offer insight into the process of setting guidelines for the expectations of graduate engineers.

Integral to this discussion is also the question of the predominant purpose of tertiary education institutions and the extent to which they are responsible for developing graduates in preparation for employment. Bridgstock (2009) (from a higher education perspective) highlighted the need for career management skill development to be better recognised in universities. Considering the importance of career motivation from an engineering perspective, shown in this paper, it is hoped that the emphasis placed on career motivation will increase, thus encouraging education institutions to give students the opportunity to prepare for not only employment but also their professional careers.

Limitations and Recommendations

Findings in relation to employer expectations of graduate attributes are reflective of the data available in the public domain and the small sample size. It is acknowledged that these may be differently emphasised in-house during the recruitment process. Further, expectations would vary depending on the organisational or industry context, i.e. the sample of engineering employers used in this study does not necessarily represent all engineering employers, nor focus on one single discipline of engineering. Nevertheless, the emphasis placed on 'career motivation' by nine out of eleven organisations is clear. Further research would be beneficial to allow representation of more engineering employers and to distinguish between different disciplines of engineering.

Only a snapshot overview of graduate programs is presented in this paper. Consequently, little insight is given into the issue that graduate programs do not always result in satisfied graduates or correlate with graduate retention (Connor and Shaw, 2008) (a drawback for both the graduate and the organisation). Understandably, this insight cannot be gained from desktop research alone and calls for further analysis of the offerings and outcomes of a program. Further research is also recommended to determine graduate program outcomes value added to a graduate's transition into the workplace and their professional careers.

The authors are currently conducting interviews and further research to overcome these drawbacks. It is anticipated that the current findings will shed light on the discussion of engineering graduate attributes by providing new insight into the initiatives that are utilised in industry. It is expected that future findings will highlight initiatives that could be utilised in tertiary education to better prepare graduates for the workplace and their future careers.

Conclusions

Technical knowledge and skills alone are not sufficient for a successful engineering career. This paper has added to the understanding that not only are technical and non-technical attributes essential, but so too are certain attitudinal competencies. As such, the necessity for engineering students to develop competencies stipulated by accreditation providers such

as Engineers Australia is not doubted. However, the emphasis placed on 'career motivation' by industry cannot be ignored and is a key attribute that requires deeper insight at a research level and emphasis at an educational level.

This paper gives insight into the support provided to graduates through a graduate program. It is anticipated that this insight into the entry-level role (which is different to that of an experienced engineer) would have implications on the expectations placed on graduate engineers. It is anticipated that these initial findings will encourage further exploration into the role of engineering graduates as they transition into their professional roles. Future detailed findings would also have significant implications for the educational context, where initiatives utilised by employers could be adapted and integrated into undergraduate courses to better prepare engineering students for the workplace and their professional careers.

References

Barrie, S.C. (2006). Understanding what we mean by the generic attributes of graduates. *Higher Education, 51*, 215-241.

Bridgstock, R. (2009). The graduate attributes we've overlooked: enhancing graduate employability through career management skills. *Higher Education Research & Development*, *28*(1), 31–44.

Connor, H. & Shaw, S. (2008). Graduate training and development: current trends and issues. Education + Training, 50(5), 357–365.

Elshorbagy, A. & Schonwetter, D. J. (2002). Engineering Morphing: Bridging the Gap Between Classroom Teaching and the Engineering Profession. *International Journal of Engineering Education,* 18(3), 295–300.

Engineers Australia (EA). (2011). Stage 1 Competency Standard for Professional Engineer. Retrieved January 11, 2013 from http://www.engineersaustralia.org.au/sites/default/files/shado/Education /Program%20Accreditation/110318%20Stage%201%20Professional%20Engineer.pdf

Graduate Careers Australia (GCA). (2013). *2012 Graduate Outlook Survey - Summary Report for Construction, Mining and Engineering Employers.* Retrieved August 2, 2013, from http://www.graduatecareers.com.au/wp-content/uploads/2011/12/2012-GOS-CME-Industry-Report.pdf

Hadgraft, R. & Muir, P. (2003). *Defining Graduate Capabilities for Chemical Engineers at RMIT*. Paper presented at the Australasian Association of Engineering Education, Melbourne, Australia*.*

Jollands, M., Jolly. L., & Molyneaux, T. (2012). Project-based learning as a contributing factor to graduates' work readiness. *European Journal of Engineering Education*, *37*(2),143-154.

Katz, S. M. (2007). The Entry-Level Engineer: Problems in Transition from Student to Professional. Journal of Engineering Education, 82(3), 171–174.

King, R. (2008). Engineers for the Future: addressing the supply and quality of Australian engineering graduates for the 21st century [Adobe Digital Editions version]. Available from http://www.engineersaustralia.org.au/sites/default/files/shado/ACED/Engineers%20for%20the%20Future.pdf

Kumar, S. & Hsiao, J. (2007). Engineers Learn "Soft Skills the Hard Way": Planting a Seed of Leadership in Engineering Classes. Leadership and Management in Engineering, 7(1), 18–23.

Litzinger, T., Lattuca, L. R., Hadgraft, R. and Newstetter, W. (2011), Engineering Education and the Development of Expertise. *Journal of Engineering Education*, 100: 123–150.

Male, S. A., Bush, M. B., & Chapman, E. S. (2010). Perceptions of competency deficiencies in engineering graduates. *Australasian Journal of Engineering Education*, *16*(1), 55-67.

Male, S. A., Bush, M. B. & Chapman, E. S. (2011). An Australian study of generic competencies required by engineers. *European Journal of Engineering Education, 36*(2), 151-163.

Maynard, N., Kingdon, J., Ingram, G., Tade, M., Shallcross, D. C., Hadgraft, R., … Kavanagh, J. (2012, July). *Bringing Industry into the Classroom: Virtual Learning Environments for a new generation.* Paper presented at the 8th International CDIO Conference, Queensland, Australia.

Nguyen, D. Q. (1998). The Essential Skills and Attributes of an Engineer: A Comparative Study of Academics, Industry Personnel and Engineering Students. Global Journal of Engineering Education, 2(1), 65–76.

Seat, E., Parsons, J. R., & Poppen, W. A. (2001). Enabling Engineering Performance Skills: A Program to Teach Communication, Leadership, and Teamwork. *Journal of Engineering Education*, *90*(1), 7–12.

Sheppard, S. D., Macatangay, K., Colby, A., & Sullivan, W. M. (2009). *Educating engineers: Designing for the future of the field* (Vol. 9). San Francisco, CA: Jossey-Bass.

Spinks, N., Silburn, N., & Birchall, D. (2006). Educating engineers for the 21st century: The industry view. *London: The Royal Academy of Engineering*.

Treleaven, L. & Voola, J. (2008). Integrating the Development of Graduate Attributes Through Constructive Alignment. *Journal of Marketing Education,* 30(2), 160-173.

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