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Research Article

Engineering Students' Perceptions of Graduate Attributes: Perspectives from Two Educational Paths

— CHIEN-CHING LEE AND SOO-FUN CHIN

Abstract*—This study aimed to provide insights on the perceptions of engineering students from two educational paths in Singapore of desired graduate attributes by employers.* **Research questions:** *1) Do graduates from the polytechnic and junior college paths have similar perceptions with regard to the ranking of desirable graduate attributes? 2) If not, in what ways are their perceptions different?* **Literature review:** *A review of literature on employers' ranking of desirable graduate attributes revealed mismatches in employers' and graduates' rankings. There has not been any published study on student awareness of employability skills in Singapore in particular. Hence, this study investigated the perceptions of final-year engineering students from two different educational paths of their ranking of graduate attributes.* **Methodology:** *The students were asked to rank eight attributes and explain their ranking from an employer's perspective*. **Results:** *The findings show that*

communication, teamwork and problem-solving were ranked the top three desirable attributes by both groups of students. However, polytechnic students seem to reflect greater familiarity and confidence in tackling workplace requirements compared to junior college students. The implications of the findings are presented.

Index Terms*—Educational paths, employability skills, engineering, graduate attributes, perceptions.*

Employees, retrenched staff, and students are starting to realize that jobs are no longer permanent. Many countries are facing a gloomy economic outlook with high unemployment rates [1]. In response, industries are offering varied forms of employment like contract, part-time, flexible time, and full-time employment so that they can adjust their manpower needs accordingly. Higher education seemed to promise a brighter future for many in the past, but mass education has normalized the playing field for many [2]. Even higher education stakeholders have recognized that a degree by itself does not guarantee graduates jobs [3], [4]. Graduates are also aware of the declining value attached to their academic credentials as they are positioned relative to another graduate with similar credentials; hence, they need to reinforce experiences outside their degrees [5], [6].

In Singapore, the role of equipping undergraduates with the graduate attributes desired by employers has often been tasked to universities, and the effectiveness of their role is often seen in the annual graduate employment surveys that list the overall employment of each university's graduates by employment rate, salary, and bachelor's degree [7]. We argue that increasingly, graduates need to be empowered to manage their employability because permanent jobs no longer exist and graduates are likely to be in different forms of employment or jobs throughout their working life [8], [9]. The Singapore government has also acknowledged these facts and has thus launched the SkillsFuture program where all

Singaporeans are encouraged to engage in lifelong learning to be able to respond effectively to industry's evolving needs and develop their own careers [10]. The importance of continuous employee upgrading is further supported by Allen and van der Velden, who found that skill mismatches have a more pronounced influence on employability compared to educational mismatches [11].

We believe that empowering graduates starts by helping them gain the correct perception of the graduate attributes desired by employers. This is especially pertinent as studies have shown that there are mismatches in employers' and graduates' rankings of desirable graduate attributes [12]-[15]. There has not been any published study of student awareness of employability skills in Singapore in particular. Hence, this study investigated the perceptions of final-year engineering students of their ranking of desirable graduate attributes. These students came from two different educational paths in Singapore before enrolling in undergraduate studies. The polytechnic students came from a practice-based curriculum with 44 weeks of work placement before graduation, while the junior college (JC) students came from a theoretically-based curriculum with 10-22 weeks of work placement.

We pose the following research questions in this paper:

> **RQ1.** Do graduates from the polytechnic and junior college paths in Singapore have similar perceptions with regard to the ranking of desirable graduate attributes for employment?
>
> **RQ2.** If not, in what ways are their perceptions different?

This study did not aim to validate either of the two educational paths, as each student learns differently and has different interests at different stages in life. We hope that the findings from this research will inform recruitment by universities with regard to student mix and

admission criteria, and also provide insights about possible alignments that should be made by universities, the government, and the graduates themselves with regard to empowering graduates to manage their own employability.

The next sections present the literature review on employers' and graduates' perceptions on the ranking of desirable graduate attributes, followed by the methodology of the study. The findings and their implications are then discussed.

LITERATURE REVIEW

This section introduces the theoretical orientation that underpins our study and the way that we conducted the literature search. We then present a review of literature on employers' ranking of graduate attributes in general, the graduate attributes specified by the respective countries' engineering accreditation boards and the alignment of these attributes with employers' expectations of engineering graduates, the gaps in graduate attributes identified by employers, and lastly students' or graduates' perceptions of the ranking of the graduate attributes. We then proceed to provide the justification for the research model adopted in this study.

Theoretical Orientation This study defines graduate attributes as "specialized and differentiated forms of underlying generic abilities that are developed to meet the needs of a specific discipline" [16, p. 266]. Employability skills, however, refer to the workplace skills and personal attributes needed for employment. For example, Charles Darwin University lists "creativity" as a graduate attribute and the corresponding employability skill as "initiative and enterprise skills that contribute to innovative outcomes" [17]. In light of the dynamic changes in the global economy affecting the local economy and the realization by employees that no job is permanent, we agree with Harvey [8] and Nilsson [9] that empowering graduates to manage their employability is the real challenge, rather than the question of how

employers can accommodate employability.

Selection of Literature for the Review The literature review included searches on the following keywords:

- Employers' expectations of (engineering) graduates
- Students' perceptions of what employers look for in graduates
- Educational mismatch
- Skills mismatch
- Employability skills framework
- Engineering accreditation requirements
- Polytechnic education in Singapore
- Junior college education in Singapore

The inclusion criteria from results returned by general searches were mainly determined by the sample size of the study. Studies that presented findings for a large sample size, with employers representing 1000 employees or more, or nationwide surveys were preferred, as they were more representative of employers' expectations. For example, the study by the Council of Industry and Higher Education [12] was cited because 233 employers were surveyed, while the SCRE survey [18] covered only 22 informants.

The next section presents the literature review of employers' rankings of graduates attributes.

Employers' Ranking of Graduate Attributes (Generic) Table I presents findings from large-scale studies of employers' expectations of graduate attributes in six countries. Note that there are more studies on employability skills in Western countries compared to Asian countries [15]. Furthermore, the Workforce Skills Qualifications (WSQ) framework is included in Table I as a point of reference rather than as a finding because there is currently

no large-scale published survey on employers' expectations of graduate attributes in Singapore. Even though the WSQ framework developed by the Workforce Development Authority is a national credentialing system, it certifies skills from the certificate to the graduate diploma level only [19].

Table I shows that there are many similarities in employers' ranking in the six countries [12]-[19], [20]-[23], although the rankings of the attributes differ for each country. Among the ranked attributes, *communication* and *teamwork* are ranked among the top four attributes in the UK, US, and Hong Kong. Among the unranked attributes, *communication, teamwork, problem-solving, planning and organizing,* and *self-management* skills are commonly cited attributes. Interestingly, the *health and workplace safety* and *lifelong learning and global mind-set* attributes are unique to Singapore. Both attributes are driven by the government. The Ministry of Manpower [24] regulates workplace safety and health issues, while International Enterprise Singapore [25] helps Singapore-based companies to venture overseas and be globally competitive.

Graduate Attributes Expected by the Engineering Accreditation Board Even though Table I has identified that there are common graduate attributes desired by employers, employability is gradually viewed in a relational, contextual, and individual manner [9] because employees are increasingly responsible for their employability, rather than employers. Thus, besides having the educational qualification, employees must also cultivate and maintain social networks and interpersonal skills, update their technical skills continuously for the specific industry and occupation they are working in, and be flexible and adapt quickly to new contexts.

In Singapore, there is a growing recognition that employability skills are job related, and this is exemplified by developing skills in two aspects of the WSQ framework: foundational skills

and industry-specific skills [19]. The graduate attributes for engineers in Singapore are set by the Engineering Accreditation Board [26]. These attributes are the ability to:

1. *Apply knowledge of mathematics, science and engineering* to the solution of complex engineering problems
2. *Design and conduct experiments*, analyze, interpret data and synthesize valid conclusions
3. *Design a system*, component, or process, and synthesize solutions to achieve desired needs
4. Identify, formulate, research through relevant literature review, and *solve engineering problems* reaching substantiated conclusions
5. *Use the techniques, skills, and modern engineering tools* necessary for engineering practice with appropriate considerations for public health and safety, cultural, societal, and environmental constraints
6. *Communicate effectively*
7. Recognize the need for, and have the ability to engage in *life-long learning*
8. Understand the impact of engineering solutions in a societal context and to be able to respond effectively to the needs for sustainable development
9. Function effectively within *multi-disciplinary teams* and understand the fundamental precepts of *effective project management*
10. Understand *professional, ethical and moral* responsibility

The attributes set by the Singapore EAB are similar to those in the US [27], UK [28], and Malaysia [29]. The close match in the graduate attributes for the four countries implies that there is a strong community of practice that engineering graduates need to integrate into to develop as professional engineers regardless of the country they practice in.

Graduate Attributes Expected by Employers of Engineering Graduates The idea of a strong engineering community of practice is supported by findings of employers' expectations of engineering graduates in the US [30], Malaysia [31] and India [32] as shown in Table II.

Communication skills was rated as the most important skill in the US and Malaysia, but fifth in India. A greater difference in the ranking across countries is seen in the importance placed on applied technical skills (*solve problems; apply math, science, and engineering; use modern engineering tool; design a system; design and conduct experiments*). In the US, applied technical skills were ranked 2-4, 7, and 9, while these skills were ranked 4-6, 9-10 in Malaysia and 4, 6, 7-9 in India. This difference reflects the fact that although there is an alignment in the standards set by the Engineering Boards of each country, the rankings of these attributes differ for each country. There is no published study on employers' expectations of engineering graduates in Singapore. The EAB graduate attributes above (italicized font) however, align with employers' expectations of engineering graduates as shown in Table II.

Given the strong alignment in graduate attributes by the engineering bodies and employers, one might expect that graduates have no employability issues. Studies however, show that there are gaps in graduates' skills. In a study cited by Archer and Davison [12], the gaps identified by UK employers by percentage were graduates' foreign language skills (49%), business awareness (44%), ability to self-manage (33%), work in teams and communicate (30%); and have a positive attitude toward work (25%). In Malaysia, a survey of 302 employers of graduate engineers and 305 employers of engineering interns found that both groups were rated highly on teamwork and the ability to carry out instructions, and poorly on leadership skills and the ability to communicate in public [33].

These gaps need to be addressed as they affect graduates' educational and skill matches, job satisfaction, wages, and on-the-job search (job searches by employees who are dissatisfied with their current jobs). A study of 2460 individuals in 11 European countries and Japan found that educational mismatches (misalignment of level and field of education acquired and level and field of education required for a job) has a strong effect on wages, with the most competent being offered jobs that are above their qualification level, while the least competent are offered jobs below their qualification level [11]. This finding implies that the worry about over-education (working in a job that requires a lower qualification than that acquired) or under-education (working in a job that requires a higher qualification than that acquired) is not meaningful in the labor market because employers sort graduates according to their ability level, which is an indicator of their productivity, and hence wages. A more daunting challenge faced by graduates is skill mismatches which lead to the underutilization of skills, lower job satisfaction, and increased on-the-job searches (it is noted that educational mismatches did not have any effect on these three outcomes).

These findings have implications for graduate employability. First, graduates must acknowledge that there are other factors that employers look for in hiring besides education. Factors such as graduates' work experience and ability are assigned different weighting by different employers and have to be considered. Second, the focus in improving graduate employability is not on competing with other graduates via education to get a job but on continuous learning to broaden opportunities in the current job and to have the ability to hit the ground running in a future job. As skill mismatches seem to be the more pertinent issue in graduate employability, students need to be empowered to address this issue if they are to manage their own employability.

The next section examines students' perceptions of the ranking of graduate attributes to

identify mismatches with employers' perceptions of the attributes.

Students' Perceptions of the Ranking of Graduate Attributes One way to help graduates manage their own employability is to help them be more aware of the attributes desired by employers. If causes for misalignments in their perceptions of these graduate attributes can be identified, targeted steps can be taken to address those misalignments.

One of the causes of the differences in perception is due to differences in self-evaluation. A survey of 294 industry representatives and 827 students in engineering capstone courses in Canada found that even though the students claimed that they were very confident in conveying technical information and using teamwork and communication skills, these were among the top five areas employers identified as their weakest [14]. Another study of 35 employers and 90 participants in India found that the top 10 graduate attributes desired by employers in software companies were self-management skills, while the top five attributes ranked by graduates were technical skills [13].

Gender also plays a role in differences of perception. A study of 26 employers and 54 computer science graduates in Sri Lanka found that employers ranked problem-solving skills as most important, while male and female graduates ranked learning skills and self-confidence as most important, respectively [15]. In addition, female graduates perceived themselves to have a significantly higher level of learning skills and confidence compared to male graduates. Other studies have either shown no difference [34] or mixed results between genders [35].

The students' work placements also influence their perceptions. Chitra's study, for example, found that students' ranking of graduate attributes were vastly different from employers' and that this difference might result from the fact that 84.4% of them did not have any work experience [13]. Studies have also found that students who have work placements get

employed more easily compared to students who have not undergone work placement because it generally improves graduates' teamwork, communication, self-management, critical thinking, and problem-solving skills [36-38].

Not all work placements, though, have the same effect on graduates. Jackson's study of 131 graduates who assessed their own abilities after placement found that factors like age, gender, years of study, degree type, duration of work placement, and size of organization have an effect on the benefits gained from work placement [39]. In terms of age, graduates aged 19-21 years old felt that they were not as capable as those aged 22-25, but there was no significant difference for those aged 26 and above. Her findings further show that males perceived themselves to have significantly higher critical thinking skills before and after work placement. In addition, students who were in the later years of their degree studies showed greater improvement in their skills after placement compared to those who were in their earlier years of study. Furthermore, Engineering and Health and Science students had a higher mean improvement for "analyzing data and using technology" and "developing professionalism" compared to students undertaking other degrees. In terms of duration, students who underwent more than 200 hours of work placement in medium-sized organizations showed a higher mean rating for problem-solving skills compared to students who had fewer hours, as the former were given more responsibilities and varied challenges in the organizations. Moreover, students who worked in the private sector seem to have a significantly higher improved ability to communicate effectively compared to those who worked in non-profit organizations or in the public sector.

The duration of graduates' work experience after graduation also influences their perceptions of graduate attributes desired by employers. Nilsson (2010) interviewed 20 Masters in Information Technology graduates in Sweden with three to four years of working experience

prior to pursuing their postgraduate degrees. The graduates perceived that education serves as a merit and sorting tool in the pre-employment stage. Once employed, soft skills and personal attributes are more important than formal and technical vocational skills in relation to an individual's employability.

The next section looks at two groups of students in Singapore who took different education paths before enrolling for a bachelor's degree, leading to the research model for this study.

Research Model for this Study The aim of education in Singapore is to develop students at their own pace, providing opportunities for further education depending on the students' aptitude and talent in specific areas. Figure 1 illustrates the education landscape in Singapore and the way that the Ministry of Education hopes to achieve the aim mentioned via different education pathways [40].

In Singapore, all students undergo six years of primary education (aged seven to 12) before pursuing their secondary education.

At the secondary school level, students who perform well in their respective streams can fast-track to a higher stream. For example, students who perform very well in the Primary School Leaving Examination (PSLE) could enroll in an Integrated Program school, where they could take the GCE "A" level examination after six years of study (bypassing the "O" level). In addition, students who have a minimum of 200 out of a maximum of 300 points will enroll in the Express stream, which constitutes four years of study leading to the GCE "O" level. Students who have scored fewer than 200 points will enroll in the Normal (Academic) or Normal (Technical) streams which constitute four years of study leading to the GCE "N" level. If they perform well in the "N" level examination, they will study one more year to take the GCE "O" level examination. Students studying for the "N" level can request to be fast-tracked to the "O" level at any stage of their studies if they do well in their studies.

At the post-secondary level, students who perform well in the "O" level can opt to study in a polytechnic for three years, leading to a diploma in a specialized field, or pursue their GCE "A" level in a junior college (JC) for two years. Students in the polytechnics undergo a practice-based curriculum, 22-week work placement with companies in Singapore, and a final-year project which is industry-based. Students in the junior colleges, however, study a more theoretical curriculum (the "A" level) and do not undergo work placement. Students in the junior college could also opt for polytechnic education after their "A" level. All males in Singapore have to perform their national service for two years after their post-secondary education before enrolling in undergraduate studies or going into full-time employment. In the university, both JC and polytechnic students undergo 10-22 weeks of work placement in the third year of their studies.

In Singapore, the decision to attend a JC for a more theoretically-based curriculum or a polytechnic for a more practice-based curriculum after the "O" level is often hotly debated by parents and students alike. The present study takes a longer-term perspective and examines the perceptions of graduates from both of these education paths in comparison to employers' perceptions, with a focus on graduate attributes. With reference to Jackson's study [39], the Singapore students have an age difference of about two years (males perform national service), are in the same year of study (final year), taking the same degree (engineering), with different durations of work placement (polytechnic students have an additional 22 weeks of work placement as compared to JC students). Thus, we wanted to focus on investigating whether polytechnic and JC students have similar perceptions of the ranking of the graduate attributes, and if not, in what ways they differ. We acknowledge that there are other factors besides education that influence graduates' perceptions of graduate attributes. However, these factors are outside the scope of this study.

METHODOLOGY

This section presents the justification for our research methodology. This is followed by a description of the context of the study, the participants, and procedures for collecting and analyzing the data.

Choice of Research Methodology As there has not been any large-scale study of employers' or students' perceptions of graduate attributes in Singapore, the authors chose to use the "case history" [41, p. 183] research methodology, which is a narrative of what we explored with students regarding their perceptions of graduates attributes desired by employers. In addition, this study employed both quantitative and qualitative analysis methods. Quantitative data was derived from the students' ranking of the graduate attributes. Qualitative data came from the students' explanations of their ranking and allowed us to examine students' perceptions in greater detail without any preconceptions or predetermined categories so that themes could emerge from the explanations themselves. The use of qualitative data is in line with our small sample size, and the focus of the qualitative explanations is to draw connections in the "rich descriptions of the context and experiences of the participants to ensure trustworthiness of the findings and transfer to other contexts" [42, p. 59]. However, the findings in this study cannot be generalized due to the small sample size.

Context *Professional Communication* is a two-credit core course offered to graduating engineering students at a Singapore university. One of the objectives of the course is to provide career development training that requires students to write cover letters and resumes, and prepare for job interviews. The course lasted 12 weeks, with weekly one-hour lectures and two-hour tutorials held every alternate week. One lecture and one tutorial were designated for preparing students to write cover letters and resumes.

Participants The participants consisted of 21 graduating students from the School of

Mechanical and Aerospace Engineering in a university in Singapore taking the *Professional Communication* course. Eight of them were from the JCs, and 13 were from the polytechnics. There were six female and 15 male participants. The males were two years older (23-24 years old) than the females because they had performed their national service before beginning their engineering studies.

The participants were chosen from one class via random sampling among the classes taught by the second author at the beginning of the semester. During the first face-to-face tutorial in week two, the students were briefed about the study, the consent form was distributed, and the students were invited to participate in the online survey on graduate attributes desired by employers, which was conducted in week three. This online survey was the only additional activity the students had to participate in as compared to other students taking this course. The students were informed that participation in the survey was voluntary, that there was no monetary compensation or extra credit for participating in the study, and that their non-participation would have no impact on their grade for their resume. The study was approved by the university's Ethics Board.

How Data Were Collected From the literature review, it can be seen that the graduate attributes set by the EAB and desired by employers were closely aligned. For this study, the graduate attributes identified in the literature were consolidated for ease of reference and understanding by the participants. The attributes used for the survey were: *communication, teamwork, problem-solving* (apply knowledge of math, science and engineering; design a system; design and conduct experiments), *initiative and enterprise, planning and organizing*, *self-management* (professional, ethical and moral responsibility), *technology* (use modern engineering tools), and *life-long learning*.

In week three, the students ranked each graduate attribute according to the level of

importance they perceived engineering employers desired from new hires. They were not asked to rank the items within a graduate attribute (those identified in parentheses above) as doing so might lead to confusion (ranking items within a ranked item). Furthermore, it was felt that asking students to provide the reasons for their ranking of the graduate attributes might be more revealing of their perceptions than ranking the sub-items because the reasons mentioned are not influenced by any pre-defined categories and reflect their perceptions in their own words.

The survey was conducted in week three before the lecture on resume writing in week four. So the students' ranking and explanations of their ranking were not influenced by the lectures.

How Data Were Analyzed The mean of the students' ranking of the graduate attributes was calculated, and the qualitative responses were analyzed based on the frequency of the responses.

No study of engineering graduate attributes desired by employers in Singapore exists except the list defined by the EAB. Thus, the findings in this study can only be compared with those found in the literature. The authors also acknowledge that inferences about the reported data are limited by the small sample size.

RESULTS

This study aimed to examine whether graduates from the polytechnic and junior college paths had similar perceptions with regard to the ranking of graduate attributes, and if not, in what ways their perceptions differed. The students were asked to rank the eight attributes in terms of what they perceived were employers' expectations for potential hires and then to explain their ranking of the attributes.

Students' Ranking of Employers' Expectations The students were asked to rank the eight attributes with a score of one as most important and a score of eight as least important. A lower mean score for an attribute means that it is ranked as more important than another attribute with a higher mean score. The mean scores in Table III show that both JC and polytechnic students ranked *communication*, *teamwork*, and *problem-solving* as the three most important skills employers expect in a candidate, similar to findings by Lattuca et al. [30] and Yuzainee et al. [31]. These three skills are also among the top four generic graduate attributes identified by employers in the US and Hong Kong (Table I). The importance of these three skills to employers was reiterated by Murnane as cited in Hilton [43], who mentioned that solving ill-defined problems often requires the collaboration of others through communication and teamwork to arrive at suitable solutions, rather than the expertise of one individual.

It is interesting to note that polytechnic students ranked *initiative and enterprise* and *self-management* fourth and fifth respectively, while JC students ranked them seventh and sixth respectively. This finding might suggest that polytechnic students are more aware that they have to take a proactive rather than passive role in their jobs. Furthermore, the polytechnic students ranked *life-long learning* higher than JC students, while JC students ranked *technology* higher than *self-management*, *initiative and enterprise*, and *life-long learning.* This finding might imply that polytechnic students are more open to learning on the job while JC students are more focused on proving their technical expertise.

The students' explanations for their rankings are presented below.

Students' Explanations of Their Ranking The students' explanations in Table IV provide insight about their perceptions of the value of each attribute to employers.

Communication: This attribute was perceived as the most important for both the polytechnic

and JC students. However, the polytechnic students seemed to have a broader view of the role of communication in the workplace compared to JC students. The polytechnic students, who had two industrial work placements, valued *communication* because it helped them communicate with their employers and peers to get the job done correctly. In contrast, the JC students did not ascribe similar value to it as they perceived *communication* mostly as communication with their peers and not with their managers or supervisors.

Teamwork: Both polytechnic and JC students ranked this attribute second in importance. They mentioned that *teamwork* was important because it is a common job requirement and boosted efficiency.

Problem-solving: Both polytechnic and JC students ranked this attribute third in importance. More polytechnic students recognized it as a trait of a good engineer than did JC students, however. Having had the additional industrial experience, the polytechnic students most likely knew first hand that problem-solving was the essence of an engineer's everyday work whereas the JC students did not seem to have the same level of awareness in this respect.

Initiative and Enterprise, Self-management: The polytechnic students ranked these two attributes fourth and fifth in importance. The polytechnic students felt that *initiative and enterprise* were important in seeking ways to solve problems without prompting, and having a positive mind-set helps them to hone their skills as they gather more experience over time. Their proactive attitude was also reflected in their responses on *self-management* as they mentioned that by knowing their own strengths and weaknesses, they could improve themselves, and increase their efficiency. JC students however, ranked these two attributes seventh and sixth. They valued *initiative and enterprise* and *self-management* more for job security and future employability. Hence, it seemed that polytechnic students had a higher level of confidence in solving problems and going beyond their comfort zone compared to JC

students.

Planning and Organizing: The JC students ranked this attribute fourth, while the polytechnic students ranked it sixth in importance. The explanations for both groups, however, were generally similar. The polytechnic students might have ranked the attribute lower than JC students because they knew that engineering work is very procedural in nature. Many companies have put in place very robust standard operating procedures for even complex engineering work.

Technology: This attribute was ranked fifth by JC students and eighth by polytechnic students. The lower ranking by polytechnic students might be the result of their believing that they would be sent for on-the-job training if they lacked any skills after being employed. JC students might have ranked this attribute higher because they felt that employers valued them for their technological skills, similar to findings by Chitra [13]. A reason for this lower ranking for both groups may be a result of a close relationship between the academics and the industry players, which enables the university to update its curriculum regularly and rigorously.

Life-long Learning: The JC and polytechnic students ranked this attribute eighth and seventh respectively. It was the lowest ranking attribute, but students noted that even though they may not plan to stay with one employer for the long term, they need to keep upgrading themselves because employers in Singapore, the US, Malaysia, and India (Table II) expect their graduate hires to engage in life-long learning to remain competitive, competent, and relevant.

CONCLUSIONS, LIMITATIONS AND SUGGESTIONS FOR FUTURE RESEARCH

The final section summarizes the main findings in this study and situates it within the existing literature. We also acknowledge the limitations in this study and suggest areas for future

research.

Conclusions This study aimed to examine whether graduates from the polytechnic and JC paths had similar perceptions with regard to the ranking of graduate attributes, and if not, in what ways their perceptions differed. The results show that both JC and polytechnic students ranked *communication, teamwork,* and *problem-solving* as the top three attributes desired by employers. This finding might be attributed to their work placement experiences, reading of advertisements relevant to the jobs they were applying for, or their own reading. We note that employers also rank *communication* and *teamwork* in the top five attributes in the UK, US, Hong Kong, Malaysia, and India, and these attributes were mentioned in the graduate attributes desired by employers in Canada, Australia, and Singapore (Tables I and II). This finding could spur educators to focus more on the top two skills to improve students' employability, possibly in line with the detailed communication outcomes suggested by Ruff and Carter [44].

In addition, polytechnic students' explanations seemed to reflect a higher level of familiarity and confidence in tackling workplace requirements. The polytechnic students were more familiar with *problem-solving* and showed more willingness to take *initiative* and be *enterprising*, practicing proactive and positive *self-management*. The JC students' explanations for the attributes, however, reflected their concern about ensuring their job security. The difference in perception for both groups of students might be due to their educational path prior to entering university. Polytechnic education is more practice-based, with an additional 22 weeks of work placement during their polytechnic studies on top of the 10-22 weeks of work placement during their undergraduate studies, as well as their final-year project which is industry-based. These exposures to industry might have familiarized them with industry requirements and employers' expectations in graduates. Interestingly,

Singapore employers (as reflected in the WSQ framework), expect their employees to take *initiative* and *be enterprising*. Hence, whatever the motivations for both groups of students, they need to be aware of the importance attached to this attribute if they plan to work for Singapore employers.

Planning and organizing, technology, and *life-long learning* were ranked relatively lower than the rest of the other attributes by both groups of students. These attributes however, are in fact attributes sought by the Engineering Accreditation Boards in Singapore, the US, the UK, and Malaysia. Thus, graduates are expected to have the technical knowledge and skills upon joining the workforce, and to keep themselves updated with the latest technological advancements to maintain their employability.

The implications of the findings seem to point towards the role of industrial experience in enhancing students' awareness of employer expectations, as observed in the differences between the polytechnic and junior college students noted above. Thus, we would like to recommend that industrial work placement or placement with employer involvement be made a core module in university education because unless the learning experience is formally incorporated and assessed in the curriculum, it will not be valued by students or employers [5], [45].

To facilitate adoption of this recommendation, universities could embrace the Singapore government's Work and Learn scheme where students alternate between working and learning during the week. It could be quite challenging for universities and employers to adopt the scheme in every year of the students' studies, however. We would like to propose a modified version of the scheme where students go for two work placements during the course of their studies. The first work placement could be done in their first or second year of studies, outside of class time, to familiarize students with industrial norms; hone attributes

such as effective communication, collaborative team work and problem solving; and help students focus better on what they need when they return to continue their studies. The second work placement could be done in the third year of studies during class time, where they could be given actual projects in the workplace that are employer-defined, and which could form the basis for their final-year dissertation. The work placement mentors at the university and the workplace would thus have a common platform to evaluate, debrief and monitor the learning outcomes and support the student work placement experience in a fruitful manner [46].

The tripartite interaction and feedback from the mentors and the student would also help improve curriculum design, teaching, and learning, and eliminate the risk of students being engaged in inconsequential work during their work placement. Students likewise could be required to write a reflection essay after their work placement that requires purposeful and critical evaluation of their learning journey [5].

With these work placement supports in place, universities would also be encouraged to widen their admissions criteria to admit students who might not meet the academic criteria but who have the aptitude, passion, and experience in the workplace. As reflected in the literature, employers look beyond a graduate's academic excellence. Attributes such as initiative and enterprise, and self-management in problem-solving are valued along with effective communication and teamwork. Having a good student mix of JC and polytechnic students could enhance discussions from both the theoretical (JC) and practice (polytechnic) perspectives, and result in better learning for all in the university.

The engineering employers in Singapore may also want to consider preparing a list of desirable employability skills to set the benchmark for graduate engineers. With the necessary administrative and financial assistance from the Singapore government, this might

become a reality more easily than expected. An engineering employers' association is a good platform to start compiling such a list based on feedback and contribution from members. The students could be made aware of this employability skills list through lectures and an online quiz designed and administered by the career counselling center to measure the readiness of engineering students to embark on their professional career. The quiz could be publicized through relevant course lectures, as well as flyers and posters around the campus. After the quiz, the students would receive a score that would inform them about their strengths and weaknesses, and suggestions for improvement. Further career counselling could be offered by the career center.

Limitations There are several limitations to the implications that we can draw from the findings of this study. Due to the small sample size, the findings in this study are mainly exploratory in nature and cannot be generalized. Furthermore, as there is no published research on employers' perceptions on graduate attributes in Singapore, we could not compare the findings of this study with that of employers to determine whether there was a mismatch in the level of importance placed on each graduate attribute. The comparison could only be made based on the WSQ framework, the graduate attributes required by the Engineering Accreditation Board of Singapore, and those described in the literature.

Suggestions for Future Research While the students' ranking of the attributes informed us about the relative importance that they perceived that employers place on each attribute, their explanations provided insights about possible reasons for the differences in perception between the two groups of students. Further large-scale studies need to be conducted to confirm that these explanations represent the perceptions of JC and polytechnic students in Singapore. Furthermore, more empirical studies could be conducted to study employers' needs according to specific industries, with a focus on identifying skills that need upgrading.

The findings from these studies could be made accessible on the Ministry of Manpower website to facilitate greater collaboration among employers, academics, and graduates in curriculum design and training in employability skills.

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