Chapter 10
What Vietnamese Employers and Educators Want in Impactful Engineering Degree Programmes

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ABSTRACT

This chapter presents results and analysis from the ENHANCE project survey for the views of employers and educators towards the impactful improvement of engineering degree programs in Vietnam. This building capacity project aims to find ways of strengthening the employability of engineering graduates by improving the quality of engineering programs. The survey was carried out by inviting respondents from industry (employers) and from higher education (educators) to answer online questionnaires. The number of respondents was 116, of which 69 are educators and 47 are employers. This chapter presents results that encompass the following three topics: university graduate attributes, capabilities,

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knowledge, and understanding; the teaching and learning methods used in universities; and the future of engineering programs in Vietnam.

INTRODUCTION AND VIETNAMESE CONTEXT

The engineering profession in Vietnam is for versatile and impactful careers that create a legacy for society and for the lives of everyone (Arunkumar et al., 2018). To support their businesses, employers are demanding engineering graduates be better trained and better educated. Within the Higher Education (HE) sector, today's agenda in Vietnam focuses on engineering graduate employability and the development of measurable outcomes for higher quality in graduates' attributes and skills. Because of these society-driven HE changes, there is an unstoppable push for engineering programmes to go far beyond the traditional core teaching of fundamental principles in science and technology. This is reflected in the Vietnamese university system, which has three pillars to the content of graduate programmes. These unpinning pillars are knowledge; abilities and skills; and personal qualities and attitudes. To successfully achieve the required learning outcomes from embedding these pillars into engineering programmes Vietnamese HE must identify the desired attributes of its graduates. It is observed that these graduate attributes are delivered primarily through traditional or online lecturers and/or stand-alone specialized laboratory-based practical.

It is generally accepted that engineering graduates need to be prepared for the increasing use of advanced and appropriate technologies in their workplaces. In 2007 Patil and Codner (Patil & Codner, 2007) distinguish hard, soft and global skill sets as essential components of engineering students' competencies. of Hard skills are fundamental knowledge; expertise in engineering subjects; engineering design and problem solving skills; project management skills, etc. Under the soft skills are listed general knowledge; communication skills; managerial and organization skills; negotiation and interpersonal communication skills ; ethics, empathy; leadership and listening; financial management and budgeting; and safety and sustainability; The global skills set encompasses understanding global, political and societal issues; cross and multi-cultural issues; international labour market and workplace imperatives; engineering solutions/applications in a global context, etc.. For Vietnamese students to effectively be able to apply soft and global skill sets in the engineering workplace we observed that education and training requires the introduction of new graduate attributes and non-traditional teaching and learning methods, which are not familiar within current Vietnamese HE. These same Vietnamese students are well-known historically to cope well with education scoping the hard skills by way of the teaching of fundamental principles covering core science and technology subjects that are assessed by traditional paper examinations.

In recent years there has been an upsurge in the attention in Vietnamese universities for programme leaders to map and develop a new set of workable graduate attributes. The underlying factors that have influenced the growing importance of these attributes, include education being a lifelong process, a focus on graduate employability and the development of outcome measures to demonstrate the overall quality of HE throughout the country (Bath et al., 2004). Most Vietnamese universities prepare their engineering curricula in accordance with the frameworks and guidelines of the well-known engineering accreditation bodies, such as Accreditation Board for Engineering and Technology (ABET) in North America and ASEAN University Network (AUN). Departments and faculties with engineering programmes implement these accreditation requirements to define, monitor, and articulate essential graduate attributes. Accordingly, Vietnamese universities have recently addressed the importance of properly including employability skills in their graduate programmes. This is achieved through courses with learning outcomes linked to assessing development and applications of skills. It is noteworthy that in 2016 the Vietnamese government issued the National Qualifications Framework which embeds the concept of learning outcomes to increase quality of HE with respect to graduates' employability skills.

The authors are partners in the Erasmus+ project *Enabling Humanitarian Attributes for Nurturing Community-based Engineering*, which is known be the abbreviation ENHANCE. This project under No: 598502-EEP-1-2018-1-UK-EPPKA2-CBHE-JP (2018-2582/001-001) was to have a duration of 36 months starting in November 2018. Because travelling was suspended from March 2020 owing to the Coronavirus (COViD-19) pandemic the project completion was postponed to the end of May 2023. As an integral part to the project's workplan an online survey (pre-COVID) was run in partner countries (namely, Bangladesh, Greece, Indonesia, United Kingdom, and Vietnam) from 16 July to 18 November 2019. Its questions and responses focused on interdisciplinary teaching and learning, skills and attributes that graduate engineers may need to permit them to tackle complex interdisciplinary, inter-professional problems, which can involve humanitarian engineering challenges. The first part of the ENHANCE project survey has common background questions and the second part is with bespoke questions for either HE (educator) or industry (employer) respondents.

For background context, the ENHANCE project (https://warwick.ac.uk/fac/sci/eng/enhance/.) has European partners from UK (The University of Warwick as project lead) and Greece (University of West Attica), that are working with eight universities in the three South Asian partner countries of Bangladesh, Indonesia, and Vietnam. There are three universities in Indonesia (Gadjah Mada University, Institute Technology Bandung and Universitas Brawidjaja), two in Bangladesh (Bangladesh University of Engineering and Technology (BUET) and University Dhaka) and two in Vietnam (Ho Chi Minh University of Transport (UT) and Ho Chi Minh City University of Technology (HCMUT)) (Kremmyda et al., 2020). The partners from the Ho Chi Minh University of Transport carried out the survey and its analysis in Vietnam.

The ENHANCE project is to nurture advancement of education and professional attributes (skills) in the field of community-based engineering that serve unsupported communities in collaboratively identifying problems and defining solutions that are sustainable. ENHANCE focuses on initiating sustained educational changes by modernising study programmes to address inclusive, interdisciplinary, problem-based, experiential curricula in programmes in South Asian partner countries.

In summary, the overall aim of this multi-partner ERASMUS+ project is to strengthen and build capacity in engineering programmes in the three South Asian countries by:

- introducing modern, innovative pedagogical approaches;
- identifying and tackling inherent barriers to quality, knowledge organization, curriculum content, and hierarchy; and,
- ensuring advancement of emerging skills to increase accountability, raise the quality of engineering graduates for employability, raise the quality and consistency of humanitarian services and to improve in-country capacity to operate safely.

In this paper, the authors are presenting the results from 116 responses to the 2019 ENHANCE project online survey sent in by contributors in Vietnam. 69 of these responses were received from educators (lecturers on engineering programs for undergraduate or/and postgraduate degrees), and another 47 responses are from employers (industry-based), which represent the opinions of Vietnamese companies and organizations employing graduate engineers. In what follows we use the survey analysis to elaborate on the established competency gaps between current graduate attributes and expectations of industry. Herein, we are using the terminology 'industry' to encompass, in a single word, all types of employers who require Vietnamese engineering graduates. The paper identifies ways in which engineering graduate attributes may be aligned to the preferred skills linked to employability. To address the issue of variability of taught attributes in Vietnamese HE programmes the paper presents results from the survey concerning how Vietnam universities taught, assessed, and reported employability skills. This clarifies mismatches between skills that are developed during existing degree programmes and those other skills needed in the workplace for graduates to be successful professional engineers.

- Based on the survey's structure, the authors have divided the paper into three sections: Section 2 for attributes of graduate engineering students from the point of view of educators and industry
- Section 3 for teaching and assessment methods on the quality of engineering programmes; and,
- Section 4 with proposals for future engineering programmes.

In the framework of the ENHANCE project the online survey was run concurrently in the other four partner countries of the UK, Greece, Bangladesh, and Indonesia. This enabled the authors of this paper to compare selective survey results from the other partner countries in South-East Asia with the survey findings from the 116 respondents in Vietnam in methods of teaching and learning that lecturer using and quantify the percentage of their contribution to the delivery of their program.

Attributes of Graduate Engineering Students in Vietnam

This section presents the survey's analysis for employers and educators' opinions regarding three the main pillars of graduate skills associated with employability, namely: 1) attributes, 2) capabilities, and 3) knowledge and understanding.

Graduate attributes are defined in several publications, with the definition in Bowden *et al*. (Bowden et al., 2000) relevant to the ENHANCE project. This definition says that they possess: "…*the qualities, skills and understandings a university community agrees its students would desirably develop during their time at the institution and, consequently, shape the contribution they are able to make to their profession and as a citizen*". It is to be noted that the term 'graduate attributes' can also be referred to by other descriptors such as: generic skills, graduate qualities, generic attributes, and graduate capabilities (Nair et al., 2009). This lack of a single, well-recognized descriptor (and definition) can create a certain ambiguity in discussion and dissemination because it is observed that these descriptors have been used interchangeably and can have ambiguous meanings if unfamiliar.

Presented in Table 1 are the ENHANCE project survey results for graduate attribute gaps between HE and the expectation of industry. In column (2) of the table there is, in alphabetic order, a list of 14 graduate attributes (skill sets) that had been ranked as 'most important' within the framework of the objectives of the ENHANCE project. There might well be other graduate attributes that could have been prioritized, yet the the project partners decided to limit to 14 the number surveyed. Column (1) in Table 1 allocates an integer number to each of the 14 attributes, which in column (2) have conveniently been ordered in alphabetical order. To answer this survey-question a respondent was asked to rank 10 of the 14 attributes, with 1 being the most important and 10 the least important. Column (3) presents

Table 1. Rating of the importance of graduate attributes by respondents from higher education and industry

No.	Graduate attribute	Higher Education (*HE*)	Industry (*Id*)	*D* (%)	*(HE+Id)/2*
(1)	(2)	(3)	(4)	(5)	(6)
1	Analytical Skills	**3.88**[1]	**3.81**[1]	1.82	3.85
2	Communication Skills	**4.54**[3]	4.78	-5.15	4.66
3	Creativity	4.58	**4.39**[2]	4.24	4.49
4	Critical Thinking	**4.41**[2]	5.68	-25.2	5.05
5	Culture Sensitivity	8.05	8.29	-2.94	8.17
6	Empathy	7.60	6.82	10.8	7.21
7	Entrepreneurship	7.05	6.13	14.0	6.59
8	Ethical principles	6.19	4.82	24.9	5.51
9	Interdisciplinary Perspective	6.77	7.63	-11.9	7.20
10	Leadership Skills	6.77	6.00	12.1	6.39
11	Practical Skills	4.65	**4.77**[3]	-2.55	4.71
12	Prioritization	7.75	6.22	-21.9	6.99
13	Problem Solving	5.00	5.47	-8.98	5.24
14	Team Working	5.42	5.77	-6.26	5.60

Note: $D(\%) = \dfrac{HE\text{ - }Id}{0.5\times\left(HE+Id\right)}\times 100\%$

for Higher Education (variable *HE*) the mean ranking scores for the 14 attributes based on 69 educator survey returns, and the numbers (in bold font) with superscript numbers 1, 2 or 3 are to highlight the attributes with the three lowest scores (i.e., they are ranked **most important**). The equivalent survey results for Industry (variable *Id*) are similarly reported in Column (4) using responses from 47 surveys.

Reported in column (5) are the percentage differences, *D*, calculated using the formula given in the Note at the bottom of Table 1. These percentage differences are determined based on the mean of the scores in columns (3) and (4). The overall mean values for the 14 attributes in columns (3) and (4) are 5.90 for *HE* and 5.76 for *Id*. These means should be the same at 5.5 when every survey return ranks ten attributes with integer numbers 1 to 10. The higher means show that surveys were not always completed to the instructions. Although there are 22 more survey respondents from HE than from industry, the lower number of 47 for industry is deemed sufficient for the authors to treat the two populations as being sufficiently representative of their sector so that a direct unweighted comparison between the mean ranking scores can be made with confidence. For additional comparison column (6) shows the average of the mean HE and Id scores from respectively column 3 and 4 ((HE+Id)/2).

To commence a discussion on the survey results presented in Table 1 the authors first considered the mean ranking scores for the three most important attributes. The lower the score listed in the table the higher is an attribute's importance to Vietnamese engineering graduates. Based on the fourteen attributes *HE* ranks the first three attributes in order of importance to be: Analytical Skills (3.88 is the lowest score); Critical Thinking (4.41); and Communication Skills (4.54). It is noteworthy that because Creativity with 4.58 and Practical Skills with 4.65 have ranking mean scores within 0.07 of Communication Skills (4.54) there's evidence to say that these three attributes are of equal importance. The sixth ranked attribute is Problem Solving with a score of 5.00, and with an increase in the mean of 0.35 this attribute can be said to belong in the less important HE group that includes nine attributes with scores between 5.00 and 8.05 (the latter has the second highest value in Table 1 for a least important ranking). In line with these findings, over the recent years, the education sector in Vietnam has directed higher education institutions to actively innovate training content, curricula, and teaching methods in the direction of a competency approach, enhancing application and practical skills. Training institutes link training with the labour market, proactively grasp the needs of enterprises or develop training programmes with the participation of enterprises to ensure the quality of their training output (Bui Thi Hong Dung, 2019).

Applying the same evaluation methodology to the Industry (*Id*) survey results in column (4) it is seen that employers rank their first three attributes in order of importance to be: Analytical Skills (3.81), Creativity (4.39); and Practical Skills (4.77). It is observed for *Id* that because Communications with 4.78 and Ethical Principles with 4.82 have ranking scores within 0.03 of Practical Skills there's a case to be made that each of these three attributes are of equal importance to industry. The sixth industry ranked attribute is Problem Solving at 5.47, and with an increase in the mean score of 0.65 this attribute belongs in the lesser important group with the remaining eight attributes, whose scores are from 5.68 to 8.29 (the latter is highest values in Table 1 for the least important ranking).

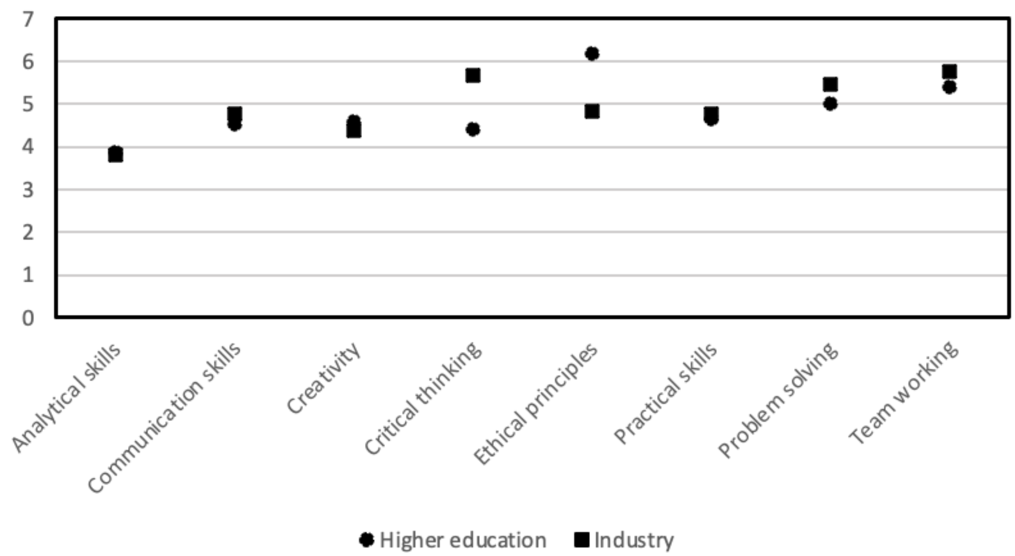
Though employers' needs vary from country to country, and among industries, analytical skills, creativity, practical capabilities, and skills in teamwork, communication and problem-solving are generally desired by the majority of employers. According to an employers' assessment, most graduates can't immediately start doing professional jobs, students can't plan their own study to perfect themselves at work and they lack the necessary soft skills to serve the assigned work. Accordingly, in order to provide training related to the needs of enterprises, universities must cooperate with enterprises in building training program objectives and content based on what society and learners need (Pham Thi Hang, 2021).

Given the high-level of commonality between the means of the two groups the average score values (column (6)), given by $(HE + Id)/2$ is used to find a joint ranking of attribute importance. This results in the highest importance being Analytical Skills (3.85), which is for the core and fundamental principles underpinning engineering programmes. This is not a surprising finding given the prominence of this attribute in existing engineering programmes.

In combination with Analytical Skills (table 1, column (6)) Creativity at 4.49, Communication skills at 4.66 and Practical Skills at 4.71 belong to the top four attributes of highest importance having a combined mean score < 5.0. The fifth ranked attribute is Critical Thinking with a combined score of 5.05. Whereas educators rank Critical Thinking as second most important (*HE* score is 4.41), which suggests they find that this attribute should have improved delivery, industry does not share this opinion and ranks Critical Thinking seventh with a significantly higher mean score of 5.68. From knowledge of their business activities employers rank Ethical Principles fourth with a score of 4.82, indicating this attribute lacks relevant content in existing curricula. HE on the other hand, returns a score for Ethical Principles of 6.19 (and rank this attribute eighth), which suggests that educators believe that the existing offer in teaching and learning is satisfactorily scoping this attribute in support of graduate employability. One important finding from the Vietnamese survey analysis is that HE and industry need to hold conversations to discuss and agree on the importance in teaching and learning of the two attributes of Critical Thinking and Ethical Principles.

This evaluation of the survey results next targets a gap analysis using the scores in the range 3.8 to 6.0 and the variable D for percentage differences, reported in column (5) of Table 1. Figure 1 plots the mean scores for these eight attributes with the solid circle symbol for *HE* and the solid square symbol for

Figure 1. Comparison of the eight mean ranking scores from 3.8 to 6.0 for the most important student graduate attributes



Id. In addition, the bar chart in Figure 2 exposes the magnitudes of differences by plotting the absolute values of *D* for the eight attributes. The percentage differences between HE and industry are found to be from 2 to 25%. With percentages of 9, 25 and 25 (to nearest percentage) the three attributes with the

Figure 2. Absolute differences as a percentage (D) between higher education and industry for the most important student graduate attributes receiving a mean ranking score in range 3.8 to 6.0

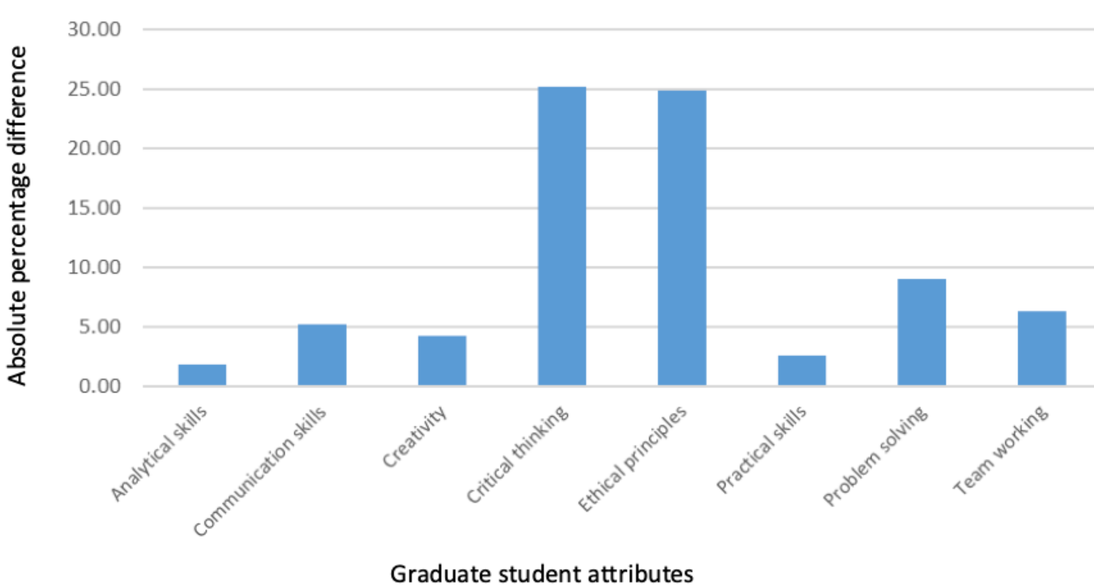
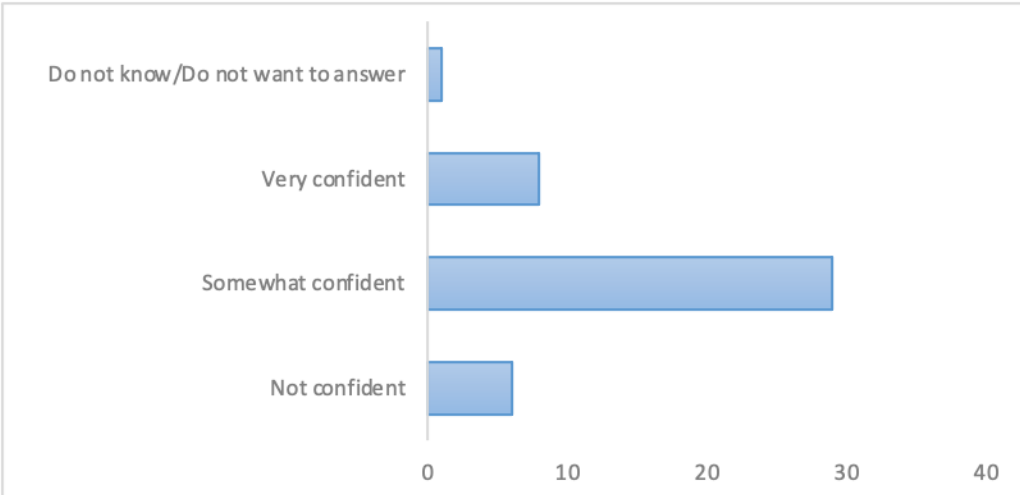


Figure 3. Confidence levels rated by 47 employer respondents to the survey question: 'do Vietnamese engineering graduates have the skills to fill high-skilled job vacancies?



greatest divergence are Problem Solving, Ethical Principles and Critical Thinking. On the other hand, the three attributes of Analytical Skills, Practical Skills and Creativity have percentage differences < 5%, which from the gap analysis are deemed not significant. Another finding from the survey analysis is that both Vietnamese sectors consider the relevance and importance of these attributes in the same way.

Another outcome from the ENHANCE project survey is the finding that in the opinion of employers Vietnamese engineering graduates neither have the depth or breadth in Analytical Skills (ranked first) and Problem-Solving Skills (ranked sixth) as required in the future. Information from the survey's free-text questions further shows that employers also desire graduates to possess higher levels of application skills, which is inherently linked to the attribute Practical Skills (ranked third). Vietnamese industry knows from experience that such graduate skills are essential for working efficiently, and for business successes with improvements in creativity, innovation, and productivity.

Survey results presented in Table 1 and Figures 1 and 2 show consistency with a finding from another question in the industry's bespoke set of survey questions. The question is: "*As we move towards an economy driven by the Fourth Industrial Revolution (also known as Industry 4.0), there are clear implications for the engineering sector and its skills needs. How confident are you that there are enough engineering graduates in your country with the skills to fill high-skilled job vacancies?*" The bar chart in Figure 3 presents this question's results from 47 employer respondents. 12% said they are 'not confident' and 66% only thought they are 'somewhat confident' that Vietnamese engineering graduates possess the necessary skills to fill their high-skilled job vacancies.

The survey subsequently invited employers to categorize the capability of graduate engineers by way of 10 capabilities and rank them as either Poor, Average, Good, Very Good or Excellent. The results are presented in Table 2 as percentages rounded to the nearest integer except for the Excellent percentages. These are rounded up or down to one decimal. Column (2) of the table lists capabilities in alphabetical order with their ordering number in column (1). Our evaluation clusters the capabilities as perceived by Employers and Educators into one of the following three classifications:

Table 2. Rating by employers and educators of 10 capabilities as perceived in graduates of engineering programmes

		Poor and Average		Good and very good		Excellent	
	Capability	**Industry**	**HE**	**Industry**	**HE**	**Industry**	**HE**
		%	%	%	%	%	%
(1)	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**	**(7)**	**(8)**
1	Analytical Skills	35	12	63	86	2.5	2.3
2	Creativity	51	37	44	58	4.9	4.7
3	Experience in Real-Life Applications	59	29	41	69	0.0	2.4
4	Leadership Skills	61	47	39	51	0.0	2.3
5	Practical Skills	30	19	70	77	0.0	4.7
6	Problem Solving Skills	41	16	59	81	0.0	2.3
7	Project Management	68.	44	32	56	0.0	0.0
8	Team Working Skills	46	30	54	63	0.0	7.0
9	Theoretical Knowledge	17	5	78	81	4.9	14
10	Understanding of Regulations, Standards and Codes of Practice	32	26	63	72	4.9	2.3

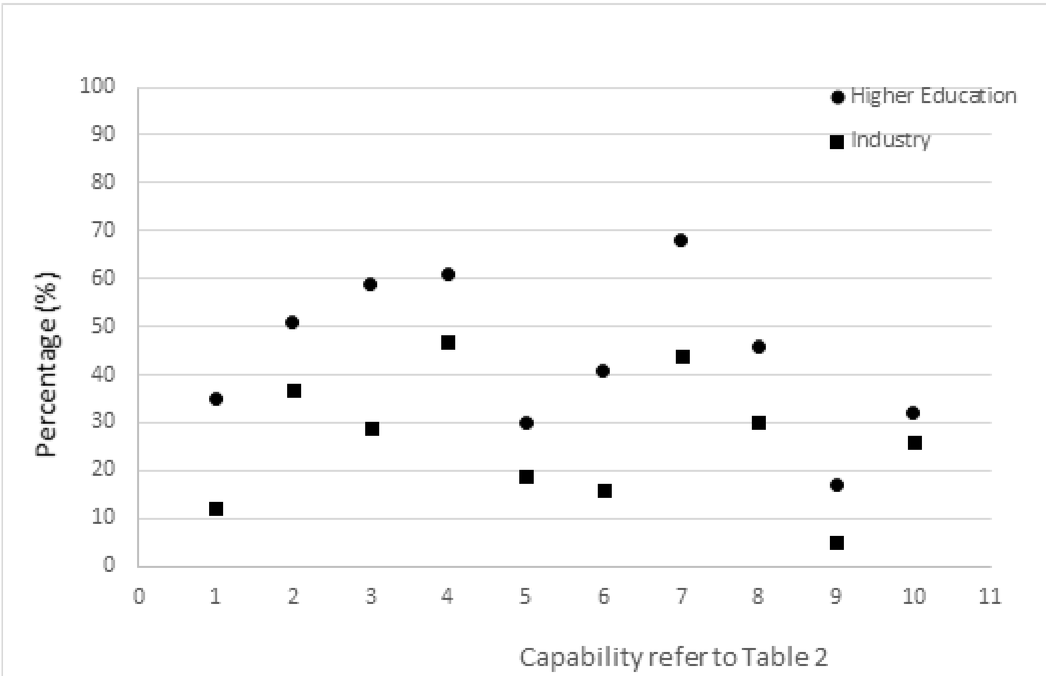
- Average and Poor Good;
- Very Good; and
- Excellent.

For each capability the three percentages across the row reported in columns (3), (5) and (7) for Industry or columns (4), (6) and (8) for Higher Education should add up to 100%.

The percentage values listed in column (3) show us that the five capabilities Creativity, Experience in Real-Life Applications, Leadership Skills and Project Management were judged as Poor or Average by more than 50% of industry respondents. This judgment may be interpreted as an appeal from employers to educators in HE to improve on these capabilities in the curricula. Figure 4 illustrates the percentages for the ten capabilities in Table 2 with the abscissa axis numbering corresponding to the capability numbers in column (1) of the table. Secondly, we can see from the data in Figure 4 that educators consistently assess the capabilities as less poor/average. This is true for Analytical Skills with a 23% difference, Experience in Real-Life Applications showing 30% difference, Problem-Solving Skills with 25% difference, and lastly Project Management having 24% difference. These four capabilities are judged with a difference > 20%. It could be argued that employers possess the most realistic understanding on the skill needs of graduates entering the workforce. As a consequence of this observation the authors want to see an increase in the number of employer influencers on committees preparing new or revised engineering curricula because this will undoubtedly benefit the graduates' capabilities and their employability.

Thirdly, we find that employers rated four of the capabilities (>60%) as Good and very good. These are Analytical Skills, Practical Skills, Theoretical Knowledge, and Understanding of Codes and Practices. With respect to the relative importance of these four capabilities they agreed more or less with

Figure 4. Percentages for capabilities (1 until 10) assessed Poor and Average with higher education values given by the circle solid symbols and industry values given by the square solid symbols



the educators. The outcome that not less than 35% of employers find that graduates have a poor/average capability with respect to Analytical Skills (and of highest importance), must be an incentive in HE to implement actions for an improvement.

The abscissa numbers are the capability numbering in column (1) of Table 2.

Another survey question scoping topics related to the soft and global skill sets in engineering education is: *Rate from 1 to 10 the need for graduate engineers to have knowledge and understanding of the following topics: (1) Community Needs; (2) Culture Preservation; (3) Diversity and Equality (Gender, Sex, Age, Ethnicity, etc.); (4) Economic Factors; (5) Ethics; (6) Human Needs and Human Rights; (7) International Market; (8) Political factors; (9) Professionalism; (10) Sustainability; (11) Other (please specify*)". This question was answered by all 116 respondents with the results presented in Table 3. The respondents were asked to score the most needed topic by 1 and the least needed of the ten topics by 10. Column (1) gives the topic a number based on alphabetical ordering of their names in column (2). Columns (3) and (4) present the HE survey results with mean values in column (3) having the same meaning as the equivalent values in column (3) of Table 1, and column (4) is for their rank order. The columns (5) and (6) present the results from the industry respondents.

As can be observed from inspecting the results in Table 3 both Industry and HE agree by-and-large on the order of importance of the 10 topics for soft and global skill sets. Both are assigning highest importance (first and second ranking) to students receiving curriculum exposure to Community Needs (scores of 3.43 and 4.08) and Professionalism (scores of 4.45 and 3.51). Of lower, yet significance importance, both sets of survey results rank third and fourth Economic Factors (scores of 4.46 and 4.82)

Table 3. Survey results for the importance of topics of knowledge and understanding for engineering graduates

No.	Topics of knowledge and understanding	Mean HE	HE ranking	Mean Industry	Industry ranking
(1)	(2)	(3)	(4)	(5)	(6)
1	Community Needs	3.43	1	4.08	2
2	Culture Preservation	5.81	7	6.38	8
3	Diversity and Equality (gender, sex, age, ethnicity, etc.)	5.95	8	7.05	10
4	Economic Factors	4.64	3	4.82	4
5	Ethics	5.74	6	5.65	6
6	Human Needs and Human Rights	5.62	5	6.13	7
7	International Market	6.55	9	5.46	5
8	Political Factors	7.12	10	6.95	9
9	Professionalism	4.45	2	3.51	1
10	Sustainability	5.38	4	4.79	3

and Sustainability (scores of 5.38 and 4.79). Again demonstrating commonality, HE and Industry rank Ethics and Human Needs in the range of fifth to seventh.

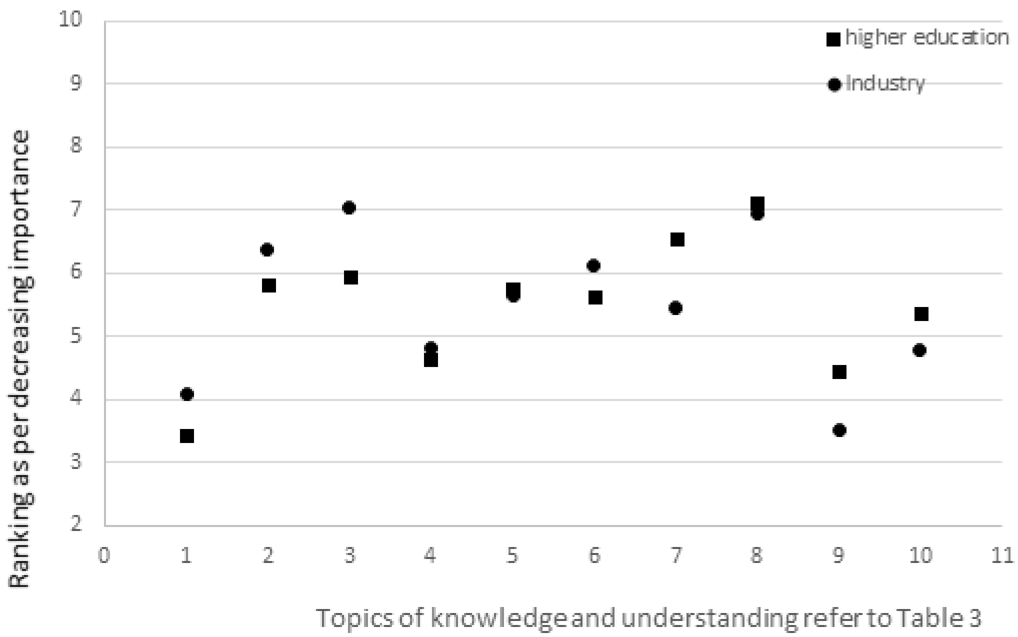
Employers give low importance to students having received knowledge and understanding to the important topics of Diversity and Equality and Political Factors. It would be interesting, in particular for these topics to find out to what degree these rankings are specific to Vietnamese educators and industry or are ranked similarly by their counterparts in other countries. Employers are found to consider the topic International Markets to be of greater importance (ranked fifth) than by educators (ranking it ninth). Educators in Vietnam either judge this topic to be outside of their engineering programmes or consider it to be integrated into the knowledge of Economic Factors, which is ranked in the top four of the 10 skill sets (see Table 3).

For a clear overview the topic ranking given in table 3 is plotted in figure 5.

To complete this section, we collate the three most important attributes from Table 1 and three most important topics from Table 3. From an industry position they are Analytical Skills, Creativity and Practical Skills (from Table 1) and Professionalism, Community Needs and Sustainability (from Table 3). These can be compared with the survey results from HE which have Analytical Skills, Critical Thinking, and Communication Skills from Table 1 and Community Needs, Professionalism and Economic Factors from Table 3. Encouragingly we find that there is a high degree of similarity in the priorities of the two survey groups. Possible major gaps in the priorities for teaching and learning on undergraduate/postgraduate programmes can be with Critical Thinking, which is ranked higher by HE and Ethical Principles, which is ranked higher by the employers. With regards to the perceived capabilities of engineering students on graduation we observe from the results in Table 2 that Vietnamese HE assesses graduates to be consistently more capable than does industry.

Employers' responses to a question on the confidence they have in the skills of graduates (refer to Figure 3) show that their confidence is low. When we now consider the perceived shortcomings in graduates' capabilities both sets of survey results agree with respect to weaknesses in project management and leadership skills. Moreover, employers would like their graduated engineers to have more education

Figure 5. Mean values from Table 3 for topics of knowledge and understanding (with abscissa numbering according to column (1) of the table)
Note: Values assigned by higher education are indicated by circle symbols and by industry by square symbols.



covering analytical skills and real-life experience(s). To conclude on the main outcomes from this section of the paper, the authors are encouraged that HE in Vietnam is providing much of what industry expects from graduate engineers, and following the ENHANCE project survey results, we strongly recommend that there is dialogue and collaboration so that industry's priorities are aligned with what educators advance in their engineering programmes.

IMPACT OF TEACHING AND ASSESSMENT METHODS IN VIETNAM

This section presents survey analyses of teaching and learning and of performance assessment methods that are current in Vietnamese engineering programmes. One of the bespoke survey questions in the HE survey is "*In the list below identify which methods of teaching and learning you are using and quantify the percentage of their contribution to the delivery of your program (total = 100%)?*".

For teaching and learning methods Table 4 presents the survey results expressed as a percentage of delivery time over degree programmes. Column (1) allocates an integer number to 14 methods with their descriptors listed in column (2). The maximum values from the 69 Higher Education (HE) surveys are reported in column (3), together with mean values in column (4). The summation of the 14 mean values equals 100% and to highlight their relative importance this is shown by the bar chart in Figure 6.

These ENHANCE project survey results can lead us to the following observations. With a mean at 32%, which is three times greater than the next highest mean value, and with the highest maximum at 70%, method No. (4) for traditional Lectures is by far in way the most applied approach for the delivery

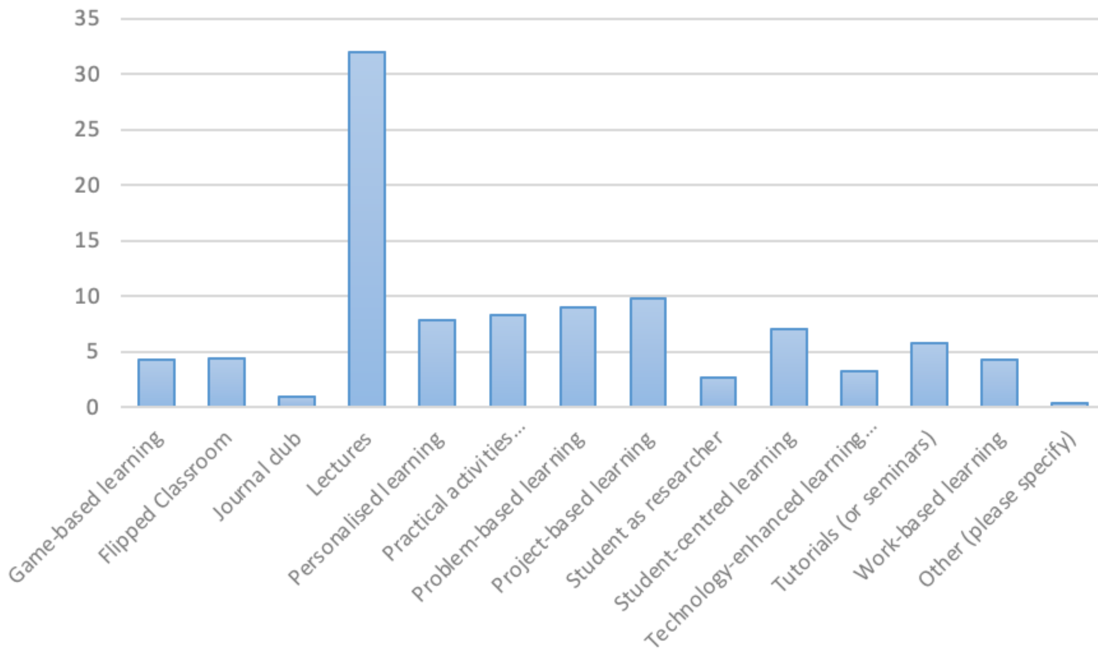
Table 4. Maximum and mean percentages of teaching time spent on different methods for teaching and learning on engineering programmes

No.	Method for teaching and learning	Maximum (%)	Mean (%)
(1)	(2)	(3)	(4)
1	Game-Based	20	4.3
2	Flipped Classroom	40	4.4
3	Journal Club	12	0.9
4	Lectures	70	31.9
5	Personalised Learning	30	7.8
6	Practical Activities (Laboratories, field visits, etc.)	30	8.3
7	Problem-Based Learning	30	9.0
8	Project-Based Learning	70	9.9
9	Student as Researcher	12	2.7
10	Student-Centred Learning	60	7.0
11	Technologically Enhanced Learning (e.g., e-learning)	20	3.3
12	Tutorials (or seminars)	40	5.8
13	Work-based learning	30	4.3
14	Others (please specify)	16	0.4

of teaching and learning. This expected finding is vividly highlighted by the tallest bar in Figure 6. Next, with means of up to 10% are Problem-Based Learning and Project-Based Learning. These two are followed in the rankings by Practical Activities for laboratories, field visits, etc., with a mean percentage just over 8%. Practicals, of all types, form a core teaching activity in the delivery of engineering programmes. The remaining 10 methods accounts for about 42% (or on average four percent each) of the delivery time and a for a wide variety of methods. From amongst these ten, a middle group, namely Personalized Learning, Student-Centred Learning, and Tutorials represent over 20% of delivery time, having means, respectively, of 7.8%, 7.0% and 5.8%. The remaining seven methods are less important taking minor time percentages.

It is of interest that column (3) in Table 4 shows us that the maximum time recorded is usually, and unsurprisingly, much higher than the average time. This finding does hold, yet at a more modest degree for Lecturing (mean 31.9%, maximum 70%). Despite the solid role of lecturing it is noteworthy to record that the minimum time spent can be 0%, indicating that on certain programmes lecturing has no place. Although the evidence is hidden from how the survey results have been analysed there is every likelihood that when there are no or few lectures this method has been replaced by Project-Based Learning, which has a maximum at 70%. Given enticing thoughts on how newer programmes are structured for their delivery time column (3) in Table 3 informs us that maximum percentages are relatively high at 60% for Student-Centred Learning and at 40% for Flipped Classroom and Tutorials; these maximums are to be compared with means of 7.0%, 4.4% and 5.8%, respectively. Another modern method with an impact on at least one programme is Game-Based learning, which has a maximum at 20%, yet a mean barely exceeding 4%.

Figure 6. Mean percentages of delivery time over degree programmes from 14 methods of teaching and learning currently employed on Vietnamese engineering programmes



As expected the face-to-face traditional lecture method is the most common approach for instructional delivery in most countries in the world, especially when programmes have curricula dominated by traditional teaching of fundamental engineering principles for analytical skills (Arunkumar et al., 2018) (Akor et al., 2019). Vietnam, HE programmes are no exception. By introducing into this discussion, the ENHANCE project survey results from the countries There are established that lecturing contributes 41.22% in Bangladesh, 33.67% in Indonesia, 36% on average to the total teaching delivery methods in Asia countries.

It is understood that the Lecture method offers several pedagogical advantages, this is because they:

- present material not otherwise available to students by another person who can be familiar with the students;
- present substantial amounts of information in an effective way;
- be specifically organized to meet the needs of particular student audiences;
- appeal to those who learn by listening (Bonwell, 1996) (Cashin, 1985).

Moreover, a fifth advantage is that experienced lecturers can use lecturing to communicate the intrinsic interest of a subject through their enthusiasm and (localized) subject expertise.

Yet is well-known that lecturing has disadvantages that makes it not suitable for the acquisition of every skill set that Vietnamese employers are seeking in graduate engineers. Some of these disadvantages are discussed by Bonwell and Cashin (Bonwell, 1996) (Cashin, 1985), and can be summarized as:

- lectures are not well suited for teaching complex, abstract material;
- lecturing presumes that all students learn at the same pace and are at the same level of understanding;
- lecturing requires effective speakers (who should have empathy with the needs of the students);
- lectures are not suited for delivering material in support of learning higher orders of thinking, such as for applications, analysis, synthesis or evaluation, for teaching physical skills and for influencing professional attitudes or values.

Moreover, it is known that a fifth weakness is that information tends to be forgotten quickly when students are passively learning in the lecture room environment. A sixth disadvantage is that the lecture method emphasizes learning by listening (with watching), which is a challenge for students who prefer to educate themselves by way of other methods that deliver teaching and learning (refer to the other 13 methods in Table 4).

Highlighted from the ENHANCE project survey results in Table 4 is that teaching and learning methods in Vietnamese universities are diverse, with important contributions for a mean percentage of 35.0% from Project-Based Learning, Problem-Based Learning, Practical Activities and Personalised Learning. Different delivery methods are associated with different skills or student attributes that engineering students possess on graduation. Embracing the survey results there can be an aspiration that, even accounting for the diversity between employers and educators, they collaborate to find common ground for programme developments. As a consequence, confidence in graduate skills would grow and we shall find in, say, five years a positive change to the current poor situation, as shown in Figure 3. Furthermore, our survey finds that employers are seeking professional graduates with improved capabilities to be creative, having sound experiences of real-life applications, and possessing strong leadership and project management abilities. It is important to note that these attributes are not likely to be enhanced or developed if lecturing is the method of teaching and learning.

Clearly, methods of assessment play a key role in ensuring the level and quality of student learning and for ranking the knowledge, skills, and behaviour of graduates. In order to guarantee that on graduation Vietnamese engineering students have career skills, alternative teaching methods are advocated, such as Project based learning and Problem-Based Learning. The approach to assessing students is changing accordingly to (Akor et al., 2019), (Kipper & Ruutmann, 2012) and (McDowell et al., 2004), with formative assessment methods now given more prominence than summative assessment methods (Subheesh & Sethy, 2018). In Vietnam, owing to the lack of consistency in their application, there is considerable scope for changing to more innovative methods of assessment. Currently, the government regulations on the percentage composition of marks in degree programmes creates local difficulties for universities to make radical changes in teaching delivery. Throughout Vietnam the convention in 2022 is to employ a marking framework based on 10% for diligence, 20-30% for mid-term, and 60-70% for end-of-term assessments. Adding further restrictions to what Vietnamese educators in HE can do to assess their engineering students these internal marking frameworks are often fixed by government regulations for specific degree subjects.

To understand which methods of assessment are used the survey included the following question, "*In the list below please identify which methods of assessment you are using and quantify the percentage of their contribution to the delivery of your programme (total = 100%): (1) Artefact, (2) Blog; (3) Essay; (4) Group Oral Presentation; (5) Group Portfolio; (6) Individual Oral Presentation; (7) Individual Portfolio; (8) Journal Article; (9) Laboratory Report; (10) Online Tests (including Quizzes); (11) Peer Assessment; (12) Poster Presentation; (13) Reflective Essay; (14) Written Examination; (15) Other (please specify)*".

According to this question the educator has 14 different assessment methods to choose from, plus a fifteenth, should the programme use another assessment method. Evaluation of answers using the 79 HE surveys show that the prominent four methods of assessment are by Written Examinations at 36%, Group Oral Presentations at 17%, Essays at 11%, and Individual Oral Presentations at 9%. Combined these four traditional methods of assessment account for 73% to the total contribution. Because programmes will change, and new programmes start the authors expect that, if an ENHANCE project survey is repeated in 2024 (five years after the original survey), the total contribution from the other 10 assessment methods will be higher than at 27% in 2019.

To conclude this section of the paper, we have found that university teaching of engineering students is dominated, in terms of delivery time, by lecturing, with a complementary role for problem-based learning, project-based learning and all forms of practical activities, including internships. The internship program is usually designed in all engineering training programs as 2 credits, placed in the last semester to support students in fact-finding, serving the implementation of their graduation thesis. In addition, the study program, may include 1 to 2 credits for site visits or field trips to the industry for students to visit and learn related to their field of study. Because the latter method is ideal to expose students to real-life experiences (refer to Table 1) the time allocated to this method of delivery has to be increased, from its current 8.3% contribution, to say between 12 and 15%. Because of government regulations assessment methods are remaining mostly traditional. The results of the ENHANCE project offers support from industry that educators can be empowered to introduce new educational goals and assessment methods.

In view of the societal challenges that Vietnamese engineering graduates must cope with lecturing needs to be supplemented by appropriate delivery methods that will stimulate and develop analytical skills, creativity, and skills in project management and leadership.

FUTURE ENGINEERING PROGRAMMES IN VIETNAM

One finding from the discussion in Section 2 is that employers in Vietnam need graduate engineers with improved capabilities regarding analytical skills, creativity, experience in real-life applications, and skills in leadership and project management. These graduates should also be professionals with open eyes to community needs. What needs to be done to bring about improvements in graduate capabilities? Common to the delivery of many of the desired capabilities for skill sets, as presented in Sections 2 and 3, is that students need increased exposure to the World and its demands, outside the university campus environment. Relevant to the future of engineering programmes is that ASCE (ASCE, 2004) has established that a lack of cooperation between industry and HE in delivering degree programmes elicits the danger of undesirable outcomes, to the detriment of all stakeholders. The authors are aware that to increase the desired exposure that will build capabilities in graduate employability requires pro-active participation between employers, educators and students (i.e. all the stakeholders).

How could universities interact and mutually collaborate with industry so that employers can contribute to the successful development and delivery of engineering programmes? Interaction and collaboration can take various forms, such as industry providing high-quality internships and relevant societal and industrial problems (in the framework of problem-oriented studies). In addition, industry should be prepared to take part in the final assessment at the end of students' studies. Furthermore, universities would welcome employers that are willing to work closely with educators to strengthen both programme content and methods for delivery of teaching and learning.

The survey has confirmed the need for educators to adapt degree programmes, e.g. by replacing traditional lecturing with problem-oriented studies (laboratory work, or project or problem-based learning activities). Possibilities could be to reserve laboratory space for more laboratories and to allocate teaching funds for field work (in student groups) undertaken in the framework of problems proposed by industry or other societal actors (e.g. NGOs).

From the students perspective there already exists an understanding that Vietnamese students highly appreciate working on problem-oriented studies. This enthusiasm stems from the fact that these activates open students to real-life engineering problems, which cater for the needs of local and global communities, industry and the Vietnamese society at large.

Teaching students to be creative as engineers, which is a key graduate attribute, will certainly be stimulated by an increased exposure to real societal problems. Engineers need to be creative in how they go about solving problems they are tasked to work on. This is especially so in 2022 because Vietnam is experiencing a rapid societal transformation. Seventeen years ago, Cropley *et al.* (Cropley & Cropley, 2005) reviewed findings on fostering creativity in engineering education within the United States, and concluded that there was little support for engaging creative students. Two years later Sternberg (Sternberg, 2007) outlined the three learning activities that promote the habit of students/graduates working creatively. First, he said that students must have the opportunity to engage in exercises whose solutions require creativity. This learning opportunity must be woven, holistically, throughout degree programmes in an integrated and mutually reinforcing manner. Second, this author posited that students must receive positive encouragement from facilitators as they engage in learning tasks requiring them to give creative solutions. Third, Sternberg said that students must be rewarded with marks when they achieve outcomes that demonstrate creativity. In the changes towards a stronger interaction between engineering programmes and societal practice the recommendations regarding creativity should be taken to heart; it must be prominent in teaching and learning activities and be supported by assessments of study outcomes.

Given existing regulations in Vietnam the necessary pedagogical changes, highlighted by the ENHANCE project survey, are likely to require structural adjustments in Vietnam's university system. Here, not only individual educators and their departments and faculties must play a role, but for necessary changes (meeting the needs of all stakeholders) to take root, they must be embraced by higher administrative levels. Without such high level adoption, we can say that radical modifications of assessment methods in degree programmes (linked to innovative methods of teaching and learning) are not going to be approved.

For future engineering programmes in Vietnam the authors propose three approaches to assure a better alignment of graduate attributes based on the survey results discussed in this paper, and they are that:

- Curricula need to integrate more problem-oriented learning with traditional instructions to develop graduates with practical skills.
- Engineering educators and employers need to work together so that more teaching and learning activities are dedicated to graduate attributes that support student employability.
- To satisfy the industry's need for graduates having enhanced competency standards for professional and personal attributes, knowledge and skills, engineering programmes require a higher education alignment to workforce needs through curricula content with more practical experience, and employer-educator collaboration delivering new teaching and learning activities.

CONCLUSION

The world has entered the era of the fourth generation of industrial transformation, with information and communication technologies driving changes and their impacts are felt in every sector of Vietnamese society. Undergraduate/postgraduate higher education is one of the many sectors that are severely impacted, meaning that higher education educators need to update their curricula and modify their teaching and learning, and their assessment methods to be impactful in meeting the continuing changing requirements of graduate engineers entering the industry workforce. Continuous change will need to be flexible and innovative, and appropriate to cope with development trends in technology and communication. To ensure that advances in teaching and learning activities are aligned with the set of graduate attributes, as presented in this paper by way of a ENHANCE project survey, the authors advocate that there must be stronger and more effective collaboration between employers, educators and student engineers.

Engineering jobs require of Vietnamese graduates stronger attributes and capabilities (skill sets) in a variety of domains. The ENHANCE project survey has shown that in 2019 employers were only moderately confident that engineering graduates could satisfy the requirements of their job vacancies. While they found that graduates should possess analytical skills, creativity and practical skills, their opinion was that graduates needed to have more exposure during degree programmes to real-life experience(s) and be better equipped in terms of project management and leadership skills. In addition, graduates should have open eyes to the needs of the communities they serve. By way of the survey also showed' that the opinions of educators did not differ much from those of employers; yet, educators valued graduate skill sets generally higher than did the employers.

Amongst a list of 14 teaching and learning methods the survey confirmed that lecturing takes up most delivery time in engineering programmes. Modern methods of delivery such as project-based learning, problem-based learning, practical activities or personal-based learning have their place, but their share of programme delivery time needs to be enhanced in view of present societal needs (for soft and global topics), and the employability of graduates. This important conclusion is evident from the survey's results.

The survey informs us that assessment of performance in engineering programmes is usually dominated by written examinations. This is not consistent with the views on the importance of graduate skill sets. The authors thereby recommend that innovative assessment methods need to be aligned with the goals and teaching and learning methods employed in future engineering programmes. Another recommendation is that educators need to adjust their curricula, teaching and learning, and assessment methods according to societal needs. Among these needs, those required by Vietnamese industry and the development trends in technology and communication are preeminent for the future content of state-of-the-art engineering programmes.

Finally, the authors strongly recommend to all Vietnamese stakeholders that for the country to have impactful engineering degree programmes they must implement the recommendations for changes (refer to Sections 2 to 4) that are evidenced by the analysis of the ENHANCE project survey results of 2019.

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