Revising Engineering Education Curriculum as a Marketing Strategy to Boost Student Enrollment

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Abstract: *In today's rapidly changing and competitive marketplace, engineering education institutions recognize the critical role of updating their curriculum as a strategic marketing tool to attract and retain students. The objective of updating the curriculum for future engineering education courses is to bridge the gap between traditional teaching and learning methods and the evolving needs of the industry. To gain valuable insights into the implementation and impact of curriculum updates, this study employs a thematic analysis technique. The thematic analysis aims to determine the main themes that address the following key research questions; What is the impact of updating engineering education curriculum towards student enrollment?.By conducting a thorough analysis of these research articles, this study seeks to provide practical recommendations for engineering education institutions looking to leverage curriculum updates as a marketing strategy in today's highly competitive landscape. By identifying the necessary changes in curriculum elements and addressing the challenges and barriers, institutions can enhance their appeal to prospective students and improve their ability to retain students. Ultimately, the findings of this study aim to support engineering education institutions in effectively utilizing curriculum updates to attract, engage, and retain students in an evolving educational environment.*

Keywords: Engineering Education, Curriculum, Students Enrolment
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1. Introduction

Engineering education plays a pivotal role in shaping the future of any nation, as it equips students with the necessary knowledge and skills to drive technological advancements and contribute to economic development. In the context of Malaysia, a rapidly growing nation in Southeast Asia, understanding the structure and content of the engineering education curriculum is of utmost importance. Malaysia, known for its multicultural society and vibrant economy, has made significant progress in developing its engineering education sector over the years. The country's commitment to science, technology, engineering, and mathematics (STEM) education has resulted in the establishment of numerous universities and higher education institutions that offer engineering programs. These institutions strive to cultivate a workforce that can meet the demands of a fast-paced and evolving industry.

The Engineering Accreditation Council (EAC), in its engineering program accreditation standard (2020), has outlined twelve outcomes (as displayed in Table 1) that emphasize the essential engineering skills, knowledge, and behaviour that students are expected to acquire upon completion of their engineering programs. However, despite these defined outcomes, employers remain unsatisfied with the skills possessed by graduates (Salleh, H., 2019). Such feedback has had a negative impact on the perception of prospective engineering students, as they become apprehensive about their employability prospects in the future. This concern is supported by data collected by Jinn, L.C. (2022), which reveals a decline in undergraduate enrolment in STEM courses. Therefore, this study focused on gaining valuable insights into the impact of engineering curriculum updates towards student's enrolment.

Table 1: EAC 2020 Programme Outcomes

Program Outcomes (PO)	Outcomes
PO1	Engineering Knowledge
PO2	Problem Analysis
PO3	Design/Development of Solutions
PO4	Investigation
PO5	Modern Tool Usage
PO6	The Engineer and Society
PO7	Environment and Sustainability
PO8	Ethics
PO9	Individual and Teamwork
PO10	Communication
PO11	Project Management and Finance
PO12	Life Long Learning

2. Current Engineering Education Curriculum Needs

The declining enrolment in engineering programs presents a significant challenge in the competitive landscape of higher education. Despite the increasing demand for engineers in various industries, there has been a noticeable decrease in the number of students choosing to pursue engineering courses. This research aims to address this issue by exploring the potential of updating the engineering education curriculum as a marketing strategy to attract more students.

According to Das, Kleinke and Pistrui (2020), current pace of technological development is exponential, making many formerly useful ideas, bodies of information, and areas of skill quickly outdated leading to the greatest issue that occurs where; when technology is expected to develop at an unprecedented rate, but educational institutions are relatively slow to adapt (Ismail, Wahid, Yusoff, & Wahab, 2020).

The advent of IR 4.0 has brought about a significant shift in the context of the educational sector. To prepare educators for IR 4.0, today's educational institutions are stressing the need of aligning their pedagogical practices with the needs of students. Due to the prevalence of students from the Z and Alpha generations, who prefer to study through digital means, educators of the new millennium must excel in the realm of information technology (Ismail et al., 2020). The evolution of ICT-based pedagogical tools is certain to be affected by sweeping reforms in the educational system, along with the content of curricula, the reputation of educators, and the nature of classroom instruction. There is a fresh pressure to reimagine the

way education works to produce students with the skills, creative thinking, and innovation to succeed on a global scale (Lase, 2019). Numerous studies have shown that the actual practice of implementing curricula degrades over time, becoming less focused on students' ability to comprehend science in perspective of their everyday lives and life skills capabilities, and more concerned with the target accomplishment associated with educational values (Lase, 2019).

The greatest challenge for individuals is to make use of their diverse sets of knowledge and abilities to come up with original ideas that can be implemented by modern technology (Almeida & Simoes, 2019). Next is the high cost of machinery and facilities is an important barrier, particularly in the case of "disposable" technologies that become outdated quickly (Das et al., 2020). Nonetheless, educators with strong self-efficacy will be confident in their abilities as educators and will do their best to ensure that their students learn as much as possible from them (Ismail et al., 2020). Hence, prepare the students to be well-equipped with the information and abilities necessary to satisfy the IR4.0 expectation, which necessitates mastery of a new skill (Ramli, Majid, Badyalina, & Shaari, 2022).

The implementation of the aforementioned educational changes necessitates the collaboration of various stakeholders, including lecturers, universities, and the industry. This partnership is crucial to ensure that the courses and curriculum provided by universities align with the industry's requirements, thereby maximizing the employment chances for students upon their graduation.

Hence, this paper aims to investigate whether evidence can be found in the research literature on the effects of updating the engineering education curriculum towards engineering students' enrolment at university. The paper will try to answer the following questions:
i. What is the impact of updating engineering education curriculum as a marketing strategy on student enrolment?

3. Methodology

This study employed qualitative research by using documents found in both printed and digital sources, including books and journal articles as the main data collection. Thematic analysis technique was implemented to analyses and report the theme in these qualitative data. According Braun and Clarke (2006), thematic analysis is a qualitative method that analyses and reports the themes occurs in qualitative data. This analysis method aims to analyses and reports the theme in the documents found which related to updating engineering education curriculum and marketing strategy for students' enrolment.

The utilization of thematic analysis for analysing qualitative data has gained recognition among researchers due to its adaptable nature (Braun and Clarke, 2006). However, there remains a lack of specific guidelines on its precise implementation (Attride-Stirling, 2001; Boyatzis 1998; Braun and Clarke, 2006). In this regard, this study employed Braun and Clarke's (2006) proposed step-by-step process for thematic analysis as a framework to analyze diverse themes occur in the data collection.

Braun and Clarke (2006) present six-phase approach to thematic analysis, which encompasses:
(a) acquainting oneself with the data,
(b) generating preliminary codes,
(c) identifying themes,

(d) reviewing the identified themes,

(e) defining and labelling the themes, and ultimately,

(f) composing the final report.

Specifically, there are 20 out of 50 articles including journal papers have been chosen and thoroughly examined to find the occurred theme. The details of each thematic analysis phases implemented in this study including the findings are described in result and discussion part below.

4. Result and discussion

The importance of modernizing the engineering education curriculum to align with the evolving needs of the industry is undeniable. In today's rapidly changing technological landscape, where innovations are shaping various sectors, educational institutions must equip future engineers with the skills and knowledge that are directly relevant to the demands of the job market. This entails incorporating cutting-edge technologies, industry practices, and real-world problem-solving into the curriculum. By doing so, educational institutions can ensure that graduates are well-prepared to address the challenges and opportunities presented by the dynamic field of engineering. Moreover, updating the curriculum in response to industry demand also fosters a more seamless transition for students from academia to the professional realm, as they will have already gained exposure to the tools and techniques commonly employed in their chosen field.

Numerous studies, both conducted by local and international researchers, have been dedicated to examining the impact of curriculum updates on the perceptions and confidence levels of prospective engineering students. These studies delve into how aligning the curriculum with current industry standards can influence students' perception of the relevance and applicability of the education they receive. When students perceive that their education is directly connected to the needs of the industry, it can bolster their confidence in their ability to successfully enter and contribute to the workforce after graduation.

Thematic analysis technique (as explained in Part 3) was applied by the researcher to analyse the documents including articles and journals. Figure 1 shows steps the researchers applied in analysing the data using thematic analysis.
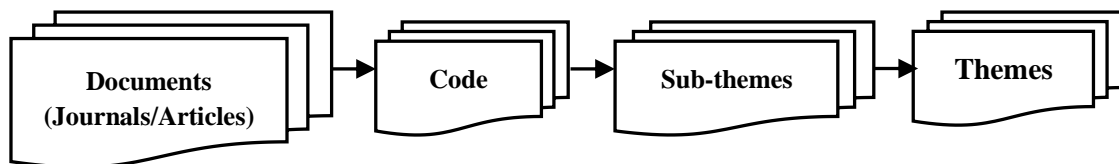
Figure 1: Thematic Analysis Applied in Analysing Documents Data

Based on Figure 1 illustrated on how the researcher analyse the collected journals and articles data. All the data have been thoroughly examined to identify and sort the relevant codes appear in the journal or articles writing. In this phase, the identified codes are presented as in Table 2 below.

Table 2: The Codes Identified in Journal/Articles Data

No.	Author	Description from the Journals/Articles		Codes
		Action Taken	**Impact/Results**	
1.	Anderson, L. S. and Gilbride K.A. (2003)	Faculty of Engineering and Applied Science, Ryerson University, Toronto, Canada, has expanded its Discover Engineering, a summer day camp programme that brings hands-on activities in class.	The authors' studies have shown that outreach programmes are essential tools for increasing awareness about the engineering profession at the pre-university level.	Summer camp outreach program - Increase awareness
2.	Omboi, Bernard Messah and Immaculate, M.J.N. (2011)	Adopted a descriptive research design. Correlation was undertaken to determine the relationship between the dependent (student enrolment) and independent variables (public relations, advertising, personal selling, and direct marketing) addressing the effect of selected marketing communication tools on student enrolment in private universities	It is crucial that higher learning institutions understand the perceptions and expectations of students and translate them into marketing activities that would attract and retain students.	Marketing communication tools – look beyond marketing paradigms
3.	Maura Borrego, David B. Knight, Kenneth Gibbs Jr., Erin Crede (2018)	We administered a survey about graduate study to 1082 undergraduate engineering students from four US institutions… We created multinomial logistic regression models to predict intention to pursue a master's or PhD degree.	Self-efficacy most strongly influenced graduate school intention.	Self-belief
4.	Alvarez, N.L , Callejas,Z. and Griol (2020)	We have employed institutional data of 456 students and performed several experiments for predicting their permanency into three (promotion, repetition, and dropout) or two classes (promoting, not promoting).	Tutoring and mentoring actions have proved to be successful retention strategies in different contexts.	Tutoring and mentoring
5.	Law, K.L.Y., Geng, S. and Li,Tongmao (2020)	Data samples were collected from 96 students taking blended learning course and 111 students taking a traditional course.	Findings in this study reveal the impacts of student enrolment and learning motivation on learning performance in the blended learning environment. The usage of computer and technology in BL setting is indispensable.	Blended learning course
6.	Raja, I. S., Ashraf, R.U., Ahmad, W. and Ahmad, N. (2013)	The primary focus of this study was to uncover the factors that students deem vital related to their choice of university and desired courses. Undergraduate engineering and business students (N=226) from five universities in three cities of central Punjab i.e. Lahore, Faisalabad and Sahiwal, participated in the study.	Findings of study revealed that higher education commission ranking, institutional reputation, employment, and career prospects have been found most important allied to desired university and course.	Universities ranking and employment

7.	Moulignier, M. G. R. and Kövesi, K. (2022)	Semi directive interviews were carried out with engineering students of three French graduate engineering schools and completed content analysis of our data.	The findings indicate that the pre-university model (preparatory classes) has a key influence on engineering schools' recruitment process for attracting talented students	Pre-university model (preparatory classes) – influence students' choice
8.	Amir, E., Rahemi,H. R., Budhoo, Y., He, S. and Ducharme,M. (2018)	NSF STEM Scholarship program at Vaughn College of Aeronautics and Technology-hands-on modules are intended to assist students in making connections between math and physics courses and their engineering applications.	Students of this program had better performance through their discipline of study than those who were not part of NSF learning community cohorts. The benefits of the scholarship program have been reflected in students' graduation and job placement rates; Students involved in the NSF-STEM program have the highest rate of graduation within 4 years and the highest rate of job placemen	NSF STEM Scholarship program – hands on modules – connections between Math and Physic – high students' graduation and job
9.	Shahhosseini, M. A, Moayed, F. A. and McLeod, A. (2020)	Strategy aims to institutionalize recruitment techniques of low-income and talented students, increase participation of students from under-represented groups including females and also increase co-curricular activities.To engage students the inclusion of the following activities are paramount: 1) creating a strong cohort framework for students, 2) developing mentor relationships, and 3) hosting co-curricular activities to promote interaction, learning, and exchange.	The project will significantly increase participation of low-income talented groups in MET and SM programs, presenting a model for increasing recruitment, retention, and graduation in other technology disciplines.	Students-support program-promote learning – increase graduate from technology dicipline
10.	I. Amaral, S. Santos (2019)	Analysis the use of Facebook by Portuguese universities as a tool for institutional communication by studying the visibility on Facebook of the Portuguese higher education institutions	The results show that HEIs with more visibility are those who have a number of fans consistent with the level of 'applause'. Nevertheless, it was also verified that not all HEIs with higher activity of publication have more fans or a greater level of 'applause'	Marketing – visibility – nombor of followers
11.	Spearman,J.J. A.,Rahim,M.M .A., Ghanayem, S. W. and Ljepava, N. (2016)	586 students participated in a survey. Recent research showed that colleges and universities websites play the key role of creating students' perceptions and decisions about the place they will study in.	Majority of surveyed students reported that word of mouth was one of the most important factors that influenced their choice of university. Participants also paid attention on	Marketing and Program Info

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			university Internet presentation – especially on how university presents itself on social media.	
12.	Miller, K.A, Sonnert, G. and Sadler, P.M. (2020)	The study uses data from the Outreach Programs and Science Career Intentions survey (N 5 15,847), a large U.S. sample of college students enrolled in mandatory English courses. Our analysis reveals that the relationship between completing a pre-college engineering course and interest in a STEM career appears to be field-specific.	Students completing a precollege engineering course were two times more likely to want to pursue an engineering career than those without such a course.	Precollege engineering course – before pursue
13.	Cho, H. J., Zhao, k., Lee,C.R. ,Runshe d. and Kraousgrill C. (2021)	The large lecture-focused courses have faced challenges, such as having higher withdrawal rates and impeding student engagement in course. To address these challenges, there has been an attempt to redesign or transform large-lecture courses.	To respond to the recent paradigm shift from the traditional classroom to interactive course redesigned classroom, the flipped classroom model was implemented in the undergraduate curriculum..	Re-design the course
14.	Baytiyeh, H. and Naja, M. (2010) (2011)	Engineering programs in the Middle East have witnessed a remarkable increase in students' enrollment. To investigate the motives behind such increase, three universities in Lebanon were targeted as a case study.	One-way repeated measures ANOVA showed that the professional growth including job satisfaction that improves the level of students' creativity in a challenging environment was the leading motivator..	Job satisfaction
15.	Walter Alexander Mata-López, and Sergio Tobón (2018)	A documentary analysis was carried out to analyze the factors related to the demand for careers in the field of computer systems engineering.	Knowledge society there are challenges for educators due to a generational change that cannot be avoided, technological advances and educational resources evolve, and each generation has new characteristics to which the teacher has to adapt. In the same way, the profile of the teacher plays an important role to face these challenges.	Teachers' skills
16.	Langie, G., Craps, S. and Broeck, L.V.D (2022)	The goal of the programme reform in 2020-2021 was fourteenfold: enhancing our typical profile of (1) hands-on engineering in (2) strong interaction with the labour market and setting up (3) a technology hub with more attention to (4) multidisciplinary, (5) professional competencies, (6) personal	This study proves that it is possible to make students aware of the importance of professional competencies. Since we are not the only faculty integrating professional competencies into the	Programme reform

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		development & support, (7) lifelong learning and (8) challenges including (9) complex problem solving	core of the curriculum, this is hopeful information for many curriculum reforms	
17.	Palmer, S. (2013)	..shows that student data stored in institutional systems can be used to predict student academic performance with reasonable accuracy, and it provides one methodology for achieving this. Importantly, significant predictor variab	These results confirm findings by others that prior academic performance is an important predictor of current performance, and that time variant data, in addition to time-invariant data, can improve the performance of student predictive models.	Prior academic knowledge
18.	Ahmed, N., Chowdury, A.M., Urmi, T., and Jamal, L. (2023)	…explores the current status of female students' enrollment in science, technology, engineering, and mathematics (STEM) at the tertiary education system in Bangladesh	A qualitative study was conducted with 48 participants in pre- and during COVID-19 eras to understand barriers hampering women in STEM-related education and jobs.	STEM for female students
19.	Nortvedt, G. A. and Siqveland A. (2018)	Beginning students who fail to master basic skills, such as solving arithmetic and algebra problems, will most likely face difficulties in their further course	…students reported high levels of intrinsic and extrinsic motivation,	Master the basic arithmetic skills

Table 2 illustrates the coded elements extracted from the descriptions found in the journals and articles. Some of these codes exhibited overlaps, which subsequently led to the identification of sub-themes. Once all the sub-themes have been identified, they undergo a rigorous review and refinement process to establish the primary themes within the dataset.

Hence, this stage necessitates the meticulous refinement and review of the sub-themes to derive the core themes of the data, aligning with Braun and Clarke's approach (2006). To facilitate the correlation of these sub-themes, the researcher employed a "table-form" method for comparison. An exemplar of this process can be observed in Table 3, demonstrating how the researcher systematically compared each sub-theme within the table format. This systematic approach culminated in the development of the primary themes within the dataset. Notably, the identification of overlapping sub-themes was conducted manually by the researcher.

Table 3: The Codes, Sub-themes, and Themes Identified in Data Collection

No.	Codes	Sub-themes	Themes
1.	Summer camp outreach program - Increase awareness	Outreach program	Curriculum
2.	Marketing communication tools – look beyond marketing paradigms	Marketing tools	Marketing
3.	Self-belief	Self-belief	Self-belief
4.	Tutoring and mentoring	Teaching technique	Curriculum
5.	Blended learning course	Teaching technique	Curriculum
6.	Universities ranking and employment	Program ranking	Curriculum
7.	Pre-university model (preparatory classes) – influence students' choice	Preparatory Classes	Curriculum

8.	NSF STEM Scholarship program – hands on modules – connections between Math and Physic – high students' graduation and job	Hands on module	Curriculum
9.	Students- support program – promote learning – increase graduate from technology	Support program	Curriculum
10.	Marketing – visibility – number of followers	Visibility	Marketing
11.	Marketing and Program Info	Visibility and Program Reform	Curriculum and Marketing
12.	Precollege engineering course – before pursue	Pre-college Course	Curriculum
13.	Re-design the course	Updating the course	Curriculum
14.	Job-satisfaction	Employability chance	Curriculum
15.	Teachers' skills	Teaching technique	Curriculum
16.	Programme reform	Programme Reform	Curriculum
17.	Prior academic knowledge	Fundamental knowledge	Curriculum
18.	STEM for women	STEM course	Curriculum
19.	Master the basic arithmetic skills	Fundamental knowledge	Curriculum

Based on Table 3 shows that there are seventeen themes which represented the curriculum aspect and three themes reported about marketing. The impact of these themes extends beyond the surface, bearing far-reaching implications for the field of engineering education. The "curriculum" theme cultivates a sense of wonder and enthusiasm in students, inspiring them to consider engineering as a viable and exciting career path. By bridging the gap between theory and practice, these initiatives create a nurturing environment that supports students' exploration and self-discovery. Besides, with an active teaching and learning method, the class become more real and has active interaction between lecturers and students. Conversely, the "marketing" theme empowers universities to proactively shape their image and attract the right candidates. By understanding students' preferences, institutions can craft messages that resonate with their audience, fostering a sense of belonging and alignment with the university's values.

Collectively, these themes converge to transform the landscape of engineering education. The emphasize the importance of proactive engagement and targeted communication in nurturing a pipeline of diverse and enthusiastic engineering students. By updating the curriculum initiatives will spark students' curiosity. Additionally with strategic marketing applications to ensure both align and contribute significantly to the growth and evolution of the engineering profession. Through this strategic approach, universities can ensure that the engineering workforce of the future is skilled and eager to drive progress and innovation. Based on Table 3 shows that there are seventeen themes which represented the curriculum aspect and three themes reported about marketing. The impact of these themes extends beyond the surface, bearing far-reaching implications for the field of engineering education. The "curriculum" theme cultivates a sense of wonder and enthusiasm in students, inspiring them to consider engineering as a viable and exciting career path. By bridging the gap between theory and practice, these initiatives create a nurturing environment that supports students' exploration and self-discovery. Besides, with an active teaching and learning method, the class become more real and has active interaction between lecturers and students. Conversely, the "marketing" theme empowers universities to proactively shape their image and attract the right candidates.

By understanding students' preferences, institutions can craft messages that resonate with their audience, fostering a sense of belonging and alignment with the university's values.

However, with the implementation of advanced and extensive marketing strategies, its role remains as a tunnel, directing potential students toward a diverse range of engineering academic programs. The students will still explore and assess the latest and high demand of engineering programs, especially those have high demand from the industries in order to secure their job in the future.

5. Conclusion

Engineering education and enrollment have witnessed dynamic shifts in recent years, driven by a growing recognition of the need for diverse, skilled professionals in the field. To address these evolving challenges and opportunities, researchers and institutions have explored various strategies to attract and retain students in engineering disciplines. This research delves into two prominent themes that emerge from the literature; a) curriculum aspect and b) marketing aspect. These themes encapsulate the actions taken by institutions and researchers to enhance the engineering student enrollment positively.

The findings indicate that several factors significantly influence the percentage of student enrolment in engineering courses. However, the importance of updating the engineering education curriculum cannot be denied in order to align with the current industry demands. This not only enhances the institution's reputation but also prepares future engineering graduates to meet the high demand and secure employment opportunities within their respective industries.

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