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Recent Developments in the Engineering Education Sector in Australia

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Abstract

Graduate Engineer is one of the most demandable occupations in Australia. This is one of the most crucial parts of higher education sectors in Australia both domestically and internationally. However, the engineering education sector in Australia is rapidly transforming during the last two decades because of several challenges including technological advancements, the necessity of sustainable solutions and a fast-changing socio-economic environment. Industry revolution, incorporating AI, and advancements in information technology now enforcing to cross-fertilize the concepts from various disciplines. Besides, the global pandemic also showed the world how to adapt in critical moments to maintain the economic balance, such as distance work, distance learning, and AI-assisted learning. These challenges are working as a driving force to upgrade the education courses. Besides, preparing multi-skilled employable engineering graduates is also highly required. Hence, the advancement in the engineering education system is already in progress in recent times. The transformation from a traditional academic curriculum to a more engaging and involving curriculum clearly shows positive outcomes because of newly emerged active learning, team-based learning, and project-based learning. This paper aims to focus on the recent state-of-the-art advancement in the Australian engineering education sector and to present the current challenges that still need to be addressed in future to prepare engineering graduates with more adaptability, creativity, and multi-disciplinary knowledge.

Keywords: Engineering education, Engineering profession, Australian education.

1. INTRODUCTION

The engineering education section is one of the major education streamlines in the higher studies domain globally. The Australian Engineering Education system offers a wide range of high-quality, industry-focused, and professionally accredited programs that are recognized globally (Palmer & Ferguson, 2008). These programs are delivered in well-equipped, internationally benchmarked facilities by experts renowned in both engineering and engineering education. They emphasize engineering practice, design, creative problem-solving, and innovation (Burnett et al., 2021). The system is dedicated to contributing to the broader society by enhancing the quality of life and ensuring a better future for everyone.
Australia's higher education sector offers entry-level training for professional engineers, engineering technologists, and engineering officers, along with advanced education and research in engineering. The system, which includes educators, professional bodies, and employers, holds a strong international reputation. It is delivered through engineering schools (the term used for each university's unit responsible for engineering education, regardless of its specific academic structure) across 35 Australian universities. These institutions provide a diverse array of programs in both metropolitan and regional areas, as well as internationally. The system has consistently adapted to shifts in engineering practices driven by advancements in scientific and technological knowledge, along with evolving economic and regulatory conditions. This occupation group became one of the most demanded occupations because

of the professional stability and future demand. Hence, the engineering education system is well-structured and the education quality in Australia is maintained very strictly. The professional and accreditation body for engineering occupations is the Engineers Australia (EA), formerly "Institute of Engineers, Australia".

The education sector is recently transforming tremendously due to several changes such as technological advancement, involvement of AI tools in education and teaching, global changes due to the pandemic and socio-economic updates. This significant transformation includes the change in teaching methods, teaching contents, course structure, industry involvement etc. In Australia, similarly, over the last two decades, enormous transformation observed in the engineering education system with the collaborative work of engineering schools, professional institutes, academics, and relevant societies. The system demonstrates high strength of the system by providing world-class education as well as the ability to adapt to technological upgrades and societal demands. The stakeholders have actively worked to anticipate future needs and shape the system to produce graduates who are fully prepared to assume leadership roles in both their profession and society as a whole. Several factors that play a crucial role in the transformation have been discussed in this study.

1.1. Industrial revolution impact on engineering education

The Industrial Revolution changes the way of thinking for both academic and industry personnel. Technology is upgrading more rapidly than ever before. Industry 4.0 is reshaping the future of engineering education and practice, as engineering graduates need to keep learning technological advancement at a rate that is higher than ever before (Create, 2022). They have to deal with consumer desires which is greater than ever as well. Professional engineers have to work with advanced AI-driven tools and machinery that are high-valued, unique, eliminating dangerous and time-consuming activities, and adaptive to change as required in real-time operations. The machines are flexible and autonomous and feed on data, regularly improved through machine learning models. Hence, the education system has also changed with the direction required as the industry person assumes that the graduates should be industry-ready after completing their university studies.

1.2. Inclusion of AI in Education and Industry

Progress in information technology and its applications has driven greater adoption of digitalization and automation across various industries. A notable advancement in this field is artificial intelligence (AI), which has steadily evolved in recent years, offering a range of practical benefits across different sectors. Recently, there has been significant research exploring the use of AI chatbots in education, particularly as an engaging and innovative tool to support self-directed learning. Self-paced courses for micro-credentials also now contain AI tools which greatly benefit the engineering education sector.

1.3. Global pandemic

The pandemic-related restrictions have affected daily life, including work, education, and healthcare. With significant changes in global operations, there have been shifts in both employer expectations and student pursuits (Umar Iqbal, 2022). A stronger focus has emerged on teleconferencing and various other technological skills. The pandemic has affected everyone involved in education, particularly teachers, students, administrators, and parents. Educational institutions quickly adapted to remote teaching, with leadership playing a crucial role in restructuring systems to prioritize the health and safety of faculty, students, and staff. This included transitioning lectures and lab classes online and moving student's home. Additionally, COVID-19 has led to budget cuts and unemployment, with university administrations needing to consider the long-term financial impact on students' ability to afford higher education. Engineering education combines theory with hands-on activities like projects, lab work, and instrument training. Project-based courses help students develop problem-solving, creativity, decision-making, and teamwork skills while emphasizing safety, ethics, and engineering standards. Teachers play

a key role in facilitating organized learning. However, in online classes, many instructors struggle to engage students, leading to shallow participation. Better training in using Learning Management Systems (LMS) and promoting student collaboration could improve engagement and reduce the sense of social disconnect in virtual learning environments.

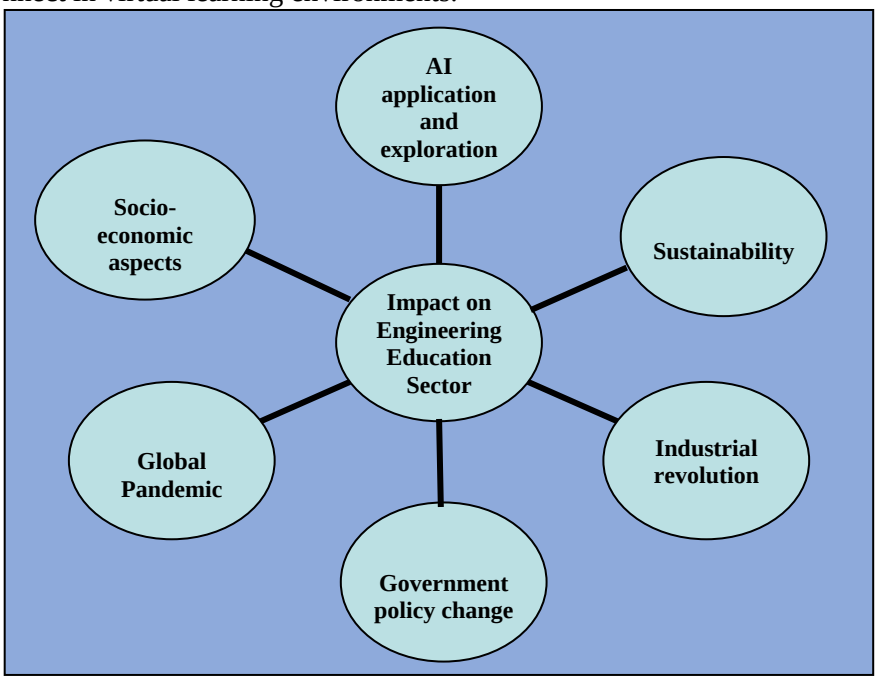

Figure 1: Factors influencing the engineering education transformation

1.4. Sustainable education requirements

In 2015, the United Nations adopted the 2030 Agenda for Sustainable Development, which includes 17 Sustainable Development Goals (SDGs) aimed at addressing societal, economic, and environmental challenges. These goals cover areas like climate change, food, energy, water, and sanitation, with STEAM disciplines playing a key role in developing innovative technologies to support them. In 2019, UNESCO established World Engineering Day for Sustainable Development (WED) to highlight engineering's contribution to global welfare and climate change mitigation. In 2021, UNESCO's report "Engineering for Sustainable Development" emphasized the importance of engineering in achieving the SDGs, particularly in tackling climate change, and called for inspiring young people, especially women, to pursue careers in engineering (Ramos-Gavilán et al., 2024). This driving forces actually pushing the transformation faster towards a reshaped strong engineering education system for sustainable real word solutions and engineering professionals.

1.5. Government policy change impact

Nearly 58% of engineers in Australia were born overseas. Migrants join the engineering workforce through both temporary and permanent visa programs. The number of international students has increased substantially in recent years, and since 2018, the number of international engineering students has surpassed that of domestic students. The Australian Qualifications Framework Council (AQFC) oversees the Australian Qualifications Framework (AQF), ensuring its national implementation across high schools, VET institutions, and universities. The AQFC is working on the "Strengthening the AQF" project, which includes recommendations for VET institutions to offer higher education awards like associate degrees, bachelor's degrees, and Vocational Graduate Certificates and Diplomas. Some VET institutions, such as Chisholm, are already in the process of offering engineering degrees, and others, like TAFE NSW, have been accredited to offer these programs (Dowling, 2010). The Tertiary Education

Quality and Standards Agency (TEQSA), established in 2011, oversee the quality of both VET and higher education, including the introduction of academic standards. Additionally, Skills Australia's expanded role in 2009 aims to bridge the gap between sectors by advising on skills and workforce development. This collaborative effort improving the students from different levels to enter engineering education. The Australian government has recently implemented several measures to improve engineering education, addressing global trends and societal needs. Key actions include:

1. Promoting Diversity in STEM: There is a strong focus on making STEM fields, including engineering, more accessible to underrepresented groups, with programs aimed at increasing diversity and removing barriers to participation.

2. Enhancing the Australian Qualifications Framework (AQF): Efforts to improve AQF include enabling VET institutions to offer higher education degrees, which supports the demand for skilled engineers and promotes flexible pathways into higher education.

3. Industry-Education Collaboration: The government is fostering partnerships between universities, research institutions, and the engineering industry to integrate practical learning with academic studies, ensuring graduates are prepared for real-world challenges.

4. Educational Reform via the Australian Universities Accord: New policy reforms focus on improving higher education's accessibility, affordability, and quality, while aligning engineering curricula with industry needs.

These initiatives aim to modernize and improve engineering education in Australia, ensuring it meets global challenges and technological advancements.

1.6. Socio-economic influence

A recent ACER study, The STEM Pipeline: Pathways and Influences on Participation and Achievement of Equity Groups, explores the STEM pathways of four equity groups in Australia: non-metropolitan students, those from low socioeconomic backgrounds (low SES), first-generation university students, and women (Discover, 2023). Using longitudinal data, the researchers investigated how the pathways of these groups differed from non-equity students in terms of STEM education and careers. The study found that critical "leaks" in the STEM pipeline occur during transitions from school to university and from university to the STEM workforce, particularly for women and low-SES students, pointing to barriers in their participation and advancement in STEM fields.

2. CHANGES IN ENGINEERING EDUCATION IN AUSTRALIA

The goal of recent changes to Australia's engineering education system is to make programs more relevant and high-quality in order to better meet the changing demands of society and industry (Nguyen & Pudlowski, 2007). Leading these reforms is the Engineering 2035 study, which contains a number of suggestions from the Australian Council of Engineering Deans (ACED). Important projects consist of:

- **Increased Emphasis on Practical Learning:** Engineering programs now place more of an emphasis on incorporating real-world, hands-on experiences. By encouraging students to work through real-world issues and participate in industry-driven projects and internships, this method makes sure that learning is directly related to how it will be used in the workplace.
- **Encouraging Inclusion and Diversity:** Attempts are being made to increase the number of women and Indigenous students in engineering programs, which have historically had lower enrolment rates, especially in mechanical and electrical engineering.

- **Industry Partnerships**: To guarantee that engineering curriculum are in line with industry demands, there is a drive for increased cooperation between academic institutions and business. With initiatives like ChallENG, which concentrate on tackling societal challenges through student-led projects, universities like UNSW are leading the way in this direction.
- **Curricular Innovation**: New educational models are being developed, replacing traditional lecture-based learning with project-based and experiential methods. The TEDI-London initiative, for example, allows students to work on practical projects with global partners, rather than attending conventional classes.

The goal of these modifications is to enhance the overall quality of education and equip engineering graduates to meet the challenges of the future. The Australian engineering education system strives to develop a qualified and diverse workforce by emphasizing experiential learning, inclusion, and closer industry ties.

3. EXISTING CHALLENGES

There are several challenges still existing which need to be addressed for better engineering education system and real-world problem solver professionals (Nguyen & Pudlowski, 2007). Some of the challenges are:

- Transdisciplinary engineering knowledge of the professional engineers still needs to be taken under consideration to the engineering education framework, so that, complex problems in the field can be solved by an efficient high-performance team.
- Education 4.0 empowers individuals to adapt to the evolving technological landscape. This approach to learning enables students to grow in alignment with societal advancements, fostering the practical use of emerging technologies. In today's world, continuous learning and personal development are essential. As a result, Education 4.0 goes beyond traditional education, emphasizing ongoing growth and adaptation. This application still needs to be adopted to the universities. And hence, the academic professionals also need to be adaptive.
- "Women in Engineering" the term is now getting familiar but still bringing the girls from school level to the engineering education with their self interest is still needs lots of framework changes and social engagements.
- Practical involvement is largely increased in the higher education sector, however, attachment with the real world is still not up to the level. Performing laboratory works in controlled environment largely helps in the research work and also preliminary engagement with instruments but solving solutions in the real field with industrial environmental engagement still needs to be addressed by the industry and education institutions collaborative engagement.
- Cultural barrier has still present in the current education system as can be seen in the society. Addressing this challenge will need a shift in both pedagogy and policy for the alignment of industry and society needs.

4. CONCLUSION AND RECOMMENDATIONS

Technological advancement, evolving of AI, and unparallel demand of the multidisciplinary professionals working as potential driving force for the rapid transformation and advancement of the engineering education system. In Australia, the world class engineering education system currently educating students from all around the glove and preparing graduates of industry 4.0 age. Lots of developments and research is going on to improve this potential sector for fulfilling the industrial requirements as well as sustainable professional engineers to solve the real-world problem. Government policy change, collaborative work between industry and universities are now greatly mobilized the development growth. However, there are still some challenges exist such as: adaptability to the new technology, learning inter-disciplinary knowledge, equality of genders in engineering education, cultural barrier and the practical industry experience attachments still need to be developed for sustainable graduates. Some future recommend dation can be provided from the study conducted in this paper from

Australian perspective, such as:

- Courses can be modified with assessments containing multi-disciplinary knowledge such as mechanical design coupled with software development.
- Study contents and industry requirements need to be matched. So the course content and practical assessment should be developed largely collaborated with industry leaders and need to be updated regularly based on new technologies.
- Costing of education for different socio-economic level people need to be checked whether it affects their interest to study engineering education.
- Using AI assisted tool, hybrid teaching and delivery methods can be improved through survey to find the most efficient methods for the engineering students to understand the theme of the study and reflect it on real world problems.
- National as well as international collaboration can also be done to improve the graduates' transferable skills by conducting some compulsory courses outside of the student's comfort region to get attach with complex scenarios.

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REFERENCES

Burnett, I., Crosthwaite, C., Foley, B., Hargreaves, D., King, R., Lamborn, J., Lawrence, R., Reidsema, C., Symes, M., & Wilson, J. (2021). Engineering change: The future of engineering education in Australia.

Create. (2022). *Industry 4.0 is transforming the future of engineering practice and education*. Engineers Australia. Retrieved 18/11/2024 from https://createdigital.org.au/industry-4-0-is-transforming-the-future-of-engineering-practice-and-education/

Discover, A. (2023). *Finding the leakages in STEM pathways for equity students*. Retrieved 18/11/2024 from https://www.acer.org/au/discover/article/finding-the-leakages-in-stem-pathways-for-equity-students

Dowling, D. (2010). A review of para-professional engineering education in Australia: Exploring the VET-HE divide. Proceedings of the 21st Annual Conference of the Australasian Association for Engineering Education (AAEE 2010),

Nguyen, D. Q., & Pudlowski, Z. J. (2007). Issues and challenges in engineering education and the future outlook of the engineering profession in Australia. *Global J. of Engng. Educ, 11*(2).

Palmer, S., & Ferguson, C. (2008). Improving outcomes-based engineering education in Australia. *Australasian Journal of Engineering Education*, *14*(2), 91-104.

Ramos-Gavilán, A. B., Rodríguez-Esteban, M. A., Frechilla-Alonso, M. A., Raposeiras, A. C., Movilla-Quesada, D., & González-Rogado, A. B. (2024). Raising awareness of the important role of engineering in sustainable development. *Heliyon*, *10*(1), e23494. https://doi.org/https://doi.org/10.1016/j.heliyon.2023.e23494

Umar Iqbal, A. U., Javier Gerardo Gómez, Muneebah Umar (2022). *Impact of COVID-19 Pandemic on Engineering Education: Evaluation of Limitations and Recommendations for Effective Teaching* ASEE Southeast Section Conference, https://sites.asee.org/se/wp-content/uploads/sites/56/2022/03/2022ASEESE88.pdf