

Educational Diversity in Engineering Entrance Pathways

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ABSTRACT

CONTEXT

In the current tertiary environment, there is an increasing number of pathways into an engineering degree. This indicates that within the starting and continuing cohort of students there is a large range of educational diversity. Ranging from high school leavers, to students who can have years at university. This educational diversity is further amplified as international and domestic students have different pathway options. Domestic students now have a range of entry methods that can include undertaking a diploma, up-skilling through incubator programs or the standard admissions path. As such, it is more important than ever, to look at the educational diversity of students entering engineering programs. This is particularly important so educators can better understand individual students' abilities and begin capacity building to meet current industry demand.

PURPOSE OR GOAL

This project seeks to inform the engineering education community on the different pathways of students entering engineering programs, focusing on the college system. As a by-product of COVID, colleges began to change their options to be more inclusive of domestic students. Due to pathway options, it is hypothesised that the variance in education may make it difficult for some, whilst simultaneously making it easier for others. This is not just at the course level, but program and institutional. As such, this review of students' pathway options will allow for educators to make better informed decisions about student specific learning and the educational diversity of the students.

APPROACH OR METHODOLOGY/METHODS

All of the different pathway options that students can enter a tertiary engineering degree will be reviewed by web search, consultation and authors experience as an academic within the college systems. Through information gathered through a literature review and discussion with these pathway directors a comprehensive review of these pathways will be discussed.

ACTUAL OR ANTICIPATED OUTCOMES

Arising from this review, it is expected that educators will have a better understanding of the educational diversity of the student's in engineering degrees. Alongside this, it will inform the community on the pathways into the degree as well as the entry points as it has been noted previously that not all educators are aware of the entry points and pathways. This review is set to frame a longitudinal study that will comprehensively evaluate the differences in skills set of students in engineering degrees based on a multitude of different diversity factors, educational being one.

CONCLUSIONS/RECOMMENDATIONS/SUMMARY

This study reviews the entry pathways into engineering degrees. It will show the educational diversity in the student base through these pathways. It is expected to inform the community of currently unknown pathways such that educators can better understand the differences in educational diversity of students. Furthermore, this review will consolidate the different pathway options for a select few colleges and make comparisons between them.

KEYWORDS

Diversity, college, pathways

Introduction

The higher education (HE) sector in Australia presents an ever-changing landscape for prospective students and service providers (Dawkins et al., 2019; Goedegebuure & Schoen, 2014). This landscape continues to evolve in response to changes in government policies, society's expectations, and an ever-increasing demand for a more highly educated workforce. Key policy changes introduced since the early 1990's have broadly achieved stated goals of promoting greater access and participation in higher education (Jackson et al., 2023). However, by 2015 certain equity issues had still not been addressed with only marginal increases in HE enrolments for underrepresented students including those of low socioeconomic status, from non-English-speaking backgrounds, with a disability, who are mature age, or who identify as Indigenous and/or reside in remote or regional areas (Chesters et al., 2018).

From around 2012 pathway (enabling, bridging or preparation) programs began to be offered more widely by universities to cater for the ever-increasing diversity of students. A pathway program is "a course of instruction provided to a person for the purpose of enabling the person to undertake a course leading to a higher education award" (Australian Government, 2022). These pathway programs present a valuable opportunity for underrepresented students to gain entry to higher education, via a range of pathway options and commencing with quite varied educational backgrounds. This is still a clear focus of government policy and is noted in the recent Australian Universities Accord Discussion paper (Department of Education, 2023).

Recent work reports the successes of a range of pathway programs. Chesters et al. (2018) conclude that "tertiary preparation programs provide viable alternative entry pathways into higher education and are associated with similar levels of retention and completion of university study as the traditional pathway", and that "graduates of the tertiary preparation pathway program performed as well as other commencing students and were equally as likely to complete their degree programs." Jackson et al. (2023) conclude "the strongest growth was observed for students entering through 'other' pathways – particularly access and enabling programs – which were introduced for under-represented students."

Boles and Whelan (2017) point out that there is plenty of research on persistence and retention in engineering programs, but few systematic or longitudinal studies on the diversity of students and the barriers (perceived or not) which prevent them from succeeding in engineering studies. The factors which sign post the various underrepresented groups of students – socioeconomic status, disability, age, origin, location etc – may identify the pathway(s) open to the student, but they only hint at the level of commitment, beliefs, and perception of self which the student holds. Furthermore Boles and Whelan (2017) encouragingly conclude that "while there are many complex factors enabling or hindering student success, teachers (colleges / schools) do have the power to create a teaching–learning environment that supports more students to persist with their study and perform to the best of their ability." (Boles & Whelan, 2017)

Evidently there is more work to be done - including providing better pathways for Indigenous students, attracting more female students into STEM fields and further developing the support systems which truly underpin most pathway programs. The provision of the pathway itself is a great first step but understanding the diversity of the students utilising these pathways, determining how best to transition them into university, facilitating their learning and mentoring them to complete a university degree remains a rich field for research. As such, this paper will critically review the different pathways into an engineering program and will answer the following research questions.

What pathways exist for students to enter tertiary education in Australia?

What are the pathway options for both domestic and international students entering the college system?

Methodology

The pathways into institutions, specifically a Bachelor of Engineering will be identified by a web search and use of the Queensland Tertiary Administration Centre (QTAC) website. Both standard (widely known and used) and non-common pathways that use QTAC or other means of entry through articulation from Australian Qualifications Framework (AQF) levels will be identified. Moreover, Diploma programs both offered through enabling institutions (colleges) or university faculties will be identified from a web search of Queensland higher education providers. The college institutions will be identified from a web search, authors experience in working in these institutions, as well as meetings with various college program conveners and directors. Furthermore, the college pathways will be broken down into international and domestic pathways including bridging, foundation and English programs. Whilst this paper focuses on Queensland pathways as representation for all in Australia, individual institutions and states may have specific information as there is many small differences between different college institutions and pathways. Recognition of prior learning and previous degrees will not be discussed in this paper, nor will pathways into AQF level 9 or 10 courses.

Discussion and Conclusions

Standard Pathways

There are many different options to entering a university undergraduate program. These options are evolving rapidly in an attempt to increase student numbers. Many of the options were not possible, even 5 years ago. With the pathways now available, most students are now able to enter a bachelor program with a very diverse educational background, including those who have not completed high school, others who have completed high school in another country and students who have been in the workforce for many years. The standard pathways still exist today and make up the majority of the students entering programs. These pathways include high school leavers obtaining the required Australian Tertiary Admission Rank (ATAR) and fulfilling the necessary requirements of the degree, mature age learners that have completed high school and obtained a high enough equivalency. The ATAR achieved upon completing year 12 stays current until a change from a higher education is noted. Last and what is a popular option for mature age learners who do not have a high school completion, is the Technical and Further Education (TAFE)/ Vocational Education and Training (VET) articulation pathways. Articulation pathways are linked to the AQF levels and as such, it is possible to articulate into a bachelor's degree with obtaining a certificate III. There are many different options for this pathway which won't be explored in great detail due to the focus on the college pathways.

Whilst it is not considered a direct pathway into a bachelor's degree without need of an ATAR and meeting other pre-requisites, beginning to study at a tertiary institution while in high school is quickly becoming the norm. These programs typically involve a student in year 11 or 12 to undertake a single university subject. Whilst the general premise of these programs is the same, they can vary drastically. An example is a program where students must undertake a 2-day intensive program to gain entry and once successful, students can undertake a single course with modified assessments only in a small group. Others may simply enrol students directly into the course offering to be completed with all other students. The benefits of these programs are they allow students the option to see what studying a degree is all about. Other benefits are that it can boost internal ATAR's and can offer guaranteed entry with provisions.

Non-Standard Pathways

Whilst these pathways are the more standard options for domestic students there is a range of other options to articulate into a university degree. There is the Special Tertiary Admissions Test (STAT). This test allows for the articulation into a degree through sitting one or two tests on either English or general reasoning skills. This pathway is typically not accepted solely without other pathway options.

Professional qualifications can contribute to enrolment into bachelor's degrees. Common professional qualifications are health care, apprenticeships and traineeships, emergency services, creative arts, language degrees and professional associations with qualifying exams. Many of these will need to have other pathways options for a full articulation into an undergraduate bachelor's degree.

Learners also have the option to undertake external high school examinations to receive a high school equivalent certificate and ATAR score. This can then be either combined with another pathway but may be able to be used on its own to enter a bachelor program.

Diplomas

Due to the overwhelming demand for graduates in certain fields (Professionals Australia, 2023) (engineering being one) some universities have started to offer one and two-year diplomas however, these degrees have been around for some time at some institutions. These are stand alone and different from what typically university colleges offer. The purpose of these diploma or associate diplomas are to get industry engineers graduate ready such that they can begin work as an associate engineer and be accredited by Engineers Australia. The other benefit to this, is that students can enrol in a 'low stakes' degree and if wanting to continue, there is a more simplified articulation pathway.

Colleges

The main source of alternative pathways that will be discussed in this paper, is the college system. Colleges started by housing the international articulation and bridging programs. These colleges are attached to a university by either acting as a department under the governing body or attached through a 3rd party institution. One such example is Griffith College, being owned and operated by Navitas. An example of an embedded college is QUT college, where the operations are carried out and funded by QUT. There are many pathways in the college sector that are confusing and complex to not only students, but to staff as well. Whilst some colleges only have singular pathways others offer a large range of pathways that can articulate students into many facets of study. To better explain and describe the differences three colleges will be discussed in the following section and the pathways for both domestic and international students. One difference to note between colleges and faculties within a university is the staff to student ratio and demand of staff time. Students who enrol in colleges typically will spend more time, in some cases 20 hours with their academic. This is important to note as some students may find it difficult to translate from a diploma with 10 students, into a second-year bachelor program with 400, this case will be further examined below. To compare and contrast the differences in the college offerings, three colleges in Australia will be dissected by each program.

UniSQ College

University of Southern Queensland (UniSQ) college offers three articulation pathways into a bachelor's degree. More than one of these pathways may be required to be considered for a bachelor's degree depending on the student's prior study. The programs are broken up into the tertiary preparation pathway (TTP), English language program (ELP) and the Diplomas.

TPP is only available for domestic students and prepare students for university life through a range of courses such as mathematics, humanities and science. At the completion of TPP courses, students will get an ATAR ranking. Students will undertake TPP when they do not meet the pre-requisites to study a degree, have not completed year 12 or it has been some time since last study. One criterion for students undertaking TPP is that they must be over the age of 18 to apply. They must also possess an International English Language Testing System (IELTS) score of 5.5.

To articulate from TPP to an associate degree in engineering students should undertake the following courses. Study management, Communicating at University and General Mathematics. It is also recommended that students undertake Mathematical Methods. In comparison to articulation into the Bachelor of Engineering honours. Study management, Communicating at

University and Mathematical Methods and Preparatory Physics as a recommended. As such, depending on the degree students would like to articulate into, there is a specific plan set out for students.

The program of study for TPP is quite different from a standard university offering. There are 6 study blocks throughout a calendar year and each block only lasts 5 weeks. To be considered full time through TPP, at least 2 units must be undertaken at any one time. There is no limit on the duration that students can study or a limit on how many subjects. All TPP courses are ran by the college and this program has no interaction with the courses offered by UniSQ.

There are two offerings to the ELP from UniSQ college. One program is the English for Academic Purpose (EAP). This program is designed for students to improve their IELTS score from 5 to 6 through 0.5 increments. Each of these are broken into a 10-week program. To enrol in standard diplomas, an IELTS of 5.5 is required, as such, only one 10-week program is needed. To improve from an IELTS of 5.5 to 6, another 10-week program is needed. An IELTS of 6 is the standard score for most bachelor's degrees however, there are some that require even higher. For these programs, another program exists, which is the Academic Communication Skills (ACS) program. This allows students to improve their IELTS from 6 up to 7. This is particularly important for degrees such as nursing. There are between 2 to 3 entry rounds for the various ELP is noted that both domestic and international students may enrol in the ELP programs.

The diploma offered through the UniSQ college is quite unique in nature. You cannot directly study a diploma in engineering. The diploma of study is a diploma of university studies in engineering. The program is split between courses ran by the college and those ran by the faculty and school. For the engineering offer the four courses ran by the college are E-Literacy for Contemporary Society, Academic and Professional English, Strategies for Successful Study and Essential Mathematics. Students can then choose four subjects from the first-year engineering degree within the college. To complete the diploma 8 subjects must be completed as standard across diplomas. The articulation into a four-year Bachelor of Engineering will land students halfway through first year. Undertaking this diploma will also advance students from a IELTS from a 5.5 to 6.

QUT College

Queensland University of Technology (QUT) College has four pathway programs to translate students into an award program. This varies depending on if the student is domestic or international. The foundation program is offered only to international students, and these are pathways into a bachelor's degree. The diplomas are offered to both international and domestic students however, since COVID-19 the domestic market has increased as a response to the international borders being closed. The ELP program is open only to international students. Finally, the bridging program is open to all that would like to undertake the program as it is not award based.

The foundation program is made up of two programs that use a pool of courses to complete. These courses are offered in house at QUT college, and they are nominally six hours of contact time for each course. The intensive program is 6 months (one semester – 13 weeks) in duration with four subjects to complete and standard pathways are eight subjects over 12 months (two semesters). To meet the requirements for the intensive program, students must have an IELTS score of 6, have finished year 12 (or equivalent) and have an ATAR of 60 (or equivalent). There are several different program streams that students can enrol into with varying differences in specific subjects. Some students may undertake general or advanced mathematics depending on future program of study. Whilst the foundation program is to prepare students to meet the IELTS level, some students may choose of study an ELP after or before the foundation program. The foundation program is a pathway program into a bachelor's degree, not a diploma as some other pathways are.

The diploma program at QUT college consists of six programs of study that includes engineering. The diploma is unique in nature as the subjects are replicas of those offered by the faculty.

Noting the exception of academic communication. This course is a required part of the diploma to ensure students are at the correct English level, regardless of if the student is domestic or international. The entry for a domestic student is an ATAR of 60 – which is ~15 points lower than typical bachelor programs. The diplomas operate on a semester calendar and allow students to complete the diploma in 8 months if studying full time. It should be noted that there is no option to study these diplomas online. All of the diploma courses have their own separate course from those offered by the faculty but maintain the same content. The assessment and learning classes can be different and more focused on the students in the diploma. To ensure that the courses are functionally the same in terms of learning outcomes, the convenor of the faculty course is consulted on assessment.

The articulation of students into the bachelor's degree can allow students to be directed into second year, however depending on discipline, some first-year courses may still be required. For example, students who would undertake the diploma and then articulate into a bachelor majoring in civil engineering would have three subjects that would give credit for electives from the diploma and there would be three first year subjects that students would have to undertake during the bachelor. This can impact on enrolment patterns and is a consideration for students to undertake certain pathways. A change from the previous offerings is to make students undertake a more simplified mathematics course during the diploma. This is based on feedback from academics and students alike that students articulating from the diploma are lacking in mathematics skills.

The ELP program at QUT college is split into three sections. The first is English for academic purposes (EAP) and the second is the general English program and last is the IELTS advanced. The IELTS advanced is for students that are needing to achieve an IELTS of 7.0 which is a requirement of the Bachelor of Nursing.

The general English program prepares students for entry into EAP. This program is flexible and is available to be undertaken for a period of five weeks up to 45 weeks. It is worth noting that this five-week period is intensive in nature. There is no online offering for this program and students are required to spend 20 hours per week in class with an educator.

The final program is the EAP. This program is the most common structure of ELP programs offered by institutions. It will develop students' English skills to an IELTS level of 5.5 or 6 depending on the program. Depending on the IELTS level students are aiming for, they can undertake EAP 1 or EAP 2. Each of the EAP programs offer an extended or standard offering. The standard offering requires slightly higher IELTS to enter but will only take 10 weeks. The extended offer will take 15 weeks to complete but requires a slightly lower IELTS level.

The bridging courses are intended to fulfill the pre-requisites governed by some degrees. In the last few years, the prerequisites for some engineering programs have dropped down to only passing English in high school or equivalent. This has led to some bridging programs removing some offerings. QUT college has 3 offerings for bridging that are open to anyone who is wanting to undertake them. These are mathematics, physics, and chemistry. All of these programs will offer a year 12 equivalency in the selected subject with mathematics offering equivalent to mathematical methods (the highest high school offering). Whilst it is the intended offering for these programs are to fulfill pre-requisites they have been undertaken in the past by those just wanting to brush up on these skills.

Griffith College

Griffith college offers two programs of study. They do not offer ELP inhouse, but there is an offering of this by Griffith University. The college offers a foundation program, similar to that offered by QUT college and diplomas. The foundation program is only offered to international students however, the diploma is offered to both domestic and international students.

The foundation program is a single offering of eight months or two Trimesters and has three intake rounds. Students must complete 8 units to advance from the foundation program. Whilst there are some (four) specific foundation courses that students must undertake there is also four elective courses that are tailored to student's future study option. Students have the option upon

completion to articulate into either the diploma or a bachelor's degree depending on their graduate GPA. For students to finish foundation and articulate directly into a Bachelor of engineering with Honours they require a GPA of 5.5. This GPA is an average of 70% over their program. To articulate into the diploma program, students are required to achieve a passing GPA of 4.0.

There are several diploma options open to students to undertake. The diploma of engineering is a 9-unit diploma that takes 3 trimesters to complete. This differs from most other diplomas due to the 9th course that is required. This course is a core mathematics course that builds students mathematics over the trimester to a year 10 high school equivalent. Students are offered the chance to skip this course if that sit a mathematics test and pass. This course was bought in to not only engineering but science diplomas due to students struggling with the mathematics offered in the diploma. The courses can be tailored to the intended major of the bachelor's degree through the selection of a final trimester elective. This elective can be either electronics or mechanics based. The diploma offers a full articulation into the second year of the program. Griffith college operates the same as QUT college by offering all the courses in house and is ran and approved by the faculty within Griffith University.

Differences in Pathways

As seen above there is a lot of variation in the specifics to each of the offerings and this is just three of the many college institutions in Australia. These can be mixed by duration or entry requirements or a range of other parameters. Table 1 shows a summary of the key programs of offer by each of the colleges discussed. Two examples of students (domestic and international) on the pathways into university. The domestic example is presented in Figure 1 and the international student presented in Figure 2.

Table 1: Summary of key programs offered by selected colleges, including types, duration and eligibility.

		<i>UniSQ</i>	<i>Griffith</i>	<i>QUT</i>
<i>Bridging</i>	Type	TPP	N/A	Mathematics, Physics and Chemistry
	Duration	5 week to 1 year		4 weeks or 12 weeks
	Eligibility	Domestic		Domestic and international
<i>Foundation</i>	Type	N/A	8 course program	8 course program
	Duration		Two trimesters	Two semesters
	Eligibility		International	International
<i>ELP</i>	Type	ACS and EAP	N/A	General, EAP and Advanced IELTS
	Duration	10 weeks to 30 weeks		10 weeks to 1 year
	Eligibility	Domestic (EAP) Domestic and international (ACS)		International
<i>Diploma</i>	Type	University Studies (Eng)	Engineering	Engineering
	Duration	Two semesters	Three Trimesters	Two semesters
	Eligibility	Domestic and international	Domestic and international	Domestic and international

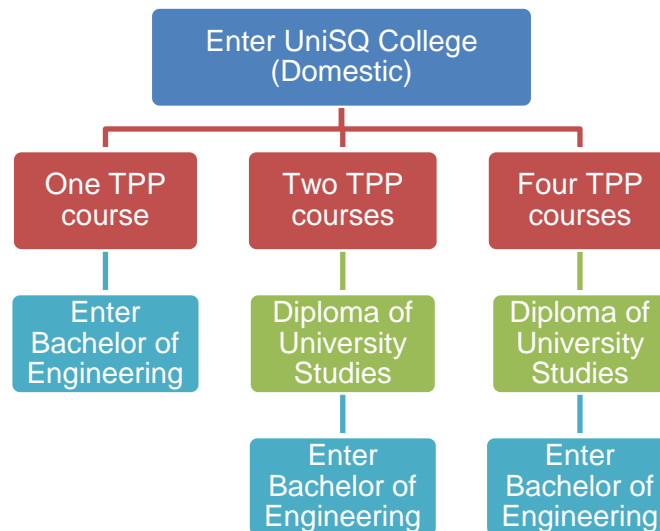


Figure 1: Pathway for domestic student entering UniSQ college. First pathway (left) shows the minimum time within the college (Five weeks). The second pathway (middle) shows a more accurate pathway students undertake (One year). The last pathway (right) shows a pathway where all programs are assessed and a large time at the college is undertaken (One year and 20 weeks).

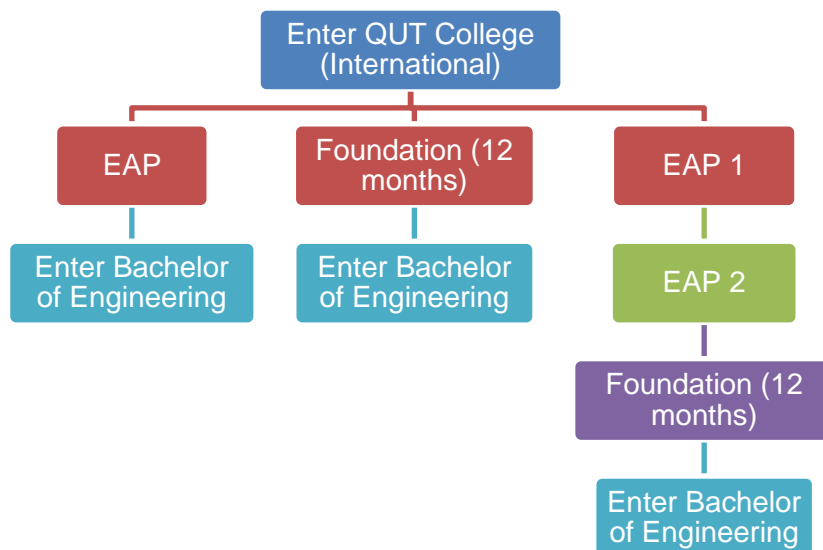


Figure 2: Pathway for an international student entering QUT college. First pathway (left) shows the minimum time within the college (10 weeks). The second pathway (middle) shows a more accurate pathway of an average students (One year). The last pathway (right) shows a pathway where all programs are assessed and a large time at the college is undertaken (One year and 30 weeks).

Articulating case study and recommendations

As discussed earlier, there has been cases where students have had trouble articulating from these pathway programs into bachelor degrees. One such example is a student who was very high achieving in their college diploma but when articulating across into the bachelor at the second year the student was finding it difficult to study and pass. When questioned about this the student responded “at the college I had time with my teachers, but here I have not talked to my lecturer all semester”. When diving further into this, it was noted that the college had 4 contact hours of teaching a week, a dedicated drop in consultation room that was always staffed and more teaching resources (e-learning content). In contrast to the 1 hour of lectures and 2 hours of tutorials offered in the bachelor program. As this student articulated from a college diploma into a second year bachelor degree the teaching staff of several courses did not know that this was an option for students. This also raises the question of how this can be better fixed in the future.

Whilst this paper does not provide a solution, the first step is understanding the diversity of the students within that class.

Academics should understand the pathways into their institution, not just through the standard or non-standard pathways but also by the college offerings. This is crucially important to understand the knowledge skills of the students. In the past (Kara et al., 2019) there has been a mismatch between domestic and mature age students undertaking learning. Now, there can be students that are studying at University or a University affiliated program for many programs and offerings for years before enrolling into a bachelor program. A recommendation from the outcomes of this review is to understand the diversity of students in an undergraduate engineering degree.

Conclusions

This paper has reviewed and explained the entry pathways into Engineering degrees. A key emphasis has been made on the college sector and the need for academics to understand and welcome the unique and diverse pathways into undergraduate engineering programs. Whilst only three colleges were identified and unpacked, they are similar in nature to that of other institutions. It is imperative that all academics review and understand the pathways and backgrounds of students entering their own programs for student retention and satisfaction. The examples provided showed that whilst a student may be a first-year student, they have already been studying at a HE institution for years. The experiences that they have had may also be different to the current offering, so it is critical that academics are empathetic to the change in environments. It is expected that this paper will begin a programme of research to unpack the student learning models from the college system and allow academics to begin creating student-specific educational plans based off the diverse backgrounds of students.

References

- Australian Government. (2022). *Higher Education Administrative Information for Providers*. Retrieved September 12, 2023 from <https://www.education.gov.au/higher-education-publications/higher-education-administrative-information-providers>
- Boles, W., & Whelan, K. (2017). Barriers to student success in engineering education. *European Journal of Engineering Education*, 42(4), 368-381.
- Chesters, J., Rutter, K., Nelson, K., & Watson, L. (2018). Alternative pathways into university: Are tertiary preparation programs a viable option? *The Australian Universities' Review*, 60(1), 35-44.
- Dawkins, P., Hurley, P., & Noonan, P. (2019). Rethinking and revitalising tertiary education in Australia.
- Department of Education. (2023). *Australian Universities Accord - Discussion Paper*. Retrieved September 12, 2023 from <https://www.education.gov.au/australian-universities-accord/resources/australian-universities-accord-panel-discussion-paper>
- Goedegebuure, L., & Schoen, M. (2014). Key challenges for tertiary education policy and research—An Australian perspective. *Studies in higher education*, 39(8), 1381-1392.
- Jackson, D., Li, I., & Carroll, D. (2023). Student access to higher education through alternative pathways and differences by equity group and discipline. *Journal of Higher Education Policy and Management*, 1-33.
- Kara, M., Erdogan, F., Kokoç, M., & Cagiltay, K. (2019). Challenges faced by adult learners in online distance education: A literature review. *Open Praxis*, 11(1), 5-22.
- Professionals Australia. (2023). *Australia faces engineering skills crisis by 2040*. Retrieved September 5, 2023 from https://members.professionalsaustralia.org.au/PA/Latest_News/Australia_faces_engineering_skills_crisis-by_2040.aspx

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