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Study into the Confidence - Competence Measures of Engineering Work Integrating Learning (WIL) Placement Students based on the Transferable, Innovative and Technical Skills Development

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ABSTRACT

CONTEXT

This study involves the analysis of innovation, employability and technical skills of an engineering undergraduate WIL program, which can be used as a tool to establish the confidence-competence measure to support students in their long-term professional development. As part of the WIL placement topic, each student is required to undertake an industry-based project with the potential to benefit a host organisation by applying an innovative approach to creative problem solving and transferable skill development. However, very limited research has examined students' experience of 'open-ended real-world projects' in the context of developing healthy confidence-competence.

PURPOSE OR GOAL

The aim of the study is to answer the following research question: What are the key factors that influence students' innovation and employability, stemming from an industry-based project that contribute to perceived self-confidence-competence?

APPROACH OR METHODOLOGY/METHODS

The questionnaire that students have been asked to complete stems from a framework from Jackson (2013), which broadly represents typical industry skill requirements in new graduates. On a scale of one to ten, participants rated the level which best described their ability to perform each skill in the workplace before, in the middle, and after their work placement. By drawing on the dyadic perspective, the information requested directly addresses the research objective.

ACTUAL OR ANTICIPATED OUTCOMES

The goal is to allow students to meaningfully develop the capacity to work creatively, innovatively and harmoniously not only with their working environment - but also with themselves.

CONCLUSIONS/RECOMMENDATIONS/SUMMARY

The qualitative data responses have confirmed that the learning process resulted in an overall development of the transferable, innovative and technical skills - underpinning realistic healthy self-perception/confidence development. Although the self-management skills scored the highest increase in skills level, the analysis also revealed that the least increase in skills level is associated to the social responsibility and accountability skills (that are culturally specific) and therefore need educational enhancement in the nearby future.

KEYWORDS

Confidence, Competence, Work Integrating Learning (WIL)

Introduction

Despite the recognition and importance of the transferable, innovative and technical skills development of the most recent engineering graduates, little effort has been spent on the analysis related to the self-perception and self-preservation of such individuals. Through the Work Integrating Learning (WIL) Placement at Flinders University, our engineering students have been exposed to a sudden change in their learning environment (from in-class/online university-based learning to the real-life industry-based project-driven experience.) The aim of this exercise is to shift students from their 'pure student's perspective' to a 'new fully-professional perspective' in just twenty weeks. It is a process that requires a lot of energy, knowledge and willingness from our students to adapt. With appropriate student preparation, this usually results in very satisfying experiences for both the industry placement providers/organisations and the students themselves.

In this study, we will analyse the impact of transferable, innovative and technical skills development of our engineering students involved in Work Integrating Learning (WIL) Placements (and how the development of such skills and competencies impacts their self-confidence.)

Background and Motivation

This study is based on Jackson's transferable skills framework (for more details see Table 1-Section Methods) which broadly represents typical industry skill requirements in new graduates (Jackson, 2013) as well as the confidence versus competence grid presented by Chamorro-Premuzic (2013). The study is linked to previous work by Rampersad and Zivotic-Kukolj (2018), which is related to the development of innovation and employability skills in STEM students undertaking placement. However, the same framework was used with the aim of measuring how self-observation in the development of innovation, transferable and technical skills can influence students to positively perceive and develop healthy-realistic confidence built upon set-up skill based competencies.

It is a common misconception that the key to success in life and business is confidence alone, when in reality self-esteem is nothing without competence as the core skill to back it up. According to Chamorro-Premuzic (2013), 'Confidence is feeling capable,' while 'Competence is being capable.' He rightfully points out that successful people are confident because of their skills and competencies that they are able to use and demonstrate (not the other way around.) Figure 1 presents the confidence – competence grid as a visual tool that provides links between them.

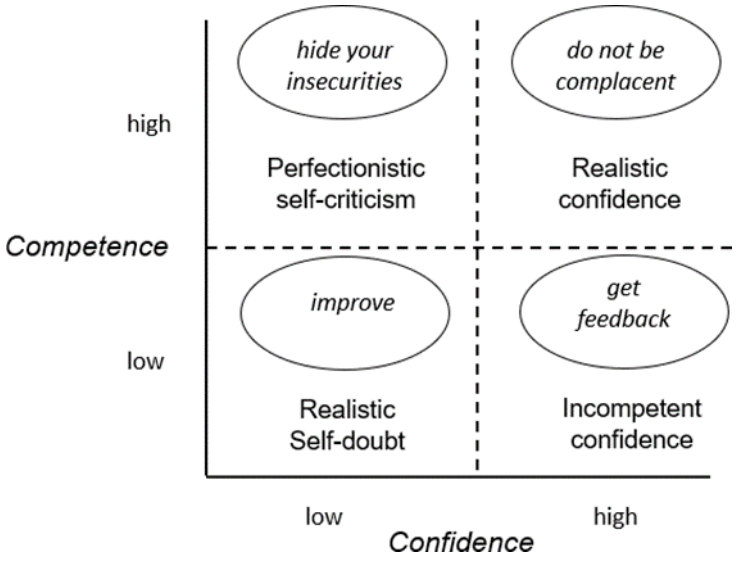

Figure 1: The Confidence – Competence Grid by Chamorro-Premuzic (2013)

Figure 1 [borrowed from Chamorro-Premuzic (2013)] shows that there are four possible confidence-competence categories that could be considered as a measure of confidence: Incompetent confidence, Realistic self-doubt, Perfectionistic self-criticism and Realistic Competence. Each of them occupies a different quadrant in the confidence-competence grid. The following paragraph provides descriptions for each of these categories, as well as the author's interpretation and instructions on how to use the confidence-competence grid tool.

The first and the most dangerous category is 'Incompetent confidence' (related to high confidence, low competence) which is a product of delusional self-serving biases, rather than actual competence. People in this category could be dangerous for themselves as well as for others, due to their lack of skills/abilities to perform. The best advice in this situation is for them to seek proper feedback from professionals in the field to change their self-perception. The second category is 'Realistic self-doubt' (related to low confidence and low competence) – when the person is aware of a lack of skills and competencies (therefore feeling insecure.) This awareness results in an increase of motivation to self-improve and is an important stage in the development of required skills and competencies. The third category is 'Perfectionistic self-criticism related to low confidence and high competence,' when an individual (despite high levels of accomplishment) still does not feel "good enough." This is the characteristic of an individual with perfectionistic tendencies combined with low self-esteem. The only way to deal with such confidence is to hide insecurities and continue to improve skills and competencies. The fourth and final category is 'Realistic Competence related to high confidence and high competence.' This is the quadrant where the person possesses a balance between competencies and confidence. This is where we would like to see our students to be at the end of their placement experience. The only thing that should be considered for a person in this category is that they should not become complacent and still maintain a desire to grow their skills and competencies.

Our intention in this study was to enable students to be aware of their level of self-confidence and competence; thus, enabling them to be better emotionally prepared once they leave the educational institution and become a part of the engineering workforce.

Method

This quantitative study involved data collection using the online Qualtrics survey tool. It required students to complete a questionnaire on their perceived experience of the specific skills presented in Table 1 under measures/items. The survey was conducted across the 3rd year undergraduate student cohort enrolled in the civil, biomedical, electrical and electronic, mechanical and robotics – Flinders University engineering cohorts in twenty weeks of placement over the last three years (from July 2019 to July 2022.) The survey questionnaire was completed before the placement commencement, in the middle of the placement in week 10 and at the end of placement in week 20. The questionnaire was designed to track each student's performance related to educational experiences in order to determine the possible impact on the confidence-competence level.

This questionnaire (as presented in Table 1) was based on multi-item, 11-point Likert scale to not only be an investigation instrument, but also as an assessment tool. Participants rated the level which best described their perception of the specific measures and items used in the survey. Of the 200 participating engineering students enrolled across two placement topics (from July 2019 to July 2022) 160 were male and 40 were female. The age of students ranged from 19-21 years (67), 22-25 years (89) and 26+ years (44).

Questionnaire

Instructions: Please highlight your answer on a scale of 0-10 (for items related to transferable skills competencies: 0=not competent at all,10=highly competent, 5=neither competent nor incompetent; for items related to self-confidence 0=not confident at all and 10=highly confident, 5=neither confident nor unconfident; for the employability skill item 0=not employable at all and 10=highly employable, 5=neither unemployable nor employable) concerning your self-perception about the presented skill statement. Please note that the transferable skills competencies and self-confidence in the development of transferable and technical skills were measured separately.

Table 1: Questionnaire Measures and Item Definitions

Measure	Item Definition
TEAMWORK	***Task collaboration**: Complete group tasks through collaborative communication, problem solving, discussion and planning.*
	***Team working**: Operate within and contribute to a respectful, supportive and cooperative group climate.*
	***Social intelligence**: Acknowledge the complex emotions and viewpoints of others and respond sensitively and appropriately.*
	***Cultural and diversity awareness**: Work productively with people from diverse cultures, races, ages, gender, religion and lifestyles.*
	***Influencing others**: Defend and assert rights, interests and needs and convince others of the validity of one's point of view.*
	***Conflict resolution**: Address and resolve contentious issues with key stakeholders.*
COMMUNICATION	***Verbal communication**: Communicate orally in a clear and sensitive manner which is appropriately varied according to different audiences and seniority levels.*
	***Giving and receiving feedback**: Give and receive feedback appropriately and constructively.*
	***Public speaking**: Speak publicly and adjust style according to the nature of the audience.*
	***Meeting participation**: Participate constructively in meetings.*
	***Written communication**: Present knowledge, in a range of written formats in a professional, structured and clear manner.*
CRITICAL THINKING	***Conceptualization**: Recognize patterns in detailed documents and scenarios to understand the 'bigger' picture.*
	***Evaluation**: Recognize, evaluate and retain key points in a range of documents and scenarios.*
PROBLEM SOLVING	***Reasoning**: Use rational and logical reasoning to deduce appropriate and well-reasoned conclusions.*
	***Analysing and diagnosing**: Analyse facts and circumstances and ask the right questions to diagnose problems.*
	***Decision making**: Make appropriate and timely decisions in light of available information in sensitive and complex situations.*
PROFESSIONALISM	***Efficiency**: Achieve prescribed goals and outcomes in a timely and resourceful manner.*
	***Multi-tasking**: Perform more than one task at the same time.*
	***Autonomy**: Complete tasks in a self-directed manner in the absence of supervision.*
	***Quality of work**: Complete work to a high-quality standard aligned to expectations.*
	***Time management**: Manage time to achieve agreed goals.*
	***Commercial awareness**: Aware of commercial viability or cost considerations.*

	***Drive**: Go beyond the call of duty by pitching in, including undertaking menial tasks, as required by the business.*
	***Goal and task management**: Set, maintain and consistently act upon achievable goals, prioritized tasks, plans and realistic schedules.*
INNOVATION AND ENTERPRISE	***Innovation**: Contribute towards the development of new products, services and/or technologies (e.g. software, applications, devices).*
	***Entrepreneurship/Intrapreneurship**: Initiate change and add value by embracing new ideas and showing ingenuity and creativity in addressing challenges and problems.*
	***Lateral thinking/creativity**: Develop a range of solutions using lateral and creative thinking.*
EMPLOYABILITY	*I believe that I am employable.*
SELF-AWARENESS	***Meta-cognition**: Reflect on and evaluate personal practices, strengths and weaknesses in the workplace.*
	***Lifelong learning**: Actively seek, monitor and manage knowledge and sustainable opportunities for learning in the context of employment and life.*
	***Career management**: Develop meaningful and realistic career goals and pathways for achieving them in light of labour market conditions.*
SELF-MANAGEMENT	***Self-efficacy**: Be self-confident in dealing with the challenges that employment and life present.*
	***Stress tolerance**: Persevere and retain effectiveness of well-being and strive to maintain a productive balance of work and life.*
	***Self-regulation**: Reflect on and regulate emotions and demonstrate self-control.*
SOCIAL RESPOSIBILITIES & ACCOUNTABILITY	***Social responsibility**: Behave in a manner which is sustainable and socially responsible (e.g. consistent with company policy and/or broader community values).*
	***Accountability**: Accept responsibility for own decisions, actions and work outcomes.*
	***Personal ethics**: Remain consistently committed to and guided by core values and beliefs such as honesty and integrity.*
	***Organizational awareness**: Recognize organizational structure, operations, culture, systems and adapt behaviour and attitudes accordingly.*
SELF-CONFIDENCE (TRANSFERABLE SKILL)	*How good you think you are?*

Results

Table 2 presents a summary of average scores for each individual item per specific measure, including the perception of self-assessed confidence level for transferable and technical skills. It can be concluded that (on average) students improved their transferable skills and gained more

confidence as the placement program progressed. The average score for all survey items increased 'in the middle' and 'at the end' of the placement process.

Please be aware, that online sources treat the technical skills as one of the transferable skills. However, by the definition the transferable (also known as a soft skills) are the skills that are learnt through experiences in any type of job and are later applicable/transferable in the any other type of job (irrespectively of job description needs associated to the specific area of expertise.) On the other hand, the technical skills are the skills obtained from the specific educational pathway – requiring specific educational training. They are part of the extremely strict accreditation requirements usually set up by the specific professional body or association (like Engineers Australia). They include specific technical knowledge and expertise that are of completely different nature compared to the standard transferable (soft) skills.

Table 2: Quantitative Summary of obtained Average Scores across 200 participating students related to Transferable/Technical Skills Development per each individual measure/item (scale 0-10)

Measure	Item	Before	Middle	After
TEAMWORK	*Task collaboration*	7.4	7.8	8.4
	Team working	7.8	8.1	8.6
	Social intelligence	7.3	7.8	8.4
	Cultural and diversity awareness	8.0	8.4	8.9
	Influencing others	6.7	7.1	7.8
	Conflict resolution	6.4	7.2	7.8
COMMUNICATION	*Verbal communication*	7.1	7.5	8.2
	Giving and receiving feedback	7.2	7.8	8.3
	Public speaking	6.0	7.0	7.9
	Meeting participation	6.7	7.5	8.2
	Written communication	7.2	7.7	8.4
CRITICAL THINKING	*Conceptualization*	7.0	7.7	8.3
	Evaluation	6.9	7.7	8.2
PROBLEM SOLVING	*Reasoning*	7.4	7.8	8.4
	Analysing and diagnosing	7.2	7.8	8.3
	Decision making	7.0	7.5	8.1
PROFESSIONALISM	*Efficiency*	7.1	7.5	8.1
	Multi-tasking	6.7	7.4	8.1
	Autonomy	7.3	8.1	8.5
	Quality of work	7.6	7.9	8.4
	Time management	7.1	7.6	8.1
	Commercial awareness	6.4	7.6	8.1
	Drive	7.4	7.9	8.4
	Goal and task management	7.0	7.7	8.2
INNOVATION AND ENTERPRISE	*Innovation*	6.4	7.4	8.0
	Entrepreneurship/Intrapreneurship	6.4	7.4	7.9
	Lateral thinking/creativity	6.9	7.5	8.1
EMPLOYABILITY	*I believe that I am employable.*	7.5	8.0	8.6
SELF-AWARENESS	*Meta-cognition*	7.0	7.5	8.1
	Lifelong learning	7.4	7.8	8.4
	Career management	6.8	7.5	8.0
SELF-MANAGEMENT	*Self-efficacy*	6.9	7.7	8.1
	Stress tolerance	6.9	7.5	7.9
	Self-regulation	7.3	7.8	8.2

SOCIAL RESPOSIBILITIES & ACCOUNTABILITY	*Social responsibility*	8.0	8.3	8.8
	Accountability	8.0	8.4	8.8
	Personal ethics	8.4	8.6	8.9
	Organizational awareness	7.6	8.1	8.6
SELF-CONFIDENCE (TRANSFERABLE SKILLS)	*How good you think you are?*	7.1	7.8	8.4
SELF-CONFIDENCE (TECHNICAL SKILLS)	*How good you think you are?*	6.9	7.7	8.3

It is Important that we provide an in-depth explanation of each skill and sub-skill of Jackson (2013) framework during the Pre-placement Preparation topic and introduce an Excel Tool that enables each individual student to produce his/her own transferable skills spider diagram (from the survey responses before, in the middle and after the placement.) The students would then insert the obtained spider diagrams into the closing section of their final placement reports and reflect upon it. This is how the survey data was integrated into the final placement assessment piece. As the weighting of the reflection was only 7 out of 35 total final report mark, the benefit of teaching students the transferable skills framework was far more beneficial than a possible bias related to data collection. Please note that the total score across all assessments in the topic was 100.

Figure 2 presents the transferable skills outcome of the survey per measure on the scale from 0 to 10. The diagram has revealed that of (all stated measures) the most significant increase has been achieved in the self-management category of skills. This result is not surprising due to the fact that all our students need to pass the Project Management topic before entering into their placement (as this topic covers all needed tools related to successful self-project management.) However, the fact that the most significant increase of skills was achieved across self-management skills points out of a healthy self-perception - resulting in an appropriate increase in confidence level related to transferable skills development.

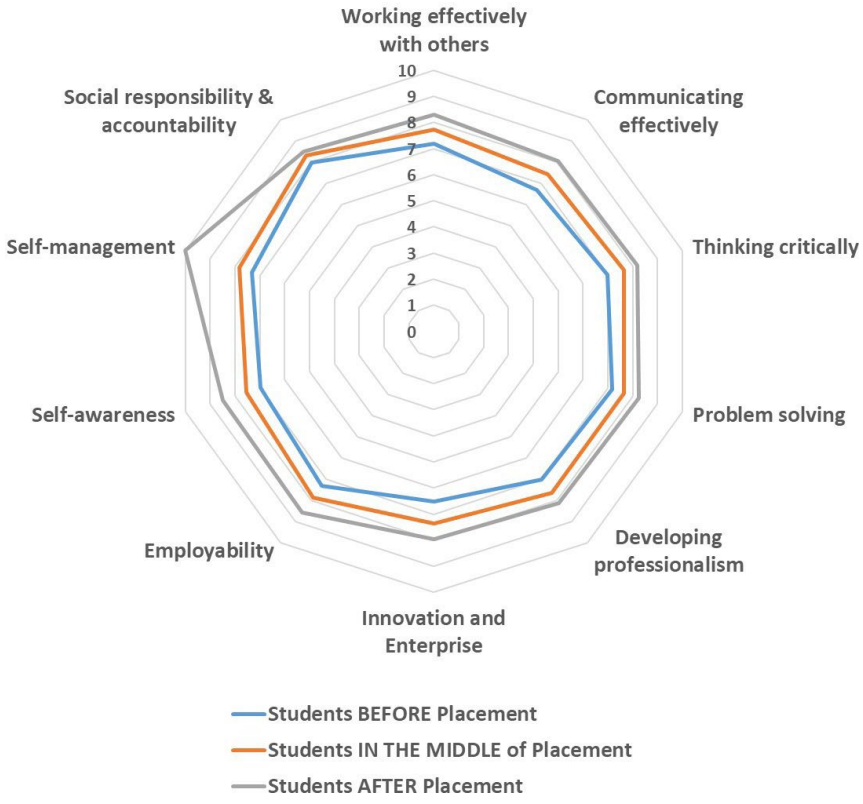

Figure 2: Transferable Skills Development Average Score Results across whole engineering student cohort

In contrast, the least increase has been related to the social responsibility and accountability. These findings are significant, as social responsibility and accountability are the most difficult skills to develop (if we would like to shape our new engineering graduates into the future leaders responsible for heading engineering related industries.) The difficulty in preparing individuals to act socially responsible and accountable lays in the fact that each different culture possesses completely different perceptions and expectations related to what is actually socially responsible and accountable. Please note that our engineering student cohort is comprised of people from many different cultural backgrounds. The duration of our courses do not last a lifetime, but only two and a half years before entering into the placement program. This conclusion means that we should in the future develop better accommodating educational programs that will be able to address these or similar cultural issues.

Figure 3 a) presents an average scoring across 200 engineering students (related to the confidence-competence grid before, in the middle and at the end of the placement process related to transferable skills development on the same scale from 0-10 used in the questionnaire.) It is apparent that both the confidence and the competence have increased almost linearly as the placement process progresses from the start to the end. The fact that on average students score (for transferable skills only) both 7 for confidence and slightly above 7 for competencies (even before entering into the placements) lays in the fact that they have passed two and a half years of undergraduate engineering education that built up their technical skills. They were very carefully prepared before placement by passing the compulsory Pre-preparation Placement Topic and Project Management topic (that built up their transferable skills.)

On the other hand, Figure 3 b) presents confidence related to both transferable and technical skills perceived by students versus competence level judged by placement supervisors. The placement supervisors' marks were recorded and used as a measure of competencies across both technical and transferable skills (and were converted to 0-10 scale.) The group average result was then determined. It shows that the actual development of both set of skills combined is slightly higher (8.35 out of 10 for confidence, and 8.5 out of 10 for competence) compared to transferable skills only (8 out of 10 for confidence, and 8.3 out of 10 for competence) due to the impact of the technical skills development before, during and after the placement process that was supported by self-management skills.

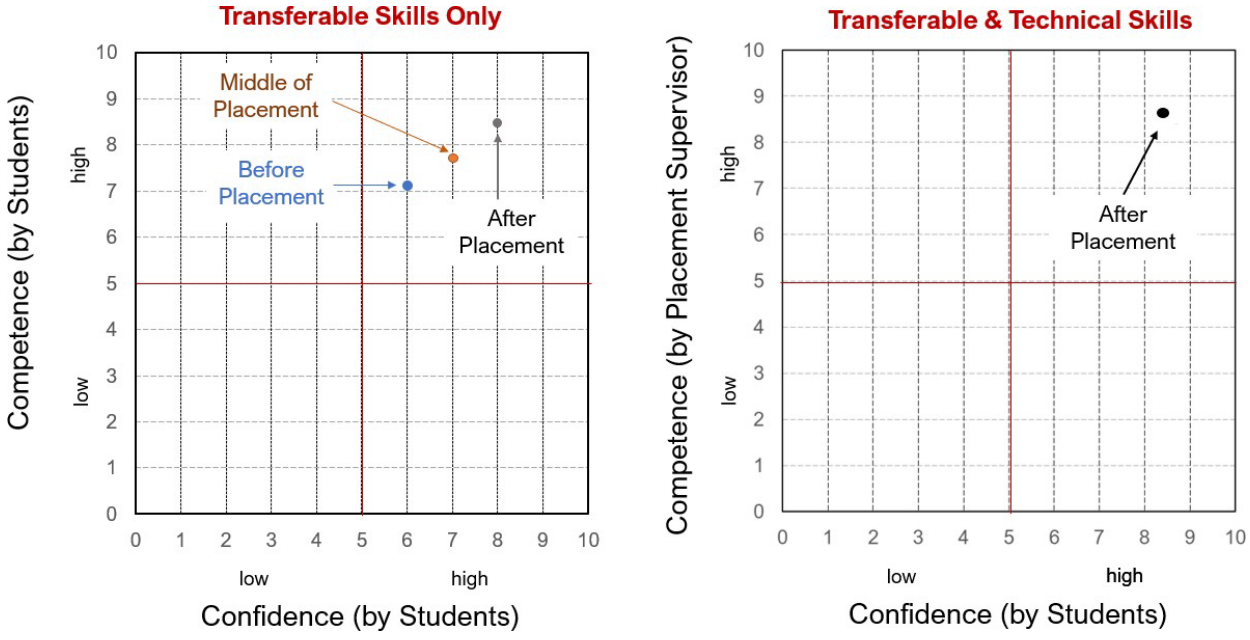

Figure 3: The Confidence - Competence Grid calculated across the whole engineering student cohort

Please note that we provided in depth explanation of each skill and sub-skill of Jackson (2013) framework during the Pre-placement Preparation topic and introduced an Excel Tool that enables each individual student to produce his/her own transferable skills spider diagram (from the survey responses before, in the middle and after the placement.) The students would then insert the obtained spider diagrams into the closing section of their final placement reports and reflect upon it. This is how the survey data was integrated into the final placement assessment piece.

Findings/Benefits

The proposed research is significant, as it contributes equally to the research literature in: (a) education and (b) innovation/employability (particularly related to engineering education and work-integrated learning.) Additionally, qualitative data responses have confirmed that the learning process supported by the proper pre-placement preparation and project management topics resulted in an overall development of the transferable, innovative and technical skills (as well as contributed to realistic healthy self-perception/confidence development). It also reveals that (as engineering educators) we will need to pay more attention to the social responsibility and accountability skills enhancement (including personal ethics and organisational awareness in our graduates) if we wish to ensure the most appropriate training for our future engineering leaders.

Future Work

It would be interesting to investigate how the obtained results defer across different age/gender groups and engineering disciplines. As the sample size at this stage is relatively small (200 participants), the longitudinal data collection needs to continue in the future so that we can perform the Confirmatory Factor Analysis (using Structural Equation Modelling software like AMOS.)

The other possibility is that we form a common project across different Universities with a similar theme and collect a desirable number of responses in order to perform proper Structural Equation Modelling. This would be a far better outcome and will provide far more insights into the dynamics of the engineering Work Integrating Learning (WIL) processes associated with the Australian educational system.

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