Getting the hang of it: Engineering education from an end-user perspective

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Engineering education must not only be scientifically based, but also relevant to the future job market. Education incorporating elements of work-integrated learning (WIL) aims to achieve this by combining academic learning with practical work experience. This literature review examines WIL's impact on engineering education. Through a snowballing process, 29 empirical studies published between 2000 and 2023 were identified and analyzed. Key findings reveal that WIL enhances employability, fosters critical thinking, and improves problem-solving skills by connecting classroom concepts with real-world applications. Successful WIL programs depend on strong collaborations between educational institutions and industry stakeholders, structured support systems, and reflective learning practices. The review underscores the need for carefully designed WIL programs that integrate contextual understanding. Based on these findings, a new model for WIL in engineering education is proposed, in which elements of contextual understanding from an end-user perspective are accentuated.

Keywords: Engineering education, literature review, contextual understanding, end-user

Engineering education must align with the evolving job market, necessitating a strong connection between education and industry. Work-integrated learning (WIL) is an educational approach that bridges academic learning with practical work experience. Prior research has identified various WIL formats, including internships, cooperative education programs, apprenticeships, field placements, and practicums. These formats involve students dedicating a significant portion of their studies to professional work environments relevant to their field. By integrating theoretical knowledge with workplace applications, WIL enhances students' understanding and fosters critical thinking and problem-solving skills (Zegwaard et al., 2023). Effective WIL programs rely on close collaboration between educational institutions and industry partners. Employers provide mentorship, guidance, and meaningful projects, while educators ensure that learning objectives are met through structured oversight and support.

In the context of WIL for engineering education, *contextual understanding* refers to the ability to interpret technical information and engineering challenges within real-world work environments. This includes understanding how theoretical concepts are applied in practice and how social, economic, and technical constraints influence engineering solutions (Vailasseri et al., 2021a). However, traditional WIL models often overlook the end-user perspective—the individual who ultimately interacts with the engineered product or service. For instance, in excavator manufacturing, the end-user is the machine's operator.

This article aims to examine WIL models in engineering that incorporate contextual understanding as a foundation for proposing a novel model. Specifically, it has two objectives: (1) to review the existing literature and (2) to propose a new WIL model that integrates the end-user perspective, addressing a gap in current educational designs. Enhancing WIL in this way aims to provide engineering students with a more holistic view of their field, benefiting both students and industry stakeholders.

To achieve this, a literature review was conducted, focusing on peer-reviewed articles published between 2000 and 2023 to establish a scientifically grounded understanding of WIL and cooperative

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education in engineering. Additionally, dialogue with university educators and industry professionals helped identify gaps in contemporary engineering curricula and explore ways to incorporate contextual understanding. The insights gained from these steps inform the development of a WIL model that explicitly integrates the end-user perspective.

LITERATURE REVIEW AND METHOD

The purpose of the literature review was to develop a comprehensive understanding of the benefits associated with incorporating WIL into engineering education, as well as the challenges and opportunities inherent in WIL educational design. Following a defined review protocol, a search was conducted for articles published in peer-reviewed journals between 2000 and 2023, specifically concentrating on WIL or cooperative education in the context of engineering students in higher education. Only articles presenting empirical study results were included in the review.

Search Procedure

A literature snowballing process, as outlined by Wohlin (2014), was adapted and implemented. In particular, the following steps were undertaken:

1. Establishing a seed article: The initial article, Ngonda et al. (2022a), was identified through a search of the ERIC database using the terms 'work-integrated learning' and 'engineering'. The article was selected since it clearly fulfilled the above stated inclusion criteria, as well as being the most recently published articles to do so at the time of the search (Spring of 2023).
2. Snowballing through Mendeley*:* The seed article was imported into the Mendeley online reference management system. By using the ”related” function in Mendeley, articles that satisfied the criteria to the set were iteratively identified and added. Inclusion of articles was determined solely based on title examination. For each new article, related articles were identified and added until a point where no new articles were identified. This first set consisted of 55 articles and demonstrated diversity in geographical distribution (with representation from all continents except South America), year of publication (2001–2022), and author affiliation.
3. Exclusion based on formal criteria, abstract and full text*:* This process resulted in the exclusion of 38 articles based on formal criteria (e.g., conference papers, books, and book chapters), lack of empirical data, and insufficient engineering focus, reducing the final set to 17 articles.
4. Backward snowballing using recent articles*:* For each article in the set published 2020 or later, the list of references was parsed. The 2020 cutoff was chosen since we wanted to ensure that we incorporated the most recent work in the field. Each cited article meeting the inclusion criteria was incorporated into the set, and for those published in 2020 or later, their reference lists were systematically reviewed for additional relevant articles. This procedure had to be repeated three times. The first iteration identified 8 additional relevant articles. The second iteration identified yet another 4. Based on these last 4, no further articles were identified. The final set of 29 articles is presented in Table 1 in Appendix A.

Data Extraction and Analysis

All included articles were first read separately by both authors, and secondly jointly analysed. In the initial step of the analysis, the following information was extracted from each included article: (1) the country in which the study was conducted, (2) the type of study data (qualitative or quantitative), and (3) the theoretical framework employed (if any). This was done to gain a better understanding of the methodological, theoretical and contextual bases of the dataset. Regarding geographical distribution, over half of the studies were conducted in South Africa or Australia. The 29 identified articles span 8 different countries over 5 continents (see Figure 1). The analysis also showed that the body of knowledge on WIL has been acquired through both quantitative and qualitative studies, using primarily (but not exclusively) theoretical frameworks (T in Table 1 in Appendix A) on experiential and reflective practice-based learning. In the second step of the analysis, all reported results in terms of effects, challenges, or experiences reported by students, teachers and industrial stakeholders were identified. Based on the insights and findings derived from the preceding steps, the final stage identified two themes: WIL design, collaboration and reflection (W in Table 1 in Appendix A), and Learning outcomes, employability and work readiness (L in Table 1 in Appendix A).

RESULTS OF LITERATURE REVIEW

Topics explored in the articles range from employability, contribution to learning, occupational and generic skills, WIL-related problems, equality, assessment of knowledge, to educational design for WIL. One of the included articles (Vailasseri et al., 2021a) is a literature review with a similar scope to this one. Even though the scope of that study slightly differs, the article was primarily used as a reference to identify any potential gaps or contradictions in our own search and analysis. No such gaps or contradictions were found.

FIGURE 1: Geographical distribution of included articles. Circles indicate number of articles.

Results from the literature review (Table 1 in Appendix A) indicate that WIL enhances student employability and prepares them for the workforce by improving their technical knowledge, problem-solving abilities, and fostering critical thinking and social skills. However, the effectiveness of WIL-based education depends on well-structured WIL design and robust partnerships between universities and industry. Additionally, it is essential that students are provided with opportunities to reflect on the experiences they gain in the workplace.

Theoretical Frameworks

Theoretical frameworks for analyzing learning in work-integrated education appear in 11 of the 29 reviewed articles, drawing from cognitivism, constructivism, situated learning, and sociological theories. Kolb's experiential learning theory (1984), combining constructivism and cognitivism, is used by Dipitso (2021), Mutanga (2021), and Ogba et al. (2022) to emphasize learning through experience and reflection. Raelin's framework (1997), applied by Mutereko and Wedekind (2016), focuses on collaborative problem-solving, reflection, and dialogue, alongside Rauner's (2007) integration of theory and practice in vocational education and Winch's (2012, 2013) three knowledge types: acquaintance, procedural, and propositional.

Socio-cultural perspectives, often termed social constructivism or situated learning, highlight social interactions in learning. Lave and Wenger's communities of practice (1991) are used by Ngonda et al. (2022a, 2022b) and Oliveira (2015), while Ngonda also applies Bandura's social cognitive theory (1977, 1999, 2006), emphasizing modelling and self-efficacy. Oliveira incorporates Beach's learning transfer model (1999), addressing knowledge transfer across contexts. Kemmis et al.'s practice architectures and ecologies (2014), used by Clerke et al. (2021), explore how social structures shape educational practices and opportunities for transformative change.

Paull et al. (2019) apply Bourdieu's cultural reproduction theory (1977) and Tomlinson's critical education theory (2017) to examine power dynamics and social inequalities in education. Main et al. (2020, 2021) use Terenzini and Reason's (2005) higher education framework, integrating cognitive, constructivist, and socio-cultural theories to explain student learning and institutional influences.

Work-Integrated Learning Design, Collaboration and Reflection

WIL incorporates various practices and strategies to connect academic learning with workplace experience. This section examines key aspects of WIL, including factors that support its design, the role of collaboration between universities and industry, and the importance of reflection in enhancing learning outcomes. The focus is on understanding how these elements contribute to the effectiveness of WIL programs in diverse contexts.

Work-Integrated Learning Design

Three of the 29 studies focus on identifying factors that are beneficial in developing work-integrated learning methods. Ruayruay et al. (2020) emphasizes the need for leadership, teamwork and problem-solving skills in students undertaking WIL. According to Magnell et al. (2016), it is crucial for institutions to establish strategies that integrate both clear objectives and pedagogical aspects for work-related teaching and learning, when incorporating work-related learning into engineering curricula. Also, Wessels (2014) identifies the necessity for universities to establish structures and guidelines for WIL programs to ensure effective implementation, thereby enabling students to manage their workplace studies effectively. These results are consistent with the work of Mutereko and Wedekind (2016), showing that there is reduced throughput when students in WIL programs are not offered placement at employers both accredited and secured by the university.

A study at a Swedish university (Magnell et al., 2016) showed that institutions need strategies for faculty members to be familiar with the idea of WIL and even offer faculty members the opportunity to work outside academia through sabbaticals in industry, to enhance the amount of work-related material in the curriculum. If so, faculty members can draw on examples from their own work experience. The ability to include work-integrated activities in teaching and the ability to identify projects and cases increase when faculty members rise the number of professional contacts in the industrial sector. Barry et al. (2015) posits that the recruitment of WIL students is also influenced by job market dynamics. High-ability students demonstrate consistent interest in WIL education regardless of market conditions. Conversely, low-ability students exhibit heightened interest in WIL opportunities during challenging job market phases compared to periods of economic strength.

Collaboration

Vailasseri et al. (2021b) present suggestions to consider for an enhanced WIL (EWIL) education. The proposals are based on results from an Australian study with 84 engineering academics and 37 engineering professionals who have worked as workplace mentors for students in work-integrated activities. The results show that it is important that universities establish close and effective partnerships with industrial partners and develop flexible arrangements for work-integrated learning activities to achieve reciprocal and mutually beneficial outcomes. The understanding among university teachers or industry partners can differ and a study by Ziegler et al. (2020) shows that a WIL duration reduction from 12 to 6 months, decided by the university, was perceived by industry partners to substantially undermine the quality of the learning experience.

Reflection

A WIL assessment record book developed in collaboration with workplace partners has been found valuable for both students and workplace mentors (Ferns et al., 2016). In an assessment record book, the students formulate experiences gained from the workplace. The book also includes workplace mentors' comments, learning outcomes, learning plans, resources, activities, and assessment goals. Vailasseri et al. (2021b) as well as Ferns et al. (2016) recommend that WIL activities are monitored and that students should get regular feedback during the work placement both in as well as after completion. Both workplace mentors and university academics should encourage students' self-reliance in workplace learning, and engagement in self-assessment and reflection and motivate students to develop creativity and adaptability to apply in the assigned workplace challenges. Similarly, the work of Ogba et al. (2022), conducted in Nigeria, highlight the importance of designing work-integrated activities around students' opportunities for exploration, elaboration, engagement, and evaluation. This model for work-integrated learning gives students the ability to reflect on learning on their own and facilitate their work-related knowledge, skills and attitudes related to their future career development and employability. Also, Mutanga (2021) pinpoints the importance of reflection in learning through a study that used the reflective observation method.

Learning Outcomes, Employability and Work Readiness

In a case study of mining engineering students in South Africa on work readiness and its role in employability, Dipitso (2021) found that students who participated in work-integrated components of their education demonstrated significant potential for employability. While placed in mining companies, these students were allowed to engage in complex engineering problems in a real work context, experiences that had brought generic and professional skills such as communication skills, computing and information literacy, financial planning skills, leadership, people management skills and conflict resolution, which correspondingly, are seen as skills that improve work-readiness and employability by contemporary employers. These findings were also consistent with the work of Lim and Mustafa (2013). However, Jones et al. (2017) found that technical skills were highly emphasized over generic skills.

Mandal and Edwards (2022) found that employability indicators, such as knowledge base, engineering ability and professional attributes were consistently rated above the national average for students attending a co-operative educational program by employers, compared to other graduate engineering students. Comparably, O´Brien et al. (2012) show that students who had worked within industry for a 12-week placement outside of the university term, expressed that they felt well prepared to enter a workplace. The preparedness was related to engineering practices skills, teamwork skills and leadership.

Lock et al. (2009) reported findings from a survey where participants had the option to complete a one-year industrial placement. The students who had returned from one year of placement reported increased confidence, better communication skills and found themselves as more mature and professional. Such generic skills seem to follow from work placement as also highlighted in Tennant et al. (2018). In this study technical knowledge and problem-solving skills related to engineering were also emphasized. Experiences from work placement during engineering education has also been reported productive in bringing knowledge about values and norms at workplaces (Clerke et al. (2021). However, both Tennant et al. (2018) as well as O´Brien et al. (2012) pinpoint that the transition from student to practitioner is critical and attention needs to be paid to this by educators in curricula design. An important point emphasized is that university educators should introduce students to reflective learning strategies before, during, and after their work placements. Industry partners can help educators understand the skills and expectations for new graduates. Oliveira (2015) analyzed three British engineering students' work placements and found that transitioning from university to the workplace was neither easy nor straightforward, thus arguing that the transition process between studying in higher education and working at a workplace must be more supported in education. A call that also is reported in the Kopsidas et al. (2013) study in an electrical and electronic engineering program in the UK.

Blicblau et al. (2016) compared short-term placements (12 weeks) and long-term placements (52 weeks) involving 240 mechanical engineering students. The findings indicate that students who participated in long-term placements (IBL) achieved better academic grades than those who did not. Additionally, some students received job offers after their placements. The study highlights the importance of integrating work experience into engineering curricula to enhance academic performance and employability.

The benefit in completing a cooperative educational program can also be related to higher starting salaries (Blair et al., 2004). Not only employers but also students state that the industrial training they had experienced will increase their career opportunities which is shown in a survey with 285 engineering students in Malaysia (Mat et al., 2011). These students had undergone five months of industrial training in their third year and 91% agreed that the industrial training had increased their career opportunities.

Gaps in Existing Work

The literature review reveals a significant gap in addressing contextual understanding from an end-user engineering perspective. As said earlier, the term 'end-user' refers to the individual who uses a service or product being produced. In the following section, we introduce the COIL (Context Integrated Learning-model) – an educational model for WIL. COIL is informed by previous research in that it emphasizes cooperation between industry and academia, it facilitates longer workplace periods, and it provides an opportunity for students and industrial engineers to connect. Further, COIL is designed to address the lack of contextual understanding from an end-user perspective identified in previous work. By employing the theoretical model of learning design sequence (Selander, 2008), our proposed model, COIL, aims to contribute a multimodal perspective on a WIL educational design and the learning processes in that a design. Such a multimodal perspective will enable a focus on the formation of new knowledge representations both for and in students' learning.

COIL – CONTEXT INTEGRATED LEARNING MODEL

Students in programs such as teacher education, medicine, and nursing spend a significant portion of their studies in vocational practice. The primary purpose of these placements is to help students transform the theoretical and practical knowledge acquired in campus courses into actionable skills and reflective insights that can be applied in classrooms or examination rooms. Moreover, these students often bring an inherent end-user perspective and a rich contextual understanding of school or hospital environments, shaped by their own experiences as pupils or patients.

In contrast, an engineering student learning to develop an automated excavator typically lacks the same contextual understanding of working in environments like gravel pits or quarries. This is where the COIL model comes in. COIL emphasizes creating a cooperative (co-op) educational design that not only provides students with workplace experience as system developers but also enhances their understanding of the specific contexts in which their systems will operate. Essentially, COIL builds on a traditional WIL model, enriched with elements that foster an end-user perspective.

In addition to the literature review the development of the COIL model is further informed by national Swedish research and reports (Bernhardsson, 2021; Gellerstedt et al., 2015; Sunnemark, 2020), as well as a continuous dialogue with industry partners and university teachers in engineering education. A visit to Högskolan Väst in Trollhättan, Sweden, which is a university that for years has conducted research on work-integrated learning and has implemented work-integrated moments in all their educational programs, was also influential.

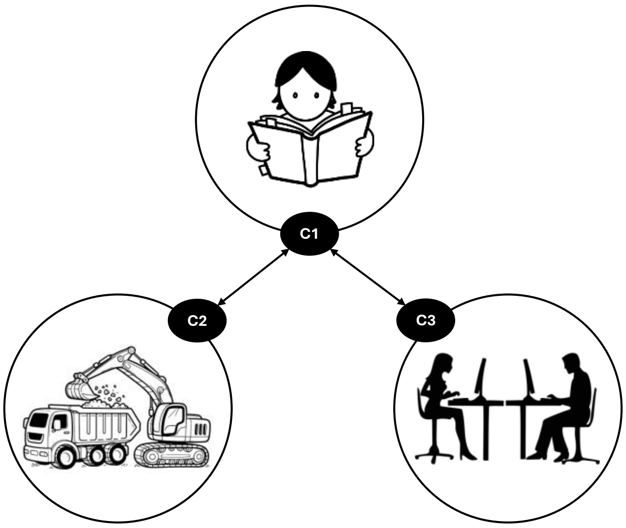
As a theoretical foundation for the COIL model, Selander's learning design model (2008) offers a multimodal perspective on student learning. Selander's model provides a framework for analyzing educational processes, mapping the progression from course design to student knowledge transformation. The model outlines three key components:

- The setting*:* encompasses educational resources (e.g., courses, teachers, materials) and institutional patterns (e.g., norms, practices). In COIL, campus-based teaching is enriched with industrial work periods, adding workplace mentors and industry practices.
- The primary transformation unit*:* focuses on how students translate their experiences into knowledge representations.
- The second transformation unit*:* involves students' meta-reflection on industrial work experiences, connecting them to course content.

In the educational design of the COIL model, support for students' contextual learning will be provided in two ways. Firstly, the industry partners will offer students in total at least ten weeks' work over two summer holidays. Work period 1 will be between year three and four, and work period 2 will be between year four and five of the program in a program of five years.

Prior to the work periods (in C1 Figure 3), students will be introduced to so-called audio logs (Conole et al., 2008). Audio logs will provide students with a tool for documentation and reflection, allowing them to record their reflections over time and at their convenience (in C2 or C3 Figure 3). In the audio logs, students will continuously reflect on their learning and describe significant events (trigger points) and how these have affected them in identifying themselves as future system developers. During the first work period students will be placed at a workplace that is a client of an industry partner specializing in system development, and an end-user of their products (C2 in Figure 3). This period is crucial for developing the students' understanding of the industrial context in which a system or service developed by a system developer is used. In preparation for work period 1, students should consider various aspects of the environment in which a particular system will be deployed. This may involve reflecting on factors such as operational hours, environmental conditions, safety concerns, and any relevant experience or knowledge gained from working within the specific environment where a system is intended to operate. These insights can prove invaluable in the development of the system. Secondly, students will, in the subsequent campus courses (C1 in Figure 3), be asked to use their audio logs as a basis for reflection upon the experiences gained by the time spent in the industrial environments (in C2 or C3 in Figure 3). They will also relate their new experiences to the theoretical and practical content of the courses at campus (in C1 Figure 3).

FIGURE 2: The three different contexts in the COIL model – the university (C1), the end-user customer (C2), and the system developer and manufacturer (C3).



Work period 1 (C2) is designed to give students a picture and an understanding of the end-user context in which modern industrial systems must operate. Again, if compared to a nursing or teaching education, which has work-integrated parts in the education, most students know what it means to be a patient or a pupil. But not many students understand the prerequisites, challenges, objectives, and practical needs of a semi-autonomous open pit mine. Work period 1 will support students to develop that type of understanding. Over the duration of three subsequent specific courses in the fourth year (C1), students will receive support to reflect upon and apply the knowledge gained from work period 1 to their roles as future system developers.

In Work period 2 (C3), they will have the opportunity to utilize the knowledge gained in their work (in C1 and C2) with an industrial partner specializing in system development (C3). In year five (C1), by the developed design of the courses, students will be supported to bring their work-integrated learning from work periods (in C2 and C3) and courses (in C1) into both a project course, and the final thesis work. Table 2 provides a timeline of an example COIL program (in this case a robotics engineering program).

TABLE 2: Example of a timeline for a COIL-designed program in robotics engineering.

Years 1-3	First three years of engineering program (C1). During year 3 students are offered one introduction day to the WIL variant of the program. Students apply for the WIL variant, starting with a work period (C2).			
	Work period 1 (Conducted in C2)			
Year 4	Industrial robotics (C1) (7.5 ECTS) Mechatronics (C1) (7.5 ECTS)	Intelligent systems (C1) (7.5 ECTS) Adv. signal processing (C1) (7.5 ECTS)	Mobile robots (C1) (7.5 ECTS) Neurotechnology (C1) (7.5 ECTS)	Control theory (C1) (7.5 ECTS) Multi-variable calculus (C1) (7.5 ECTS)
	Work period 2 (Conducted in C3)			
Year 5	Robotics – project course (C1 and C3) 30 ECTS		Thesis work in robotics (C1 and C3) 30 ECTS	

CONCLUSION

This article has proposed COIL - a scientifically grounded educational design for engineering programs that also incorporates elements of end-user perspectives in engineering programs and considers multimodal aspects of both the educational design and students' learning. In doing so, the proposed educational design aims to enhance students' real-world problem-solving skills, align education with industry needs, and improve critical thinking by fostering a deeper end-user perspective of the social, environmental, and economic impacts of engineering. Informed by the conclusions drawn from the literature review, COIL can create conditions for students and future potential employers to establish contact, and for students to gain experience from an industrial system development setting. Further, published work has established the importance of a clear and distinct structure for WIL educational designs, where students' industry placement is managed by and through the university. In COIL, this is ensured by a close collaboration, and preferably also a formal agreement, between the university and the industry partners.

Studies have shown that for the experiences students gain during the practice-integrated part of their education to be truly beneficial, the educational institution must also create conditions and provide opportunities for students to reflect upon these experiences within the framework of their education, together with teachers and other students. COIL facilitates such reflection through instructing students to use audio logs and scheduling joint reflection of the recordings in a university classroom setting. In addition, the syllabi of post-work-period courses will contain learning objectives that connect to the industry context problems, both from a system developer and an end-user perspective.

It is anticipated that implementing a COIL-based design in a master's degree program in engineering, taking multimodal aspects of education into consideration, will also contribute to the program's sustainability by providing students with a comprehensive understanding of their future profession. This understanding can enhance students' motivation to complete their education. In the planned design of such a program, students will have a broad chance to learn about end-user industry practices. In addition, they will be required to apply their theoretical and practical knowledge, improve communication skills, gain experience in teamwork, and develop critical thinking and problem-solving abilities essential for a career as a system developer. In doing so, they will obtain a clearer picture, and get the hang of, what it takes to become an engineer in practice.

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APPENDIX A:

TABLE 1: List of articles included.

Author	Year	Country	Title
Barry	2015	USA	*Influence of Job Market Conditions on Engineering Cooperative Education Participation*
(W)	**Method and main findings:** Document analysis and interviews on influence of job market conditions on engineering cooperative education (co-op) participation. Engineering students are less likely to participate in co-op programs when job market conditions are favourable. Additionally, high-ability students are less influenced by job market conditions in their decision to participate in co-op programs compared to lower-ability students.		
Blair	2004	USA	*The Impact of Cooperative Education on Academic Performance and Compensation of Engineering Majors*
(L)	**Method and main findings:** Document analysis of impact of cooperative education on academic performance and compensation of engineering majors. Engineering students who participated in cooperative education programs had higher grade point averages, took longer to graduate, and earned higher starting salaries compared to their non-co-op peers.		
Blicblau et al.	2016	Australia	*The role of work placement in engineering students' academic performance*
(L)	**Method and main findings:** Survey study and retrospective analysis of student grades after long-term versus short-term WIL. Students who participated in long-term industry-based learning placements showed significantly better academic performance, particularly in their final year capstone projects, compared to those who only did short-term placements. Additionally, work placements enhanced employability and helped students develop crucial technical and soft skills.		
Clerke	2021	Australia	*Towards praxis: A practice architecture analysis of the work-integrated learning placement experiences of three Australian engineering students*
(TL)	**Method and main findings:** Interview-based case study of how students' prerequisites affect their ability to participate in WIL placements. The article examines how institutional preconditions shape the WIL placement experiences of engineering students, highlighting that students from equity groups face significant barriers in accessing, completing, and leveraging these placements for their future careers.		
Dipitso	2021	South Africa	*Work-Integrated Learning for Mining Engineering Training and the Employability Nexus in Traditional Research Universities: A Case of Selected South Africa Universities*
(TL)	**Method and main findings:** Mixed method (questionnaire and interview) study finding that WIL significantly enhances the employability of mining engineering students by bridging the gap between theoretical knowledge and practical skills. However, challenges such as limited placement opportunities, financial constraints, and insufficient time in the field hinder the full potential of WIL programs.		
Ferns et al.	2016	Australia	*Enhancing industry engagement with work-integrated learning: Capacity building for industry partners*
(W)	**Method and main findings:** Focus-group interviews and questionnaire study on enhancing industry engagement with work-integrated learning. The article emphasizes the importance of industry engagement in WIL to enhance graduate employability. It identifies the need for clear, accessible resources on student assessment, supervision, and feedback.		

Author	Year	Country	Title
Jones et al.	2017	USA	*Work-integrated learning (WIL) in information technology: An exploration of employability skills gained from internships*
(L)	**Method and main findings:** Textual analysis of how internship postings relate to professional standard competencies. The study found that IT internships predominantly emphasize technical skills over general competencies, despite the importance of soft skills like communication and teamwork for workplace success. It suggests that IT programs should not rely solely on internships to develop these general competencies.		
Kopsidas et al.	2013	UK	*Students' perceptions of the 'With Industrial Experience' degree pathway in electrical and electronic engineering*
(L	**Method and main findings:** Interview study on students' perceptions of the 'With Industrial Experience' (WIE) degree pathway in electrical and electronic engineering. The article examines the WIE program at the University of Manchester, highlighting that students perceive significant benefits such as improved employability, practical application of theoretical knowledge, and enhanced personal growth. It also identifies areas for improvement, including better communication between the university and industry partners and more structured support for students during their placements.		
Lim & Mustafa	2013	Malaysia	*Effectiveness of industrial training in improving students' generic skills*
(L)	**Method and main findings:** Survey of students' self-assessed improvement of generic skills from WIL. Industrial training significantly enhances students' generic skills and English language proficiency, particularly in communication and spoken English. The effectiveness of this training varies by the type of company, with government-linked companies being more effective in improving communication, creative and analytical, time and group management, and information and communication technology skills, while government departments and private companies are more effective in enhancing English language proficiency.		
Lock et al.	2009	UK	*Exploring the industrial placement experience for mechanical engineering undergraduates*
(L)	**Method and main findings:** Questionnaire and interview study exploring the industrial placement experience for mechanical engineering undergraduates. The impact of industrial placements on mechanical engineering undergraduates significantly enhances students' confidence, maturity, and employability. The article also highlights challenges such as the need for better communication and support from the university, and the importance of clear information about placement opportunities.		
Magnell et al.	2016	Sweden	*Faculty perspectives on the inclusion of work-related learning in engineering curricula*
(W)	**Method and main findings:** Survey and interview study on faculty perspectives on the inclusion of work-related learning in engineering curricula. Faculty members are generally positive about integrating work-related learning into engineering curricula, with a majority believing it is necessary to increase such elements. However, they identified the need for clear goals, pedagogical tools, and opportunities for faculty to gain industry experience to effectively enhance work-related learning.		
Main et al.	2020	USA	*A Case for Disaggregating Engineering Majors in Engineering Education Research: The Relationship between Co-Op Participation and Student Academic Outcomes*
(T)	**Method and main findings:** Document analysis exploring the relationship between co-op participation and students' academic outcomes. Cooperative education participation is positively associated with higher graduation rates and longer time-to-graduation for engineering students, with significant variations across different engineering majors. Women in aerospace and industrial engineering are more likely to participate in co-ops, and co-op participation generally extends time to graduation.		
Main et al.	2021	USA	*Gatekeepers of Engineering Workforce Diversity? The Academic and Employment Returns to Student Participation in Voluntary Cooperative Education Programs*
(T)	**Method and main findings:** Document analysis exploring the relationship between co-op participation and students' academic outcomes (based on co-op employer hiring references). Participation in co-op programs significantly improves engineering students' academic and employment outcomes, including higher graduation rates, GPAs, and starting salaries. The benefits are primarily seen among students who complete all co-op rotations, with underrepresented minority students showing notable gains in graduation rates and starting salaries.		

Author	Year	Country	Title
Mandal & Edwards	2022	Australia	*Student work readiness in Australian engineering workplaces through work integrated learning*
(L)	**Method and main findings:** Retrospective quantitative study on WIL student versus non-WIL student. The study found that WIL programs significantly enhance engineering students' work readiness and professional skills, with students consistently rated above average by employers in key competencies. While the median salaries of graduates were higher than the national average, their overall employment rates were not significantly higher.		
Mat et al.	2011	Malaysia	*The Effectiveness of Industrial Training on UKM Engineering Students*
(L)	**Method and main findings:** Survey of students' self-assessed improvement of skills and employability from WIL. The industrial training program significantly improved engineering students' knowledge, skills, and attitudes, after completing the training. Most students found the training beneficial for enhancing career opportunities, qualifications, and future career guidance.		
Mutanga	2021	South Africa	*The impact of work integrated learning towards students' learning: the case of ICT students in South African universities of technology*
(WT)	**Method and main findings:** Student survey investigating WIL's impact on experiential learning. The study found that WIL significantly enhances ICT students' learning experiences, with over 90% of students reporting improved skills and knowledge. Additionally, male students showed a higher inclination towards abstract conceptualization compared to their female counterparts, highlighting a gender difference in learning outcomes.		
Mutereko & Wedekind	2016	South Africa	*Work integrated learning for engineering qualifications: A spanner in the works?*
(WT)	**Method and main findings:** Interview case study on WIL challenges in South Africa. The study found that WIL in its current form does not effectively prepare engineering students for the workforce, as it often results in reduced student throughput and is used by employers primarily for cheap labor or recruitment. Consequently, a new engineering program was developed, that does not require mandatory workplace learning, aiming to improve graduation rates without compromising graduate attributes.		
Ngonda et al.	2022a	South Africa	*Perceived influence of mechanical engineering students' work placement experiences on their occupational competency and self-efficacy.*
(T) *Start article*	**Method and main findings:** Interview study on how WIL student behaviour (passive or proactive) affects their learning trajectories. The study found that mechanical engineering students' proactive behavior during work placements significantly enhances their learning trajectories, leading to increased participation and exposure to complex tasks. Conversely, passive students tend to stagnate, remaining peripheral participants and missing out on valuable learning opportunities.		
Ngonda et al.	2022b	South Africa	*Perceived influence of mechanical engineering students' work placement experiences on their occupational competency and self-efficacy*
(T)	**Method and main findings:** Interview, logbook and portfolio-based derivation of a qualitative systems dynamics model, describing how students' WIL experiences affect occupational competency and self-efficacy. The study found that mechanical engineering students' occupational competency and self-efficacy during work placements are influenced by the learning environment, mentor support, and the meaningfulness of work. Proactive students who seek guidance and take initiative tend to experience greater growth in these areas, while passive students may see stagnation in their development.		

Author	Year	Country	Title
O'Brien et al.	2012	Australia	*Work Readiness of Final-Year Civil Engineering Students at Victoria University: A Survey*
(L)	**Method and main findings:** Survey on work readiness of final-year civil engineering students. The study shows that students felt "somewhat adequately" to "adequately" prepared for the workforce, with strengths in ethics, teamwork, and communication. Key positive aspects included problem-based learning and WIL, though there was room for improvement in areas like modern tool usage and coping skills.		
Ogba et al.	2022	Nigeria	*How do work placement learning instructional methods enhance students' learning experiences?*
(TW)	**Method and main findings:** Focus groups interview study on the most effective instructional methods in WIL. The study identified four effective instructional methods — exploration, elaboration, engagement, and evaluation (the 4E instructional methods) — that industry-based instructors can use to enhance students' learning experiences during work placements. These methods help students integrate theoretical knowledge with practical application, fostering skills and attitudes necessary for future career success.		
Oliviera	2015	UK	*Employability and learning transfer: What do students experience during their placements?*
(TL)	**Method and main findings:** Interview study on how WIL contributes to the transition from higher education to the workplace. The study found that students' transitions from university to work placements are complex and involve more than just the direct application of knowledge, challenging the straightforward assumptions of human capital theory. Instead, learning transfer is multidirectional and involves continuous negotiation of belonging to new communities of practice, impacting students' professional identities and confidence.		
Paull et al.	2019	Australia	*Engineering work integrated learning placements: the influence of capitals on students' access*
(T)	**Method and main findings:** Interview study on how different types of capitals influence students' access to WIL placement. The study found that students' access to engineering WIL placements is significantly influenced by their existing capitals, such as social, cultural, and psychological resources. Students with higher levels of these capitals are more likely to secure and benefit from WIL placements, while those with lower levels face greater challenges, highlighting the need for policy changes to ensure more equitable access to these opportunities.		
Ruayruay et al.	2020	Thailand	*Work-integrated Learning Competencies: A Case Study in a Food Engineering Practice School Program*
(W)	**Method and main findings:** Observation, interview and focus group study on competences needed for WIL. The study identified six key such competencies in a food engineering practice school program: ethics and integrity, continuous learning skills, problem-solving and research skills, leadership and teamwork skills, communication skills with English language, and knowledge of food engineering. Among these, continuous learning skills, leadership and teamwork skills, and problem-solving and research skills were found to be the most important.		
Tennant et al.	2018	UK	*Industrial work placement in Higher Education: a study of civil engineering student engagement*
(L)	**Method and main findings:** Survey study on civil engineering student engagement in higher education industrial work placement. The study shows that short-term industrial placements significantly enhance civil engineering students' practical experience, technical knowledge, and employability skills, with communication and teamwork skills showing the most improvement. The study also highlighted the need for better integration of reflective practice and structured support from universities to maximize the benefits of these placements.		

Author	Year	Country	Title
Vailasseri et al.	2021a	Australia	*A Review of Work Integrated Learning in Australian Engineering Education*
Reference article	**Method and main findings:** Literature review on WIL in engineering education in Australia. The highlights the need for more comprehensive and structured WIL frameworks to better prepare students for industry. It proposed an Enhanced WIL (EWIL) framework to address gaps in current practices, aiming to improve the quality of engineering education, graduate employability, and industry collaboration.		
Vailasseri et al.	2021b	Australia	*Embedding Bachelor of Engineering University Education with Enhanced Work-Integrated Learning*
(W)	**Method and main findings:** Survey and interview study on how to design WIL education. The study investigates the effectiveness of embedding EWIL into Bachelor of Engineering programs in Australia. It concludes that continuous EWIL throughout all study semesters significantly improves the industry-readiness of engineering graduates by integrating practical workplace experience with academic learning.		
Wessels	2014	South Africa	*Cooperative education at the Tshwane University of Technology: a new direction for work-integrated learning and employability*
(W)	**Method and main findings:** Workshop, interview and questionnaire-based study on cooperative education. The study outlines the development of a new strategy for cooperative education, emphasizing a hybrid management model to enhance WIL and employability. The findings highlight the importance of a centralized and decentralized approach, strong governance structures, and active engagement with industry to ensure effective implementation and improved outcomes for students.		
Ziegler et al.	2020	South Africa	*Workplace-based learning: An industry perspective*
(W)	**Method and main findings:** Questionnaire study on an industrial perspective on workplace-based learning. The study shows that industry partners believe reducing the workplace-based learning (WPBL) period for mechanical engineering students from 12 months to 6 months will negatively impact students' practical skills acquisition and employability. They emphasize that the longer WPBL period allows students to better acclimatize to the work environment and gain comprehensive industry experience.		

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About the Journal

The International Journal of Work-Integrated Learning (IJWIL) publishes double-blind peer-reviewed original research and topical issues related to Work-Integrated Learning (WIL). IJWIL first published in 2000 under the name of Asia-Pacific Journal of Cooperative Education (APJCE).

In this Journal, WIL is defined as:

> *An educational approach involving three parties – the student, educational institution, and an external stakeholder – consisting of authentic work-focused experiences as an intentional component of the curriculum. Students learn through active engagement in purposeful work tasks, which enable the integration of theory with meaningful practice that is relevant to the students' discipline of study and/or professional development* (Zegwaard et al., 2023, p. 38*).

Examples of practice include off-campus workplace immersion activities such as work placements, internships, practicum, service learning, and cooperative education (co-op), and on-campus activities such as work-related projects/competitions, entrepreneurships, student-led enterprise, student consultancies, etc. WIL is related to, and overlaps with, the fields of experiential learning, work-based learning, and vocational education and training.

The Journal's aim is to enable specialists working in WIL to disseminate research findings and share knowledge to the benefit of institutions, students, WIL practitioners, curricular designers, and researchers. The Journal encourages quality research and explorative critical discussion that leads to the advancement of quality practices, development of further understanding of WIL, and promote further research.

The Journal is financially supported by the Work-Integrated Learning New Zealand (WILNZ; www.wilnz.nz), and the University of Waikato, New Zealand.

Types of Manuscripts Sought by the Journal

Types of manuscripts sought by IJWIL is primarily in two forms: 1) *research publications* describing research into aspects of work-integrated learning and, 2) *topical discussion* articles that review relevant literature and provide critical explorative discussion around a topical issue. The journal will, on occasions, consider good practice submissions.

Research publications should contain; an introduction that describes relevant literature and sets the context of the inquiry. A detailed description and justification for the methodology employed. A description of the research findings - tabulated as appropriate, a discussion of the importance of the findings including their significance to current established literature, implications for practitioners and researchers, whilst remaining mindful of the limitations of the data, and a conclusion preferably including suggestions for further research.

Topical discussion articles should contain a clear statement of the topic or issue under discussion, reference to relevant literature, critical and scholarly discussion on the importance of the issues, critical insights to how to advance the issue further, and implications for other researchers and practitioners.

Good practice and program description papers. On occasions, the Journal seeks manuscripts describing a practice of WIL as an example of good practice, however, only if it presents a particularly unique or innovative practice or it was situated in an unusual context. There must be a clear contribution of new knowledge to the established literature. Manuscripts describing what is essentially 'typical', 'common' or 'known' practices will be encouraged to rewrite the focus of the manuscript to a significant educational issue or will be encouraged to publish their work via another avenue that seeks such content.

By negotiation with the Editor-in-Chief, the Journal also accepts a small number of *Book Reviews* of relevant and recently published books.

Reference
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