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Bridging the Gap: Fostering Practical Experience and Industry Impact in Engineering Education

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Abstract

This study addresses a common gap that frequently obstructs the learning experience for a seamless transition from theoretical knowledge to real-world applications to produce value for student learning experience journey. The lack of hands-on experience has a negative influence, hindering and demising their understanding of the dynamic demands in the engineering sector. A deliberate educational intervention was devised to study and produce a transforming tool to the mentioned gap through utilization of an integrated hackathon. The event served as an immersive educational agenda, incorporating lectures, group activities, and innovative tasks, all within specified and tight timelines. The hackathon, themed "Understanding the Purpose of Learning," is associated with Sustainable Development Goal 9 (SDG9), and participants are to produce economical solutions that have an impact on the user community. Two coaches from various nations were strategically appointed for cross-institutional engagement and knowledge exchange. Students were asked to design and execute their own projects, which served as a tremendous accelerator for their learning journey, allowing them to apply theoretical principles in real-world applications. The hackathon had a dramatic impact, as participants left with increased confidence in applying theoretical knowledge to real world projects. Participants' enthusiasm and ability in constructing projects from scratch have clearly increased, rising from 23% prior to the event to 85% thereafter. This demonstrates that organizing hackathons is one of the most successful ways to improve engineering education by emphasizing the critical relevance of hands-on experience. This effort not only improves students' practical skills but also establishes a long-term accelerator, cultivating engineering graduates who are well-prepared for industry difficulties.

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Introduction

The journey from academia to the professional realm poses a transformative phase for engineering students, marked by the shift from lecture halls and laboratories to huge industry workspaces, where modern expectations are challenging them more than ever (Happonen et al., 2022). Engineering students are well equipped with a foundation built on theoretical principles, problem-solving skills, and collaborative learning experiences within the confines of university classrooms and laboratories, however these young graduates are expected to contribute to the practical, real-world challenges awaiting them in the industrial sphere (Miranda et al., 2021), and be active contributions in many different areas on the companies productivity targets (Happonen et al., 2021). On some occasions, highly academic and theoretical studies might lead to situations in which the graduate has challenges to fulfill the expectations which industry might have towards the next generation of potential new employees (Happonen et al., 2021).

As these engineers embark on their professional journey, they encounter a spectrum of complexities that extend beyond the theoretical models of their academic training. Theories and equations, once neatly confined to textbooks and lecture notes, must now seamlessly translate into tangible solutions and projects, including most modern topics of green supply chain management (García Alcaraz et al., 2022; Parmawati et al., 2023), Industry of things (IoT) (Ghoreishi et al., 2020; Moraes et al., 2023), becoming an entrepreneur in technology industry (Kovaleva et al., 2023; Zaki et al., 2021) and so on. This transition has its share of hurdles and students often face difficulties during this phase.

One of the foremost challenges faced by engineers upon stepping into the industry is the balance between the theoretical knowledge acquired during their university life and the hands-on skills required for navigating the intricate landscape of real-world engineering projects. While educators do not fail in providing a solid ground in fundamental concepts and theoretical frameworks, it requires fostering beyond lecture halls and laboratories. Proper solutions would need to push on instil hands on experience, more university-industry collaboration actions (Tereshchenko et al., 2024) (Happonen et al., 2020) and industry-like time pressure experiences within students to create industry-ready graduates (Salmela et al., 2015). This has been identified as the key challenge in engineering education as the lack of hands-on experience possesses a negative impact on students understanding of the stringent requirement of engineering industry.

Through this, a critical challenge emerges - the need to bridge the gap between theoretical knowledge acquired within the academic world and the hands-on experience essential for engineers to navigate through the complexities of real-world engineering scenarios, including most modern frontline technologies like artificial intelligence (Lin et al., 2021; Fan et al., 2025; Garcia et al., 2025; Usmani et al., 2023), Creative technologies (Charter & Davis, 2024; Sosunova et al.,2024), electrification of transportation and electric vehicles (Metso et al., 2020), modern societies physical (Abdelsalam et al., 2022) and digital actions robotisation and automation (Ylä-Kujala et al., 2023). This constraint has never been more pronounced as industries demand engineers to not only conceptualize solutions but also to implement them with precision and creativity.

In this context our study delves into the dimensions of this challenge and focuses on a dynamic approach, the integration of hackathons within engineering education, as a means to foster practical experience and amplify industry impact. Hackathons usually require rapid problem-solving and creative ideation (Happonen et al., 2021) within the tech and innovation circle, have proven to be powerful catalysts for cultivating practical skills, boost gender neutrality (Kovaleva et al., 2022) and encouraging innovative thinking (Porras et al., 2018). By infusing these intense, collaborative events into engineering education, a paradigm shift occurs.

The study was conducted with a total of 40 engineering students with 2 coaches from different backgrounds and nationalities via an integrated hackathon event which ties closely with the university's engineering modules. The hackathon was designed based on the Conceive Design Implement Operate (CDIO) framework and students were given the knowledge and opportunity to come up with their own projects. Participants' interest and ability to design their own projects were measured pre and post hackathon to study the effectiveness of implementing this approach into engineering education.

The hackathon was bounded to the 'Purpose Learning' model where cognitive skills with emotional and practical aspects of learning are integrated. This would provide a powerful and meaningful learning experience for participants. The 'Purpose Learning' model suggests a shift towards integrating thinking which implies a more holistic approach to education that involves emotional and practical aspects in addition to cognitive development. Based on the three key domains in the model which are thinking, feeling, and doing, the hackathon was tailor made to ensure students to explore their purpose.

This exploration seeks to unravel the potential of integrated hackathons in addressing the gap between engineering education and industry expectations. By delving into case studies, analysing participant feedback, and assessing the long-term impact, we aim to provide insights into how this methodology can revolutionize engineering education, preparing students not just for academic success but for impactful contributions to the engineering industry.

Literature

The integration of practical experience and industry relevance in engineering education is a critical step that bridges the gap between academic knowledge and the teamwork (Kovaleva et al., 2022) and dynamic demands of the engineering sector. This section explores the key methods and teaching strategies to align an educational curriculum with industry needs. The review suggests various innovative teaching techniques such as Problem-Based Learning (PBL), Project-Based Learning (PjBL), internship programs, and co-operative education, aimed at providing students with real-world engineering challenges.

Importance of practical experience in engineering education has been long emphasized by Dewey et al. (1938) and there is a growing recognition of the need to incorporate practical experiences into the curriculum (Dewey et al., 1938). According to Dewey's experiential learning theory, hands-on experiences are essential for effective learning, especially in engineering where the application of theoretical knowledge is crucial. The challenges in bridging the gap between academic practice and industry requirements are also deeply discussed by Zhou et al (2017). The authors have indicated that the gap often stems from a lack of alignment between educational curricula and industry needs and suggested faculty members and educators to keep up with the rapidly evolving industry trends.

Innovative teaching strategies such as Problem-Based Learning (PBL) and Project-Based Learning (PjBL) have been proposed as effective pedagogical approaches to bridge the gap between academic and industry by Savery et al. (1995). These methods involve students in solving real-world engineering problems, providing them with hands-on experience. Meanwhile Lattuca et al. (2006) has conducted internship programs, co-operative education, and industry partnerships to enhance students' practical skills and expose them to the real challenges of the engineering profession (Lattuca et al., 2006).

The study by Pusca et al. (2017) suggested that engineering education should be a flexible system whereby the modules should continuously accommodate changes in the industry and technology for students to adapt and possess the required skills and knowledge that is required by industry standards (Pusca et al., 2017). The study also stresses the importance of hands-on experiences in engineering classes and proposes a systematic approach whereby activities are conducted based on learning outcomes of the module.

Integration of technology within the curriculum framework would certainly contribute to closing the gap between academic and industry. Such emerging technologies such as virtual reality (VR) and simulation tools have been implemented by Tang et al. (2018) which can provide realistic and immersive practical experiences in a controlled environment. Meanwhile Nguyen et al. (2015) has explored the usage of online platforms and interactive learning modules to facilitate industry-relevant skill development, especially in remote or online education settings.

Borrego et al. (2010) emphasized the importance of continuous professional development for faculty members and educators. Programs should be conducted focusing on industry engagement and keeping educators updated on the latest technological advancements can contribute to improving the quality of practical experiences in engineering education. Meanwhile Crawley et al. (2007) has urged cross-cultural and international collaborations in engineering education which can expose students to diverse perspectives and global industry practices, enhancing their adaptability and marketability. Table 1 below shows a summary of the various approaches that have been conducted to bridge the gap between academic and industry in terms of practical experience in comparison with this work:

Table 1:

Approaches to Bridge the Gap Between Academic and Industry Practical Experience.

Reference	Approach
Savery et al. (1995)	Problem-Based Learning (PBL) and Project-Based Learning (PjBL)
Lattuca et al. (2006)	Internship programs, co-operative education, and industry partnerships
Crawley et al. (2007)	Cross-cultural and international collaborations
Borrego et al. (2010)	Continuous professional development for faculty
Nguyen et al. (2015)	Online platforms and interactive learning modules
Pusca et al. (2017)	Hands on activities based on module learning outcomes
Tang et al., (2018)	Virtual reality (VR) and simulation tools

In the pursuit of enhancing the educational landscape of engineering modules and narrowing the gap between theoretical knowledge and industry application, this study adopts an innovative and immersive approach, the integrated hackathon methodology which is explained in detail in the following section.

Method

As the demand for engineering graduates equipped with practical skills and a deep understanding of real-world challenges continues to grow, the integrated hackathon emerges as a dynamic platform for fostering practical experience and industry impact within the educational framework. In addressing the overarching research questions of how to enhance practical experience in engineering education and create lasting industry impact, the integrated hackathon serves as a strategic vehicle for achieving these goals. This methodology allows participants to immerse themselves in real-world problem-solving, receive guidance from international coaches and industrial partners, and ultimately produce projects and prototypes that are not only academically sound but also viable in professional settings. This section provides a comprehensive overview of the step-by-step process employed in the integrated hackathon. Each element has been carefully designed to contribute to the overarching goal of fostering practical experience and industry impact in engineering education. The CDIO (Conceive, Design, Implement, Operate) framework is an engineering education framework that focuses on the integration of engineering fundamentals with practical skills and emphasizes project-based learning. The integrated hackathon was implemented based on the CDIO framework. The hackathon phases were aligned with the key components of CDIO. Figure 1 below shows the implementation of hackathon phases based on the CDIO framework.

Design Approach

While the concept of a hackathon may inherently seem spontaneous and dynamic, a well-designed and systematic methodology is essential for its success. A structured approach ensures that learning objectives are met, challenges are relevant and aligned with educational goals, and participants are guided through a transformative experience, with positive push to include different cultural, educational and gender backgrounded people to the teams, to improve innovativeness potential as discussed by Kovaleva et al. (2022), giving students insights how to prepare to help companies to organize their front end innovation processes (Salmela et al., 2013). We have come up with a step-by-step framework that can act as a blueprint, providing educators with a clear path to follow and ensuring that the integrated hackathon aligns with the overarching objectives of engineering education.

Figure 1:

CDIO Framework Based Integrated Hackathon Phases

Conceive

- Define objectives of hackathon by identifying the challenges participants will address
- Encourage participants to conceive innovative solutions, emphasizing the importance of creativity and critical thinking

Design

- Develop a detailed plan for the hackathon, specifying the structure, timeline, and activities for each phase.
- Design the hackathon to include interdisciplinary teamwork, mirroring the collaborative design approach

Implement

- Ensure that participants are engaged in hands-on activities, problem-solving, and collaborative implementation of their solutions as per developed plan
- Integrate industry collaboration during the hackathon to expose participants to real-world perspectives,

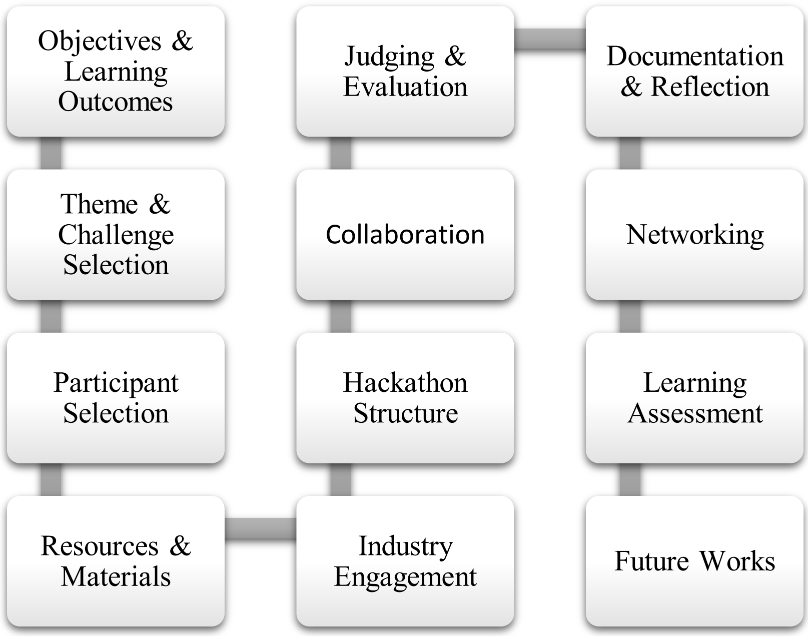
Operate

- Encourage participants to operate their solutions within the constraints and requirements of the challenges, fostering a practical understanding of the operational aspects of engineering projects
- Reward the participants with the best project and guide the project to be marketable

The step-by-step methodology outlined in this section encompasses various critical components. From defining the overarching goals and themes of the hackathon to carefully planning logistics, engaging industry collaborators, and facilitating post-hackathon reflection and improvement, each step plays a pivotal role in instilling practical experience in participants and creating industry-ready engineers. Figure 2 below depicts the step-by-step process involved in designing an integrated hackathon for engineering education.

There are nine key steps that can be followed as a blueprint to design an integrated hackathon which will aid in fostering practical experience in engineering education. These are discussed further. The objectives and learning outcomes of the integrated hackathon should be clearly defined, such as enhancing problem-solving skills, fostering teamwork, and connecting theoretical knowledge with real-world applications. Specific learning outcomes are also to be established which aligns with the goal of the hackathon and the outcomes should be measurable and achievable. The theme and challenge selection should include a relevant and industry specific theme that is in line with participants' engineering module should be set. Challenges should involve participants applying their theoretical knowledge to solve practical, real-world engineering problems.

Figure 2:
Framework in Designing an Integrated Hackathon for Engineering Education



For participant selection, set a criterion for participation and ensure students who join have completed or undergoing a certain engineering module which is relevant to the theme of the hackathon. This will allow them to apply their theoretical and fundamental knowledge learned during their lectures and convert them into tangible projects and innovations. For resources and materials, prepare relevant materials including literature, case studies, and access to any required software or tools that may be needed for the hackathon. Workshops or lectures can be conducted at the beginning of the hackathon to educate participants on essential concepts and skills related to the hackathon theme. To develop industry engagement, it is recommended to collaborate with industry partners to provide real-world problem statements, mentorship, and insights during the hackathon. The industry professionals can be arranged to participate as judges or mentors, offering feedback and guidance to the teams. For the structure of the hackathon, come up with a structured model of the hackathon and devise agendas for each day of the hackathon. Ensure the schedule is followed thoroughly and participants are aware on what they are in for.

For collaboration, collaborate with universities or faculties from different regions for cross-institutional engagement and knowledge exchange. Having diverse participants with different backgrounds will promote a collaborative and holistic problem-solving approach. Select faculty members from different universities as coaches, mentors, and guest speakers. Then, conclude the hackathon with team presentations, where each group showcases their solutions to a panel of judges. Evaluate projects based on predetermined criteria, including innovation, feasibility, and integration of theoretical knowledge. The rubric for judging can be devised based on the theme of the hackathon.

For documentation and reflection, encourage teams to document their progress, challenges faced, and solutions developed throughout the hackathon. Reflection sessions should be implemented. Post hackathon, teams can discuss their experiences, share insights, and identify areas for improvement. For networking, facilitate networking opportunities for participants to connect with industry professionals. This will be a great opportunity for students to engage with industry professionals and get to understand their expectations. For learning assessment, gather feedback from participants, mentors, and industry partners to assess the effectiveness of the hackathon. Evaluate participants based on the established learning outcomes, considering both individual and team achievements. Use assessment tools such as rubrics, surveys, feedback forms etc. to measure the application of theoretical knowledge, teamwork, and problem-solving skills. For future works, consider feedback from participants, mentors, and industry partners to enhance the overall effectiveness of the integrated hackathon. Following this 12-step framework that we have come up with to conduct an integrated hackathon will create a dynamic and immersive learning experience, foster practical skills and industry impact while strengthen the connection between engineering education and real-world applications.

The SDR hackathon was a 7-day extended and immersive event where participants engage in collaborative projects, problem-solving, and innovation related to SDR technology. Unlike shorter hackathons, a 7-day format allows for more in-depth exploration, iterative development, and a comprehensive learning experience. In this program, participants were to come up with their projects within a stipulated time frame and they were given sufficient hands-on exposure before commencing their projects. Awards were also given to projects that were outstanding and categories such as ‘Best Business Potential’ and ‘Best Pitching’ were given awards too. This did not only serve as motivation to students but also gave an opportunity to reflect on their theoretical knowledge acquired and apply it into solving a real-world problem which is a relevant skill required in the engineering industry.

Evaluation Strategy

To measure the impact and evaluate the success of implementing an integrated hackathon into engineering education to foster practical experience and industry impact, the developed hackathon model in the previous section was put to test by carrying it out in Taylor’s University, Malaysia. The developed 12-step framework was used as a reference to conduct an effective and deliberate educational intervention which would benefit the participants and the industry as well. After carefully choosing the participants and aligning the theme of the hackathon with the engineering module, we conducted a 7-day Software Defined Radio (SDR) hackathon. Figure 3 below shows the summary of the hackathon model that was conducted for this work to measure the impact and also evaluate the success of implementing this approach.

The hackathon was conducted based on the usage of Software Defined Radio (SDR) in the engineering world. Participants get to understand the use of SDR in current industry and familiarize themselves with the principles and capabilities of SDR. They also get invaluable experience of hands-on experience with SDR hardware and software tools. To stimulate creativity, participants were required to design novel prototypes and projects using SDR technology. They were required to apply SDR technology to solve real-world challenges or address specific industry problems. These objectives are in line with their engineering module ‘Circuits & Devices’ where participants can apply their theoretical and fundamental knowledge learned through the module to come up with novel prototypes and projects using SDR technology.

Figure 3:
Hackathon Framework Implemented for this Work

The theme of the hackathon centres around exploring and comprehending the purpose of learning. This broad and open-ended theme provides participants with the opportunity to delve into various aspects of learning, education, and knowledge acquisition. The integrated hackathon aims to provide sufficient practical experience to engineers that they can relate with the theoretical and fundamental knowledge taught during lectures. The hackathon is explicitly linked to SDG9, which stands for "Industry, Innovation, and Infrastructure." This connection suggests that the hackathon's goals and outcomes align with the targets set by SDG9, emphasizing sustainable industrialization, innovation, and the development of resilient infrastructure. Participants in the hackathon are tasked with creating prototypes and projects that solve a current real-world problem, and the solutions should be economical. This implies that the solutions should be cost-effective, efficient, and financially viable. Emphasizing the economical aspect aligns with the broader goals of sustainability and economic development.

Participants

A total of 40 participants joined this hackathon, and they were all engineering students from various ethnic groups. The students were grouped into 5 members per team, totalling up to 8 groups. The eligibility criteria for participation are specifically tied to students who are currently enrolled in or have completed the 'Circuits and Devices' module. This approach ensures that participants have a foundational understanding of circuitry, electronic devices, and related concepts-knowledge that is directly applicable to the challenges and tasks they may encounter during the SDR Hackathon. This targeted approach can enhance collaboration, problem-solving efficiency, and the overall learning experience during the hackathon, as participants share a common foundation in circuits and devices within the context of engineering education.

Participants have gained an invaluable opportunity whereby for those participants who have completed the hackathon and submitted a full report, they received 6 European Credit Transfer and Accumulation System (ECTS) in official LUT University, Finland. This again proves that conducting an integrated hackathon with collaboration with other universities can bring vital benefits to participants with exposure to international study systems and learning styles and boost people's interest towards openness and open eyes for wider range of career choices, including entrepreneurship as depicted in Kovaleva et al. (2023). The judging panel was assembled consisting of industry professionals, SDR experts, and representatives with relevant technical knowledge. The judging panel aimed to be diverse to bring varied perspectives and experiences. Rubrics were developed to guide judges in assigning scores for each criterion.

Materials

Organising a successful hackathon requires careful planning and access to relevant resources and materials. For this hackathon the following resources and materials were prepared before the event to ensure a smooth sailing experience for participants: a) SDR hardware devices – sufficient number and variety of devices were prepared for participants to get their hands on experience; b) Software resources - ensured participants have access to laptops or workstations equipped with the necessary software tools for SDR development; c) Learning materials - provided educational materials, tutorials, and documentation for SDR development and signal processing techniques.

Analysis

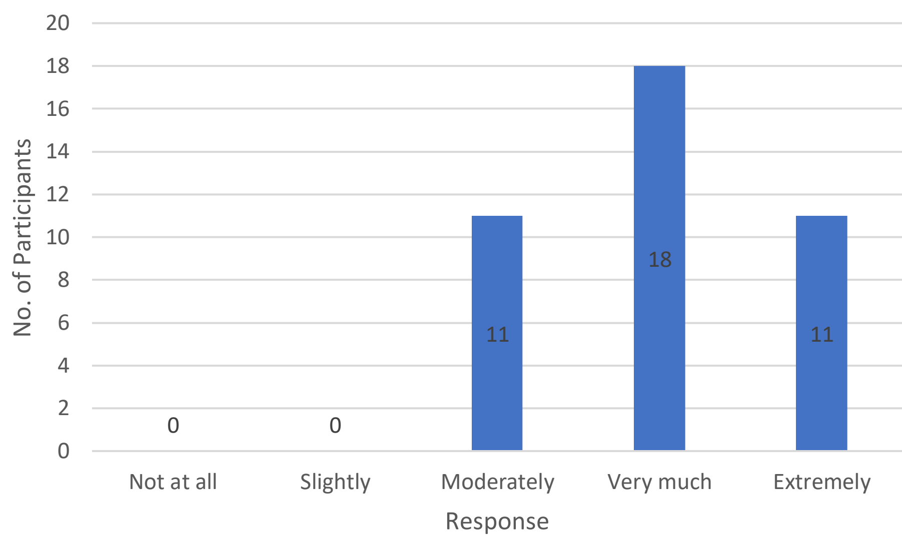
Participants were required to come up with a complete report consisting of details of their project, sharing their experiences from the hackathon, and what they would like to experience in future hackathons. Personal reflection sessions were also conducted during the closing ceremony of the event. Gathering feedback from participants, mentors, and judges is crucial for assessing the success of an SDR (Software-Defined Radio) hackathon and identifying areas for improvement. This was done through post-event surveys where feedback forms were sent to participants and other stakeholders after the conclusion of the hackathon. Respondents were allowed to provide feedback anonymously to encourage honest opinions. This was used as a tool to measure the impact and the success of the hackathon and whether the objectives of the event were met or not.

Results

This section will discuss the impact and success of the integrated hackathon conducted in the context of bridging the gap between practical experience and industry impact in engineering education. A comprehensive survey was developed that covers various aspects of the hackathon experience. Questions about the perceived value of the event, the relevance of the challenges, the quality of mentoring, the impact of practical experience, industry engagement and the overall satisfaction of participants were included in the survey. A total of 40 participants were given the survey and data collected from the survey were used to measure the impact and success of the integrated hackathon in line with bridging the gap between practical experience and industry impact in engineering education. To analyse the impact and success of this hackathon, we will be discussing responses to 5 questions from the survey above. Figure 4 below shows the responses from the participants.

Figure 4:

Participant Response on Understanding of Concepts through Hackathon

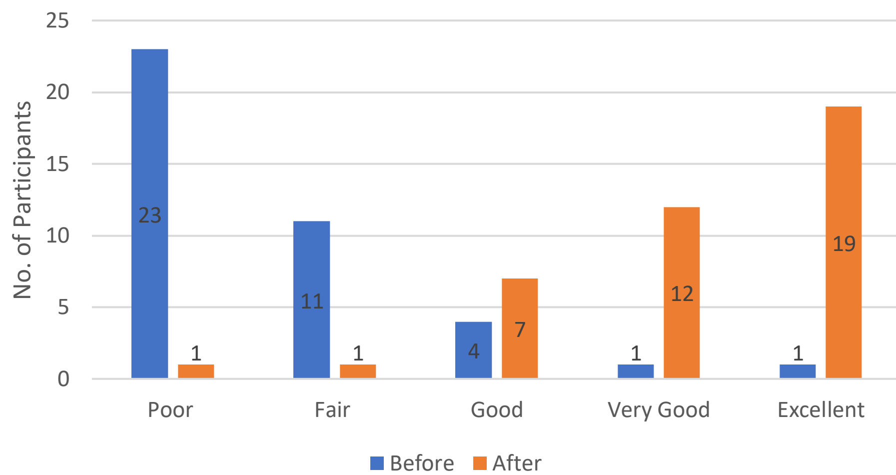


Participants who responded with "Moderately" (27.5%) indicate that the hackathon had a moderate impact on their understanding of SDR concepts. A moderate response could indicate that the hackathon provided a reasonable exposure to SDR concepts, but participants may have encountered challenges or limitations in fully grasping certain aspects. The majority of participants responded with "Very Much (45%)," indicating a significant positive impact on their understanding of SDR concepts. This is a strong indicator that the hackathon successfully contributed to bridging the gap between academic knowledge and practical, industry-oriented understanding. Their positive experiences may include successful application of theoretical knowledge, effective mentorship, and exposure to real-world challenges. Participants who responded with "Extremely" (27.5%) indicate an exceptionally high impact on their understanding of SDR concepts. Their responses could highlight the integration of theoretical knowledge with hands-on application, exposure to advanced industry practices, and the acquisition of skills directly applicable to real-world scenarios (Figure 5).

The significant number of participants initially rating their proficiency as "Poor" (57.5%) suggests a baseline skill gap that the hackathon aimed to address (Figure 7). The post-hackathon response of 1 participant still indicating poor proficiency may indicate that more targeted support or resources are needed for individuals with this initial proficiency level. It could also be due to the time of the intensive event, the participant was not able to take part in the level he/she wanted and could not get the learnings, as were intended. The shift from “Fair” to higher proficiency levels for 10 (25%) participants indicates a positive impact on skill development. However, the 1 participant who maintained a fair rating suggests that there may be varying levels of effectiveness in addressing the needs of individuals with fair proficiency initially. The increase in the number of participants reporting “Good” (10%) proficiency after the hackathon suggests that the event positively impacted the skills of participants who already had a good baseline. This is an encouraging sign of the hackathon's effectiveness in fostering skill development. The significant increase in participants reporting very good proficiency after the hackathon suggests a successful enhancement of skills, particularly for those who already had a relatively high baseline proficiency.

Figure 5:

Participant Response on Proficiency in Project Design Before and After Hackathon

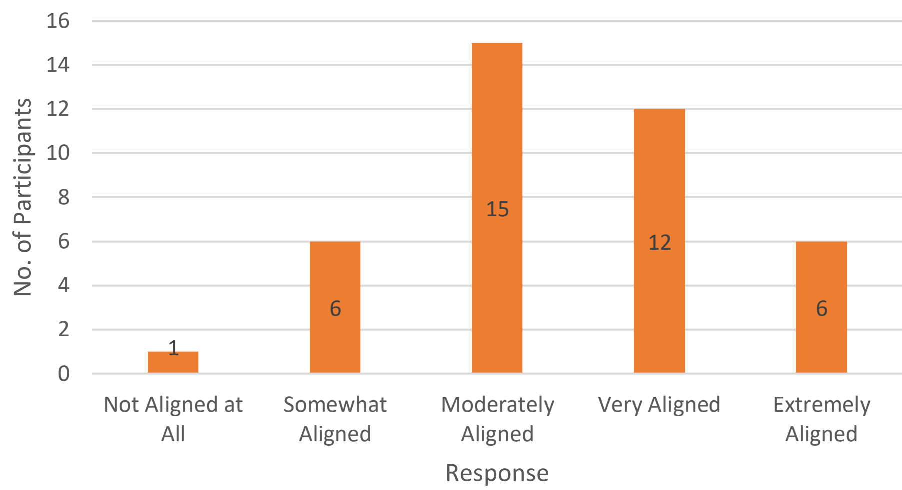


The notable increase in participants reporting excellent proficiency after the hackathon suggests that the event had a transformative effect on participants' project design skills, lifting them to an advanced level. Many participants also highlighted that they did learn more in the 7 days than normally in a month or two. The responses reveal a significant improvement in participants' proficiency in engineering project design after the hackathon. The majority of participants moved to higher proficiency levels, indicating a successful bridging of the gap between academic understanding and industry expectations. This shift in proficiency aligns with the goal of fostering practical experience and industry impact in engineering education.

Participants who indicated that the challenges were "Not Aligned at All" (2.5%) suggest a potential misalignment between the hackathon content and their perception of real-world industry needs in SDR. Participants who felt that the challenges were "Somewhat Aligned" (15%) indicate a partial alignment but with room for improvement (Figure 6). The participants in this category may have recognized some connection between the challenges and industry needs, but there may be aspects that they believe could be better tailored to address practical industry scenarios. The majority of participants perceived a “Moderate” (37.5%) alignment between the hackathon challenges and real-world industry needs. The moderate alignment suggests that a significant portion of participants found a reasonable connection between the challenges and industry requirements. This may indicate that the hackathon effectively integrated practical elements while allowing room for improvement in enhancing alignment for future events. Participants who felt that the challenges were "Very Aligned" (30%) indicate a strong alignment with industry needs.

Figure 6:

Participants Response on Hackathon Challenges with Real-World Industry Needs

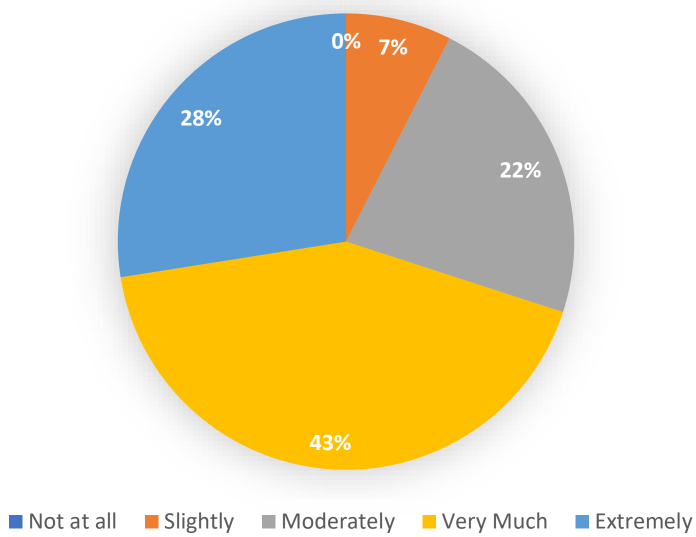


The substantial number of participants in this category suggests that a notable portion of the participants recognized a high degree of relevance and applicability in the challenges presented. This positive feedback is indicative of successful alignment with industry expectations. Participants who indicated that the challenges were "Extremely Aligned" (15%) suggest an exceptional level of alignment between the hackathon content and perceived industry needs. The participants in this category likely found the challenges highly reflective of real-world industry demands in SDR. Their responses could highlight a successful implementation of practical, industry-relevant scenarios, contributing significantly to bridging the gap between academic and industry perspectives. While there is room for improvement, especially for those who indicated partial alignment, the overall positive responses in the "Moderately Aligned," "Very Aligned," and "Extremely Aligned" categories suggest that the hackathon made significant strides in aligning challenges with industry expectations.

The absence of responses in the "Not at all" (0%) category is a positive indicator, suggesting that participants, as a whole, recognized some level of contribution to their technical skill enhancement (see Figure 7). This aligns with the goal of bridging the gap by providing practical experiences that positively impact participants' skill development. Participants who indicated "Slightly" (7%) may have experienced some level of improvement in technical skills but felt that their contribution was relatively minor. A moderate (22%) response suggests that a considerable number of participants experienced a notable improvement in their technical skills during the hackathon. Participants in this category likely recognized a meaningful contribution to their technical skill development. The hackathon has provided a balance between challenging tasks and effective support, contributing to a moderate level of enhancement in prototype design and debugging skills.

Figure 7:

Participant Enhancement in Practical Skills Post Hackathon



The majority of participants felt that the hackathon contributed "Very Much" (43%) to the enhancement of their technical skills. The significant number of participants in this category suggests a strong positive impact on technical skill development. The hackathon activities, challenges, and mentorship likely played a crucial role in fostering practical experience and enhancing participants' technical skills which would be beneficial for them when entering the industry of engineering. Participants who indicated "Extremely" (28%) suggest an exceptionally highly perceived impact on the enhancement of their technical skills. The participants in this category found the hackathon to be transformative in terms of technical skill development. The integrated hackathon provided advanced challenges, comprehensive support, and a conducive environment for participants to significantly improve their hands on skills in return acting as a long-term accelerator preparing them for the industry.

The majority of participants reported a substantial contribution to the enhancement of their technical skills during the hackathon. The varied responses, ranging from "Moderately" to "Extremely," suggest that the event effectively bridged the gap between academic knowledge and practical, industry-relevant technical skills, aligning with the goals of fostering practical experience and industry impact in engineering education.

Students also provided qualitative responses including “Working on a real-world project in SDR allowed me to see the direct applications of concepts I've learned in class”, “It was good to see how concepts from lectures could be practically implemented, and it gave me a deeper understanding of the subject,” “The experience enhanced my ability to translate theoretical concepts into tangible outcomes.”, “This hands-on approach gave me more confidence in building projects which would be beneficial for me in future”, “It gave me the confidence to tackle similar challenges in my future career”, and “There were aspects that aligned well with what I've learned, but I also encountered some practical challenges that made me realize there's more to consider in real-world projects”.

From the survey conducted, it is evident that the majority of participants reported a significant to extremely high impact on their understanding of concepts through the integrated hackathon. The responses indicate a substantial improvement in participants' proficiency in project and prototype design after the hackathon. The majority of participants moved to higher proficiency levels (Good, Very Good, Excellent), signaling success in enhancing practical skills relevant to the industry. While there were varying perceptions of alignment with real-world industry needs, a significant portion of participants expressed moderate to extremely high alignment of the hackathon challenges with industry expectations. This indicates positive strides in integrating practical industry scenarios into the educational experience.

The majority of participants (70%) reported a significant to extremely high contribution to the enhancement of their technical skills, particularly in prototype design and troubleshooting. This suggests that the hackathon effectively facilitated practical skill development, aligning with the goal of bridging the gap between academic knowledge and industry expectations. In terms of ‘Purpose Learning’, it is evident through the survey and reflection sessions that participants were able to jive with the three key domains of the ‘Purpose Learning’ model. They have improved their cognitive skills (thinking) by engaging in critical thinking, analyzing challenges, and devising innovative solutions through the hackathon. The hackathon has also induced emotional engagement (feeling) whereby groups of participants work on projects they are passionate about. Connecting with a project personally can evoke strong emotions, making the learning experience more engaging. Also, through teamwork during the hackathon, emotional intelligence is encouraged as participants navigate group dynamics and communicate effectively. Participants were also involved in practical applications (doing) and have gained exclusive hands-on experience, and they applied their theoretical knowledge in coming up with real solutions. By combining the dynamic and collaborative nature of hackathons with Purpose Learning principles, participants did not only develop technical skills, but also gained a deeper understanding of themselves, their motivations and the broader impact of their work. This holistic approach can lead to a more enriching and purposeful learning experience.

Overall, the survey results suggest that the hackathon made substantial progress in achieving its goal of bridging the gap between academic and industry perspectives in engineering education, with a specific focus on practical experience and industry engagement. The positive outcomes in terms of knowledge transfer, skill enhancement, and practical application of theoretical knowledge demonstrate the effectiveness of the event. Continuous improvements based on participant feedback can further enhance the impact of future initiatives in fostering practical experience and industry relevance in engineering education.

Conclusion

The study introduces an innovative approach to narrowing the gap between academic knowledge and real-world job life industry career skill and knowledge needs (Rohm et al., 2021). The studied and presented integrated hackathon model serves as a reference point and baseline framework for future hackathons and intensive code camps (Happonen & Minashkina, 2018) in engineering education, offering a guiding framework that successfully facilitates the bridging of this crucial gap. The post-hackathon survey results provided valuable insights into the effectiveness of the proposed model. The majority of participants reported a significant improvement in their understanding of concepts, enhanced proficiency in project design, and a positive impact on their technical skills. Moreover, participants recognized the alignment of the hackathon challenges with real-world industry needs and their engineering module, indicating a successful integration of practical experiences into the educational setting. The positive outcomes outlined in the survey responses affirm the model's ability to achieve its overarching goal of fostering practical experience and industry impact in engineering education, which also aligns well with previous research, indication proper university industry collaboration hackathons to also promote new innovative solutions generation (Happonen et al., 2022) and will boost business model development and solution generation for more efficient business operations.

As the engineering education landscape continues to evolve, the presented hackathon model stands as a testament to the importance of hands-on, industry-relevant experiences in preparing students for the challenges of the professional world. The success of this integrated hackathon not only validates its efficacy but also opens avenues for further research and refinement of the model to address the ever-changing demands of the engineering industry, including the need to evaluate trust-based models efficiency, seen in industrial collaborations (Happonen and Siljander, 2020), in the context of industry-university shared innovation efforts and novelty generating hackathons too. In essence, the integrated hackathon model we have introduced serves not only as a bridge between academia and industry but also as a beacon for transformative educational practices in engineering. Through continued exploration, adaptation, and implementation, the principles and successes outlined here have the potential to shape the future of engineering education, ensuring that graduates are not only well-versed in theoretical concepts but also succeed at applying their knowledge to real-world challenges.

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References

Abdelsalam, A., Happonen, A., Kärhä, K., Kapitonov, A., Porras, J. (2022), *Toward Autonomous Vehicles and Machinery in Mill Yards of the Forest Industry*: *Technologies and Proposals for Autonomous Vehicle Operations*, IEEE Access, Vol. 10, pp 88234-88250, https://doi.org/10.1109/ACCESS.2022.3199691

Borrego, M., Froyd, J. E., & Hall, T. S. (2010). *Diffusion of engineering education innovations: A survey of awareness and adoption rates in US engineering departments*. *Journal of Engineering Education*, *99*(3), 185-207.

Charter, M., & Davis, T. (2024). *Createch: peer-to-peer networking (P2P) and knowledge exchange (KE).*

Crawley, E. F., Malmqvist, J., Östlund, S., & Brodeur, D. R. (2007). *Rethinking engineering education: The CDIO approach*. Springer.

Dewey, J. (1938). *Experience and Education*. Kappa Delta Pi.

Fan, J. Du, Y., Siemon, D., Happonen, A., (2025). *Designing a Modular University-Based Online Course Framework for Ethical and Efficient Utilization of Generative Artificial Intelligence*, *In Proceedings of the 58th Hawaii International Conference on System Sciences* | 2025, Waikoloa Village, Hawaii, United States, 2025, pp. 80-89, https://doi.org/10.24251/hicss.2025.011

García Alcaraz, J.L., Díaz Reza, J.R., Arredondo Soto, K.C., Escobedo, G.H., Happonen, A., Vidal, R.P.I., Macías, E.J. (2022), *Effect of Green Supply Chain Management Practices on Environmental Performance: Case of Mexican Manufacturing Companies*, *Mathematics*, Vol. 10, Iss. 11, Article: 1877, pp. 1-19, https://doi.org/10.3390/math10111877

Garcia, M. B., Goi, C. L., Shively, K., Maher, D., Rosak-Szyrocka, J., Happonen, A., Bozkurt, A., & Damaševičius, R. (2025). *Understanding Student Engagement in AI-Powered Online Learning Platforms: A Narrative Review of Key Theories and Models*. *In A. Gierhart (Ed.), Cases on Enhancing P-16 Student Engagement With Digital Technologies*, pp. 1-30, https://doi.org/10.4018/979-8-3693-5633-3.ch001

Gibbs, G., & Simpson, C. (2004). *Conditions under which assessment supports students' learning*. *Learning and Teaching in Higher Education*, *1*(1), 3-31.

Ghoreishi, M., Happonen, A., Pynnönen, M. (2020), *Exploring Industry 4.0 Technologies to Enhance Circularity in Textile Industry: Role of Internet of Things*, In Twenty-first *International Working Seminar on Production Economics*, February 24-28, 2020, Innsbruck, Austria, pp. 1-16, https://doi.org/10.5281/zenodo.3471421

Happonen, A., Minashkina, D. (2018), *Ideas and experiences from university industry collaboration: Hackathons, Code Camps and citizen participation, LUT Scientific and Expertise Publications report* 86, pp. 1-21, https://doi.org/10.13140/rg.2.2.29690.44480

Happonen, A., Siljander, V. (2020), *Gainsharing in logistics outsourcing: trust leads to success in the digital era*, *International Journal of Collaborative Enterprise*, Vol. 6, No. 2, pp. 150-175, https://doi.org/10.1504/IJCENT.2020.110221

Happonen, A., Minashkina, D., Nolte, A., Medina Angarita, M.A. (2020). *Hackathons as a company-University collaboration tool to boost circularity innovations and digitalization enhanced sustainability, AIP Conference Proceedings*, Vol. 2233, Iss. 1, pp. 1-11, https://doi.org/10.1063/5.0001883

Happonen, A., Tikka, M., Usmani, U. (2021), *A systematic review for organizing hackathons and code camps in Covid-19 like times: Literature in demand to understand online hackathons and event result continuation*, *In 2021 International Conference on Data and Software Engineering (ICoDSE),* pp. 7-12, https://doi.org/10.1109/ICoDSE53690.2021.9648459

Happonen, A., Manninen, L., Santti, U., & Mariappan, M. (2021). *Online brand, opportunities, realities, and challenges for SMEs. Fresh recruits, a solution or new kind of orienteering challenge? International Journal of Engineering and Technology*, *10*(2), 220–231. https://doi.org/10.14419/ijet.v10i2.31813

Happonen, A., Manninen, L., Hirvimäki, M., Nolte, A. (2022), *Expectations for young job applicants' digital identity related to company's social media brand development strategies, Small Enterprise Research*, *Vol. 29*, Iss. 2, pp. 87-108, doi: https://doi.org/10.1080/13215906.2021.2000482

Happonen, A., Nolte, A., Bystriakova, N., Santti, U., Kärhä, K. (2022), *Study on Hackathons for New Innovation Seed and Business Model Development Needs in Digitalization Driven Sustainability, Circularity and Environmentally Friendly Solutions Demanding Digitalizing Societies, In Book: New Innovations in Economics, Business and Management*, Vol. 4, pp. 1-29, https://doi.org/10.9734/bpi/niebm/v4/14443D

Kovaleva, Y., Happonen, A., Mbogho, A. (2022). Towards gender balance in modern hackathons: Literature-based approaches for female inclusiveness. In *Proceedings of the Third Workshop on Gender Equality, Diversity, and Inclusion in Software Engineering*, pp. 19-26. https://doi.org/10.1145/3524501.3527594

Kovaleva, Y., Happonen, A., Hasheela-Mufeti, V. (2022), *Pros and Cons of running educational Hackathons in a gender-neutral fashion, GE@ICSE '22 IEEE/ACM International Conference on Software Engineering,* pp. 27-34, https://doi.org/10.1145/3524501.3527603

Kovaleva, Y., Happonen, A., Kindsiko, E. (2022). *Designing gender-neutral software engineering program. stereotypes, social pressure, and current attitudes based on recent studies, Proceedings of the*

Third Workshop on Gender Equality, Diversity, and Inclusion in Software Engineering (GE@ICSE '22). ACM, pp. 43-50, https://doi.org/10.1145/3524501.3527600

Kovaleva, Y., Hyrynsalmi, S., Saltan, A., Happonen, A., Kasurinen, J. (2023)*. Becoming an entrepreneur: A study of factors with women from the tech sector. Information and Software Technology*, *155*, 107110, pp. 1-12,https://doi.org/10.1016/j.infsof.2022.107110

Lattuca, L. R., Voigt, L. J., & Fath, K. Q. (2006). *Does engineering education need liberal arts? Journal of Engineering Education*, *95*(3), 179-193.

Lin, C. H., Yu, C. C., Shih, P. K., & Wu, L. Y. (2021). *STEM based artificial intelligence learning in general education for non-engineering undergraduate students. Educational Technology & Society*, 24(3), pp. 224-237

Nguyen, T., Chen, W., & Su, C. (2015). *A Review of Emerging Technologies for Teaching Electrical and Computer Engineering. IEEE Transactions on Education*, *58*(2), 114-122.

Metso, L., Happonen, A., Rissanen, M., Efvengren, K., Ojanen, V., Kärri, T. (2020), *Data Openness Based Data Sharing Concept for Future Electric Car Maintenance Services, In Advances in Asset Management and Condition Monitoring. Smart Innovation, Systems and Technologies*, Vol 166, pp. 429-436, https://doi.org/10.1007/978-3-030-57745-2_36

Miranda, J., Navarrete, C., Noguez, J., Molina-Espinosa, J. M., Ramírez-Montoya, M. S., Navarro-Tuch, S. A., ... & Molina, A. (2021). *The core components of education 4.0 in higher education: Three case studies in engineering education. Computers & Electrical Engineering*, 93, 107278.

Moraes, E. B., Kipper, L. M., Hackenhaar Kellermann, A. C., Austria, L., Leivas, P., Moraes, J. A. R., & Witczak, M. (2023). *Integration of Industry 4.0 technologies with Education 4.0: advantages for improvements in learning. Interactive Technology and Smart Education*, 20(2), pp. 271-287.

Parmawati, R., Mulyadi, F., Rosyani, R., Suaedi, S., & Yunikewaty, Y. (2023). *The role of environmental education and green supply chain practices in achieving sustainable development: evidence from Indonesia. International Journal of Energy Economics and Policy,* 13(1), 421-430.

Porras, J., Khakurel, J., Ikonen, J., Happonen, A., Knutas, A., Herala, A., Drögehorn, O. (2018). *Hackathons in software engineering education: Lessons learned from a decade of events*. In *Proceedings of the 2nd International Workshop on Software Engineering Education for Millennials* (pp. 40–47). ACM. https://doi.org/10.1145/3194779.3194783

Pusca, D., Bowers, R. J., & Northwood, D. O. (2017). *Hands-on experience in engineering classes: The need, the implementation, and the results. European Journal of Engineering Education*, *15*, pp. 12-18.

Rohm, A. J., Stefl, M., & Ward, N. (2021*). Future proof and real-world ready: the role of live project-based learning in students' skill development. Journal of Marketing Education*, 43(2), pp. 204-215.

Salmela, E., Santos, C., Happonen, A. (2013), *Formalization of front end innovation in supply network collaboration, International Journal of Innovation and Regional Development*, Vol. 5, No. 1, pp. 91-111, https://doi.org/10.1504/IJIRD.2013.052510

Salmela, E., Happonen, A., Hirvimäki, M., & Vimm, I. (2015). *Is time pressure an advantage or a disadvantage for front end innovation – case digital jewelry. Journal of Innovation Management, 3*(4), 42–69. https://doi.org/10.24840/2183-0606_003.004_0005

Savery, J. R., & Duffy, T. M. (1995). *Problem Based Learning: An instructional model and its constructivist framework*. *Educational Technology*, *35*(5), 31-38.

Sosunova, I., Hasheela, V., Happonen, A. (2024*). Novel Creative Technologies Decision Support System for Small and Medium Enterprises: Exploring the Potential, Current Findings and Future Research Consideration, In 2024 IEEE International Conference on Systems, Man, and Cybernetics (SMC),* Kuching, Malaysia, 06-10.10.2024, pp. 4901-4907, https://doi.org/10.1109/SMC54092.2024.10831174

Tang, Y., He, L., & Yan, W. (2018). *Virtual Reality Technology and Applications in Engineering Education*. *IEEE Access*, *6*, 25487-25497.

Tereshchenko, E., Phang, S.K., García Alcaraz, J.L., Happonen, A. (2024). *Practice-Based Views on Key Success Elements in University-Industry Collaborative Activities, International Journal of Knowledge Management*, Vol. 20, Iss. 1, pp. 1-25, https://doi.org/10.4018/IJKM.345653

Tereshchenko, E., Salmela, E., Melkko, E., Phang, S.K., Happonen, A. (2024). *Emerging best strategies and capabilities for university–industry cooperation: opportunities for MSMEs and universities to improve collaboration, Journal of Innovation and Entrepreneurship*, Vol. 13, Article:28 (2024), pp. 1-45, https://doi.org/10.1186/s13731-024-00386-4

Usmani, U.A., Happonen, A., Watada, J. (2023). *Enhancing Artificial Intelligence Control Mechanisms: Current Practices, Real Life Applications and Future Views, Lecture Notes in Networks and Systems*, Vol. 559, pp. 287-306, https://doi.org/10.1007/978-3-031-18461-1_19

Ylä-Kujala, A., Kedziora, D., Metso, L., Kärri, T., Piotrowicz, W., Happonen, A., (2023). *Robotic process automation deployments: a step-by-step method to investment appraisal, Business Process Management Journal,* Vol. 29, Iss. 8, pp. 163-187, https://doi.org/10.1108/BPMJ-08-2022-0418

Zaki, Y., Al Muwali, A., & Mahdi, N. (2021). *The Role of Nurturing Technopreneurship Education and Building University Students' Entrepreneurial Mindsets and Skill Sets in Fostering Digital Innovation and Augmenting the Tech Start-Up Ecosystem in Bahrain. International Journal of Learning, Teaching and Educational Research*, 20(6), 152-173.

Zhou, M., Liu, M., & Chang, Y. (2017). *Bridging the Gap Between Engineering Education and Practice: A Case Study of Project-Based Learning in Structural Engineering*. *International Journal of Engineering Education*, *33*(6), 1901-1912.