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Integrating Industry 4.0 into Higher Education: A Case Study of a Drone Course for Multidisciplinary Learning Course

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Abstract

This study investigates the integration of Industry 4.0 (IR4.0) technologies into higher education, focusing on a co-curricular drone course designed to prepare students for future career landscapes. The research aims to assess student engagement, the effectiveness of hands-on learning approaches, and the alignment of the course with the needs of IR4.0. Utilizing a case study approach, we collected data from a cohort of students across various disciplines at a higher education institution (HEI). The course incorporated a kinesthetic learning model, where students tackled real-world industry problems using drones, guided by experts from the drone sector. Feedback was gathered through structured online questionnaire to evaluate the course's impact and areas for improvement. The study revealed strong student enthusiasm for drone technology and IR4.0 applications, driven by curiosity, career prospects, and personal interests. Students advocated for more practical, hands-on activities and increased interaction with industry experts. The findings underscore the need for HEIs to develop flexible, future-oriented curricula that can adapt to diverse student profiles and rapidly evolving technological landscapes. Challenges identified include course design, pedagogical strategies, and the need for adequate teaching facilities and evaluation methods. This research highlights the importance of creating educational frameworks that are agile and responsive to the demands of IR4.0. It suggests a synergistic approach involving government, industry, and academia to foster high-quality talent capable of thriving in the digital era. The study also points to the necessity of addressing diversity and inclusion to bridge gender and rural-urban gaps in technology education. This work provides valuable insights into the practical integration of IR4.0 technologies in higher education. It offers a

baseline for other HEIs to design and enhance their IR4.0 curricula and suggests areas for future research to optimize educational strategies in preparing students for a dynamic, technology-driven world.
Keywords: IR 4.0, Education 4.0, Drones, Futuristic Curriculum, Digital Talent, Industry 4.0, Higher Education, Drone Technology, Kinesthetic Learning, Curriculum Development, Future-Ready Graduates, Educational Strategies

Introduction

"*Education needs to be aligned with the fundamental changes like work and address the issue of employability*" - Albert Einstein.

The Fourth Industrial Revolution (IR4.0) is significantly impacting our lifestyles, societies, and cultures, fundamentally altering the nature of future jobs and industries globally. This revolution is ushering in a demand shift in the workforce towards digital-related skills and jobs. The definition of "talent" is evolving amidst fierce competition, with uncertain futures for skills, roles, and tasks. Some jobs may be redesigned, interchanged, rebranded, or even replaced entirely.

In response to these unpredictable changes, higher education institutions (HEIs) play a crucial role in nurturing industry-ready talent to meet emerging demands (Ahmad, 2024; Wawak et al., 2023). The ongoing IR4.0 revolution necessitates transformation by HEIs to equip students with hybrid skills Hevi et al (2023); Zabidin et al (2023) and digital literacy Jayabalan et al (2021); Kaushik & Verma (2020), thus future-proofing them. The term Education 4.0 is frequently referred to describe this transformation. Education 4.0 is a methodology of practice that is aligned with the ongoing fourth industrial revolution, focuses on transforming the future of education through advanced digital technology and inovationn. Education 4.0 reimagines education as an inclusive (Ellahi et al., 2019; Liangyu et al., 2024), lifelong experience Rasiah et al (2023); Tee et al (2024) that places the responsibility for skill-building on the learner, teachers and institutions. Embracing digital transformation and staying current with evolving technologies such as artificial intelligence, drones, robotics, big data, and the Internet of Things (IoT) are essential steps. This demand for a profound transformation is further intensified by the fact that the traditional classroom model is no longer sufficient to prepare students for the challenges and opportunities of the 21st century.

To this end, we introduced the elective course "Drone for Aerial Photography" to provide IR4.0 exposure across various bachelor's programs. This study explores students' initial motivations for enrolling in the course, their perceived gains applicable to future careers, and their suggestions for course enhancement.

We commence by reviewing existing literature on HEIs' roles in fostering future-ready curricula and developing future-proof talent. Subsequently, we present a qualitative analysis of students' motivations and improvement recommendations regarding our drone course. Finally, we discuss study limitations and propose future research directions.

Ir4.0: The Roles of Heis, Future-Ready Curricula, and Future-Proof Talents

Previous studies have highlighted significant concerns regarding the competencies and readiness of students, particularly youth, to face IR 4.0 and ensure future employability (Souza

& Debs, 2024, Gupta et al., 2023; Santos, 2020; Succi & Canovi, 2020). This issue is not localized but rather a global challenge affecting both developed and developing nations.

Puriwat and Tripopsakul (2020) found a notable lack of preparedness among Thai youth in adopting IR 4.0 digital and information skills. This observation was echoed by Thirunavukarasu et al (2020), who assessed the expectations, experiences, and perceptions of graduate employability among Australian engineering students, revealing a gap between academic preparation and awareness of employability. Similarly, Succi and Canovi (2020) conducted research in Germany and Italy, concluding that students are inadequately prepared for the workforce and emphasizing the need for HEIs and industries to collaborate in developing essential skills for graduates to adapt to evolving job markets. In Portugal, Santos (2020) argued that graduates encounter diverse career limitations in both domestic and international job markets, underscoring the necessity for coordinated efforts among government bodies, higher education policymakers, and employers. These studies collectively indicate that the skills gap between youth and employer expectations will widen as IR 4.0 reshapes industries and professions faster than employees can adjust.

IR 4.0 technologies continue to transform work dynamics, exacerbating the disparity between the future talent pool and job opportunities aligned with their qualifications (Yong & Geok, 2024, Pistrui et al., 2020; Wolor et al., 2020). While theoretical knowledge remains crucial in education, rapid technological and economic transformations necessitate students to be more practically engaged than ever before to succeed (Akimov et al., 2023;Brunner et al., 2018; Liao et al., 2019). Consequently, HEIs face mounting pressure to cultivate talent pipelines equipped with future-proof skills. Adaptation to evolving needs Abdul Bujang et al (2020); Goh & Abdul-Wahab (2020); Mian et al (2020) is imperative, as relying solely on theoretical knowledge is inadequate for students to thrive in dynamic environments (Halinen, 2018; Rohm, Stefl, & Saint Clair, 2019; Sandhu & de Wolf, 2020).

IR 4.0 poses challenges for HEIs to develop flexible and adaptive curricula, incorporate diverse pedagogies, and integrate cutting-edge technologies to support teaching and learning activities. Creating future-proof curricula entails adopting new delivery modes that leverage digital solutions.

To thrive in future careers within the IR 4.0 landscape, students require a blend of broad and specialized knowledge, deep expertise in specific fields, and sufficient digital literacy across complementary areas (Aini et al., 2020; Angle, 2020; Firdaus et al., 2020). Frankiewicz and Chamorro-Premuzic Tomas (2020), in a recent Harvard Business School Cases issue, assert: "While you can acquire almost any technology, the ability to adapt to an increasingly digital future depends on developing the next generation of skills, bridging the gap between talent supply and demand, and futureproofing individual and collective potential." HEIs must thus foster students' curiosity, creativity, and resilience to excel in their learning journeys, facilitated by technological integration. Extending this perspective, Hernandez-de-Menendez et al (2020) emphasize the necessity for students to gain foundational knowledge and digital competencies to confront an uncertain and evolving world. Forward-thinking, interdisciplinary curricula provide opportunities for exploring creativity and collaborative digital problem-solving skills.

Traditionally, HEIs prioritize theoretical knowledge over practical skills in talent development (Bennett et al., 2020; Byrne, 2020; Herbert et al., 2020; Jackson & Tomlinson, 2020). However, the disconnect between digital talent supply and demand impedes the establishment of a sustainable talent ecosystem. Therefore, HEIs must offer dynamic curricula and robust digital ecosystems that equip students with relevant knowledge and industry-aligned skill sets. Collaboration between industry and HEIs is critical in curriculum development, knowledge transfer, and training to produce industry-ready graduates and drive economic growth.

The above discussion underscores the urgent need for a highly skilled digital workforce to drive IR 4.0 implementation. HEIs must take proactive and agile steps to empower students with the skills, tools, and training needed to thrive amidst IR 4.0 challenges. Integrating digital technologies into educational experiences is essential for students to adapt to new ways of living, communicating, and learning. Strong partnerships among government bodies, academia, and industry are pivotal in seizing opportunities. HEIs and industries must collaborate to establish dynamic curriculum structures, transformative teaching and learning methodologies, and robust industry-academia synergy to institutionalize future-ready education in the teaching and learning process. Courses like our drone technology course serve as pilot studies to evaluate their effectiveness in preparing IR 4.0-ready students and fostering collaboration between HEIs and industries.

Method

A structured online questionnaire was administered to 84 students comprising the first cohort enrolled in the Drone Course.

The Drone Course, officially titled Drone for Industrial Applications, is offered at the Centre for Liberal Studies and is designed as a future-ready curriculum aligned with IR 4.0.

The course includes three main components:

1. Theoretical knowledge (covering drone types, basic drone uses, drone operation techniques, etc.)
2. Practical drone applications (including drone applications in the industry, professional drone-related careers, and drone entrepreneurship).
3. Exposure to drones in transdisciplinary fields and industrial settings.

Ethical considerations, such as ensuring confidentiality and privacy of student feedback, were observed. Responses collected via Google Form were exported and analyzed using ATLAS.ti version 8.4.25.

Sample and Demographics

Table 1 presents the demographic profiles of the respondents.

Table 1
Demographic Profile of the Respondents

Respondents' Characteristics		Percentage
Gender	Male	74%
	Female	26%
Year of Study	Year 1	26%
	Year 2	26%
	Year 3	39%
	Year 4	9%
Programme/ Faculty	FTSM	22%
	FST	39%
	FSSK	22%
	FKAB	4%
	CITRA	13%
Permanent Residential Areas	Urban	70%
	Rural	30%

The course cohort predominantly consisted of male students (74%), with the majority residing in urban areas (70%) (Table 1). These findings diverge from Malaysian government initiatives aimed at narrowing gender and rural-urban disparities. The observed gender imbalance aligns with global trends where females are underrepresented in STEM fields (Card & Payne, 2020; Cimpian et al., 2020; Eaton et al., 2020; Kricorian et al., 2020). Addressing these disparities within the context of IR 4.0 competitiveness will be briefly discussed in the concluding section.

Finding and Analysis

Question 1: What motivated you (referring to respondents) to enrol in the Fundamentals of Drone for the Industrial Applications course?

Motivation plays a crucial role in determining students' success, influenced by both intrinsic and extrinsic factors. Many students enrolled in the Drone Course due to prior experience with drones, either through ownership or piloting, driven by a desire to delve deeper into practical drone applications in various industries.

Some respondents shared their motivations:

> *I have a drone, and I like taking photographs using my drone for recreational purposes. I want to learn professional photo-taking techniques using drones. I hope that after attending this course, I will learn more professional photo-taking techniques using drones. (Respondents 23)*

> *I have my drone, and I like to fly the drone to take pictures and videos. Indeed, I have an Instagram account to share my drone's photos and videos. By taking part in this course, I hope to learn more practical aspects of using the drone more effectively. (Respondents 58)*

The students' prior experience with drones indicates their cognitive abilities and self-paced learning preferences. Intrinsic motivation, stemming from a genuine interest in mastering hands-on drone activities, fueled their decision to enroll in the course and engage beyond academic goals.

Respondents 15 and 37 expressed specific interests:

> *I have chosen this Drone Course because it has learning activities that involve fieldwork. I hope that the classes will be conducted hands-on and that there will be more group outdoor activities. (Respondents 15)*

> *To gain technical knowledge about hands-on drone applications, which will be used in completing the undergraduate thesis. (Respondents 37)*

Despite varying motivations, students consistently expressed a keen interest in exploring drone applications. This enthusiasm reflects their intrinsic drive to master practical aspects of drone technology.

Here are excerpts demonstrating their interests:

> *Drones are one of the most up-to-date applications in the industry. Before taking this course, I was exposed to drones' importance and their industry applications through the internet. I also have sound experience in operating a drone. Through this course, I hope to learn about drone applications' applications in various industries, acts related to drones from a legal perspective, and software development to support drone operation.*
>
> *(Respondents 49)*

> *I want to explore fields that make practical uses of the drone as a tool to facilitate on-the-job tasks. Apart from that, I have chosen this course because society still views drones as something strange. I want to learn the limits of using drones, the rules and regulations related to flying the drone.*
>
> *(Respondents 2)*

The students' responses reveal that personal interests, especially those related to their careers, significantly motivated them. Driven by these interests, they exhibited a strong curiosity about the practical applications of drones and eagerly participated in hands-on activities. Their responses underscore a high level of creativity and innovation demonstrated throughout the course. Below are some of their insights on how they envision using drones in their future careers:

> *I have owned a drone for a year. All this while, I have only used drones for capturing stunning aerial photography images for recreational purposes and as a hobby. By joining this course, I want to gain knowledge on how to become a*

professional drone pilot. After graduation, I want to set up a drone-based business startup that offers drone-related services. (Respondents 4)
I'm excited to learn how to become a professional drone operator and generate income as a student using drones. (Respondents 20)

Since drones are considered new technology, drone-related services are expensive. So, I want to learn the techniques of using drones in the industry, and I intend to become a drone-based entrepreneur. (Respondents 58)

Some students enrolled in the program despite not owning or having previous experience with drones, motivated by the technology's potential future applications. This interest likely stems from their belonging to Generation Z, a cohort known for their strong affinity with and interaction with modern technologies (Gaidhani et al., 2019; Gould et al., 2020).

I am very interested in using a drone; however, I cannot afford to buy one. Courses that teach how to use drones outside of the university are expensive, and respondents cannot afford the fees. I hope to learn and learn about the drone, and I hope to use the knowledge gained when I have my drone later. (Respondents 35)

I am interested in learning about drones, and I intend to buy one shortly, but I do not know what kind of drone would be suitable for my use. By attending this course, I want to find out more information about the types and uses of drones in the industry and become drone-savvy. (Respondents 18)

Overall, the students found the course both enjoyable and beneficial. They acquired fundamental and practical knowledge about drones, which they could apply in various contexts. The course also boosted their aptitude and eagerness to explore additional drone applications. Moreover, it encouraged them to develop their design-thinking skills and navigate the learning process at their own pace, fostering personalized learning. This finding suggests that students were empowered to customize, explore, and direct their learning journey according to their individual needs.

How can this course be improved to prepare students for Industry 4.0?

During the course, students engaged with the subject matter to solve real industry issues and propose solutions using kinesthetic learning (learning-by-doing). They applied their knowledge and skills to complete industry-based projects guided by experts from drone-related industries. In response to the hands-on activities, Respondents 45 and 61 suggested:

More hands-on or practical activities for the students... The lecturer should describe the drone components' details, how they are built, and their functions in the early stage. These are essential because each drone has different functions and purposes. (Respondents 45)

I suggest that the teaching mode is conducted 100% outside of the classroom and include more practical exposure. (Respondents 61)

The industry-based projects enabled students to enhance their problem-solving skills, creativity, and critical thinking. Their general knowledge of drones developed throughout the learning process, while the cognitive component was nurtured through hands-on activities.

For continuous improvement, students suggested incorporating specific drone-related activities in the next version of the course:

> *The focus of teaching is more on the techniques of using drones. Emphasis should also be placed on drone image processing and analysis using software*
> *(Respondents 12)*

> *More practical input on flying drones to capture great shots and videos like a professional. Rather than for recreational purposes, I am keen to explore exciting drone applications in photography, especially for motion and cinematography.*
> *(Respondents 34)*

> *The lack of this course is less exposure to the practical way to perform maintenance, service, and repairs of a drone system. It is essential to keep our drone in good working order with a minimum of downtime. I believe drone maintenance and repair services will become a demanding profession in the future.*
> *(Respondents 68)*

> *Many students are interested in participating in drone-related sports, but they lack exposure to such sports. (Respondents70)*

> *Learning activities are more oriented towards the techniques of using drones. In the future, more input should be given to applying the knowledge gained from the lessons to become a drone programmer. (Respondents 28)*

> *Expand the programme's initiative to introduce the practical uses of drones to create a powerful business opportunity. (Respondents 36)*

> *To consider drone races in the syllabus. It will be more exciting to organise the Drone Racing League (DRL) at the university as the final project.*
> *(Respondents 73)*

Instead of employing a lecture-centered approach, the Drone Course adopted a hands-on methodology where students engaged in activities guided by industrial experts. These activities encompassed drone-operation techniques, drone entrepreneurship, and professional drone-related careers. This approach offered students firsthand experience, valuable professional insights, and opportunities to explore potential career paths.

Comments regarding industrial engagements included:

> *I am hoping that the industry representatives can be invited to the final project presentation. We can get comments regarding our projects from industry*

panellists, and if they are interested in our projects, they can recruit us for industrial training or employment. (Respondents 25)

If possible, please engage an industrial mentor to come in at the beginning of the course..so that we can get a fast guide from the very beginning rather than having them come in to verify our work (Respondents 25)

Exposing students to practical and real-world perspectives provided an excellent opportunity for them to prepare for their future careers based on their interests and classroom learning.

Respondents 70 and 9 provided their perspectives:

Include more industrial visits. Even though industry representatives have been invited to share their experience and knowledge about drone use, this is not enough. We want to know how to do business using drones. (Respondents 70)

Respondents should also be exposed to how to design their drones for this purpose. Overseas visits also become necessary if there are no experts in the country who can share their knowledge and benchmark drone-related sports implementation.

(Respondents 9)

The Drone Course is a 2-credit hour course, with students and instructors meeting for two hours per week. However, some students expressed concerns about the adequacy of the time allocation. As highlighted by Chan et al (2020) and Sojayapan and Khlaisang (2020), sufficient learning time is crucial for practical subjects to enhance academic interest and success.

Respondents 47 and 20 suggested extending the meeting time and field activities:

Time allocation for fieldwork is only 2 hours per week, and this is not enough. It is hoped that fieldwork can be done during the weekend. People in the industry should be encouraged to come over to the university to share knowledge with us.

(Respondents 47)

I hope lecturers can record their theory lectures before class and conduct hands-on and practical activities during class time. (Respondents 20)

The Drone Course was conducted within a single semester. Students have suggested expanding the course to include specific applications related to the practical use of drones.

Their recommendations include:

Not enough for just one semester. I hope this course can be offered according to levels. Level 1 – Basic: Aerial Photography using drones, Level 2 – Image processing and analysis using software, and Level 3 – Setting up a drone-based business. (Respondents 39)

Students had the freedom to explore various types and applications of drones based on their preferences. The learning approach emphasized hands-on activities, with students encouraged to bring their own drones (BYOD) to class. They proposed establishing a university drone lab to enhance learning experiences. Additionally, they recommended that the university provide drones of different sizes, functions, and applications.

Here are excerpts from the students' suggestions:

> *Add more drones. Now, the university does not provide us with the drone, and we have to share. A lot of the planned activities could not be carried out. (Respondents 83)*

> *The learning activities are conducted either in the classroom or in the field. It would be great if learning activities in the future could be carried out in the laboratory. This opens up opportunities for us to link drone technology with other technologies, such as AI, programming, machine learning, etc. (Respondents 72)*

> *So far, drone-related activities only involve taking pictures and videos. I suggest that in the future, a drone-related lab or studio can be created. The lab should be equipped with hardware for photo/video editing and image processing.*
> *(Respondents 54)*

> *The final project presentation using videos about drones is not suitable to be conducted in the classroom. It is hoped that this course can be conducted in the lab or state-of-the-art gallery with high technology that supports high-resolution pictures/ videos. (Respondents 21)*

> *The course is exciting… but again, the best technical hands-on activities can be done in the lab. We are also able to use the assignments in this course as a final project. (Respondents 56)*

> *Learning activities should not only be conducted in the classroom. UKM should provide a lab for drone-based teaching and learning. This is important for teaching the Drone Course and helping students complete our final project. (Respondents 32)*

Throughout the course, students engaged in practical drone handling and operational training. They participated in sessions focusing on "Dronepreneurship," which explored the startup aspects of drone-related businesses. Feedback indicated strong student interest in pursuing drone-based entrepreneurial activities:

> *Focus more on the drone business startup process. (Respondent 2)*
> *Most sharing with industry panels is based on technical activities. I hope that there will be more sharing on how to become a drone entrepreneur in the*

future. Alternatively, as a continuation of this course, Dronepreneur courses could be offered in the future. (Respondents 26)

Expose respondents more to the potential of drone-related professional jobs. (Respondents 34)

More sharing sessions with entrepreneurs who have ventured into the drone-based industry. (Respondents 71)

Lecturers and industry experts collaborated to supervise and evaluate the students' project assignments. For enhancing the final presentation sessions, students suggested the following:

For the final project, I suggest that members of each group should think of a drone-related innovation. They need to develop a prototype and pitch their idea at the end of the semester. (Respondents 42)

Discussion

This study represents an initial effort to align with the Framing Malaysian Higher Education 4.0 initiative. This framework encompasses four main components: future-ready curriculum, agile governance, talent planning, and research and innovation (see Figure 1).

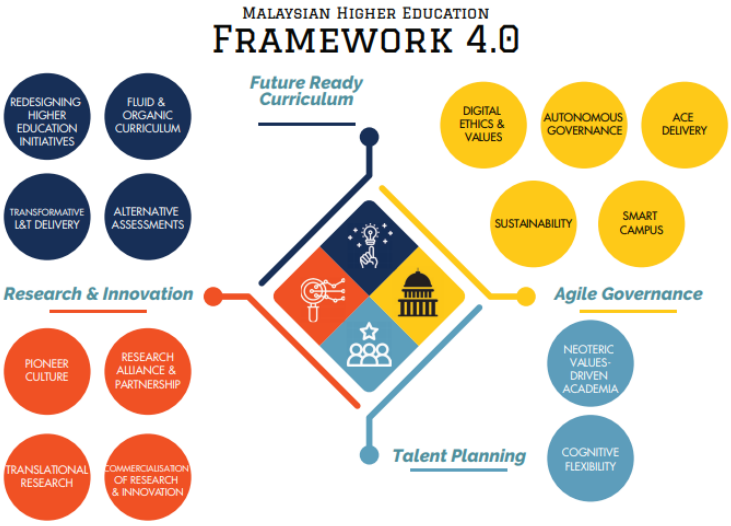

Figure 1: Malaysia Higher Education Framework 4.0

To be future-ready, graduates must possess the ability to think across disciplines and connect ideas. In accordance with the rapid advancement of IR4.0 technologies, our findings indicate that students were aware of, prepared for, and enthusiastic about learning and applying these technologies, such as drones. This readiness could be attributed to Generation Z's intrinsic affinity for contemporary technologies. This is a positive sign, as it can propel Higher Education Institutions (HEIs) to develop adaptable and forward-looking curricula that meet the demands of digital talent in a global, digital, and post-digital era. Consequently, IR4.0 curricula must be forward-thinking, adaptable, and aligned with the latest technological advancements. This recommendation aligns with previous studies by Hussain et al. (2024) and Gkrimpizi et al (2023) and, which emphasized the need for HEIs to redesign curricula to be consistent with Industry 4.0 requirements.

Although the Drone Course was offered as an elective, it was met with high expectations from the students. Factors such as previous experiences, curiosity, personal interests, and potential careers in drone-related industries (like photography, cinematography, and sports) motivated them to enroll. Their strong enthusiasm led many to explore and customize their learning processes, engaging deeply in both theoretical and practical drone activities. This involvement enabled lecturers to identify the strengths and weaknesses of each student and provide tailored guidance.

Students expressed a desire for more practical activities and shared sessions with industry experts. They were eager to apply their drone knowledge and skills to novel and evolving situations. These applications require mobilizing a broad range of skills, including creativity, critical thinking, problem-solving, and a solid understanding of IR4.0 technologies. This enthusiasm can be partly attributed to the inclusion of drone subject-matter experts who enhanced the teaching activities within the course. The findings underscore the importance of the Quadruple Helix model, which fosters symbiotic relationships between HEIs, industry, government, and community, in producing high-quality talent for IR4.0 and cultivating a pool of digital talent.

While each student's learning approach and pace varied, the overall goals and academic standards remained consistent; each student was required to attain a certain level of drone mastery by the semester's end. Engaging with real industry problems allowed students to find purpose in their learning. Achieving this goal necessitates interdisciplinary and collaborative skills, alongside a strong grasp of discipline-based knowledge. This underscores the challenge for HEIs to provide flexible learning that caters to each student’s prior knowledge, interests, and capabilities.

As part of the strategy to produce students prepared for IR4.0 careers, this study identified several challenges, including:

1. *Course design*: The primary challenge for an IR4.0-based curriculum is to design a course that accommodates students from diverse disciplines, levels of experience, and expectations regarding educational and career goals. Unlike conventional courses tailored to specific programs (e.g., medicine and engineering), our course attracted students with varied profiles from multiple programs. This diversity necessitated a move away from a one-size-fits-all approach in curriculum development.

2. *Pedagogies*: For the Drone Course, which involves rapidly evolving technology integral to IR4.0, we adopted a "learning to learn and innovate" approach. This method encourages students to take charge of their learning through project-based activities. Instructors facilitate the application of drone technology to real-world problems and explore its potential in various commercial areas. Consequently, instructors must continually update their skills and knowledge to stay abreast of technological advancements. This motivation was central to our study, aiming to enhance the current version of the course.

3. *Planning activities:* Effective course design and pedagogy are crucial for planning activities. Mastery of fundamental drone knowledge and the ability to apply this knowledge in practical tasks are essential for successful learning. This process is time-intensive as it involves both theoretical and practical components, with the latter requiring guided, hands-on activities. As indicated by our study, the existing 2-hour per week course schedule is insufficient for achieving higher levels of learning.

4. *Teaching Facilities*: Students expressed a preference for outdoor classes, highlighting the need for dedicated learning spaces where they can experiment with drones. A skills-based approach underscores the importance of a conducive learning environment that supports technology-based courses like drone-related activities.

5. *Evaluation*: Standard evaluation methods are inadequate for capturing students' performance and creativity, given their diverse backgrounds, project-based assessments, and the rapid pace of technological change. Flexible evaluation criteria are needed to assess students' skills, abilities, and competencies fairly. However, determining how to implement fair and flexible assessments remains a challenge for Education 4.0.

Another significant finding is the recognition of diversity and inclusion as vital competitive strengths for IR4.0. The study revealed that less than one-third of the students were female (26%), and 30% came from rural areas. Further research is necessary to understand the underlying reasons for this gender and rural-urban imbalance and to promote equal opportunities in IR4.0 education.
Overall, the findings provide valuable insights for HEIs in planning strategies to offer IR4.0-related co-curricular courses that acknowledge and cater to students' diverse needs. Based on student feedback, several improvements have been suggested. It is hoped that more IR4.0-oriented courses will be developed to better prepare students for the challenges of the digital era.

Conclusion, Limitations, and Recommendations for Future Research

The future is unpredictable, and we must prepare for it. Inspired by the rise of IR4.0, this study raises important questions about equipping students for their future careers. Our findings highlight student eagerness for IR4.0 technologies and underscore the need for enhancements in curriculum delivery. Additionally, a robust synergy between government and industry is essential for success in this realm.

This research focused on a single IR4.0-related subject - a co-curricular drone course designed for students from various disciplines. The sample was drawn from only one cohort at a single higher education institution (HEI). Given that this was the inaugural implementation of the drone course as part of an IR4.0 curriculum, there are areas that require further refinement. Despite these limitations, the substantial usability data collected can serve as a foundational reference for other HEIs looking to develop and improve their IR4.0-based curricula.

Future studies could adopt a longitudinal approach to assess the policy needs for IR4.0-related courses and understand the long-term impacts and challenges faced by HEIs. Moreover,

exploring alternative pedagogical strategies is crucial for enabling HEIs to provide a futuristic curriculum that can cultivate future-proof talent.

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