

Inclusive Design Capabilities of Diploma-Level Industrial Design Students: An Empirical Investigation

Amirul Fahmi Razali^{1,*}, Sharih Ahmad Mohamad¹, Addy Putra Md. Zulkifli²,
and Shahrul Anuwar Mohamed Yusof³

ABSTRACT

This research delves into assessing diploma-level industrial design students' proficiency in employing design thinking in their projects in Malaysia. The study addresses the difference between practical skills and design thinking, comprehensively evaluating the students' capabilities. Malaysia's industrial design diploma program is designed to equip students with the requisite skills and knowledge for a successful career, emphasising creating functional and aesthetically pleasing products that enhance lives. The research seeks to gain insights into the student's ability to apply design thinking principles throughout the product design process, mainly focusing on their comprehension and implementation at each stage. The study involved observing students working on a project themed "Redefining Local Culture," which aimed to breathe new life into local traditions through design. The research also incorporated industry mentorship to enhance the student's practical application of design thinking, highlighting the significance of integrating industry insights into the curriculum. The findings underscore the importance of integrating design processes and design thinking into the curriculum to produce well-prepared graduates for the demands of the design industry. The study proposes curriculum enhancements that focus on aligning academic knowledge with practical application, ultimately aiming to bridge the gap and better prepare diploma students for the industrial design sector in Malaysia.

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¹ Centre of Design Studies, Sultan Zainal Abidin University, Malaysia.

² Center for Management of Academic Excellence & Innovation, Sultan Zainal Abidin University, Malaysia.

³ Centre for Corporate Communications and Relations Management, Sultan Zainal Abidin University, Malaysia.

* Corresponding Author:
e-mail: amirulfahmi@unisza.edu.my

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1. INTRODUCTION

The field of industrial design plays a pivotal role in shaping the products and objects that surround us in our daily lives. It is a discipline that marries aesthetics, functionality, and user experience, ultimately giving form and purpose to the tangible artefacts of society. In Malaysia, the journey into industrial design typically begins at the diploma level, which serves as the earliest academic exposure to students interested in pursuing a career in this dynamic field. A Diploma course is a level below an undergraduate degree and can be considered equivalent to a first-year degree at a university. It focuses on practical and industry-specific skills and knowledge to train students for the working world.

The diploma level in the Malaysian educational landscape represents a crucial starting point for aspiring

industrial designers. In this stage, students are first introduced to the foundational principles of arts and design. It is a phase that sets the stage for their future endeavours in the creative industry and marks the initial step on their path to becoming design professionals. This level of education is particularly significant in Malaysia, as it often bridges secondary education and higher-level design studies.

However, the educational landscape in Malaysia imposes certain constraints on industrial design diploma programs. One of the most significant challenges these programs face is the limited time students can explore and master the intricacies of the design thinking process. Typically, students have only two years to complete their diploma studies, a timeframe approved by program standards and the Malaysian Qualification Agency (MQA) guidelines. Within this compressed timeframe,



students must grasp the fundamentals of arts and design and attempt to delve into the more complex realm of design thinking.

The curriculum of industrial design at the diploma level in Malaysia has traditionally emphasized the development of practical skills. While these skills are undoubtedly crucial for executing design concepts, the emphasis on practicality has sometimes overshadowed the development of critical thinking and problem-solving abilities inherent to design thinking. This shift towards practical skills has been driven by industry demands for graduates who can immediately contribute to the design and manufacturing processes.

Given these constraints and the emphasis on practical skills, it becomes imperative to evaluate the readiness and capability of industrial design diploma students in transitioning to studio projects where they are required to apply design thinking. This study posits a crucial gap in understanding how well-prepared these students are to engage in design projects that demand a holistic understanding of the design thinking process, particularly when exposed to a curriculum that places greater emphasis on practicality.

Considering these gaps, this research seeks to investigate and shed light on the ability of industrial design diploma students in Malaysia to employ design thinking in their projects. By examining their preparedness and proficiency in this regard, this study aims to contribute valuable insights to Malaysia's academic standard and design industry. This study attempts to bridge the gap between practical skills and design thinking, thus offering a more comprehensive understanding of the capabilities of industrial design diploma students as they embark on their journey towards becoming adept design professionals.

2. BACKGROUND OF RESEARCH

In Malaysia, the industrial design diploma program is a compact yet comprehensive educational offering, with 90 credits of subjects and enabling students to complete their studies within a concise 2-year timeframe. This program is structured with a specific focus on equipping students with the skills and knowledge necessary for a successful career in industrial design, making it a crucial component of our institution's curriculum.

Within the 90 credits required for graduation, a strategic allocation has been made to ensure the students' balanced and well-rounded education. Approximately 20% of the credits are dedicated to university-level subjects, providing students with a broader academic foundation. Exposure to diverse subjects enriches their overall educational experience and prepares them for future academic pursuits. The remaining 80% of the credits are thoughtfully divided, with 40% dedicated to art and design fundamentals and another 40% reserved for the core subject of industrial design. This allocation reflects the department's commitment to nurturing students' creative abilities while simultaneously providing them with the specialized knowledge and skills required for success in industrial design.

The popularity of this diploma program within our university is a testament to its value and appeal. This program offers students a taste of university-level education

during their formative years and awards them a diploma upon completion. This diploma, earned in just two years, holds significant weight and can expedite their progress when they choose to pursue degree programs in fields related to art and design. Furthermore, empirical data on the employability of industrial design diploma graduates is promising. Based on a five-year analysis of 'graduate employability' data obtained from the SKPG's system by the Ministry of Higher Education Malaysia (MOHE), it is evident that more than 90% of the students graduating with an industrial design diploma either continue their studies or successfully secure employment within the design industry.

This remarkable statistic underscores the program's practical relevance and real-world applicability, indicating its effectiveness in preparing students for the demands of the industrial design profession. In light of these considerations, this study aims to delve deeper into the abilities of Industrial Design Diploma students and their capacity to apply the principles of design thinking in their product design endeavours. By examining the background and context of the program, this study will gain valuable insights into the unique educational environment within which these students are nurtured, setting the stage for a comprehensive exploration of their design thinking capabilities.

3. THE DIPLOMA PROGRAM

The diploma program in Industrial Design is considered an important foundation in art and design studies where creativity meets functionality, shaping the future designers of the field. Rooted in the principles of form, function, and innovation, this program equips students with the essential skills and knowledge to excel in industrial design. As [Andersson \(2021\)](#) aptly put it, "Industrial design is the marriage of art and science, where aesthetics blend seamlessly with engineering to create products that are not only visually appealing but also highly practical."

This program provides many essential tools for aspiring designers, as it plays a crucial role in establishing a strong foundation for their careers. During the 2-year journey of studies, the students will be equipped with a deep understanding of the design process, teaching them how to conceptualise, prototype, and refine their ideas in fundamental ways. Also, it imparts critical problem-solving skills, allowing students to tackle complex design challenges with ingenuity and precision. Most importantly, it instils a profound appreciation for user-centred design, emphasising the importance of creating products that enhance the human experience. As [Baha et al. \(2018, p. 2\)](#) put it, "*Good design is about improving people's lives. It's about creating products that are a joy to use and interact with.*"

This program also nurtures an environment where students can experiment, innovate, and push the boundaries of conventional design. This spirit of experimentation is essential in a rapidly evolving technological landscape, where the integration of new materials and manufacturing processes constantly reshapes the possibilities for design. A diploma program in Industrial Design is considered a cornerstone for budding designers, providing them with

the tools, knowledge, and mindset required to excel in the field. It lays the groundwork for a career dedicated to creating products that serve a functional purpose and enrich the lives of individuals and communities through thoughtful, aesthetically pleasing design.

3.1. Diploma Program: The Review

Incorporating studio projects, design processes, and design thinking into educational programs has become a prominent topic of discussion within the field of design education. Recently, there has been a growing emphasis on developing design thinking skills, which are essential in fostering creativity, innovation, and problem-solving abilities among students (Abdullah, 2020; Laakso & Clavert, 2014). However, most studies in this domain have focused on undergraduate and postgraduate design programs, while more attention needs to be given to diploma-level programs. This literature review seeks to address this gap by examining the ability of diploma students who have undergone studio projects utilizing design processes and design thinking, particularly within a condensed two-year program.

As a problem-solving approach, design thinking has been praised for its applicability in various disciplines (Rodgers & Winton, 2010). In their seminal work, Koskinen et al. (2011, p. 73) emphasized that design thinking fosters a mindset characterized by empathy, collaboration, experimentation, and iteration. This methodological framework encourages students to adopt a user-centred approach and iterate through prototypes, enhancing their capacity to generate innovative solutions.

While design thinking has primarily been championed in the context of longer and more comprehensive educational programs, its application in shorter diploma courses still needs to be explored. This situation is an essential gap in the existing literature, as two-year diploma programs are becoming increasingly popular due to their cost-effectiveness and the potential for students to enter the workforce more quickly (Elsbach & Stigliani, 2018). Given the abbreviated time frame of such programs, it is essential to investigate whether the condensed nature of diploma programs hinders the development of design thinking skills or accelerates the acquisition of these skills.

One key study that begins to address this gap is conducted by Ahmad Sayuti et al. (2018), who investigated the effectiveness of the Diploma of Art and Design, Industrial Design (DIDE) Programme towards students' early academic and career development. Their findings suggested that, while the program duration was shorter, students showed remarkable growth in design thinking abilities, partly attributed to the intensive and practical nature of the studio projects. However, it is important to note that this study was limited to a single design discipline, and further research is required to assess the generalizability of their findings to other design domains.

The condensed nature of two-year diploma programs may offer a unique advantage for instilling design thinking skills. A shorter timeframe necessitates a more focused curriculum, often involving fewer distractions from non-design coursework. This intensive experience may enable students to delve deeper into the design process, experience

a higher degree of real-world problem-solving, and develop a more concentrated skill set.

On the other hand, it is essential to consider the potential challenges associated with the brevity of diploma programs. A book written by Temple (2018) has indicated that design thinking is not a one-size-fits-all solution, and its effectiveness may depend on the individual's traits and the educational context. Therefore, the condensed timeframe of a diploma program might only be suitable for some students, and it could limit their exposure to the diversity of design challenges in the professional world.

While the literature on design thinking in more extended design education programs is extensive, there is a notable gap in this research's understanding of the potential benefits and limitations of its application in shorter, two-year diploma programs. The existing studies highlight the need for further investigation to determine the impact of program duration and intensity on the development of design thinking skills among students. This paper aims to contribute to the knowledge in this area by assessing the capability of diploma students who have undergone studio projects using design processes and design thinking in the context of a two-year program, shedding light on this underexplored aspect of design education.

3.2. Industrial Design Diploma: Malaysia Module

In the context of Malaysia's educational landscape, two-year diploma programs in industrial design hold particular appeal for recent high school graduates. The short duration of this program, typically completed within two years, makes it an attractive choice for candidates looking to expedite their education and accumulate transferable credits for subsequent enrolment in degree programs (Malaysian Qualification Agency, 2013). This feature facilitates a quicker entry into the workforce and offers a cost-effective path to further education.

The curriculum design divides the subjects between university-level courses, art and design fundamentals, and core industrial design subjects. This division allows students to cultivate a comprehensive skill set, including the ability to apply theoretical knowledge to practical projects. Studio projects and hands-on experiences are integral to these programs, enabling students to hone their practical skills and gain valuable insights into the design process (Ahmad Sayuti et al., 2018). While the programs provide a well-rounded education, feedback from industry stakeholders suggests room for improvement. These stakeholders advocate for an increased emphasis on subjects related to art and design fundamentals and core industrial design topics. The aim is to better align the curriculum with the demands of the design thinking process that underpins real-world design projects.

A closer examination of the design thinking process reveals specific areas that require further development within Industrial Design Diploma programs. These include research, ideation, design development, and outcome justification (Liem & Sigurjonsson, 2012). Developing proficiency in these areas is essential for students to effectively apply design thinking principles in their projects and contribute meaningfully to the industry.

Traditional Living

'Redefining Local Culture'

In this design studio project, we aim to explore the concept of "Redefining Local Culture" through the medium of furniture design. Culture is a dynamic and multifaceted aspect of society, deeply rooted in the local context, traditions, and history. Furniture, as an integral part of our daily lives, has the potential to reflect, celebrate, and redefine local culture. This project challenges students to investigate, interpret, and reinterpret their local culture through innovative and meaningful furniture design.

Aims and Objectives	Details
1. Explore Cultural Significance	<ul style="list-style-type: none"> - Delve into the rich tapestry of local culture, traditions, customs, and history. - Identify key cultural elements for representation or reinterpretation in furniture design.
2. Promote Sustainability	<ul style="list-style-type: none"> - Emphasize sustainable and eco-friendly design principles in materials, manufacturing, and lifecycle. - Explore the alignment of sustainable design with local cultural values.
3. Foster Creativity and Innovation	<ul style="list-style-type: none"> - Challenge students to creatively integrate cultural elements into functional and aesthetic designs. - Inspire innovative approaches while respecting cultural sensitivities.
4. Functional and Aesthetic Balance	<ul style="list-style-type: none"> - Develop furniture that celebrates local culture while meeting functional needs, comfort, and safety. - Balance aesthetics, ergonomics, and cultural symbolism.
5. User-Centred Approach	<ul style="list-style-type: none"> - Consider end-users' needs, preferences, and cultural experiences when designing furniture. - Create designs that resonate with and enhance the users' connection to local culture.
6. Cross-Cultural Dialogue	<ul style="list-style-type: none"> - Encourage students to engage in cross-cultural conversations, sharing interpretations through designs. - Explore how different cultures can inspire and influence design ideas.
7. Showcase Local Craftsmanship	<ul style="list-style-type: none"> - Collaborate with local artisans, craftsmen, and manufacturers to promote and preserve traditional skills and techniques. - Create opportunities for students to learn from and support local artisans in the production process.
8. Communication and Presentation	<ul style="list-style-type: none"> - Develop effective communication skills in articulating cultural narratives and design concepts. - Create visually compelling presentations and prototypes that convey the essence of local culture.

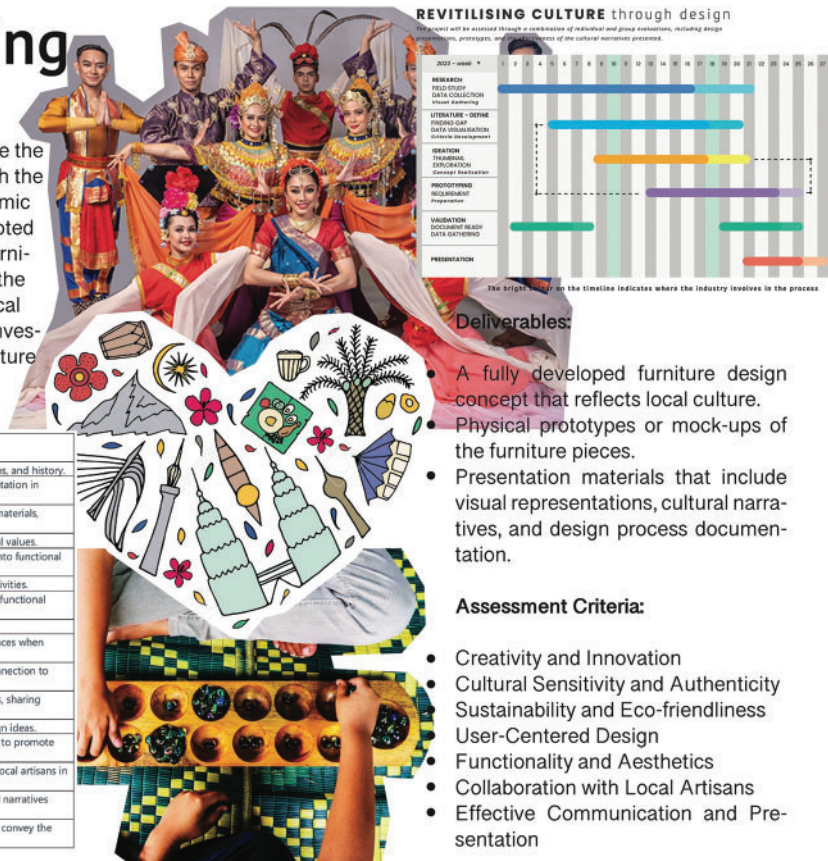


Fig. 1. Project brief.

Addressing the gap in fundamental industrial design subjects emerges as a crucial prerequisite for students before they engage in project classes applying design thinking processes. The foundation established through these subjects is paramount in preparing students to successfully apply design thinking in real-world projects and industry practices (Ibrahim, 2002). Bridging this gap equips students with essential knowledge and enhances their readiness to tackle design challenges effectively.

By synthesising these insights and incorporating relevant research, this literature review provides a comprehensive overview of the current state of Industrial Design Diploma programs and the challenges they face in preparing students to apply design thinking in product design projects.

4. METHODOLOGY

This research aims to gain valuable insights into the ability of Industrial Design Diploma students to employ design thinking in the product design process. In doing so, this research seeks to understand their comprehension and application of design thinking principles at each stage of the design process—the study centres on their reactions to each stage and their capacity to fulfil the design process requirements.

The success of any studio project hinges on effective collaboration, organization, and the division of tasks among the student groups. Next, this research will provide an overview of how the groups of diploma students were

structured and organized for this study. The design and execution of the group dynamics aimed to foster an environment conducive to holistic evaluation and collaborative learning.

4.1. Groups and Tasks

For the purpose of this research, this study has designed a project with the theme of "Redefining Local Culture" that centres on the development and giving breath to local tradition through design (as shown in Fig. 1). This project was employed for the final year Diploma students, given that they have experienced every design foundation project and passed all design and art fundamental classes. Referring to Table I, 71 diploma students participating in this research were divided into 20 groups. The rationale behind this grouping was to ensure a diverse set of perspectives, experiences, and skills within each group, reflecting real-world scenarios where multidisciplinary collaboration is often essential for successful design projects. Each group consisted of a varying number of students, depending on the category of furniture they were assigned to, which included chairs, stools, and tables.

4.1.1. Industry and Academia Roles

To comprehensively assess the students' abilities throughout the design process, each group was observed by a team of both academic experts and industry professionals (coded as in Table I). Three lecturers, possessing substantial experience in design education and pedagogy, served as the academic observers. These individuals offered valuable insights into the academic

TABLE I: STUDENT GROUPS, INDUSTRY AND ACADEMICIAN CODES, AND FURNITURE CATEGORIES

Student groups and codes	Industry and academician codes	Furniture categories
Group 1–10 Code (G1–G10) 30 students 3 students each group	Industry 1 & 2 (IA & I2) Lecturer A (LA)	Chairs
Group 11–15 Code (G11–G15) 25 Students 5 students each group	Industry 3 & 4 (I3 & I4) Lecturer B (LB)	Stools
Group 16–20 Code (G16–G20) 16 students 3–4 students each group	Industry 5 (I5) Lecturer C (LC)	Tables

aspect of the project and were guided from an educational perspective. Additionally, five representatives from the industrial sector, who had extensive experience in design and manufacturing, participated as industry observers. Their inclusion aimed to bridge the gap between academic training and real-world application, ensuring a holistic evaluation.

4.1.2. Student's Roles and Responsibilities

Within each student group, the roles and responsibilities were clearly defined to ensure the smooth execution of the design projects. These roles included but were not limited to project management, design lead, research, and prototyping. By distributing and giving responsibilities this way, this study sought to mimic the typical roles that students may encounter in professional design projects. The assignment of these roles also encouraged students to develop a shared understanding of their strengths and weaknesses, promoting a balanced contribution to the project.

To facilitate effective collaboration and project development, each group conducted regular meetings and discussions. These meetings were vital for sharing progress updates, brainstorming ideas, and addressing any challenges during the design process. Moreover, group discussions served as a platform for students to integrate design thinking principles, encouraging a dynamic and iterative approach to problem-solving.

4.1.3. The Design Categories

The division of students into furniture categories—chairs, stools, and tables—was based on the research's aim to explore local culture, design thinking and processes across various design challenges. Each category presented unique design considerations and constraints, enabling a comprehensive examination of the students' adaptability and problem-solving skills.

The group dynamics and organization for this study were structured to mirror the complexities and collaborative aspects inherent in real-world design projects.

Even though this is only a diploma-level studio class, this study should test how far these final-year students can push themselves and understand the 'design process'. This research approach was designed to offer a rich and nuanced perspective on the student's abilities to undergo studio projects using design processes and design thinking, as well as to assess the curriculum improvements needed to enhance their understanding of the design strategy. The combined expertise of academic and industry observers within the groups was pivotal in providing a holistic evaluation of the student's capabilities and performance.

4.2. Data Collection

The research employs an observational approach, where the activities and behaviours of diploma students in a classroom setting are closely observed. The selection of a classroom environment allows for a naturalistic understanding of how students engage with design thinking. This approach enables this study to capture real-time responses and actions as students tackle design challenges. By observing the students as they engage with the design process, this research aims to discern their ability and adaptability levels within each phase.

Distinct stages, including problem identification, ideation, prototyping, testing, and iteration, typically characterise the design process. This research observes students' behaviour and actions at each stage (as shown in Fig. 2). This process entails monitoring their problem-solving strategies, creative thinking, and ability to progress from one stage to the next. By examining their work and interactions during the design process, we aim to discern patterns and variations in their design-thinking abilities.

4.3. Industry Collaboration

Furthermore, it is essential to note that this research is conducted in collaboration with industry partners. The involvement of industry professionals provides a unique opportunity to bridge the gap between academic learning and real-world applications. As part of the methodology, the observations made in the classroom will be documented and analysed, and the results will be presented to the industry partners. Following this, interviews will be conducted with industry experts to gain additional insights and perspectives. Data triangulation through industry collaboration will provide a comprehensive understanding of the diploma students' ability to apply design thinking principles professionally.

Fig. 3 is a Gantt chart of the progress timeline, with each stage marked by a specific colour. The light-coloured markers represent the significant level of industry involvement for each stage. Through collaborative discussions with lecturers and industry partners, it has been agreed that industry involvement should be limited to a maximum of 25% for each stage within the allowed time. This study recognizes the importance of industry participation in the project while also ensuring that it does not dominate the project's direction.

This methodology section underscores the observational approach and collaboration with industry partners, highlighting the comprehensive methodology used to assess the design thinking capabilities of Industrial Design Diploma

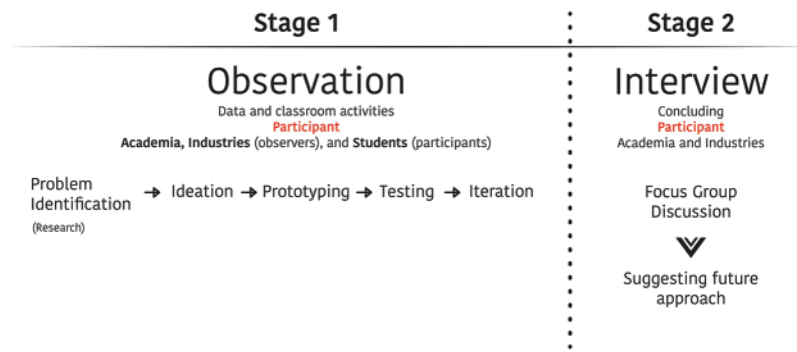


Fig. 2. The first and second stages of data collection.

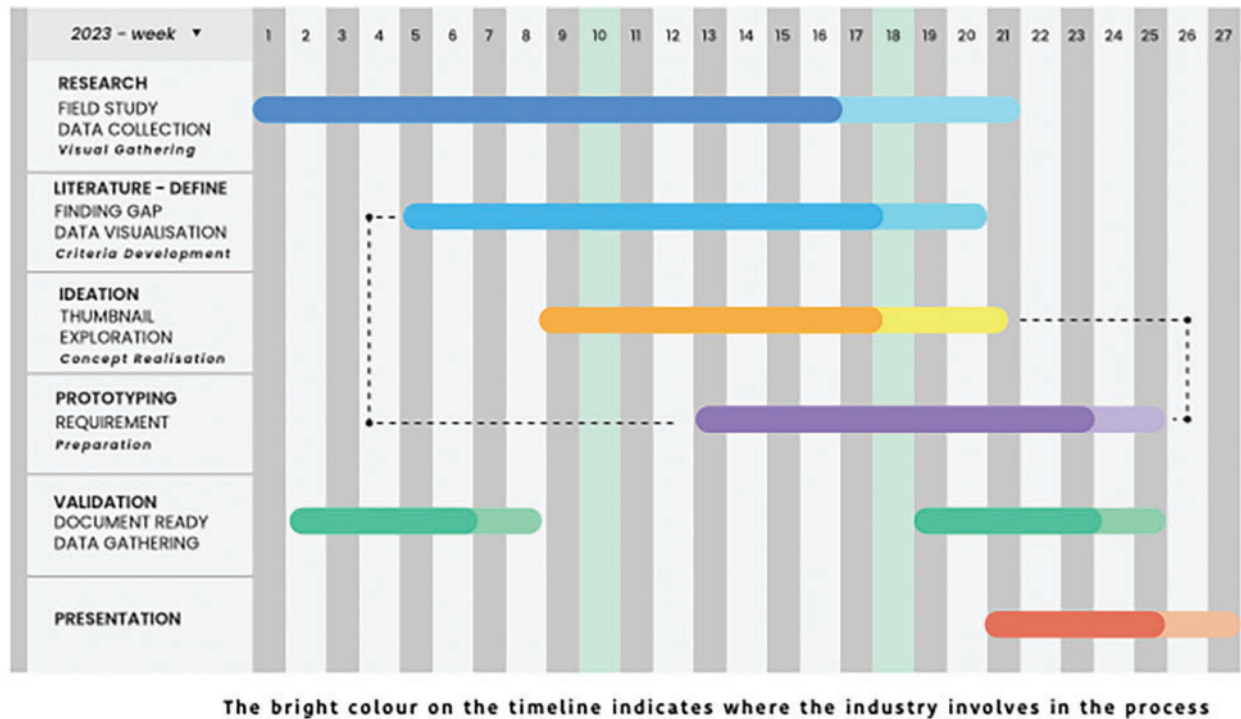


Fig. 3. Gantt chart of progress schedule.

students throughout the various stages of the design process.

5. DATA COLLECTION

5.1. First Stage (Observation)

In the first stage of data collection for this research, this study sought to evaluate the ability of diploma students to undergo studio projects using design processes and design thinking. This stage primarily focuses on observing the students' execution of tasks within the design process, comprising research, ideation, prototyping, and iteration stages.

At the research stage, it became evident that the depth of research conducted by the students could have been more comprehensive. While they gathered data and information, the research often needed to grasp the true essence of user needs. There was room for improvement in their ability to delve deeper into user requirements and gain a more profound understanding of the problem context.

Moving on to the ideation stage, it was observed that the application of design elements and design principles needed to be adequately justified. The students' ideation processes needed more detailing and explanation, making it challenging to discern how their ideas were rooted in design fundamentals. Enhancing their capacity to articulate and substantiate their creativity is crucial for the development of well-grounded design concepts.

In the prototyping stage, encompassing both mockups and the final model, the researcher noticed that the exploration of mockups could have been more detailed. There also needs to be a more comprehensive exploration of different shapes and forms, which are fundamental aspects of design development. While the final model demonstrated an acceptable level of quality, it needed to fully reflect the depth of research conducted earlier during the research stage. This discrepancy highlighted the need for better alignment between the research insights and the final design output.

The iteration stage revealed a notable challenge among the participant students. They seemed still determining when to conclude their design and finalise their projects.

This lack of clarity regarding the termination of the design process resulted in a disorganised and confusing final design. Additionally, the iteration process could have effectively referenced the data gathered during the research stage, further contributing to the design's lack of coherence and a clear origin of ideas. Addressing these issues is essential to guide students in making informed decisions during the iterative phases of the design process and ensuring that their designs remain rooted in the initial research findings.

TABLE II: CONCISE SUMMARY OF THE OBSERVATIONS AND AREAS FOR IMPROVEMENT IN EACH STAGE OF THE DESIGN PROCESS

Design process stage	Observations	Key areas for improvement
Research stage	Depth of research needs improvement	Gain a deeper understanding of user needs and problem context
Ideation stage	Insufficient justification of design elements	Enhance the ability to explain and detail ideation
Prototyping stage	Lack of detailed mock-up exploration	Improve exploration of shapes and alignment with research
	Final model doesn't fully reflect research depth	Better connection between research and final design
Iteration stage	Uncertainty about when to conclude design	Clarify the termination point and align with research data
	Lack of reference to research data during iteration	Ensure design process reflects initial research insights

The first data collection stage underscored the need for improvements in various aspects of the student's ability to execute design projects. By addressing these issues, we can better prepare them to undertake studio projects using design processes and design thinking more effectively. Table II shows the critical areas for improvement based on the study observations. The improvement area covers the general design steps, from the research stage to the iteration phase.

5.2. Second Stage (Mentoring)

In the second phase of data collection, or what this research called the *mentoring* stage, the integration of industry mentorship proved to be instrumental in enhancing the abilities of diploma students to undertake studio projects using design processes and design thinking. The collaboration between academia and industries brought about substantial improvements in the students' execution of various stages within the design process, addressing the shortcomings identified in the first stage of observation.

During the second stage, students were strongly encouraged to revisit the research stage, which had previously been subjected to criticism for its lack of depth and failure to grasp the essence of user needs. Thanks to the invaluable guidance provided by industry experts, students not only managed to delve deeper into their research but also identified market gaps and gained a much clearer understanding of their target audience. The infusion of marketing insights provided by industry partners played a pivotal role in bridging the gap between pure research and the practical application of design thinking, making the overall process

more effective and efficient. Fig. 2 shows a marked transition from surface visual research by diploma students to industry-driven visual research, marking a significant shift towards students who were driven to do research and create a strong project foundation before beginning the ideation process.

In the ideation stage, students were advised to reevaluate their approach. Industry mentors stressed the importance of aligning the design process with the criteria generated through the research findings—a connection that was often lacking before. By incorporating industry-recommended methods, the students were able to establish a more explicit link between their research data and the design criteria developed during the ideation stage. This approach allowed for a more coherent and justified design direction, as shown in Fig. 5.

Also, the guidance provided by industry professionals had a notable impact on the prototyping stage. With a more precise and more well-defined idea generated during the ideation phase, students found the prototyping process to be much smoother. The translation of conceptual drawings into tangible, detailed models became more accurate and practical. The synergy between the ideas generated in the ideation phase and their execution in the prototyping phase played a crucial role in refining the overall design process.

One of the most significant transformations occurred in the iteration stage. With the mentorship received from industry partners, students acquired a clearer understanding of the project's limitations, enabling them to determine when to conclude the design process. Furthermore, the iterative design process reflected a logical progression, with each stage seamlessly building upon the previous one. As a result, students were not only able to create designs that were more coherent but also found it easier to defend their design choices during the final presentation stage.

During the second stage of data collection, industry mentorship had a significant impact on improving the abilities of diploma students in executing studio projects using design processes and design thinking. The collaboration between academia and industries allowed the students to better understand the requirements mentioned in the syllabus and apply them practically. Preliminary findings showed that the problem was not the content of the design process needing to be understood but the seriousness of the requirements needed in every design thinking stage. Therefore, there is a need to emphasize the importance of meeting these requirements at each stage of the design process. Integrating industry insights allowed for a more comprehensive research process, a more aligned ideation phase, more accurate prototyping, and a more logical and well-structured iteration stage. Fig. 6 above shows the example of outcome reflecting on industry advice during the iteration stage. These findings highlight the effectiveness of industry-academic collaborations in enhancing the practical application of design thinking in educational settings.

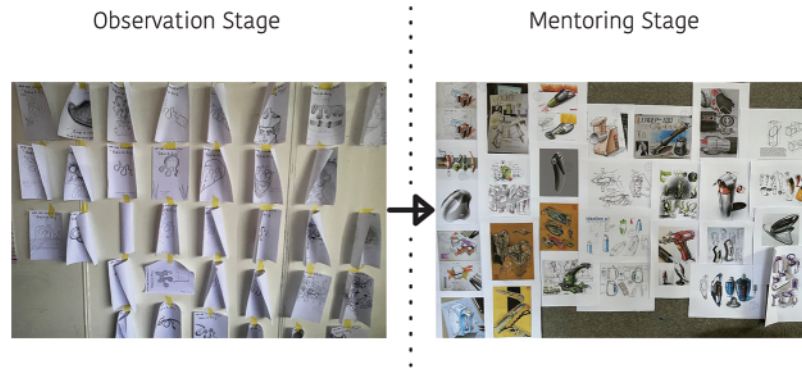


Fig. 4. Revisiting research during mentoring stage.

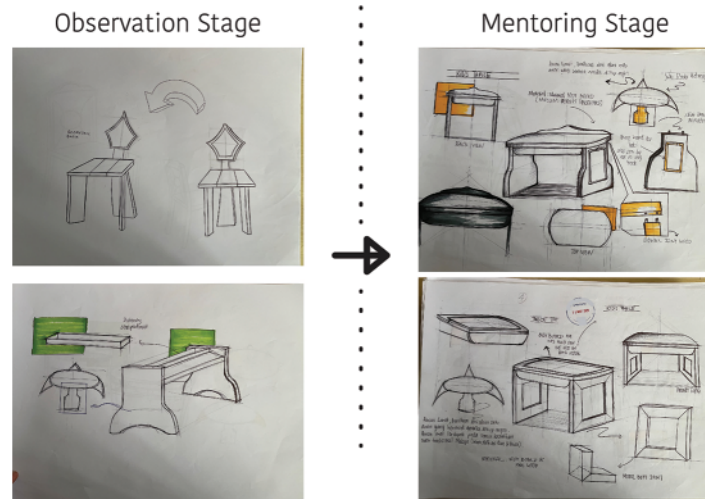


Fig. 5. Comparison of quality of ideas and presentation of design during observation and mentoring stage.



Fig. 6. More accurate prototyping using actual material during iteration stage with industry mentoring.

6. DESIGN PROCESS FOR DIPLOMA LEVEL: THE STEP FORWARD

Integrating design thinking and practical design processes is significant in academic and industrial contexts. Design education serves as a foundational framework for students to comprehend and apply creative problem-solving methodologies. Design processes foster innovation and prepare individuals to address real-world challenges. Previous research by Padzil et al. (2022) and Thi-Huyen et al. (2021) emphasises the pivotal role of design thinking in shaping students' problem-solving abilities, underlining its relevance in educational settings.

The initial phase of this research unveiled multifaceted insights into students' execution of tasks within the design process, as shown in Fig. 4, where students explore various potential outcomes in rough ideation sketches based on

reference images. It revealed a spectrum of strengths and weaknesses in the diploma student's application of design thinking within studio projects. This aligns with findings by Lor (2017), who observed varied student proficiency levels in embracing and employing design thinking strategies within educational environments. These observations formed a foundational understanding, setting the stage for collaborative efforts between academia and industry to study the future requirements to counter the issues. The joint sessions between academia and industry stakeholders were a comprehensive evaluation and discussion platform. One overarching agreement emerged: the critical importance of infusing real-industry practices into the curriculum. This alignment echoes the outcomes seen in studies by Salleh and Omar (2013) and Awasthy et



Fig. 7. Among the successful design that won award during the exhibition held by industry partners at the end of the project.

al. (2020), emphasising the synergistic benefits of collaborations between academia and industry in educational settings, particularly within design education.

Despite the educational stage, the reviews by academia and industry underscored the significance of exposing diploma-level students to genuine industry practices. This hands-on experience bridges theoretical knowledge and practical application, nurturing a deeper understanding of design thinking's role in crafting high-quality designs. The study by Camacho and Alexandre (2019) supports that real-world exposure enhances students' comprehension of design processes, preparing them for real-world challenges beyond academia. The discussions topped in actionable recommendations for enhancing the curriculum. The proposed changes aim to instil a more profound understanding of design thinking by integrating real-industry practices into the educational framework. Liao and Tang (2021) advocate for experiential learning and practical implementation in design education, reinforcing the need for a curriculum that mirrors real-world scenarios to expand students' skills and understanding.

The proposed curriculum improvements are a foundation for student's future endeavours, particularly in their transition to higher education. Equipped with an enriched understanding of design processes and thinking, students are poised to thrive in advanced academic pursuits. A study by Meyer and Norman (2020) affirms the significance of early-stage design education in shaping students' capabilities, underscoring its impact on their success in subsequent academic endeavours. Fig. 7 above shows some of the products displayed during the exhibition at the end of the project.

7. SUGGESTIONS FOR FUTURE CURRICULUM FOR DIPLOMA IN INDUSTRIAL DESIGN

The discussion between academia and industries regarding curriculum enhancements for equipping diploma students with a refined ability to engage in studio projects using design processes and design thinking presented crucial insights.

Firstly, the agreement emerged on the need to tailor department subjects towards a more specialised focus in

industrial design. Subjects like design marketing and drawing were highlighted as crucial when contextualised within industrial design. It was acknowledged that a generic approach to these subjects could have effectively translated the value of design within design marketing or drawing for industrial purposes. Therefore, the emphasis was placed on integrating these subjects within the specific industrial design framework, enabling students to grasp their relevance and application more effectively.

The suggestion to infuse the industry's approach within the early content of core department subjects found resonance among academia and industry experts. For instance, incorporating ergonomic principles within the syllabus, accompanied by a clear distinction in its application between designers and engineers, was deemed essential. Understanding the practical application of ergonomic design within the context of industrial design was seen as pivotal for students' comprehension and future professional practice.

A significant point of convergence was the early exposure to design thinking, commencing as early as the first semester. This introduction, embedded in a light project, was imperative to instil a foundational understanding of the design process. Recognising design as the core of the course, early exposure to design thinking was viewed as fundamental for students to grasp its stages and implications. Furthermore, each stage of the design process should be reflected in dedicated subjects within the syllabus. Aligning these subjects with industry practices was seen as crucial for bridging the gap between academic learning and real-world application. This approach aimed to ensure that students not only comprehend the theoretical aspects but also grasp the practical relevance of each stage in the design process.

Finally, a critical conclusion emerged: integrating design processes and design thinking should hold significant weight in the curriculum. These elements should be the secondary focal point after practical design skills. Emphasising the importance of understanding design processes alongside practical skills was seen as essential for producing industry-ready graduates.

The discussion between academia and industries highlighted the critical need to align curriculum content with industry practices, contextualise subjects within the realm

of industrial design, and prioritise early exposure to design thinking for diploma students pursuing studio projects. These proposed enhancements aim to bridge the gap between academic knowledge and practical application, ultimately better preparing the diploma students for the demands of the design industry.

8. CONCLUSION

In conclusion, this research has provided valuable insights into the capabilities of diploma-level industrial design students in Malaysia to employ design thinking in their projects. The study effectively bridged the gap between practical skills and design thinking, comprehensively understanding the students' abilities.

The research project, which involved designing a project with the theme of 'Redefining Local Culture,' provided a practical platform for students to apply design thinking principles at each stage of the design process. The study observed the students as they worked on their projects, with input from academic experts and industry professionals. The findings revealed areas for improvement in the student's research, ideation, prototyping, and iteration stages, and subsequent industry mentorship helped the students enhance these processes.

The study has underscored the importance of integrating industry insights into the curriculum to enhance students' practical application of design thinking. Suggestions for curriculum enhancements included tailoring subjects to a more specialised focus on industrial design, infusing industry approaches into core subjects, and providing early exposure to design thinking.

Potential future research could focus on the long-term impact of the proposed curriculum enhancements on the preparedness and success of industrial design graduates in the professional field. Additionally, exploring the effectiveness of different methods of integrating industry insights into the curriculum and their impact on students' practical application of design thinking could provide further valuable insights for educational institutions. Furthermore, comparative studies across different countries or regions could offer a broader perspective on the integration of design thinking in industrial design education. Overall, this research has provided valuable insights and recommendations for improving the industrial design curriculum in Malaysia, with potential for further exploration and development in the future.

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CONFLICT OF INTEREST

The authors declare that they do not have any conflict of interest.

REFERENCES

- Abdullah, S. (2020, June 17). Design thinking in fostering creativity and innovation [Paper presentation]. *Regional Program on Entrepreneurship Development in TVET Conference 2020*, Manila, Philippines.
- Ahmad Sayuti, N. A., Hashim, A. M., Abdul Karim, I. S., Hasan, A., Mamat Nawi, A., & Yusoff, F. (2018). A market study on the effectiveness of diploma of art and design, industrial design (DIDE) programme towards students' early academic and career development [Paper presentation]. *International Conference on Heritage and Civilisation (ICHAC) 2018, 2–3 May 2018*, Pulau Pinang, Malaysia.
- Andersson, T. (2021). *Aesthetic Flexibility—In Industrial Design Practice* (1st ed.). Linköping University Economic Press.
- Awasthy, R., Flint, S., Sankarnarayana, R., & Jones, R. L. (2020). A framework to improve university–industry collaboration. *Journal of Industry-University Collaboration*, 2(1), 49–62.
- Baha, E., Dawdy, G., Sturkenboom, N., Price, R., & Snelders, D. (2018). Good design-driven innovation. In C. Storni, K. Leahy, M. McMahon, P. Lloyd, E. Bohemia (Eds.), *Proceedings of DRS 2018* (pp. 98–111). Design Research Society.
- Camacho, B., & Alexandre, R. (2019). Design education. University–industry collaboration, a case study. *Design Journal*, 22(sup1), 1317–1332.
- Elsbach, K. D., & Stigliani, I. (2018). Design thinking and organizational culture: A review and framework for future research. *Journal of Management*, 44(6), 2274–2306.
- Ibrahim, M. H. (2002). The future of industrial design in Malaysia. *Seminar Kebangsaan Sains, Teknologi & Sains Sosial*, 314–320.
- Koskinen, I., Zimmerman, J., Binder, T., Redstrom, J., & Wensveen, S. (2011). *Design Research through Practice: From the Lab, Field, and Showroom*. Morgan Kaufmann Publishers.
- Laakso, M., & Clavert, M. (2014). Promoting creativity and design thinking skills among university students. *Revista de Estudios de La Juventud*, 104, 215–228.
- Liao, W. -J., & Tang, C. -H. (2021). Teaching implementation of practical education and innovative construction method. *Sustainability (Switzerland)*, 13(24), 1–19.
- Liem, A., & Sigurjonsson, J. B. (2012). The future of industrial design higher education driven by models of design thinking and reasoning. *Proceedings of the 14th International Conference on Engineering and Product Design Education: Design Education for Future Wellbeing, EPDE 2012, (September)*, 387–392.
- Lor, R. R. (2017). Design thinking in education: A critical review of literature [Paper presentation]. *Asian Conference on Education & Psychology*, Bangkok, Thailand, May 24–26.
- Malaysian Qualification Agency (2013). *Programme standards: Art and design* [Report]. The Malaysian Qualifications Agency.
- Meyer, M. W., & Norman, D. (2020). Changing design education for the 21st century. *She Ji*, 6(1), 13–49.
- Padzil, M. R., Karim, A. A., & Husnin, H. (2022). The needs of design thinking practices among D&T students based on teachers perspective: A qualitative approach. *Asian Journal of Research in Education and Social Sciences*, 4(1), 268–283.
- Rodgers, P., & Winton, E. (2010). Design thinking-a critical analysis. *DS 62: Proceedings of E&PDE 2010, the 12th International Conference on Engineering and Product Design Education-When Design Education and Design Research Meeting, Trondheim, Norway, September 2–3*, 42–47.
- Salleh, M. S., & Omar, M. Z. (2013). University-industry collaboration models in Malaysia. *Procedia-Social and Behavioral Sciences*, 102(1fee 2012), 654–664.
- Temple, S. Ed. (2018). *Developing Creative Thinking in Beginning Design*. Routledge.
- Thi-Huyen, N., Xuan-Lam, P., & Thanh Tu, N. T. (2021). The impact of design thinking on problem solving and teamwork mindset in a flipped classroom. *Eurasian Journal of Educational Research*, 2021(96), 30–50.