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PERCEPTIONS OF INDUSTRIAL DESIGN TEACHERS ON DESIGN THINKING IN MALAYSIAN ART SCHOOLS

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Abstract*: Education in Malaysia is taking a significant step towards embracing the wave of Industrial Revolution 4.0 to align with the demands of current progress. With this progress, creativity has become a vital asset in generating new ideas, which are crucial in various aspects of thinking. The education system required in the era of IR 4.0 must not only produce lifelong learners but also individuals with a comprehensive set of skills that adapt to today's rapid changes. In this context, creativity plays a central role in the process of design thinking (DT), which is essential for meeting current and future market demands. DT is a relatively new approach and has been integrated into the Industrial Design curriculum at Sekolah Seni Malaysia (SSeM) as part of the National Secondary School Curriculum (KSSM) since 2019. Given this intriguing integration, the main objective of this study is to explore and deepen our understanding of teachers' perceptions of implementing design thinking in teaching and learning for Form 4 students in the Industrial Design subjects at selected SSeM. This study employs a case study-based qualitative research methodology, with teachers who experienced in teaching Industrial Design as the subject matter expert. The results were analysed using an axial coding process, leading to sub-theme categorization. The findings reveal that DT, encompassing the entire design process, provides distinct advantages for both students and teachers by expanding their knowledge from familiar to unfamiliar contexts. This implementation empowers students to develop their design-based metacognitive strategies for solving novel problems.*

Keywords*: Design thinking, Problem Solving, Critical Thinking, Industrial Design Education, Teachers' Perception*

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Introduction

The Fourth Industrial Revolution (RI 4.0) is reshaping various aspects of our society, from the economy to politics, religion, finances, communities, and education. This impact is particularly pronounced in higher education, industry, and national policy. It underscores the importance of awareness and preparedness, particularly in the realm of education, as it leads us toward an increasingly uncertain and volatile future often referred to as the VUCA world.

VUCA, which stands for Volatility, Uncertainty, Complexity, and Ambiguity, has come to characterize the highly disruptive digital economy, posing challenges to organizations with incremental focuses (Murugan, Rajavel, Aggarwal, & Singh, 2020). Design Thinking (DT) has emerged as a valuable capacity and learning approach for tackling complex and often ambiguous problems, especially from a customer-centric perspective. DT's popularity in recent years stems from its application in navigating highly disruptive VUCA environments (Murugan, Rajavel, Aggarwal, & Singh, 2020; Tamara, Maulidan, Alkatili, Musyaffa, & Husniyah, 2021). Hence, it is imperative for researchers to delve deeper into the study of DT and its role in enhancing organizational learning.

The significance of DT in education has been recognized by contemporary researchers, including Li et al. (2019), Vaugh, Finnegan-Kessie, Donnellan, & Oswald (2020), Lynch, Kamovich, Longva, & Steinert (2021), and Balakrishnan (2022). DT in education is regarded as a comprehensive framework that offers students opportunities to learn and model critical thinking skills (Wright & Wringley, 2019; Li et al., 2019; English, 2019; McFadden & Roehrig, 2019).

In Malaysian Art Schools, the Industrial Design learning module was introduced in 2004 in the field of design specialization (Bahagian Pembangunan Kurikulum, 2011). Starting in 2019, this module was incorporated into the national secondary school curriculum, known as KSSM, and was designated as 'Industrial Design' within the design field in SSeM (Bahagian Pembangunan Kurikulum, 2019). The Malaysian education system continually seeks new ways to enhance student learning, equipping them with skills required to meet the demands of the 21st century. One promising approach centers on DT (Bahagian Pembangunan Kurikulum, 2019). Consequently, the application of DT in the teaching and learning process is considered suitable for aligning students' learning objectives with the requirements of IR 4.0's development and can serve as a model for other related subjects.

In light of this, this study was conducted to explore and deepen teachers' perceptions of DT in teaching and learning, as implemented for Form 4 students in the Industrial Design subject at selected SSeM schools. The study's findings are crucial in assessing the depth of understanding and the teachers' perceptions regarding the implementation of DT in the KSSM Industrial Design curriculum content and pedagogy during teaching and learning. This research aims to contribute to the development of creativity through critical thinking and learning competencies among students, preparing them to become valuable human resources in the related field.

Literature Review

While reviewing the existing literature, it becomes evident that there is a gap in extensive research related to Design Thinking (DT) in primary and secondary education, particularly in the context of Malaysia. Previous studies have primarily focused on DT development and implementation in higher education systems. While some international studies on DT have been conducted, their applicability to the Malaysian education context may not be straightforward.

Volume: 9 Issues: 61 [March, 2024] pp. 323 - 333
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There is a dearth of research on DT closely related to primary and secondary schools in Malaysia.

Kijima et al. (2021) argued that DT is not limited to a select group of people, and many individuals possess an innate aptitude for it. They emphasized that successful design thinkers may not necessarily come from design schools but often have some form of training. What is crucial for DT is the right mindset, as it provides the correct perspective for creating and innovating. Actions within the DT process are a reflection of attitudes and mindsets.

DT is a dynamic and non-linear framework characterized by an iterative process, typically broken down into five key steps: (1) Empathize, (2) Define, (3) Ideate, (4) Prototype, and (5) Test (Almaghaslah & Alsayari, 2022). To provide a comprehensive understanding, let's briefly outline these steps: 'Empathize' involves understanding the perspective of the end-users; 'Define' is about clearly identifying the problem or challenge; 'Ideate' encourages creative brainstorming for potential solutions; 'Prototype' involves creating tangible representations of ideas; and 'Test' is the phase for evaluating and refining the prototypes.

Goldman (2012) provides a straightforward explanation of DT in education, describing it as an approach that focuses on developing students' 'creative confidence.' In educational settings, DT engages participants in hands-on design challenges, emphasizing the development of empathy, a bias towards action, ideation, metacognitive awareness, and creative problem-solving. It serves as a formal method for the practical and creative resolution of problems or issues, with the ultimate goal of building a better future.

In the context of education, DT is not a novel concept, and its methods and strategies have been integrated into school curricula. It serves as an effective approach for students to apply the DT process to lessons taught by teachers. DT enhances their learning and problem-solving skills as they engage in every stage of the learning process.

DT in education can be segmented into three key dimensions: (1) DT in curriculum design, (2) DT as a Teaching and Learning (T&L) approach, and (3) teacher training and support for DT (Justyna, 2016). This study focuses on the analysis of the 21st-century skills model as part of the K-12 education reform agenda, particularly in the Philippines.

Mubin et al. (2017) emphasized the importance of pedagogical approaches to evaluate and develop new industrial products based on the latest DT and related methodologies for advancing educational design industry.

A systematic review conducted by Elsbach and Stigliani (2018) shed light on the relationship between DT and organizational culture. Their findings revealed three crucial insights: first, the effective use of DT tools within organizations significantly influences organizational culture. Second, organizational cultures can either positively or negatively impact the utilization of DT tools. Third, employing DT tools results in the creation of physical artifacts and emotional experiences within organizations.

Noh, Siraj, and Haili (2019) emphasized the growing momentum of integrating technology into education, including DT-based learning. Their study aimed to identify the essential elements needed for integrating technology as a tool for DT-based learning. Through a quantitative study with the Fuzzy Delphi method and expert consensus, the research identified eight elements

Volume: 9 Issues: 61 [March, 2024] pp. 323 - 333
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essential for successfully integrating technology into DT-based learning, with a consensus level of over 75%.

Problem Statement

In the era of the Fourth Industrial Revolution (IR 4.0), educators are grappling with increasingly complex challenges in fostering active and collaborative learning, particularly in problem-solving. The demands of the industry are evolving, and students must not only master theory but also practical skill sets that are highly sought after in the current job market (Khasanov, 2022).

Design Thinking (DT) fosters creativity, which is the epistemology of understanding a designer's thinking style in solving problems or achieving objectives. Knowledge of this DT style is invaluable for enhancing the effectiveness of the teaching and learning process, particularly in subjects like Industrial Design at Secondary School of Excellence in Malaysia (SSeM). However, there is a notable lack of empirical research focusing on the adoption and implementation of the DT process in an educational context from teachers' perspectives (Panke, 2019).

This study aims to explore teachers' perceptions, experiences, and the challenges they face when implementing DT within the new KSSM curriculum. It investigates an initiative by SSeM that seeks to bring innovative and creative approaches to teaching and learning, fostering innovation and creativity in students' thinking.

Specifically, this initiative introduces a DT process into the curriculum pedagogy, aiming to develop students' creative thinking skills and provide scaffolding for lifelong learning, aligning with the requirements of the 21st century and IR4.0.

The paper bridges a significant gap in the literature and provides insights into a recent initiative adopted by Malaysian art schools. The study employs qualitative case study research conducted in an art school, using teacher and student narratives as primary data sources. Data collection methods include in-depth interviews and participant observation. The findings are expected to demonstrate that teachers and students perceive the potential of DT in enhancing skills such as creativity, problem-solving, communication, and teamwork, while fostering empathy for others. However, the research also highlights several challenges, including inadequate resources, time constraints, fear of poor grades, and the difficulty of transitioning to a new teaching and learning approach that departs significantly from the traditional methods. These findings suggest that a piecemeal approach to curriculum redesign for DT adoption may not yield the desired outcomes.

Research Questions

The purpose of the exploring the T&L development of DT in the related schools was to extend the knowledge base that contributes to an improved understanding of the role of DT in classrooms. The qualitative study focused on the implementation of a design curriculum by the teachers and students during on Industrial Design class in a SSeM serving Form 4 students. These are the three key questions which framed the study:

1. What are teachers' and students' perceptions of the implementation of design thinking in the classroom during Industrial Design classes?
2. What challenges do teachers and students encounter when implementing design thinking in their teaching and learning processes?

Volume: 9 Issues: 61 [March, 2024] pp. 323 - 333
Journal of Islamic, Social, Economics and Development (JISED)
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DOI: 10.55573/JISED.096130

3. In what ways does the implementation of design thinking benefit the educational experience of students in the context of Industrial Design classes?

Methodology

The utilization of case study-based qualitative research in this study is notably suitable due to its inherent capacity for facilitating thorough investigations (Merriam, 2009; Creswell & Poth, 2018). Qualitative case study methodology equips researchers with the necessary tools to scrutinize intricate phenomena within the distinctive contexts they occur (Schoch, 2020). Moreover, case studies serve as invaluable instruments for gaining a nuanced comprehension of various aspects, including study design, participant experiences, and the insights gleaned from subject matter experts (Silverman, 2013). This approach enables researchers to delve deeply into the subject matter, explore its complexities within specific environments, and acquire comprehensive insights from firsthand sources, making it highly conducive to achieving the study's objectives.

Instrument

The study's subject matter experts (SME) primarily consisted of teachers who instruct Industrial Design to Form 4 students. The SME selection followed a purposive sampling technique to identify suitable participants for this study. The sample included individuals capable of providing all the necessary information on the topic under investigation (Merriam, 2009; Creswell & Poth, 2018).

Semi-structured interview techniques were used as the interview protocol. These techniques facilitated researchers in obtaining a wide range of in-depth data in a straightforward manner (Creswell, 2013). To enhance the reliability of information provided by the subject matter experts, the researcher sought and obtained permission and cooperation for participatory observations.

Additionally, the researchers employed probing and questioning techniques to encourage subject matter experts to provide in-depth explanations. This data extraction approach allowed the researchers to obtain valuable insights and enhance data collection. The extraction method involved capturing the viewpoints, explanations, and expressions of the subject matter experts (Yin, 2018).

Sampling

Based on the focus of the study, the selection criteria for SME are as follows: a) the study's subject matter experts were teachers who teach the subject of Industrial Design at SSeM; b) teachers who have experience with design thinking in Industrial Design subjects at SSeM; and c) the willingness of subject matter experts to share their insights, experiences, and practices in the T&L process.

A total of three SMEs, all of whom are teachers involved in the Industrial Design T&L process, were included in the study. To ensure the anonymity of the subject matter experts, all information related to the study participants will be kept confidential, including the use of nicknames instead of real identities, and the concealment of data collection locations and subject matter expert organizations throughout the research.

Volume: 9 Issues: 61 [March, 2024] pp. 323 - 333
Journal of Islamic, Social, Economics and Development (JISED)
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Table 1: Details of DT subject matter expert

Subject Matter Expert (SME)	Age	Education	Teaching Experience	Expertise
SME 1	42	Master's degree	10 years	Industrial Design
SME 2	35	First Degree	5 years	Art and Design
SME 3	38	First Degree	7 years	Art and Design

Table 1 presents the details of DT subject matter expert who participated in this study. There are three (3) respondents, namely, SME 1, 2, and 3, all of whom have a strong background and experienced in teaching in Art and Design subject. They were selected from SSeM Johor Baharu. This art school was chosen because the teachers there were the most experienced in teaching the Art and Design subject and the SSeM Johor Baharu is more established compared to the other relatively newer art schools in Malaysia. Additionally, this choice is influenced by the recent introduction of the topic of design thinking by the Curriculum Development Division of the Ministry of Education Malaysia (MOE).

Data Collection and Analysis

Data analysis for the present study encompassed a variety of sources, including interviews, documentary analysis, and highlights from the literature. As suggested by Silverman (2013), data analysis does not necessarily need to commence only after all data has been collected; instead, it can begin with transcriptions from the very first interview or observations and existing field notes. In this study, the data obtained were analyzed using the constant comparative method, as recommended by Merriam (2009). Upon reaching a saturation point and collecting all the data, the researchers combined and categorized the data according to common aspects. This process is termed categorization. It allowed the researchers to compare all the segments formed, identifying similarities and differences in the data from all SMEs, especially during the category construction process. Numerous categories were developed, and this crucial process aided in forming the final theme. Each interview lasted for approximately one to two hours, and data analysis was conducted concurrently with data collection. This involved reviewing the data, making relevant notes, and organizing the information. Categories and sub-categories were generated and coded as part of the analysis process.

Data Management

To ensure that the findings are analyzed in an orderly and easily accessible manner, each recording and transcript of the interview copy were properly labeled. This is important for the researchers to obtain and re-access data. This study provided each SME with a name code, and each interview was labeled with interview details, such as the date and time the session was conducted.Besides, a systematic data management approach to facilitate data validation for follow-up interviews was deemed essential. In relation to this, Creswell and Poth (2018) suggest five basic steps: collecting verbal data, reading data, breaking down data into specific sections, organizing and expressing data. The final step in data management adopted in this study was to synthesize and formulate data.

Volume: 9 Issues: 61 [March, 2024] pp. 323 - 333
Journal of Islamic, Social, Economics and Development (JISED)
eISSN: 0128-1755
Journal website: www.jised.com
DOI: 10.55573/JISED.096130

Table 2: Interview Questions

Research Questions	Questions posed to SME
What are teachers' and students' perceptions of the implementation of design thinking in the classroom during Industrial Design classes?	1. What is the teacher's opinion on design thinking? 2. What is the teacher's perception of the implementation of the contents?
What challenges do teachers and students encounter when implementing design thinking in their teaching and learning processes?	3. What are the curriculum contents for teaching and learning of design thinking? 4. What pedagogical approaches are being used to teach design thinking? 5. What are the students' learning abilities?
In what ways does the implementation of design thinking benefit the educational experience of students in the context of Industrial Design classes?	6. How does the implementation support teaching and learning? 7. How can it develop student's thinking skills and abilities?

Table 2 presents the semi-structured interview items used with respondents in response to the research questions. A verbatim transcript of each remark was created, including detailed recording of the date, time, and duration of the interview sessions. The transcription process is time-consuming to ensure accurate results and prevent any data loss.

Results and Discussion

Upon completing all coding processes for all SMEs, the researchers examined each independent code by linking relevant codes as part of the axial coding process. As suggested by Silverman (2013), the researchers conducted a code selection to ensure that only relevant and significant codes were chosen for the formation of categories. Subsequently, sub-themes were developed through organizing the relevant categories, and these categories supported the sub-themes. Finally, new themes were formed from sub-themes that were considered exclusive and mutually exclusive within their respective themes, without overlapping with other themes, following the approach outlined by Yin (2018). Therefore, the themes that emerged are mutually exclusive and correspond to the responses for each research question. The study's results, derived from the interviews, revealed five main themes that serve as the basis for the discussion in the research findings.

Viewpoints on Design Thinking

From the research, it is evident that all the respondents, namely SME 1, SME 2, and SME 3, were well aware of the DT approaches in the field of Industrial Design and its relevance to design education. SME 1, who was a scholar in the field of industrial design, elaborated on this concept extensively. It was apparent that DT practices aim to provide an innovative process for solving design problems. They emphasized that the best solutions to design problems often emerge through a multidisciplinary and collaborative environment that requires a thoughtful design process. They recognized the significance of teaching DT in the context of the Industrial Design subject at SSeM and believed that this thinking skill can help foster their students' maturity in their design perception as well as their social learning process. SME 1 and SME 3

Volume: 9 Issues: 61 [March, 2024] pp. 323 - 333
Journal of Islamic, Social, Economics and Development (JISED)
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also pointed out that DT can be applied to other subjects, especially in the fields of art and design.

The study's findings also indicate that DT learning can create an enjoyable and engaging learning atmosphere. This is particularly valuable, as one of the significant challenges for teachers is maintaining student engagement throughout the teaching and learning process (Indiana University, 2010). When students have an enjoyable learning experience, they become more actively involved in learning activities and are diligent in completing assignments. This was evident in SME 1's statement, as documented in the transcribed notes.

Learning Contents

The findings from this study reveal that the respondents utilized the Industrial Design Form 4 Curriculum and Assessment Standard Document, known as Dokumen Standard Kurikulum dan Pentaksiran (DSKP), as their guide to plan and evaluate their teaching and learning activities throughout the year. In terms of references, they primarily relied on the SSeM Form 4 Design Specialization Textbook, which is based on the Form 4 DSKP. Both of these documents are provided and can be downloaded in PDF format from the Ministry of Education (MOE) websites.

SME 1 and 2 explained that they plan various activities based on inquiry-based learning to stimulate students' critical and creative thinking. This textbook prioritizes self-learning, allowing students to assess their own progress. However, the content of DT topics in the textbook is considered too concise and basic. The subject matter experts believed that there is a need to find additional materials to support and enhance teaching and learning activities. SME 1 also noted that the teaching guidelines for teachers in the DSKP are provided in a suggested content format and lack detailed explanations. This can pose challenges, especially for new teachers, when delivering the learning content due to the insufficient information provided. These findings align with a study by Gajda, Beghetto, and Karwowski (2017), which suggests the need to create supplementary modules as teaching aids in the classroom. It emphasizes the importance of adding teaching aids to facilitate instruction. Consequently, these findings imply that DT educational modules should be developed and introduced, while teaching tools, instructional aids, and modules should be provided at the school level to overcome challenges in implementing DT in subjects.

Teaching and Learning Strategies

Teachers employ a variety of teaching approaches and methods in an effort to deliver DT content effectively. For instance, instructors utilize project-based learning (PBL) methods that emphasize problem-solving, critical thinking, and cooperation. Furthermore, assignments given through this method are based on real-world situations. These findings are consistent with studies conducted by Kozinski (2018), which demonstrate that PBL can enhance learning effectiveness compared to traditional approaches in social learning, science, mathematics, and literature. The SMEs in the present study explained that they integrated DT techniques and practices, such as sketching, idea development, and refinement, into the students' learning experience throughout the subject.

SME 1 and 2 emphasized that various activities can be planned based on inquiry-based learning to stimulate students' critical and creative thinking. Self-directed learning is prioritized in this book, enabling students to assess their own progress. Furthermore, design-based learning can incorporate cross-curricular elements that enhance skills and competencies, aligning with the

Volume: 9 Issues: 61 [March, 2024] pp. 323 - 333
Journal of Islamic, Social, Economics and Development (JISED)
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human capital requirements desired by the Ministry of Education Malaysia to address current and future challenges. This is supported by SME 1's statements in the transcribed notes. SME 1 also suggested that this five-step model of empathize, define, ideate, prototype, and test can be applied within the school itself.

The research also revealed that SME 1 considered that some teachers lack competence in implementing DT. One visible gap in competence is related to teacher knowledge in implementing DT, leading them to assume that DT learning is only suitable for specific subjects. SME 3 supports this view, believing that DT should be taught by subject matter experts in the field of Industrial Design. SME 3 also stressed that while teachers are positive about changes initiated by the Ministry of Education, their knowledge and workload limitations sometimes result in deviations from the intended instructional goals.

Students' Learning Competency

Identifying and implementing quality teaching and learning (T&L) assessment tools is a constant challenge for educators, and assessing DT work is no different. Understanding how to articulate student mastery and growth in relation to DT learning can be a struggle. Given the nature of the process, learning outcomes may not be immediately evident, which can make some educators uncomfortable. To address this, some respondents, such as SME 1 and 3, have utilized pacing guides to help them stay on track with curriculum frameworks. Articulating the duration of each phase of the process and connecting the work to student outcomes can facilitate the smooth progression of the process.

This study recognized diverse student learning competencies among the respondents. The SMEs noted that these competencies result from careful instructional planning, encompassing skills in prototyping, emotional intelligence, the ability to adopt different perspectives, empathy, and a specific mindset in teaching and learning. The development of these creative competencies ultimately leads to the acquisition of creative confidence, which assures students of their own abilities to act and think creatively.

Benefits of Design Thinking

The study findings emphasize that DT places empathy at the core of all work. The perspectives and needs of the end-user are central to the process. For all the respondents interviewed by the researchers, the benefits of involving students in a process that consistently focuses on the needs of others far outweigh the challenges they encounter. SME 2 stated that DT has helped recognize the value of connecting with students. SME 2 also emphasized that after understanding the importance of empathy in DT, they spend more time building relationships with students at the beginning of the year.

The subject matter experts also believed that this increased focus on empathy has improved their teaching and learning experience by fostering deeper connections with students. However, it is not just the emphasis on empathy that makes DT valuable. All the subject matter experts viewed DT as a way to adopt a more human-centered perspective in their own world. While there are challenges to DT due to the shift in the learning process and teaching approach, as discovered by SME 1, they agreed that DT can also help teachers embrace a new mindset that includes growth, reflection, and a willingness to learn from failure. This mindset is not limited to the classroom; it has changed how SME 3 perceives everything, affecting their thinking skills in engaging others and making decisions in both teaching and personal life.

Volume: 9 Issues: 61 [March, 2024] pp. 323 - 333
Journal of Islamic, Social, Economics and Development (JISED)
eISSN: 0128-1755
Journal website: www.jised.com
DOI: 10.55573/JISED.096130

Conclusion

Many secondary school students in Malaysia have limited exposure to DT and creative problem-solving, which hinders their development as creative thinkers. In this study, the researchers presented findings regarding the perceptions of DT in teaching and learning among Industrial Design teachers in Malaysia Art School Johor Bahru. The purpose was to underscore and clarify the benefits of incorporating such pedagogy for SSeM students. The findings revealed that DT, involving the entire design process, offers distinct advantages for both students and teachers as it shifts their knowledge from familiar to unfamiliar contexts. This implementation empowers students to develop their design-based metacognitive strategies for solving novel problems. Furthermore, DT skills can motivate and empower students with various cognitive learning styles to excel in their coursework. The study also highlighted motivation as a key factor in creative problem-solving and critical thinking, which can be fostered through problem identification and open-ended activities like PBL and inquiry-based learning. The study suggests that this curriculum should be adopted by other secondary schools, as indicated by the respondents, showcasing its success. This underscores the importance of teaching DT and problem-solving strategies in secondary education, as recognized by school educators.

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Volume: 9 Issues: 61 [March, 2024] pp. 323 - 333
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