Design Thinking in Learning and Innovation towards Design Process in IR 4.0

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Abstract
This paper explores the advanced concept that can inspire innovation, but the difficulty can also encourage it. Innovation is crucial in today's fast-paced world when people's perceptions may shift quickly. This study examines how the Design Thinking application is helpful in learning and innovation towards the design process in Industrial Revolution (IR) 4.0 in the classroom among students to innovate and connect the growth of the more advanced age with a creative style of thinking throughout time. When students use design thinking, they can come up with new ideas.

Keywords: Design Thinking; Industrial Revolution; Learning

1.0 Introduction

We have entered a turbulent era in which the Industrial Revolution (IR) 4.0 is bringing about rapid and significant changes in people's lives (see Romero-Gázquez et al., 2020). In terms of the skills and resources available to the next generation of leaders in the coming years. Because of this, innovation has become the most critical factor for all organizations. Innovation becomes very important to keep the organization effective and efficient in achieving goals (Chumiran, Zainal Abidin, Rahim, & Vermol, 2021). In an organization, innovation begins with the presence of intelligent individuals who have the 'sense' to discover new needs, who then create or improvise them into new methods, processes and resources to meet those unique needs. Technological advances are growing rapidly. Therefore, the things we can enjoy today may never have been imagined. If it used to start with technology that could hear people's voices separated by distance and time, now we have come to technology where we can receive visual images in addition to audio. The researcher cannot imagine the technology stand-alone that will emerge in the next fifty or a hundred years. That is one example of technological development that we can enjoy today, and there are many more impacts of development today (Toyong, Abidin, & Mokhtar, 2021a). The presence of the Industrial 4.0 revolution is no longer inevitable. The world must prepare strategic measures to adapt to the digital industrial era. The world is committed to building a globally competitive manufacturing industry by accelerating the implementation of Industry 4.0. Creating a solution with a specific design requires methods in the manufacturing and design process. Of course, the design is in the form of product innovation or application that can be useful to many people. In the context of aesthetics goal of a design concept toward formgiving can be defined or interpreted as a natural (e.g., beautiful or ugly) form and as a creation for spatial condition (Zainal Abidin, Sigurjónsson, Liem, & Keitsch, 2008). However, to relate something visual to the physical and emotional world, designers must transform brief and background information into a new idea (Abidin, Bjelland, & Øritsland, 2008). With time's passage and development, the design process's

essence began to change and evolve. This design is not just a product or application that can be easily sold in the market, has an attractive and beautiful shape, or is easy to make. But design is something about creating or making a product that is wanted and needed by users or people.

2.0 Literature Review

2.1 Design Thinking Application in Education
Design Thinking (Design Thinking) is a method for creative problem-solving using strategies used by designers during the design process (design). Design thinking has also been developed to solve problems beyond professional design practice, such as in complex business, economic, political, and social contexts. Design thinking is one of the new ways to design where the focus of the problem is on the user or user. Design Thinking was popularized by David Kelley and Tim Brown, the founders of IDEO - a design consultant with a background in innovation-based product design.

"Design thinking is a human-centered approach to innovation that draws from the designer's toolkit to integrate the needs of people, the possibilities of technology, and the requirements for business success".

-Tim Brown, Executive Chair Of IDEO

According to designthinking.ideo.com, Design Thinking is a mindset of designers who in solving problems always with a human-oriented approach. This has been used in a variety of sectors and disciplines, including business, innovation, social good, and, more recently, education and learning in general (Lor, 2017). Other than that, the author Lor (2017) cited Brown (2009) mentioned that design thinking is a powerful, successful, and widely accessible way to impact innovation that can be used in education, business and other sectors. Because of the wide range of applications of Design Thinking as a management and learning method, particularly in how it tackles issue solving.

According to (Glinski, 2012), there are four stages in design thinking, namely the stage of balance, thinking framework, the use of tools/toolkits, and approach patterns. The first stage of balance is the concept of stability, which will prove that innovation must be achievable and established by an invention. The second stage of the thinking framework. The process of innovating requires searching for new ideas by researching and learning new and future things to produce a human-centred perception. The third stage is the toolkit. Innovation needs a way to present the results of its ideas. Many designers use drawing, illustrating, prototyping, storytelling, etc., to present ideas (see Siran, Zainal Abidin, & Anwar, 2020). The last stage is the approach pattern (see Toyong, Abidin, & Mokhtar, 2021b).

2.2 Stages of Design Thinking Process
There are a number of different models that fall under the umbrella of design thinking. The d.school at Stanford University model is frequently used. This model has five modes:

i.Empathize: Students must observe, engage, watch, and listen. The purpose is to understand people/users / consumer, within the context of their design challenge. Who are they designed for, and what is the problem that needs solving? Empathy is the first stage of the design thinking process. In the concept of design thinking, this stage is an effort to know, explore, and understand the state, thoughts, and feelings of others in this community as users. For empathizing to be done well, it requires thinking critically, communicating, and asking questions with empathy. This stage aims to develop students' sensitivity to studying and identifying the community's needs. By understanding and recognizing the needs of potential users, thus students can generate innovative ideas that truly solve the problem.

ii.Define: Students define the challenge based on their new understanding of the people/user / consumer and the problem. Students write a meaningful problem statement to guide their actions. Information that has been collected during the empathy phase is examined and synthesized to determine the core issues to be identified. This stage aims to take a significant problem that can be solved with innovative ideas. The main problems or needs of users will be solved through the products that will be developed. This experience will help students think strategically and analytically whether the solution that will be given is the best solution or not.

iii.Ideate: Students need to generate an idea. Every idea is welcome. Judgment is suspended so the team can move beyond obvious solutions and find innovative ideas to explore. This level is the stage to generate ideas, all ideas will be covered to solve problems that have been set at the defined level. The concepts students create are some alternative solutions to problems that have been formulated before. Design thinkers must be able to produce creative and innovative ideas.

iv.Prototype: Students start building their solution for the end-user. This is an iterative process that tolerates failure. Prototypes do not require too much commitment of time or resources. This stage aims to produce a real product that can be tested according to the user's needs. When there is input, further improvements are made to this prototype, resulting in a good prototype. Students will develop innovative ideas through a chart or an illustration. Once a picture of an idea is made, it resembles an idea that is almost certain to happen. Next, it will be presented, if there is any feedback or feedback, then improvements should be made to the ideas they develop. Innovators must be prepared for the possibility of failure in product development but must keep retrying until the expected product can be realized.

v.Test: Students seek feedback on their prototypes from end-users. It is an opportunity to: gain empathy for and understanding of the people they are designing for, to refine prototypes and solutions. Products that have been developed need to be tested through an experiment that involves users. This stage aims to test and evaluate the product to the public, and the results will be changes and improvements, and to gain an in-depth understanding of the product and its users.

The five modes are not always sequential. Students do not have to follow any specific order and can often occur in parallel and repeat iteratively. Students cycle through the process multiple times to arrive at a workable end solution.

3.0 Methodology

3.1 Participant
This research involves 10 (ten) students in Faculty of Art and Design study programs from institutions, namely the Universiti Teknologi MARA (UiTM). In the demands of a collaborative method, these students are asked to work individually and being asked to complete a design challenge.

3.2 Research Instrument

Table 1. Results of descriptive & inferential analysis General Self Efficacy (GSE)

No	Variable Self-Efficacy / Self-Regulation	Rate Scale
1	I enjoy taking a lot of chances, even if it means making mistakes.	3 (Neutral)
2	I enjoy taking a lot of chances, even if it means making mistakes.	5 (Strongly Agree)
3	During the design phase, I spend a significant amount of time determining what users require.	5 (Strongly Agree)
4	I can quickly relate to other people's issues.	4 (Agree)
5	Design Thinkers are aware of the process in the sense that they understand where they are in the design process and if they are in a convergent or divergent phase.	3 (Neutral)
6	This is the ability to look at the big picture and examine a variety of aspects such as socioeconomic patterns, relationships, and dependencies.	4 (Agree)
7	Problem reframing is the process of reformulating the original problem.	5 (Strongly Agree)
8	To better communicate and clarify what they have in mind, Design Thinkers must collaborate, share their knowledge, and discuss using visualization tools.	4 (Agree)
9	Each Design Thinker must work in a multidisciplinary team with people from various backgrounds, perceptions, and perspectives or with people from other organizations.	5 (Strongly Agree)
10	Diversity can be defined as the collaboration of diverse teams as well as the incorporation of diverse outside perspectives throughout the process.	4 (Agree)

This instrument has high reliability in measuring self-motivation for a task, from its inception to the present, with 10 statement items and a scale of 5 (five) points. The process of measuring the level of success of the application of design thinking on 10 (ten) projects involving ten students is done at the end of the project. Measurement is based on students' General Self Efficacy (GSE) in completing assigned tasks. GSE is defined as ten variables with 5 (five) scale points. Table 1 shows the processed results of the SPPS statistical

3.3 Collection and Analysis
The research procedure begins with applying step-by-step design thinking until the project solution is produced. Self-regulation performance measurement (self-regulation) is done after the students complete their project. For the measurement results, non-parametric analysis was performed using the SPSS statistical package to (1) provide descriptive statistical results in describing the empirical findings and (2) provide inferential statistical results in proving that the calculation results correspond to the population.

4.0 Findings and Discussion
In agreement with the IDEO (2011) design thinking stage in the formulation of *Discovery, Interpretation, Ideation, Experiment, and Evolution steps*. In this study, these 5 (five) steps will be carried out and can be reported systematically below (see Table 2).

Table 2. 5 (Five) Steps of Design Thinking Stages

Phase	Activities	Remarks
1	Discovery stage	In this stage, the students need to perform a problem-solving process, identifying the participants involved to be interviewed in inspiration excavation, research planning from the beginning of the division of labour, question list, venue plan, equipment, and time allocation. Immerse themselves in the context/ environment of the problem, both during interviews and observations, is always done by asking "what or how?". So what is a finding is a new insight/ perception that will be an inspiration and should be recorded as a concise and clear keyword, where one keyword is recorded in one post.
2	Interpretation stage	The inspiration gained during these interviews and observations is told in the "story telling" forum, which is then captured by the forum in their respective perceptions. Thus, the perception becomes an increasingly fruitful inspiration for each project. Once all the inspiration has been gathered, it is time for the team to group and categorize based on similar themes/ topics. A more in-depth study of existing themes makes the relationship between themes clearer and produces a framework of action and opportunity.
3 and 4	Ideation and Experiment Stage	In generating ideas based on these action plans and opportunities, the team will focus on the number of ideas and the potential to always add to previously generated ideas. The process can also go hand in hand while producing prototypes that can be tested. Utilization of temporary materials and capturing the embodiment of ideas through scenario models, video or role play can also represent a prototype.
5	Evaluation Stage	In this stage, the team obtains responses from its potential users on prototype testing. This feedback is followed up by making design improvements. The team documents all processes and prototypes of its work in various multimedia packages to be ready to be realized or developed with investors. With these four steps, Design Thinking may enhance the learning process, allowing students to grasp capabilities more efficiently while having fun. It also encourages students to think creatively and critically. Design Thinking, which promotes the Discovery-Interpretation-Ideation-Experimentation-Creation process, may be used to create an application. The tendency that happens in the conventional notion of learning is a learning pattern based on: Behaviourism (understanding and remembering), where learning occurs in response to external stimuli, and Constructionism (creation and assessment), in which learning is defined as the process of acquiring and storing information, and Cognitively (analysis and application), in which learning is defined as the process of constructing knowledge. The foundation of connectives (recognition, understanding, and connection) is emerging in the digital era, where the learning process is accomplished by linking the points of existing knowledge sources. A full learning process emerges when the aforementioned classical learning theory is combined with the connectivity learning process in the digital era.

5.0 Conclusion and Recommendations

A complete learning process emerges when classical learning theory is combined with the context-based learning process in the digital era. To obtain full results with the appropriate learning process at this time, then by applying the rules of Design Thinking, the learning process can collaborate on current needs by paying attention to various aspects of education and the development of scientific skills. Design Thinking also accommodates to development of left-brain skills related to writing skills, language, science, mathematics and logic while synergizing it with right-brain skills were exploring creativity, spatial awareness, imagination, dimensions, music, art and more. These stages of design thinking can be practiced in or out of the classroom. To improve students' ability to build critical thinking abilities and creative thinking and jointly and progressively generate unique ideas. Students are sensitive to and concerned about the challenges that will be addressed, particularly in the subject of study they are studying and in general. Hopefully, this study can help students and researchers understand and use Design Thinking more.

Acknowledgements

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