THE RELATIONSHIP OF DESIGN THINKING PROCESS WITH 21ST CENTURY LEARNING SKILLS AMONGST STUDENTS OF ENGINEERING PROGRAMS IN MALAYSIA POLYTECHNICS

MOHAMAD IZHAM SHAH BIN HAMDAN

A project report submitted in partial fulfilment of the
requirements for the award of the degree of
Master of Education (Technical and Vocational Education)

School of Education
Faculty of Social Sciences and Humanities
Universiti Teknologi Malaysia

FEBRUARY 2021

DEDICATION

This project report is dedicated to my father, Hamdan Bin Mohamad, who taught me that the best kind of knowledge to have is that which is learned for its own sake. It is also dedicated to my mother, Roshada Binti Mohd Tahir, who taught me that even the largest task can be accomplished if it is done one step at a time. Not forgetting my supervisor, Assoc. Prof. Ts. Dr. Aede Hatib Bin Musta'amal @ Jamal and all my fellow friends who have helped me completing this project. My dedication also for any engineer and educator graduates out there that are struggling for the best, May Allah ease and bless our life.

ACKNOWLEDGEMENT

All praise to Allah s.w.t. for letting me to have an opportunity to finally reached this level despite all the hardship happens due to pandemic of COVID 19. In preparing this thesis, I was in contact with many people, researchers, academicians, and practitioners. They have contributed towards my understanding and thoughts. I wish to express my sincere appreciation to my main thesis supervisor, Assoc. Prof. Ts. Dr. Aede Hatib Bin Musta'amal @ Jamal, for encouragement, guidance, critics, and friendship. Without his continuous support and interest, this thesis would not have been the same as presented here.

A token of appreciation too for polytechnics students who are willing to participate in my research, especially from Politeknik Mukah and their student representative council who are willing to give majority contribution to the research.

I am also very grateful due to Universiti Teknologi Malaysia (UTM) for providing my master's degree study throughout 1 year and a half in Johor.

My fellow postgraduate student should also be recognised for their support. My sincere appreciation also extends to all my colleagues and others who have aided at various occasions. Their views and tips are useful indeed. Unfortunately, it is not possible to list all of them in this limited space. I am grateful too for all my family members that keep supporting me unconditionally.

ABSTRACT

The purpose of this research is to identify the current level of 21st century learning skills and level of Design Thinking among the polytechnic students around Malaysia. Another purpose of this research is to identify the relationship of Design Thinking with 21st century learning skills. Total of 335 students of polytechnic around Malaysia are willing to participate in this research by answering the questionnaire made for this research, which the students have been selected with simple random sampling through online method such as official email and Facebook, since face to face approach is not possible to be done during pandemic. The data has been collected for further analysis such as using Statistical Packages for Social Sciences (SPSS) software. The results show that majority of the polytechnic students are having high level of communication skills, high level of creative thinking, medium level of critical thinking, high level of collaboration skills, and high level of character development, in perspective of level of 21st century learning skills. Majority of polytechnic students also have high level of empathic, high level of defining problem, high level of ideation, high level of prototyping, and high level of product testing, in perspective of level of Design Thinking. Inferential analysis shows that there is no significant different of 21st century learning skills level and Design Thinking level among gender, courses, and year of study. In addition, there is a significant relationship of 21st century learning skills with Design Thinking, with strong correlation. Next, further discussion is done on implication of the study and recommendation of future research regarding Design Thinking in TVET institutions.

ABSTRAK

Tujuan penyelidikan ini adalah untuk mengenal pasti tahap kemahiran pembelajaran abad ke-21 dan tahap *'Design Thinking'* dalam kalangan pelajar politeknik di seluruh Malaysia. Tujuan lain penyelidikan ini adalah untuk mengenal pasti hubungan *'Design Thinking'* dengan kemahiran pembelajaran abad ke-21. Sebanyak 335 pelajar politeknik di seluruh Malaysia bersedia untuk mengambil bahagian dalam penyelidikan ini dengan menjawab soal selidik yang dibuat untuk penyelidikan ini, di mana para pelajar telah dipilih dengan pensampelan rawak mudah melalui kaedah dalam talian seperti e-mel rasmi dan *Facebook*, kerana pendekatan secara berhadapan adalah tidak boleh dilakukan semasa pandemik. Data telah dikumpulkan untuk analisis lanjutan seperti menggunakan perisian *Statistical Package for Social Sciences* (SPSS). Hasil kajian menunjukkan bahawa majoriti pelajar politeknik mempunyai tahap kemahiran komunikasi yang tinggi, tahap pemikiran kreatif yang tinggi, tahap pemikiran kritis yang sederhana, tahap kemahiran kolaborasi yang tinggi, dan tahap pengembangan watak yang tinggi, dalam perspektif tahap kemahiran pembelajaran abad ke-21. Majoriti pelajar politeknik juga mempunyai tahap empati yang tinggi, tahap masalah yang tinggi, tahap penghasilan idea yang tinggi, tahap prototaip yang tinggi, dan tahap pengujian produk yang tinggi, dalam perspektif tahap *'Design Thinking'*. Analisis inferensi menunjukkan bahawa tiada perbezaan yang signifikan terhadap tahap kemahiran pembelajaran abad ke-21 dan tahap Pemikiran Reka Bentuk antara jantina, kursus, dan tahun pengajian. Di samping itu, terdapat hubungan yang signifikan terhadap kemahiran pembelajaran abad ke-21 dengan *'Design Thinking'*, dengan korelasi yang kuat. Seterusnya, perbincangan lanjutan telah dilakukan mengenai implikasi kajian dan cadangan penyelidikan pada masa depan mengenai *'Design Thinking'* di institusi PTV.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF ABBREVIATIONS

DT	-	Design Thinking
HOTS	-	High Order Thinking Skills
ICT	-	Information and Communication Technology
IPG	-	Insitut Pendidikan Guru
TVET	-	Technical and Vocational Education Training

LIST OF SYMBOLS

N	-	The number of items
$\bar{c}$	-	average covariance between item-pairs
$\bar{v}$	-	average variance

LIST OF APPENDICES

CHAPTER 1

INTRODUCTION

1.1 Introduction

Malaysia's Ministry of Education has been stressing lots on 21st century learning among the teachers and students (*Kementerian Pendidikan Malaysia*, 2019). Since it is being introduced during Malaysia's Education Development Plan 2013-2025 (Mohd Rusdin and Ali, 2019), 21st century learning basically implementing the recent ways of learning and teaching in classroom especially in teaching aids and environment, in advance can increase the quality of the students on par with global benchmark, especially fulfilling industrial or society needs. Malaysia's Ministry of Education has a good attention of all the education fields, including TVET field on issues of graduates' quality. That is why 21st century learning takes part as an alternative for better education. Stated by Ministry of Educations in Malaysia's Education Development Plan (Ministry of Education of Malaysia, 2013), six main characteristics needed by students in ensuring good benchmark for global are Knowledgeable, Thinking Skills, Leadership Skills, Bilanguage Skills, Ethics and Moral Values, and National Identity.

21st learning can be executed based on few characteristics, which are student centred learning, computer as teaching aid, active learning among students, self-learning, conducive learning environment, students that understand and obey the instructions from teacher, respect culture among students and teachers, students that are responsible on their learning, achievement based assessment, and collaborative learning (*Apakah Pendidikan Abad Ke-21*, 2017).

Based on the 21st century learning, few aspects are being targeted to be applied by the students at the end of the day. Teachers that apply 21st century learning should be able to create students that can communicate well, have good collaborative skills,

critical thinking, creative thinking, and moral values and ethics practice among students (*Apa Itu Pembelajaran Abad Ke 21 (PAK21)*, 2018). All these five elements are important in ensuring the best ready-to work graduates for industry or society. The real question is, do TVET learning system has the best characteristics to fulfil the elements of the 21st century learning? Do TVET graduates has the employability skills that has been decided by the industries?

Design Thinking is a process of problem solving analytically and creatively through obtaining data by experiments for creating a prototype and testing, followed by feedbacks from targets of the prototype test field (Razzouk and Shute, 2012). Although Design Thinking is claimed to be no standardized model (Waidelich *et al.*, 2018), but we will be focusing on Design Thinking Model proposed by Hasso Plattner Institute of Design, because the model has the steps that commonly mentioned on others model, which are Ideate and Prototype (Waidelich *et al.*, 2018). This model basically has 5 stages, proposed by Hasso Plattner Institute of Design (Friis Dam and Siang Teo, 2020), which are Empathise, Define, Ideate, Prototype and Test. Each one of them is done for the sake of problem solving and product development. Design Thinking usually being used in industry for Research and Development purpose.

Referring to the brief explanation on Design Thinking module, it is no doubt that this module may have association with the nature of learning in TVET institutions, where certain assessments done by the students are project-based learning. This is good news for TVET institutions since the module should have high potential in producing TVET graduates that are not only capable on psychomotor intelligence, but also on problem solving intelligence.

1.2 Problem Background

TVET institutions like polytechnics usually targets students to pursue Diploma on respective field. Most industries are opening vacancies in large scale for Diploma holder to fulfilling heavy manpower. People with competency certificates has a better benefit for being hired, indeed for getting certain certificates, money and experience

in industry are needed as the requirement. In certain sector e.g. construction field, local workforce still in low volume compare to foreign workforce since the TVET preparation seems to make less quality graduates (Manap *et al.*, 2017). Thus, first impression is important for TVET graduates in exposing them to employer, in addition with certain soft skills. This is where 21st century learning takes part as a guidance for certain set of skills to be mastered, which are previously mentioned including – communication skills, collaborative skills, critical thinking, creative thinking, and moral values and ethics, which basically a set of learning skills that can be implemented for long life learning and future employability.

According to a research on employability skills among Engineering Technology Students (Abdul Karim and Maat, 2019), young graduates from the field has lack of industry exposure and experience, in addition with communication skills (Abdul Karim and Maat, 2019; Sa-Nguanmanasak and Khampirat, 2019). An evaluation on communication skills of veterinary students to clients has been done (Stevens and Kedrowicz, 2018) and results show that students are getting high score on open ended questions and nonverbal communication, which only 2 elements of 6 elements evaluated, showing that they are not fully mastered on majority of the elements. Communication skills are very important in industry for information changing especially during teamworking since most of industry runs with much manpower with different background. But still some of the students are not fully mastered the interpersonal skills after school.

Collaborative issues also seem to be occurred among the students too. Referring to Hidayat and else (2020), they have done on research on students' collaborative skills through learning sharing and found out that the element on listening to teammate is the highest score while element on discussing with teammates is the lowest (Hidayat *et al.*, 2020). While for the other elements like capability to speak up in team, appreciation of opinions, working together, concern on teammates, and giving guides to teammate seem to be not really balanced in overall score. Same instrument has been done on other research, showing that students are having same results (Verawati *et al.*, 2020). We can say that students are not fully developed on collaborative skills since they are only capable to be a good listener, while there are

many other aspects of collaborative skills mentioned by Doyle (2020) that they are not capable of, such as respect of differences, emotion control, and involving good speaking skills (Doyle, 2020).

According to another research, scope in skills and knowledge competency of TVET graduates (Ridzwan *et al.*, 2017), Malaysia has planned based on Rancangan Malaysia Ke – 11 (RMKe-11), regarding on TVET products to ensure people that can fit well in innovation-oriented economy, which we can see that critical thinking and creative thinking are crucial in fulfilling innovation. It is mentioned in five reports on important skills for being innovative in 21st century, which are Bloomberg Job Skills Report, World Economic Forum, IBM Global C-Suite Studies, American Management Associations, and LinkedIn, where being creative and critics in way of thinking is very important for being an innovative person (Eich, 2020). In fact, students are still not fully mastered on being critical and creative in thinking for now. Students from primary school in Indonesia shows low level of potential in critical thinking values like giving brief explanation, detailed explanation, be strategic in solving problem, and giving good conclusion (Muharram *et al.*, 2019). Next research is done on secondary school in Indonesia, which the researchers are evaluating the creativity level from 3 schools consist of high rank school, medium rank school, and low rank school (Maknun and Siahaan, 2018). Result shows that the highest level of creativity level from all the school is moderate while the lowest one is very low.

A research on employability skills capability of TVET graduates from Thailand and Malaysia (Sa-Nguanmanasak and Khampirat, 2019) showing that Malaysia has better capability than Thailand in terms of ability to application of knowledge, decision making, communication skills, interpersonal skills, ethics and morality, and etc. We can see that some Malaysian graduates are still lacking moral and ethics during their works. Looking back during university time, a research made for identifying level of moral values in final year students and foundation students (Ali *et al.*, 2010). However, the score shows that students have low level of honesty, despite all the other aspects like integrity, respect, and courage are above average level. It is suggested that all aspects of moral values should be in high level since changes of

environment like school environment to working environment can affect the students' behaviours.

Based on all issues stated above, we can see that certain students are still not fully mastered the desired 21st century learning skills, starting from their primary school, until they have graduated, which is a worrying state especially for TVET students. Despite to mass unemployed graduates' issues recently, teacher, students, institutions, and lecturers should take parts on making sure 21st century learning can be done efficiently in classroom.

Teachers always looking alternative for making sure their teaching are fulfilling 21st century learning. Certain model of teaching may fulfil collaborative learning but not fulfilling self-learning. Such perfect model does not really exist; thus, teachers can experiment which is the best for their students. Since we are discussing on the learning of polytechnics students, it is quite hard for preparing TVET students especially in engineering industry, despite any other field that are involved in the institution due to different demand in industry and less job vacancies provided. Graduates also have high competition among them, which makes graduates that are weak in technical and employability skills can be abandoned by industry (Hanapi and Nordin, 2014). We want to avoid such circumstances since TVET institution should help people who are not good in STEM to get job, in fact all unemployable issues mentioned before should be solved with implementation of 21st century learning skills in teaching.

Since 21st century learning has their own basic guidance (*Apakah Pendidikan Abad Ke-21*, 2017), it is up to the teacher on choosing suitable approach and teaching model for their respective students. Referring on Design Thinking Process, this module is a process of problem solving specially for designer. Going through all five stages (Empathise, Define, Ideate, Prototype, Test), each stage has their own task, interaction and environment that can help designer to create the best solution for the problem, usually through products. Using the same process, it should be flexible to be used as a learning environment, as well as fits the 21st century learning approach. Self-learning, collaborative learning, communication skills, student centred learning and etcetera is

applied in Design Thinking (Ray, 2012). In this research, Design Thinking process will be explained on how the process has certain characteristics that may be suitable to be implemented as a 21st century learning environment, thus should help the teachers, institutions, and related authorities in solving the issues of mastering 21st century learning skills. To prove this argument, researcher will also make an investigation on the relationship of Design Thinking on 21st century learning skills among the polytechnic students, which it concerns that students that can undergone the process of Design Thinking efficiently should have high level of 21st century learning skills.

1.3 Problem Statement

Research on the level of 21st century learning skills (Communication skills, Creative Thinking, Critical Thinking, Collaboration Skills, and Character Development) and level of Design Thinking (Empathise, Define, Ideation, Protype, and Test) among polytechnic students has not been yet identified empirically in terms of demographic (gender, polytechnic, course, and year of study). The relationship of 21st century learning skills (Communication skills, Creative Thinking, Critical Thinking, Collaboration Skills, and Character Development) with Design Thinking (Empathise, Define, Ideation, Protype, and Test) among polytechnic students has also not been identified yet. Hence, this study is focusing on identifying the level of 21st century learning skills and the level of Design Thinking among the polytechnic students, thus the relationship of both 21st century learning skills and Design Thinking will be identified.

1.4 Research Objective

Here are the research objectives of the research:

(a) To identify the level of 21st Century Skills amongst the Diploma of Engineering Programs' Students in Polytechnics

(b) To identify the level of Design Thinking characteristics amongst the Diploma of Engineering Programs Students in Polytechnics

(c) To identify the relationship of Design Thinking with 21st Century Skills level amongst the Diploma of Engineering Programs Students in Polytechnics.

1.5 Research Questions

The research questions for this research are stated as follow:

(a) What is the level of 21st century learning skills amongst the Diploma of Engineering Programs Students in Polytechnics?

   a. What is the level of communication skills amongst the Diploma of Engineering Programs Students in Polytechnics?

   b. What is the level of collaborative skills amongst the Diploma of Engineering Programs Students in Polytechnics?

   c. What is the level of critical thinking amongst the Diploma of Engineering Programs Students in Polytechnics?

   d. What is the level of creative thinking amongst the Diploma of Engineering Programs Students in Polytechnics?

   e. What is the level of moral value and ethics amongst the Diploma of Engineering Programs Students in Polytechnics?

(b) What is the level of Design Thinking characteristics amongst the Diploma of Engineering Programs Students in Polytechnics?

   a. What is the level of emphatic to problem amongst the Diploma of Engineering Programs Students in Polytechnics?

b. What is the level of expertise in defining problem amongst the Diploma of Engineering Programs Students in Polytechnics?

c. What is the level of ideation amongst the Diploma of Engineering Programs Students in Polytechnics?

d. What is the level of expertise in prototyping a product amongst the Diploma of Engineering Programs Students in Polytechnics?

e. What is the level of expertise in testing product amongst the Diploma of Engineering Programs Students in Polytechnics?

(c) What is the relationship of Design Thinking with 21st Century Skills level amongst the Diploma of Engineering Programs Students in Polytechnics?

1.6 Hypothesis

Related hypotheses created for this research are based on research question, as follow:

(a) Research Question 1

1) H_0: There is no significant difference of 21st century learning skills score between male and female students.
2) H_0: There is no significant difference of 21st century learning skills score among courses.
3) H_0: There is no significant difference of 21st century learning skills score among year of study.

(b) Research Question 2

1) H_0: There is no significant difference of Design Thinking score between male and female students.

2) H_0: There is no significant difference of Design Thinking score among courses.

3) H_0: There is no significant difference of Design Thinking score among year of study.

(c) Research Question 3

1) H_0: There is no correlation on Design Thinking with 21st century learning skills.

1.7 Theoretical Framework

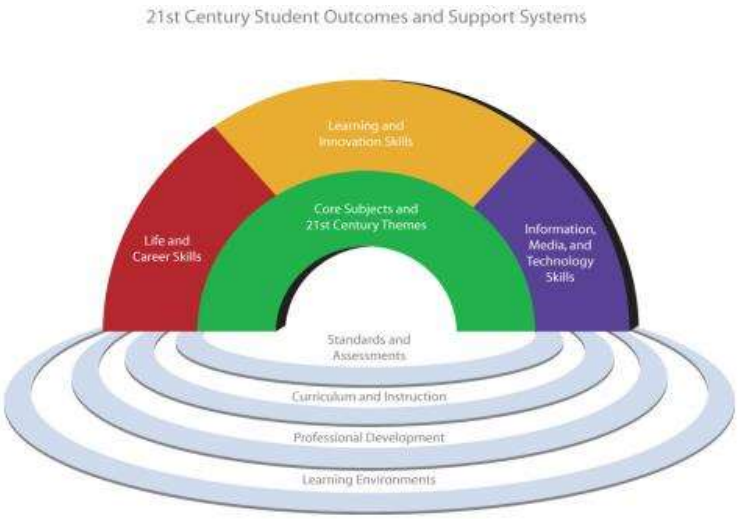

Figure 1.1 21st Century Skills of Partnership Model (Partnership for 21st Century Learning, 2015)

Based on the model above, we can see that the combination of three outcome, which are life and career skills, learning and innovation skills, and information, media and technology skills, are originated from the core subjects with 21st century themes in certain learning environment mentioned in the model above (Partnership for 21st Century Learning, 2015). We will be discussing on the stated outcomes, starting from

learning and innovation skills. There are 4 Cs describing the skills – critical thinking, communication, collaboration, and creativity (Alang Osman and Basar, 2016). Students that have high level of creativity can create innovation stuff and have great courage to try something new. For students that have high critical thinking, they can be a strategic person on everything that they do, have great decision and judgement, and great in solving problem. Communication and collaboration are both working together to ensure great teamworking with clear information changing (Partnership for 21st Century Learning, 2015).

Moving on to life and career skills, it consists of few aspects which mainly talk on character development (Partnership for 21st Century Learning, 2015) like discipline, self-direction, responsibility, and accountability. Students with high life and career skills can be a flexible person on any situation and people, work independently and have integrity whenever certain tasks are given to them. Students that have good character development can ensure good vibe in the classroom environment and in future working environment.

Next outcomes of 21st century learning is information, media, and technology skills. 21st century students should be able to have a literacy in information, media, and technology since 21st century is fulfilled with Internet of Things and mass technology (Partnership for 21st Century Learning, 2015). Students that master those skills can ensure high efficiency of information changes with other people, able to ease the task given, and can effectively use Information, Communications, and Technology (ICT) in their life as long-life learning. Based on overall outcomes of 21st century learning, we can see that set of skills are required to be mastered by students in terms of 5Cs as a conclusion – communication, collaboration, critical thinking, creativity, and character development, included with ICT literate.

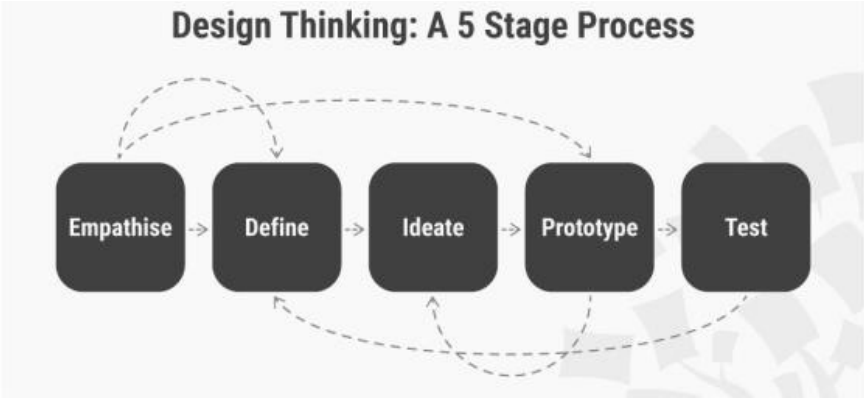

Figure 1.2 Design Thinking Model by Hasso Plattner Institute of Design (Friis Dam and Siang Teo, 2020)

After reviewing on the concept of 21st century learning skills, we can proceed with our research focus, which is Design Thinking Model. As mentioned before, Design Thinking is basically used by a designer to design a product for solving problem. It consists of 5 steps to be done in Design Thinking, which are Empathise, Define, Ideate, Prototype, and Test.

Start with Empathise, for any problem occurrence, we need to analyse and being 'empathic' on the problem's content. We need to understand on what kind of the environment, how it happens, who are involved, why the problem is needed to be solved, and anything related on the problem. We can say that this step applies the communication skills, and implementation of moral values and ethics whoever practice this step for getting information from target users.

The next step is Define stage. In this stage, all the data obtained is being analysed and a problem statement is created. Stating a correct problem statement is important for any people to understand the main objectives and aim for the solution much easier. Without clear problem statement, some people find it hard to generate idea. That is where the critical thinking takes part, where all aspects are needed to create clear objectives.

Next stage is the main one, which is Ideate stage. In this stage, idea generation is done for achieving the objectives, usually discussion, voting and analysing is done in this stage. Some of suggested ideations (Friis Dam and Siang Teo, 2020) are

Brainstorm, Brainwrite, Worst Possible Idea and SCAMPER. Be creative and realistic is very important in this stage to find the best solution. This is where all the members involved need to have good communication, good collaboration, creative thinking, and being ethical during brainstorming session together.

After going through lots of ideation and selection, next stage is the Prototype stage. In this stage, the finalised idea is converted to product, usually not with real characteristics of final product. This product is like the analogy of the experiment setup, where to take data/feedback, the instrument and apparatus are needed to be constructed. When the setup up is done, experiment/test field can be conducted. Being critical in prototype development is very important to ensure success in prototype production.

Proceeding from Prototype stage is the Test stage. This is the stage where the prototype is being tested on real environment to get any feedback and additional data. The information obtained is used for further improvement of the idea and ending up to the best product production. This is where we need to be very details and critical on finding any weakness of the prototype. Having good values and good communication also is important because we need the feedback from the users of the prototype.

1.8 Conceptual Framework

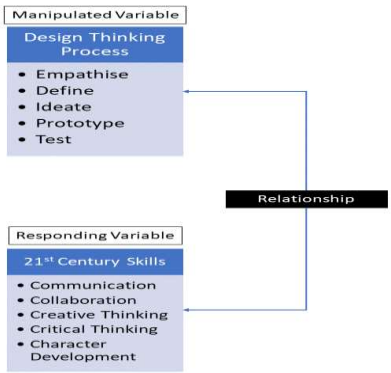

Figure 1.3 Suggested Conceptual Framework

Conceptual framework is originated due to integration of 21st Century Skills of Partnership Model - acts as responding variable, with Design Thinking Model by Hasso Plattner - acts as manipulated variable. The manipulated variable in the conceptual framework is the stages of process in Design Thinking, which involves certain characteristics of a designer should have to implement it (Owen, 2007). In each stage, users are needed to have certain skills that portray characteristics of a designer, which are 21st century skills. The responding variable in the conceptual framework is the skills outcome of 21st century learning of Partnership model (Partnership for 21st Century Learning, 2015), which should be the results or performance of the students. It is believed that when student have the characteristics of a designer in themselves, they should have also required good level of 21st century learning skills too.

1.9 Research Scope and Limitation

The focus on this study is to identify the level of Design Thinking characteristics and the 21st century learning skills amongst the Diploma of Engineering Program students in polytechnics. The research will use 21st century learning skills as a behaviour and performance aspects to be evaluated among the students. A quantitative data is obtained through questionnaire regarding on their perspectives on 21st century learning skills and characteristics of Design Thinking. Students are selected from Engineering Courses in polytechnics of Malaysia.

Limitation of this research is affecting the data collection method for the research, since the research is done during pandemic, online questionnaire distribution is the most relevant method of data collection for the research (*Soalan Lazim (FAQ) Berkaitan Perintah Kawalan Pergerakan Bersyarat (PKPB) Kementerian Pengajian Tinggi*, 2020). Permission for data collection in polytechnics around Malaysia is approved only by *Jabatan Pendidikan Politeknik dan Kolej Komuniti*.

1.10 Significant of Study

This research can help most of students, teachers, lecturers, and any institution to see Design Thinking Process as a learning process in problem solving and use it in class for efficient learning environment despite all the significant skills in 21st century learning such as communication skills, collaborative skills, critical thinking, creative thinking, and moral values can be implemented among students.

1.11 Importance of Study

Statement and answer obtained from the research questions that are created in this study is important for the following matters:

(a) Research results can increase the knowledge and experience of the researcher himself/herself, in terms of 21st century learning skills and Design Thinking process.

(b) Research results can help the researcher to identify the significant relationship of Design Thinking with 21st century learning skills.

(c) Research results can help giving feedbacks to polytechnic on their 21st century learning current mastery level. Improvement can be done with suggestion from the researcher.

(d) More research can be done on Design Thinking and 21st century learning skills involving other TVET institutions beside polytechnic.

1.11.1 Operational Definition

(a) 21st Century Learning Skills

21st century learning skills is defined by Partnership for 21st Century Learning (2015) as a set of skills, knowledge and expertise that need to be mastered by the students to be successful in work and life, which is blended with content knowledge, specific skills, expertise and literacies (Partnership for 21st Century Learning, 2015). The theme and key subjects of 21st century learning must be mastered first, which are English, reading or language, World languages, Arts, Mathematics, Economics, Science, Geography, History, and Government and Civics (Partnership for 21st Century Learning, 2015). It also stated that 21st century learning skills should be included with 21st century interdisciplinary themes too such as Global Awareness, Financial, Economic, Business and Entrepreneurial Literacy, Civic Literacy, Health Literacy, and Environmental Literacy. Partnership for 21st Century Learning (2015) mentioned on the outcomes of successful 21st century learning such as Life and Career Skills, Learning and Innovation Skills – 4Cs, and Information, Media, and Technology Skills.

Another definition of 21st century learning skills is mentioned by Soh, Osman and Arsad (2012), where they stated that enGauge defined 21st century skills as a mastery of digital age, inventive thinking, effective communication and high productivity (Soh *et al.*, 2012). Digital age is said as a knowledge of handling digital technology, communication devices, and networking for information access, management, consolidation, evaluation, and creation (Soh *et al.*, 2012).

Next definition of 21st century learning skills is mentioned by Sumardi, Rohman, and Wahyudiati (2020), where they summarize the skills as the the outcome of students' competence, e.g. critical thinking, communications, collaboration, creative thinking, innovation, metacognition, information and communication technology literacy, civic, and problem solving skills such as creative thinking and innovation (Sumardi *et al.*, 2020). They also added that collaboration skills as one of important objective in 21st century learning (Sumardi *et al.*, 2020).

As a conclusion, in the context of this study, 21st century learning skills is defined as a set of employability skills that are needed in 21st century living and society, where the skills are consist of communication, collaboration, creativity,

critical analysis, moral values and ethics, and information and communication technology. Such skills can be learn through a convenient setup of 21st century learning environment, such as mentioned in Framework for 21st century learning (Partnership for 21st Century Learning, 2015).

(b) Design Thinking

Design Thinking definition is given by Owen (2007), where he stated that Design Thinking can complete the science thinking, which it covers a wide range of creativity, including a number of special qualities of distinct value to decision makers (Owen, 2007). It is also the ways of observing in scientific ways, where designer can invent new patterns and concept to state facts and possibilities (Owen, 2007).

Design Thinking is also defined as process of designing that produces a solution-based approach to solving problems, which through process of understanding human needs, by looking at the problem in user's perspective, by making ideas in brainstorming sessions, and by using a hand off skills approach for prototyping and testing (Friis Dam and Siang Teo, 2020). Thoring and Müller (2011) also define Design Thinking as a method to solve complicated problems, by generating innovative solutions based on the user's need or user-centred approach with multi-disciplinary teams (Thoring and Müller, 2011).

Razzouk and Shute (2012) also mentioned on Design Thinking definition, where Design Thinking is a process of analysis and creative thinking that triggers the person that uses the process to experiment, create and prototype a new products, test the products for feedback, and renovation of products for improvement (Razzouk and Shute, 2012). Ray's (2012) definition of Design Thinking is a tools for solving problems, which it involves information management and seeking, collaboration with colleagues, and iterating their solutions based on real life situation, authenticity of experience and feedback (Ray, 2012).

As a conclusion, in the context of this study, Design Thinking is defined as the process of problem solving that involve deep analysis of the problems and related

knowledge, thus producing idea of new solutions which later will be tested for feedback that helps to create better idea, and the process is looping till the best idea is produced.

1.12 Summary

As a conclusion, it is necessary to conduct the research based on all the justifications made in this chapter. In addition to employability issues among students, 21st century skills are very important to be mastered, especially for TVET students, where the purpose of TVET itself is to produce a high quality ready to work graduates in any industrial field. Researcher believes that Design Thinking process is very suitable to be applied in classroom for the purpose of 21st century learning, thus this research is very important to prove that statement.

REFERENCES

Abdul Karim, Z. I. and Maat, S. M. (2019) 'Employability skills model for engineering technology students', *Journal of Technical Education and Training*, 11(2), pp. 79–87.

Alang Osman, B. H. and Basar, M. N. (2016) 'Amalan Pengajaran Dan Pembelajaran Abad Ke- 21 Dalam Kalangan Pensyarah Institut Pendidikan Guru Kampus Ipoh', *Jurnal Penyelidikan Dedikasi*, 12, pp. 1–25.

Ali, K., Salleh, R. and Sabdin, M. (2010) 'A study on the level of ethics at a Malaysian private higher learning institution: comparison between foundation and undergraduate technical-based', *International Journal of Basic and, Applied ...*, 10(05), pp. 20–29.

Apa Itu Pembelajaran Abad Ke 21 (PAK21) (2018) *Pendidik2u*.

Apakah Pendidikan Abad Ke-21 (2017) *Sistem Guru Online*.

Bhat, A. (2017) *Quantitative Research: Definition, Methods, Types and Examples*, *Questionpro*.

Bray, A. (2016) 'Teachers' experiences of the integration of 21st century learning in the mathematics classroom - the bridge21 model in action', *CSEDU 2016 - Proceedings of the 8th International Conference on Computer Supported Education*, 2(Csedu), pp. 219–230.

Carifio, J. and Perla, R. J. (2007) 'Ten Common Misunderstandings, Misconceptions, Persistent Myths and Urban Legends about Likert Scales and Likert Response Formats and their Antidotes', *Journal of Social Sciences*, 3(3), pp. 106–116.

Carlgren, L., Elmquist, M. and Rauth, I. (2016) 'The Challenges of Using Design Thinking in Industry – Experiences from Five Large Firms', *Creativity and Innovation Management*, 25(3), pp. 344–362.

Cutumisu, M., Schwartz, D. L. and Lou, N. M. (2020) 'The relation between academic achievement and the spontaneous use of design-thinking strategies', *Computers and Education*. Elsevier Ltd, 149(September 2019), p. 103806.

Deitte, L. A. and Omary, R. A. (2019) 'The Power of Design Thinking in Medical Education', *Academic Radiology*, 26(10), pp. 1417–1420.

Doyle, A. (2020) *What Are Collaboration Skills ?*

Eich, D. J. (2020) *Innovation Skills for the Future: Insights from Research Reports*.

Friis Dam, R. and Siang Teo, Y. (2020) '5 Stages in the Design Thinking Process', *Interaction Design Foundation*, pp. 1–10.

Gall, M. D., Gall, J. P. and Borg, W. R. (2003) *Educational Research: An Introduction*. 7th edn. Edited by A. E. Burvikovs, M. Kriener, and C. Tridente. United States of America: Pearson Education. Inc.

Groenewald, T. (2004) 'A Phenomenological Research Design Illustrated', *International Journal of Qualitative Methods*, 3(1), pp. 42–55.

Hanapi, Z. and Nordin, M. S. (2014) 'Unemployment among Malaysia Graduates: Graduates'Attributes, Lecturers' Competency and Quality of Education', *Procedia - Social and Behavioral Sciences*. Elsevier B.V., 112(February), pp. 1056–1063.

Henriksen, D., Gretter, S. and Richardson, C. (2020) 'Design thinking and the practicing teacher: addressing problems of practice in teacher education', *Teaching Education*, 31(2), pp. 209–229.

Hidayat, R. Y., Hendayana, S., Supriatna, A. and Setiaji, B. (2020) 'Identification of student's collaborative skills through learning sharing and jumping task on the topic of redox reactions', *Journal of Physics: Conference Series*, 1521(4).

Hrovatin, J., Machtig, S. and Prekrat, S. (2008) 'Design thinking - Multidisciplinary ways of solving problems in wood industry', *19th International Scientific Conference: Wood is Good - Properties, Technology, Valorisation, Application, Proceedings*, pp. 71–75.

Johanson, G. A. and Brooks, G. P. (2010) 'Initial scale development: Sample size for pilot studies', *Educational and Psychological Measurement*, 70(3), pp. 394–400.

Kementerian Pendidikan Malaysia (2019) 'Sembang Santai Pembelajaran Abad Ke-21', October.

Krejcie, R. V and Morgan, D. W. (1970) 'Determining Sample Size for Research Activities', 38, pp. 607–610.

Lawlor, J., Marshall, K. and Tangney, B. (2016) 'Bridge21 – exploring the potential to foster intrinsic student motivation through a team-based, technology-mediated learning model', *Technology, Pedagogy and Education*, 25(2), pp. 187–206.

Lewis, C. C., Perry, R. R. and Hurd, J. (2009) 'Improving mathematics instruction through lesson study: A theoretical model and North American case', *Journal of Mathematics Teacher Education*, 12(4), pp. 285–304.

Maknun, J. and Siahaan, P. (2018) 'Profile of senior high school students ' creative thinking skills on biology material in low , medium , and high academic perspective Profile of senior high school students ' creative thinking skills on biology material in low , medium , and high academic'.

Manap, N., Hassan, N. and Syahrom, N. (2017) 'Preparation of vocational college graduates as skilled workforce in the local construction industry', *Journal of Technical Education and Training (JTET)*, 9(2), pp. 69–80.

Ministry of Education of Malaysia (2013) 'Malaysia Education Blueprint 2013 - 2025', *Education*, pp. 1–268.

Mohamed, S. A. (2013) *Buletin UPIK: Unit Penyelidikan dan Inovasi*.

Mohd Rusdin, N. and Ali, S. R. (2019) 'Amalan Dan Cabaran Pelaksanaan Pembelajaran Abad Ke-21', *Proceedings of Islamic Civilization and Technology Management*, pp. 2013–2025.

Muharram, M. R. W., Prabawanto, S. and Jupri, A. (2019) 'Analysis of students' critical thinking skill of fractions on primary school', *Journal of Physics: Conf. Series 1157(2019) 032119*, pp. 1–6.

Owen, C. (2007) 'Design thinking: Notes on its nature and use', *Design Research Quarterly*, 2(1), pp. 16–27.

Partnership for 21st Century Learning (2015) *P21 Framework Definitions*.

Putri, T. S. Y., Wilujeng, I., Pratama, M. A. and Astuty, S. (2020) 'Critical thinking skills differences of junior high school students based on the gender', *Journal of Physics: Conference Series*, 1440(1).

Rahim, A. (2019) 'Science and 21 st Century Skill : Students ' Perspective', (May), pp. 584–588.

Raja Abdullah Raja Ismail and Daud Ismail (2018) 'Aplikasi "Konsep 4C" Pembelajaran Abad Ke-21 Dalam Kalangan Guru Pelatih Pengajian Agama Institut Pendidikan Guru Kampus Dato' Razali Ismail', *Asian People Journal (APJ)*, 1, pp. 45–65.

Ray, B. (2012) *Design Thinking: Lessons for the Classroom | Edutopia*, *Edutopia*.

Razzouk, R. and Shute, V. (2012) 'What Is Design Thinking and Why Is It Important?', *Review of Educational Research*, 82(3), pp. 330–348.

Ridzwan, C. R., Malik, S., Hanapi, Z., Mohamed, S., Hussain, M. A. and Shahrudin, S. (2017) 'Skills and Knowledge Competency of Technical and Vocational Education and Training Graduate', *Asian Social Science*, 13(4), p. 69.

Ruchira Prasad, W. M. D., Perera, G. I. U. S., Jeeva Padmini, K. V. and Dilum Bandara, H. M. N. (2018) 'Adopting design thinking practices to satisfy customer expectations in agile practices: A case from Sri Lankan software development industry', *MERCon 2018 - 4th International Multidisciplinary Moratuwa Engineering Research Conference*, pp. 471–476.

Sa-Nguanmanasak, T. and Khampirat, B. (2019) 'Comparing employability skills of technical and vocational education students of Thailand and malaysia: A case study of international industrial work-integrated learning', *Journal of Technical Education and Training*, 11(3), pp. 94–109.

Salkind, N. J. and Rasmussen, K. (2007) *Encyclopedia of Measurement and Statistics*, *Neurogastroenterology and Motility*. Edited by L. C. Shaw, T. Alpern, B. Freeman, L. Lech, and C. Freeman. United States of America: SAGE Publications.

Sándorová, Z., Repáňová, T., Palenčíková, Z. and Beták, N. (2020) 'Design thinking - A revolutionary new approach in tourism education?', *Journal of Hospitality, Leisure, Sport and Tourism Education*. Elsevier Ltd, 26(December 2019), p. 100238.

Scheer, A. and Plattner, H. (2012) 'Transforming Constructivist Learning into Action: Design Thinking in education', *Transforming Constructivist Learning into Action: Design Thinking in education*, 17(3), pp. 8–19.

Semakan Syarat Kemasukan Politeknik (2021) *Info UPU*.

Soalan Lazim (FAQ) Berkaitan Perintah Kawalan Pergerakan Bersyarat (PKPB) Kementerian Pengajian Tinggi (2020) *Ministry of Health Malaysia*.

Soh, T. M. T., Osman, K. and Arsad, N. M. (2012) 'M-21CSI: A validated 21st century skills instrument for secondary science students', *Asian Social Science*, 8(16), pp. 38–44.

Stevens, B. J. and Kedrowicz, A. A. (2018) 'Evaluation of fourth-year veterinary students' client communication skills: Recommendations for scaffolded instruction and practice', *Journal of Veterinary Medical Education*, 45(1), pp. 85–90.

Sumardi, L., Rohman, A. and Wahyudiati, D. (2020) 'Does the teaching and learning process in primary schools correspond to the characteristics of the 21st century learning?', *International Journal of Instruction*, 13(3), pp. 357–370.

Taratukhin, V. V., Karaseva, A. A., Aseeva, N. V. and Gredinar, I. (2020) 'Features of the using of the design-thinking methodology in the area of restaurant business and wine production', *CEUR Workshop Proceedings*, 2570, pp. 1–9.

Tavakol, M. and Dennick, R. (2011) 'Making sense of Cronbach's alpha', *International journal of medical education*, 2, pp. 53–55.

Thoring, K. and Müller, R. M. (2011) 'Understanding design thinking: A process model based on method engineering', *DS 69: Proceedings of E and PDE 2011, the 13th International Conference on Engineering and Product Design Education*, (May 2014), pp. 493–498.

Turiman, P., Wook, T. S. M. T. and Osman, K. (2019) '21 St Century Skills Mastery Amongst Science Foundation Programme Students', *International Journal on Advanced Science, Engineering and Information Technology*, 9(1), pp. 46–53.

Verawati, Y., Supriatna, A., Wahyu, W. and Setiaji, B. (2020) 'Identification of student's collaborative skills in learning salt hydrolysis through sharing and jumping task design', *Journal of Physics: Conference Series*, 1521(4), pp. 6–11.

Waidelich, L., Richter, A. and Bulander, R. (2018) 'Design Thinking Process Model Review. A systematic literature review of current Design Thinking models in practice', *2018 IEEE International Conference on Engineering, Technology and Innovation (ICE/ITMC)*, pp. 1–9.

Wan Husin, W. N. F., Mohamad Arsad, N., Othman, O., Halim, L., Rasul, M. S., Osman, K. and Iksan, Z. (2016) 'Fostering students' 21st century skills through project oriented problem based learning (Popbl) in integrated stem education program', *Asia-Pacific Forum on Science Learning and Teaching*, 17(1).

Wijaya, E. Y., Sudjimat, D. A. and Nyoto, A. (2016) 'Transformasi Pendidikan Abad 21 Sebagai Tuntutan Pengembangan Sumber Daya Manusia di Era Global', *Prosiding Seminar Nasional Pendidikan Matematika*, 1, pp. 263–278.