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TVET Student's Perception on Digital Mind Map to Stimulate Learning of Technical Skills in Malaysia

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Abstract: Digital mind map is a digital tool that is becoming increasingly popular in today's pedagogical visual aids. However, few empirical studies have been conducted regarding Technical and Vocational Education and Training (TVET) student's competencies on using digital mind map in learning of their technical subjects. Hence, this survey research was designed to investigate TVET student's perceptions on the digital mind map to stimulate their learning of technical skills in Malaysian higher learning institutions. Specifically, the objectives of the study were to identify the TVET student's perception regarding their digital mind map competencies and to examine the relationship between the usage of digital mind and their learning achievement of technical skills. A sample of 372 TVET students were randomly selected from several public TVET higher institutions in Malaysia. The online questionnaires were designed to measure the practice of digital mind map among TVET students. The data were analysed using descriptive and inferential statistics such as frequency, percentage, mean, standard deviation and Pearson correlation. The questionnaire also included three open-ended items and the qualitative data were analysed using thematic analysis. The key finding showed that the majority of TVET students have a positive perception towards the digital mind map. In addition, the main open-ended result illustrated that the digital mind map has a potential to stimulate creativity and design thinking among TVET students in Malaysia.

Keywords: TVET students, digital mind map, perceptions, learning of technical skills

1. Introduction

Technical and Vocational Education and Training (TVET) is a practical education and training field encompassing formal and non-formal learning that prepares young people for vocational jobs (Mustapha, 2017). In Malaysia, TVET programmes are offered at certificate, diploma, or baccalaureate levels in more than 1,000 TVET institutions such as polytechnics, community colleges, vocational colleges, and technical universities. TVET in Malaysia is recognised as one of the strategies for achieving Malaysia's Shared Prosperity Vision 2030. This vision emphasises the quality of life by focusing on the well-being of the people and forging unity among the diverse ethnic groups. In terms of technology, a better quality of life could be achieved using proper and safe technologies. Furthermore, TVET students should be trained to be technological literate in line with the Fourth Industrial Revolution (IR 4.0) requirements which are primarily engaged with the use of digital technologies, artificial intelligence (AI) and big data (Karim et al., 2020; Karim & Mustapha, 2020). One of the goals of the digital revolution is to build resilient and competent digital talent to create an inclusive digital society (The Edge Malaysia, 2020). Digital intelligent augmentation can be used to solve teaching and

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learning challenges during the Covid-19 pandemic. Online pedagogy has surged during universities shut down and is conducted using a digital platform and Artificial Intelligence (AI).

Klaus Schwab's Industrial Revolution 4.0 focused on AI, robotics, drones, IoT, quantum computing, and autonomous vehicles (Schwab, 2017). In its broader sense, Al can mimic human intelligence. Today, the gaps are bridged by the convergence of cloud computing, artificial intelligence (AI), the internet of things (IoT), humanoid robotics, autonomous vehicles, drones, 3D printing, and digital genetics sequencing. In Malaysia, advanced AI knowledge and skills are still considered black swan competencies, whereas Malaysia faces a lack of talent in these skill sets (Mustapha, 2022). That's why few National Occupational Skills Standard (NOSS) are listed as standards in categories for AI competencies. However, AI is growing rapidly - it is expected that the children entering primary schools today might end up working in "jobs" that do not yet exist (ISTE, 2021). In such a fast-changing economic and employment landscape, the ability to prepare for future skills - ensures that TVET graduates are equipped with relevant skills to meet the demands of Industry 4.0. In a few years, AI is expected to transform TVET teaching and learning. Technological change is so rapid that it will create high pressure to transform educational practices, curricula, and policies (Tuomi, 2018).

The Digital mind mapping technique uses digital technology to assist students in visualising the representation of ideas and information, which makes it easier for them to understand complex concepts in technical subjects. It could also assist them in acquiring a clearer picture of the concept and what it covers and then it improves an individual's decision-making process. Based on the 21st-century paradigm, TVET students are required to possess top five generic skills: (a) critical thinking and problem-solving, (b) teamwork and collaboration, (c) professionalism and strong work ethics, (d) oral and written communications skills, and (e) effective leadership (Chalkiadaki, 2018). The digital mind maps can develop students' creative, critical thinking and problem-solving skills (Ismail, Sidek & Mahbib, 2015; Miranti & Wilujeng, 2017). In terms of teamwork and collaboration skills, the collaborative mind mapping, especially when used for brainstorming, is a good way for collaborative learning where groups of students are required to communicate and negotiate, which leads to better individual understanding (Cendros Arouja & Gadanidis, 2017; Kashefian-Naeeini & Sheikhnezami-Naeini, 2020). Regarding personal development aspects (professionalism and strong work ethics skills and effective leadership skills), the collaborative mind mapping enables a team leader to align a team around key objectives and break down into individual workflows. Based on their empirical research, Wijayanti et al. (2020) found that students' communication skills improved by using mind mapping. Regarding the learning tools that the TVET students need to master, the digital mind map is one of them (Karim & Mustapha, 2020). Buzan (2009) describes mind mapping as a technique of storing, editing, and organising information by means of using keywords and key images.

Today, the mind map is upgraded by using digital platforms due to the advancement of technology. An empirical study by Karim and Mustapha (2020) found that students in higher institutions believed that the digital mind map had inspired them to be creative in producing ideas and encouraging their critical thinking. However, there are few studies that focus on digital mind mapping from the perspective of technical and vocational students. In the context of technical skills, Chen et al. (2019) revealed that the Mini-Map, is a digital workflow for mixed-initiative mind-mapping in which a human designer and a computer program can design a mind map to solve problems. Furthermore, the study also showed that Mini-Map named ConceptNet can imitate human-like collaborative behaviours in early design for useful idea exploration. In another study, Marshall et al. (2016) examined senior-level students who registered for design methodology courses whether they could produce novel ideas by using different methods. The study found those who used the pictorial-based mind map method performed better. Selvi and Chandramohan (2018) discovered that in the third year of Mechanical Engineering, those who applied the mind map technique to recall the technical concept showed a significant positive difference in their academic achievement and attitude towards learning Materials and Metallurgy course. Woradechjumroen (2018) studied the use of mind maps in problem-based learning and the key finding revealed that the engineering students improved their learning performance based on the outcome evaluation for System Dynamics (SD) course. In addition, the study also found that the mind maps save the student's learning time in the course. Nevertheless, there is a paucity in the corpus of literature regarding the effect of digital mind map on TVET learning. Therefore, it is critical to examine the TVET student's perceptions on the digital mind map to stimulate the learning of technical skills in Malaysia.

1.1 The Digital Mind Map

Mind mapping technique and mind maps were developed by Tony Buzan in the late 1960s. However, several studies provide varied definitions of mind mapping techniques. According to Buzan (2009), mind mapping is storing, editing, and organising information by using keywords and key images. Khoo (2014) defined the mind mapping technique as diagrams explaining connections and interrelationships among concepts. Mind mapping can be an instructional tool in terms of design principles, visual means, and map reading forms (Eppler, 2006). Previously, people used mind map using pen and paper, but today people use mind mapping using a computerised version which is known as a digital mind map. Sabbah (2015) asserted that this computerised version of mind maps has gained popularity due to the increasing learner's interest in creating mind maps.

The digital mind map offers several advantages for students, instructors, and professionals in today's digital world. For example, using the digital mind map is convenient and saves time, especially for professionals and students to understand complex concepts and produce new ideas. Myre (2020) argued that the digital map is not restricted to the size of the document, and it is simple to save and share with friends. Developing ideas, designing idea-web and creating novel ideas are some prime examples of the practicality of the digital mind map tools (Bhattacharya & Mohalik, 2020). Currently, there are several developed online mind mapping software such as Bubbl.us, Coggle, XMind, Mindmeister, LucidChart and Mindly. Coggle, for example, is a real-time collaborative and free digital mind mapping tool that generates hierarchically organised documents. It enables us to create exquisite notes quickly and efficiently. Figure 1 shows a sample of diagramming software using Coggle, which "brainstorms" the subfields of chemical engineering. The central idea or the core topic in a square in the centre starts with the topic of Chemical Engineering subfields. Then, the nodes are drawn from the central, branching into eight subfields: Fluid Dynamics, Material Science, Thermodynamics, Biotechnology, Nanotechnology, Mineral Processing, Ceramics and Environmental Science. Figure 1 shows that the digital mind maps are visual representations of the concept. Unlike traditional, linear notes in a text document or even on paper, digital mind maps allow the users to capture thoughts, ideas, and keywords on a blank canvas. These concepts are organised in a two-dimensional structure, with the title or main idea always placed in the map's centre for visibility. Related ideas radiate outward from the centre, forming a radiant structure.

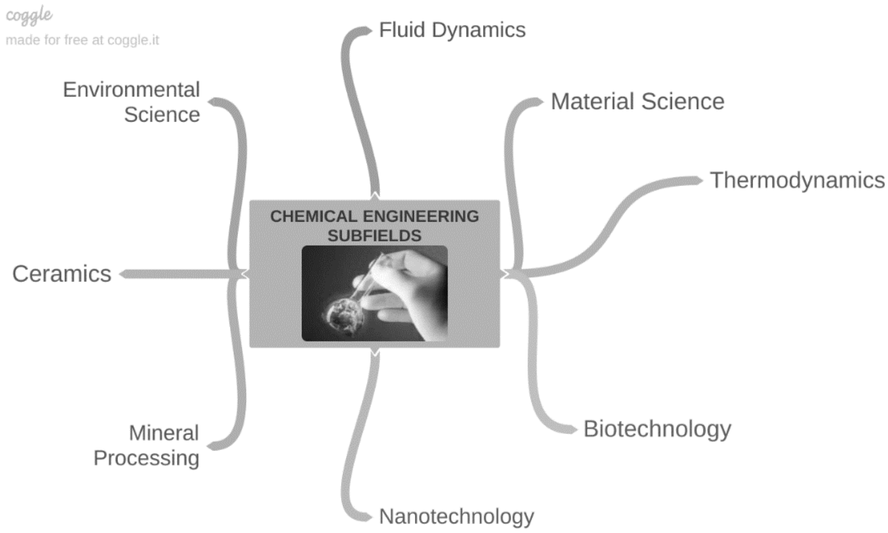

Fig. 1 - Example of diagramming chemical engineering subfields using Coggle mind mapping software. Adapted from Morin (2018)

Debagg et al. (2021) conducted a pilot study with the undergraduate students majoring in science teaching at a university in Turkey using the Coggle and found that a digital map is a beneficial tool for strengthening, evaluating, and envisioning learning in general - making courses more enjoyable and providing ease of use. Furthermore, Al-Jarf (2009) described that digital mind mapping could enhance students' creative thinking, especially in generating new ideas. In terms of students' learning, the digital mind map could assist the students in organising information systematically (Wu & Wu, 2020). Besides generating ideas, the digital mind map can be used to develop the student's critical thinking (Rezapour-Nasrabad, 2019). Thus, the digital map is a tool that can make student learning more accessible and more effective by applying it to different areas of learning, including acquiring skills in technical fields.

1.2 Technical and Vocational Education and Training (TVET) in Malaysia

UNESCO (2021) highlights the importance of Technical and Vocational Education and Training (TVET) as an educational pathway to prepare youth for relevant skills identified for Industry 4.0. Malaysia Education Blueprint 2015-2025 emphasised the need to enhance access to and improve the quality of existing education pathways including TVET (Ministry of Education, 2015). By improving its quality, TVET could attract more students to become skilled and semi-skilled workers to meet the local industry's employment requirements (Sauffie, 2015). Hence, TVET is designed to prepare students with the up-to-date knowledge and skills needed for the global economy. Given that there are gaps in the current corpus regarding AI skills needed for IR 4.0, it is recommended that TVET institutions restructure their curriculum and learning process (UNESCO, 2021). TVET Malaysia needs to adopt a more advanced technological and digital transformation. Providing the proper AI ecosystem, it is hopeful to see significant growth in the country's digital economy in the years to come. In other words, the need for AI upskilling is evident. Hence, the 12th Malaysia Plan reiterates several key points, including leveraging new technologies to achieve a high-income nation status (Economic Planning Unit, 2021). Our digital highway should be driven and powered by 5G, cloud and Artificial Intelligence (AI) - the overarching system should be built on the following pillars: high-speed connectivity; artificial intelligence; digital platforms to enable vertical industries to realise their digital transformation; personal devices for users; and wide-coverage digital infrastructure (Mustapha, 2022).

TVET policies and strategies have been put in place and they meet to some extent, the targets of Sustainable Development Goal number 4 (SDG-4) which is to ensure quality education for all. However, some critical reviews have highlighted the gaps in TVET implementations in Malaysia (Jamaludin et al., 2018). During pandemic Covid-19, for instance, TVET students complained about the inadequacy of the teaching and learning of practical hands-on TVET courses via theoretical online teaching (Mustapha, 2020). In addition, TVET should provide more opportunities for non-traditional students interested in technical fields while also learning and acquiring school-workplace competencies. Hence, in the12th Malaysia Plan (2021 - 2026), the government has put forward several ways to strengthen TVET by changing the old TVET curricula and improving the TVET ecosystem to produce future-ready talents (Economic Planning Unit, 2021). In general, TVET transformation focuses on the marketability of its future graduates is in line with the suggested efforts to strengthen the TVET education system as highlighted by the Malaysia Education Blueprint 2015-2025 and to achieve the goals outlined by the Shared Prosperity Vision 2030 (SPV2030) blueprint which are aimed at reducing wealth gap and to transform Malaysia into a high-income nation which is congruent with the 12th Malaysian Plan to improve TVET ecosystem in order to produce future-ready human resources. Today, with the advent of the Fourth Industrial Revolution (IR 4.0), the world is in desperate need of high-tech skills in the technical field. TVET is a skill-oriented education that is designed to meet the growing demand for a professionally talented workforce with advanced skills, including Artificial Intelligence (AI) (Mustapha, 2022). Presently, TVET also requires the students and graduates to be digitally literate.

Nevertheless, with the onslaught of the digital revolution, TVET lecturers and students have faced some difficulties and challenges due to abrupt changes in teaching and learning modes (Mustapha, 2020). This situation may influence their perceptions; however, changing negative perceptions to positive ones may lead to more favourable learning outcomes (Nourinezhad & Kashefian-Naeeini, 2020) and would enhance learners' satisfaction. The obstacles that students may face when we rapidly transition to fully online learning may include low resources, poor internet connectivity, and a poor home learning environment (Barrot et al., 2021; Mustapha, 2020). University students need to cope with the virtual learning caused by the pandemic. Hence, the digital map is one of the relevant tools to support online learning by making the online courses more meaningful to the learners. As previously mentioned, digital mind mapping could enhance divergent thinking among students, especially in creating new ideas. In the context of students' planning for learning, the digital mind map could help the students to reduce idea cluttering by visually branching the concepts. Creative and critical thinking could be nurtured by using a digital mind map. For TVET students, this tool is handy for solving technical problems.

1.3 Purpose and Objectives of the Study

The purpose of the present study was to investigate the TVET student's perceptions of the digital mind map to stimulate the learning of technical skills in Malaysia. Specifically, the objectives were as follows:

i. To identify the TVET student's perceptions on the digital mind map
ii. To identify the TVET student's perceptions on the digital mind map to stimulate learning of technical skills
iii. To examine the relationship between the TVET student's perceptions of the digital mind map and learning of technical skills

1.4 The Conceptual Framework

The conceptual framework of the study in Figure 2 shows the three main variables of the study. The digital mind map was set as the independent variable based on Lin and Faste model (2012), which consisted of three sub-constructs: (a) speed and efficiency, (b) appearance and mechanics and (c) ontology and concept mapping. The TVET student's learning of technical skills was designed as the dependent variable. For the dependent variable, we adapted three sub-constructs from Vygotsky's (1934) theory which are (a) knowledge in use, (b) student-centred learning, and (c) learning by discovery.

Finally, the moderator variables comprised two demographics of the respondents which were gender and age (El-Muslimah et al., 2021). The moderator variables were derived from the past research, and they were not statistically determined. Based on the theories used, the conceptual framework hypothesised that the digital mind map was expected to facilitate the learning of technical skills among TVET students.

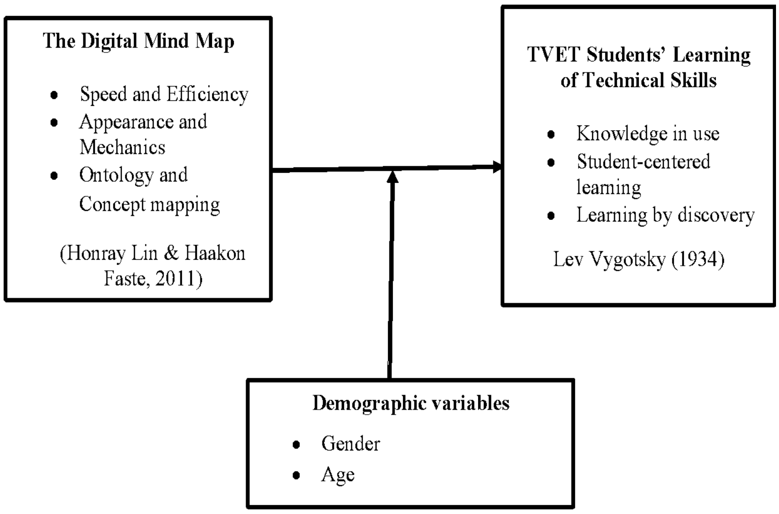

Fig. 2 - Conceptual framework for learning of technical skills among TVET students

2. Methodology

This study employed a survey design to investigate the TVET student's perceptions of the digital mind map to stimulate the learning of technical skills in Malaysia. The study participants were 400 TVET students from the estimated population size (N=59, 191) studying in selected public higher education institutions (HEIs) in Malaysia. Using Krejcie and Morgan's (1970) sample size table, the minimum number of respondents to be selected was 381. Initially, 400 online questionnaires were distributed to the sample, but only 372 valid questionnaires were returned, comprising a 93% response rate. The questionnaire data were analysed using the SPSS version 26. For open-ended items, the open-ended items were analysed using thematic analysis using Miles and Huberman (1994) method. The online questionnaire was designed based on the two models: Lin and Faste (2012) and Vygotsky (1934). For the first model, we adapted and designed the questionnaire items which included speed and efficiency, appearance and mechanics, and ontology and concept mapping to measure the perceptions on the digital mind map among TVET students. For the second model, we developed three elements: knowledge in use, student-centred learning and learning by discovery. The questionnaire items for this model were created to measure the TVET student's perceptions of the digital mind map to stimulate the learning of technical skills.

The online questionnaire consisted of five parts: (A) Student profile (6 items), (B) The TVET student's perceptions on the digital mind map (18 items) and (C) TVET student's perceptions on the digital mind map to stimulate learning of technical skills (18 items), and (D) three open-ended items. The students were asked to respond to a total of 45 items on the questionnaire. The respondents were also asked to answer the three open-ended items (Item A, Item B, and Item C) in part D of the questionnaire. First, the open-ended items asked about the main reasons the TVET students use digital mind mapping for their technical studies. Then, they were also asked to state three factors that enhance learning of technical skills when using digital mind mapping. Finally, they also need to answer what other factors besides the practice of digital mind map will enhance the learning of technical skills. All the items for Section B and Section C were measured by using a 5-point Likert scale: strongly agree (5), agree (4), uncertain (3), disagree (2) and strongly disagree (1). The Likert scale questionnaire data were analysed using the SPSS version 26. For open-ended items, the open-ended items were analysed using the thematic analysis method (Miles & Huberman,1994). The online questionnaire was developed and validated by three experts in the field and the reliability of the instrument was established by using the Cronbach Alpha coefficient, $\alpha = 0.98$.

3. Results and Discussion

This section covers the results and the discussion of the empirical data. The results and discussions of the study are as the following:

3.1 Profile of the Respondents

Table 1 shows the characteristics of the respondents of the study. The total of respondents for the study is 372. There are 162 male (43.5%) and 210 female (56.5%) students who responded to the questionnaire. Most of the respondents (60.2%) are in the age group of 17-19 years, followed by the age group of 20-22 years which is 31.5% of respondents. Next, the respondents come from the age group of 23 -25 years which is 6.7% of respondents. The lowest percentage of the respondents (1.6%) is the age group of 25 years and above. Based on the location of hometown, most of the respondents (69.1%) live in the city, whereas 18.3% stay in a rural area. Only 12.6% of the respondents stay in suburban vicinity.

From the table, it displays that almost all respondents (96.8%) said they enjoyed learning technical and vocational courses in their institution. Only 3.2% of the respondents did not enjoy the technical and vocational courses.

Regarding the familiarity with the digital mind map, most of the respondents (88.7%) said they knew about the digital mind map, whereas only 11.0% of respondents did not know about the tool. The respondents (70.4%) mostly answered that they had experienced using the digital mind map. Only 29.3% of respondents said they had never used the digital mind map before. In terms of the importance of digital mind mapping for learning technical skills, 86.8% mostly responded that they agreed that the digital mind map is essential for learning technical skills, whereas only 5.1% did not agree.

Table 1 - Characteristics of the respondents (*n*=372)

Characteristics	Frequency	%
Gender		
Male	162	43.5
Female	210	56.5
Age (years)		
17-19 years	224	60.2
20-22 years	117	31.5
23 -25 years	25	6.7
25 years and above	6	1.6
Location of Hometown		
City	257	69.1
Rural	68	18.3
Suburban	47	12.6
Do you enjoy learning technical and vocational courses in your institution?		
Yes	360	96.8
No	12	3.2
Do you know what a digital mind map is?		
Yes	331	89.0
No	41	11.0
Have you ever used a digital mind map?		
Yes	263	70.7
No	109	29.3
Do you think that using a digital mind map is important for technical skills?		
Yes	323	86.8
No	19	5.1

To fulfil the study's research objectives, the response presented in Table 2 and Table 3 illustrated the perceptions on the digital mind map and how it stimulates the learning of technical skills among the TVET students at higher learning institutions. The interpretation of the mean values in this study was divided into five parts: Strongly Agree (4.21-5.00), Agree (3.41- 4.20), Uncertain (2.61-3.40), Disagree (1.81-2.60) and Strongly Disagree (1.00-1.80). Based on the findings, we described the three highest means and the three lowest means of the items.

3.2 TVET Student's Perceptions on the Digital Mind Map

Table 2 displays the TVET student's perceptions of the digital mind map. In item 10, the respondents largely strongly agreed (M=4.26; SD=0.75) that using colours, nodes, and links while generating digital mind maps makes their learning process easier. Furthermore, respondents mainly agreed (M=4.15, SD=0.80) in item 5 that the digital mind map allowed them to quickly drag ideas, develop lines, and use pictures. From the results, it can be agreed that the mind maps let learners produce a visual image to enrich their learning (Budd, 2004). Thus, the digital mind map enables students to learn easier and more effective using visual images. Finally, the data revealed that respondents (M=4.14; SD=0.82) agreed that the digital mind map can save time since it allows students to work faster (item 6). Using digital mind mapping helps to restructure the mind map easier and makes the process of creating mind maps faster and easier (Dominik, 2014).

Evidently, the digital mind map application can support students' learning because it makes learning easier and not time-consuming.

Table 2 - TVET student's perceptions on the digital mind map

Item	Construct	*M*	*SD*	Interpretation
	Speed and Efficiency			
1	I produce ideas faster when I apply the digital mind map	3.93	0.79	Agree
2	I store my ideas efficiently when I apply the digital mind map	4.01	0.79	Agree
3	I believe that using the digital mind map is faster than using pen and paper to generate mind maps	3.91	0.98	Agree
4	I think that the digital mind map can provide more space than using pen and paper to generate mind maps	4.03	0.89	Agree
5	I think that the digital mind map allows me to drag ideas, develop lines and use pictures easily	4.15	0.80	Agree
6	Using the digital mind map can save time a lot because the software allowed us to work faster	4.14	0.82	Agree
	Appearance and Mechanics			
7	I create the digital mind map contents very well	3.73	0.87	Agree
8	I include text input easily using the digital mind map	4.02	0.80	Agree
9	I save and retrieve stored information easily using the digital mind map	3.98	0.80	Agree
10	I believe that using colours, nodes and links while generating the digital mind maps make learning process at ease	4.26	0.75	Strongly agree
11	I believe that dragging one node into another could easily make a link between them when using the digital mind map	4.00	0.79	Agree
12	I believe that the navigation and design mechanics of digital mind maps signify a potential digital tool	4.01	0.79	Agree
	Ontology and Concept Mapping			
13	I bring together my ideas in a mechanical way through the digital mind map	4.00	0.80	Agree
14	Digital mind mapping can improve my understanding of notions and ideas	4.09	0.81	Agree
15	I understand the connections across ideas within the digital mind map	4.01	0.80	Agree
16	I generate ideas using the digital mind map efficiently	3.91	0.82	Agree
17	I believe that the digital mind maps can assist me to coordinate my ideas	4.05	0.83	Agree
18	I believe that the digital mind is a good tool to connect and organise ideas	4.08	0.78	Agree
	Total average	3.93	0.79	Agree

According to the lowest mean data, respondents were scarcely agreed (M=3.73, SD=0.87) that they created the digital mind map contents very well (item 7). The respondents were similarly dissatisfied (M=3.91, SD=0.98) with item

3, which claimed that they believe using a digital mind map is faster than using pen and paper to build mind maps. Another low mean was for item 16, where respondents were slightly agreed (M= 3.91, SD =0.82) that they generate ideas in effective ways using the digital mind map. In other words, the students thought that digital mind map might not be fully effective in generating new ideas even though they believe digital mind map is a useful learning tool. They need more guidelines and practices for creating the digital mind map effectively. The TVET students should have learnt how to use and apply the digital mind map for technical skills. Moreover, the instructors should also encourage the TVET students to use the digital mind map in learning technical skills. Therefore, the digital mind map technique can be employed strongly in learning technical studies.

3.3 TVET Student's Perceptions on the Digital Mind Map to Stimulate Learning of Technical Skills

The results of the TVET students perceived on the digital mind map to stimulate learning of technical skills were illustrated in Table 3. The highest mean to stimulate learning of technical skills was that the TVET students believed (*M*=4.13, *SD*=0.78) that their previous knowledge is essential for technical learning in item 19. The result of the present study is similar to the result of Ghanat and Davis (2019) which revealed that the student's prior engineering management knowledge helped their understanding of engineering management topics at the Citadel. The second highest mean revealed that the TVET students agreed (*M*=4.10, *SD*=0.83) that the digital mind map can be used in various creative ways, and it can enhance their learning of technical skills (item 24). Finally, the students also agreed (*M*=4.06, *SD*=0.80) that the digital mind map can encourage them to think creatively and critically in completing the technical tasks as put in item 35. The digital mind map aids in the development of cognitive skills such as generating ideas, analytical and creative thinking, categorisation and content concentration, reflection, and so on (Bhattacharya & Mohalik, 2020). Therefore, this technique can enhance the TVET student's creative and critical thinking skills in learning technical studies.

Table 3 - TVET student's perceptions on the digital mind map to stimulate learning of technical skills

Item	Construct	*M*	*SD*	Interpretation
	Knowledge in Use			
1	I believe my previous knowledge is important for technical learning.	4.13	0.78	Agree
2	I believe the digital map can develop my learning of technical skills.	4.08	0.77	Agree
3	I believe my previous knowledge can create new knowledge in technical learning through digital mind map practice.	4.05	0.79	Agree
4	I develop my new ideas on technical learning using the digital mind map.	3.98	0.83	Agree
5	I believe that the digital mind map can help me in designing new ideas in my technical studies.	4.07	0.81	Agree
6	I believe that using the digital mind map in various creative ways can enhance my learning of technical skills.	4.10	0.83	Agree
	Student-centred Learning			
7	I can think of new ideas individually in technical tasks using the digital mind map	3.99	0.78	Agree
8	I can construct ideas and knowledge myself using the digital mind map	4.00	0.79	Agree
9	I feel determined to produce more creative technical ideas using the digital mind map	3.96	0.84	Agree
10	I can create ideas individually using the digital mind map	3.99	0.82	Agree

Table 3 - Continue.

Item	Construct	*M*	*SD*	Interpretation
11	I believe that the digital mind can develop my critical thinking for my technical studies	3.97	0.81	Agree
12	I believe that I can discover and transform complex information individually using the digital mind map	3.94	0.83	Agree
	Learning by Discovery			
13	I can create original ideas through the digital mind map with the help of my technical instructor	4.00	0.79	Agree
14	I think the digital mind map can facilitate my technical learning	4.05	0.76	Agree
15	I believe that the digital mind map is an effective inquiry-based learning technique for technical students	4.03	0.77	Agree
16	I believe that the digital mind map is an effective practical application for enhancing technical knowledge and skills	4.06	0.77	Agree
17	I believe that the digital mind map can encourage me to think creatively and critically in completing my technical tasks	4.06	0.80	Agree
18	I think that the digital mind map can help me to solve my problems in my technical studies	4.02	0.80	Agree
	Total average	3.93	0.79	Agree

Regarding the lowest mean, item 30 showed that the TVET students barely agreed (*M*=3.94, *SD*=0.83) that they can discover and transform complex information individually using the digital mind map. It is followed by the second-lowest mean in item 27, the respondents were barely considered (*M*=3.96, *SD*=0.84) that they feel determined to produce more creative technical ideas using the digital mind map. The third lowest mean showed that the respondents were slightly agreed (*M*=3.97, *SD*=0.81) that the digital mind can develop critical thinking for the technical studies.

With regards to examining the relationship between the TVET student's perceptions of the digital mind map and learning of technical skills, Tables 4 and 5 illustrated the findings. Table 4 showed the overall mean for digital mind map was (*M*=4.02; *SD*=0.64) and the overall mean for TVET student's learning of technical skills (*M*=4.03; *SD*=0.66) for both constructs, ie., digital mind map and TVET student's learning of technical skills. Generally, the results showed that the TVET students perceived highly positive on the digital mind map (*M*=4.02; *SD*=0.64) and learning technical skills for TVET students (*M*=4.03, *SD*=0.66).

Table 4 - Overall mean and standard deviation for constructs

Constructs	Mean	Standard Deviation
Digital Mind Map	4.02	0.64
TVET Student's Learning of Technical Skills	4.03	0.66

Table 5 showed the correlations of each sub-construct between TVET student's perceptions on the digital mind map and learning of technical skills. Results of Pearson Correlation for the sub-construct of the digital mind map show that there is a strong and significant positive correlation (r= 0.81; p<0.01) between speed and efficiency and knowledge in use. Next, the results showed that there is a strong and significant positive correlation (r= 0.80; p<0.01) between speed and efficiency and student-centred learning. Finally, the results showed that there is a strong and significant positive correlation (r= 0.79; p<0.01) between speed and efficiency and learning by discovery.

Table 5 - The relationship between the TVET student's perceptions on the digital mind map and learning of technical skills for TVET

Variable	Technical skills for TVET students					
	Knowledge in Use		**Student-centered Learning**		**Learning by Discovery**	
Digital Mind Map	*r*	*Sig.*	*r*	*Sig.*	*r*	*Sig.*
Speed and Efficiency	0.81*	0.000	0.80*	0.000	0.79*	0.000
Appearance and Mechanics	0.79*	0.000	0.79*	0.000	0.79*	0.000
Ontology and Concept Mapping	0.86*	0.000	0.86*	0.000	0.86*	0.000

*$p<0.01$

As shown in Table 5, the result for the second sub-construct of the digital mind map demonstrated that there is a strong and significant positive correlation ($r= 0.79$; $p<0.01$) between appearance and mechanics and knowledge in use. The results showed that there is a strong and significant positive correlation ($r= 0.79$; $p<0.01$) between appearance and mechanics and student-centred learning. Lastly, the table showed a strong and significant positive correlation (r= 0.79; $p<0.01$) between appearance and mechanics and learning by discovery. Corresponding to the final sub-construct of the digital mind map, the results showed a strong and significant positive correlation ($r= 0.86$; $p<0.01$) between ontology and concept mapping and knowledge in use. Next, the results indicated a strong and significant positive correlation (r= 0.86; $p<0.01$) between ontology and concept mapping and student-centred learning. Similarly, the findings showed a strong and significant positive correlation ($r= 0.86$; $p<0.01$) between ontology and concept mapping and learning by discovery.

3.4 Open-ended Items Analysis

The final part of the questionnaire consisted of three open-ended items. The respondents were requested to answer the three open-ended items. The qualitative data gathered in this section were analysed using thematic analysis as in Table 6. Item A asked the TVET students to list three main reasons to use digital mind map in technical studies. The three themes that emerged were an easy tool, saving time and increasing creativity for Item A. The highest rank for the easy tool theme was rated by the TVET students in this item. Next, the TVET students rated saving time as the reason they use the digital mind map in their studies. They also answered that the digital mind map may increase creativity in the technical studies as the third-highest frequency for the theme emerged. Tungprapa (2015) said that a digital mind map is a tool which is easier to review, update and store. Moreover, the digital tool also helps to enhance creativity and work faster (Dong et al., 2021). For Item B, the highest rank for three factors that enhance learning of technical skills when using digital mind mapping was creativity and design ideas as the most rated by the students. Then, it was followed by the second factor which was the development of ideas as the theme emerged from item B. This tool is able to write down each idea or concept individually before connecting them in groups and or in relation to one another in creative ways (Darke & Turner, 2020). The next factor that the students ranked as the third highest was better understanding. Rosciano (2015) on her study discovered that the digital mind map enables the learner to summarise information, understand basic information features at a conceptual level, and associate information with several concepts.

Table 6 - Open-ended items analysis

Open-ended Items	Rank	Main Themes	Frequency (*f*)
A. List 3 main reasons to use digital mind maps in technical studies	1	Easy tool	235
	2	Save time	80
	3	Increase creativity	57
B. List 3 factors that enhance learning of technical skills when using digital mind mapping	1	Creativity and design thinking	82
	2	Development of ideas	66
	3	Better understanding	43
C. List 3 factors besides the digital mind maps that will enhance learning of technical skills.	1	Training and practices	97
	2	Learn other skills	43
	3	Digital technology application	31

Finally, the last item was about the three factors besides the digital mind maps that will enhance the learning of technical skills. The respondents ranked training and practices as the first main factor, followed by the factor of learning other skills to enhance the learning of technical skills. Another most rated factor was the digital technology application that TVET students agreed could enhance the learning of technical skills. These factors are in line with the objective of the TVET program designed which is to improve student's practical construction skills, as well as their ability to design and repair infrastructural and machinery facilities and improve employable skills (Omar et al., 2020).

4. Conclusion

The purpose of this study was to identify TVET student's perceptions on the digital mind map to stimulate learning of technical skills. The empirical results showed that the TVET students have positive perception toward the digital mind map. In terms of the perceptions of the digital mind map, they mostly agreed that the digital mind map allowed them to learn easier and faster in their studies. Regarding the use of a digital mind map for stimulating technical skills, the results found that the majority of TVET students agreed that prior knowledge is important for learning technical skills and the digital mind map helps them to develop creative thinking skills for technical learning. The TVET students perceived that the digital tool has the potential to stimulate the learning of technical skills among TVET students. Furthermore, the results also confirmed there were strongly positive and significant relationships among the three sub-constructs of a digital mind map - speed and efficiency, appearance and mechanics, and ontology and concept mapping and the three sub-constructs of learning technical skills for TVET students - knowledge in use, student-centred learning and learning by discovery. The results from the open-ended items showed that the TVET students agreed that a digital mind map is an easy tool. In addition, the digital map saves time and can increase creativity as claimed by the respondents. Moreover, the respondents also listed three main factors that the digital mind map could support in learning technical skills - developing diverse ideas, nurturing creativity, and design thinking, and enhancing a better understanding of the subject taught. In conclusion, the empirical data show that TVET students have positive perceptions and attitudes towards digital mind map as a learning tool. In implication, the digital map could be used widely in any educational institution and in companies.

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