

# Digital Transformation of Pedagogical Skills Among Technology and Design Course Teachers in Implementing TVET Curriculum

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## Abstract

This study is conducted to determine the digital transformation of pedagogical skills required by Technology and Design Course (RBT) teachers in the implementation of Technical and Vocational Education (TVET) teaching. This research uses a mixed methods approach involving qualitative and quantitative analysis. Data was collected through expert interview and Fuzzy Delphi questionnaire developed and validated by an expert consisting of lecturers from higher education institutions and experienced teachers. Research findings show that there are five categories of skills that are critical for RBT teachers to meet the needs of students in an increasingly digital era. These included presentation and communication tools, data management and analysis, digital learning platforms and technologies, interactive and innovative technologies, as well as media production and editing. In addition, Fuzzy Delphi analysis was used to gain consensus on the most dominant and important skills. These findings provide valuable guidance to educators and policy makers in designing more effective training programs to improve teaching ability in the digital TVET context. In conclusion, this study not only emphasizes the importance of relevant pedagogical skills but also suggests steps to develop an educational curriculum that can meet the demands of industry and society.

## 1. Introduction

The digital era requires Technology and Design course teachers to master technological skills to ensure effective learning. Education 4.0 emphasizes the use of digital technology in pedagogy, while TVET plays a crucial role in producing a highly skilled workforce (Eng Ling & Kutty, 2022). RBT teachers must adapt to changes by mastering both pedagogical and technical skills, including online teaching and ICT integration. Educational leadership is also essential in guiding teachers towards digital teaching. Continuous professional development and innovation in learning materials are necessary to ensure effective teaching and better student achievement.

Digital literacy and citizenship are rarely discussed in Malaysian education, despite technology having transformed the way teaching and learning take place. The use of technology in education, including TVET, enriches the learning experience and equips students with skills relevant to the industry. Conventional learning differs from digital learning in terms of approach and efficiency. Digital learning offers flexibility and interactivity, while conventional learning maintains the advantage of physical interaction. A combination of both can optimize learning outcomes (Agir & Mohd Matore, 2022).

For TVET, teachers need to understand technology related to their field, integrate technology into teaching, and ensure students acquire the necessary digital skills for an increasingly evolving job market. TVET education plays a crucial role in equipping students with digital skills for the job market. However, challenges remain in ensuring effective teaching, including the pedagogical skills of RBT teachers in integrating technology, lack of resources, and students' readiness to adapt to digital learning. This study evaluates the gap between the skills taught and industry requirements while identifying issues such as access, motivation, and students' digital literacy. The findings will help develop strategies to enhance the curriculum and teachers' competencies, ensuring TVET education remains relevant in the digital era.

To gain a comprehensive understanding of the pedagogical skills required by RBT teachers in delivering instruction in the digital TVET era, this research aims to address the following key objectives:

1. To examine the pedagogical skill requirements of RBT teachers in implementing teaching in the digital TVET era.
2. To identify the most essential and dominant pedagogical skills of RBT teachers in integrating technology into teaching in the digital TVET era.

To achieve these objectives, this study focuses on the following research questions:

1. What are the pedagogical skill requirements of RBT teachers in implementing teaching in the digital TVET era?
2. What are the most essential and dominant pedagogical skills of RBT teachers in integrating technology into teaching in the digital TVET era?

By addressing these objectives and questions, this study aims to contribute to the ongoing efforts to modernize TVET education and ensure that teachers and students are well-equipped for the digital future.

## 2. Methodology

This section explains in detail the methods and methodology been employed in this study.

### 2.1 Study Design

This study employs a mixed-method approach using the Sequential Exploratory Strategy. The research design is crucial in determining the topic, objectives, and methodology, as well as ensuring that data collection and analysis are conducted systematically to accurately address the research questions (Creswell & Clark, 2018; Merriam, 1998; Mohd Majid, 1990).

### 2.2 Research Participants

The first phase of this study uses a thematic qualitative approach with a case study design to explore the pedagogical skill requirements of RBT teachers. A case study is suitable for gaining an in-depth understanding of processes through empirical data (Yin, 2013). This approach allows researchers to collect direct and detailed data from respondents and other sources of evidence (Hamzah, 2016).

The study involves the Head of the RBT Subject Panel as the population. In qualitative research, participant quality is more important than sample size (Welch & Patton, 1992). The sample consists of two RBT teachers from cluster secondary schools, selected using purposive sampling. Selection is based on their knowledge and experience to ensure relevant and high-quality data.

The second phase employs a descriptive survey study to identify the pedagogical skill requirements of RBT teachers. A survey study is part of descriptive research (Hamidah, 2021) and is used in both quantitative and qualitative research to collect data from a sample or population (J. Creswell, 2005). This approach provides accurate and relevant information to answer the research questions.

The study population consists of 217 RBT teachers from 30 secondary schools in Batu Pahat district. The population refers to the entire selected sample unit (Ghauri et al., 2020). The study focuses on RBT teachers with pedagogical expertise, with the list obtained from the Batu Pahat District Education Office. The study sample refers to a group of individuals from the population, where precise selection ensures the validity and reliability of the study. In the Fuzzy Delphi survey, a minimum of 10 experts is required for high consistency (Ayres & Jantsch, 1979; Erio ZiglioAdler, 1996). This study selects 15 experts from 5 schools, consisting of RBT teachers with expertise in the technology and digital fields and at least 10 years of experience. This selection aligns with Berliner (2001) and Creswell (2003), who state that individuals are considered experts if they have 5–10 years of experience. This number of experts also meets the recommendations of Ayres and Jantsch (1979) for Delphi studies.

## 2.3 Research Instrument

This study employs interviews for qualitative data and questionnaires for quantitative data to ensure that the collected data effectively addresses the research questions. Face-to-face interviews are chosen to facilitate interaction with respondents, using semi-structured questions and direct recording. Questionnaires are used as a self-report instrument that saves time and allows for measuring various respondent characteristics. This instrument has undergone refinement and validation by experts.

To meet the requirements of the Fuzzy Delphi Method (FDM), a survey is conducted to obtain expert consensus using mathematical formulas. A set of questionnaires is developed based on the pedagogical skill requirements of teachers in the digital TVET era as follows:

**Table 1** *Questionnaire Sections and Items*

Section	Questionnaire Items	Number of Items
A	Respondent Demographics	3
B	Teachers' Pedagogical Skills Needs	14

## 2.4 Data Analysis

The researcher analyzed the collected data by generating relevant themes. Several key themes were identified regarding the pedagogical skill requirements of teachers in implementing teaching in the digital TVET era. To answer the second research question on RBT teachers' pedagogical skills in integrating technology in the digital TVET era, the researcher developed a questionnaire based on interview findings and expert validation. The questionnaire was distributed to 15 RBT teachers from multiple schools. The Fuzzy Delphi Method (FDM) was used to achieve expert consensus and identify dominant skills by evaluating the threshold value, expert consensus ratio, and key ranking using the Fudelo 1.0 application. Overall, researchers used interview analysis to test the first research question before continuing with the second research question using a questionnaire. Based on the findings of the study using the Fuzzy Delphi method, the higher the percentage of the fuzzy score, the higher the position of the pedagogical skill requirement. Overall, the priority of the pedagogical skill requirement of RBT teachers in implementing teaching can be seen.

## 3. Findings and discussion

The analysis of this study is divided into two parts: respondent demographics and the pedagogical skill requirements of RBT teachers in implementing teaching.

### 3.1 Participants Demographics

The researcher plans to involve five national secondary schools in the Batu Pahat area. Three experts will be selected from each school, totalling 15 experts from the Batu Pahat area who will participate in the study. Among them, nine are male expert teachers (60%) and six are female expert teachers (40%), distributed across the five selected schools. The analysis indicates that the distribution of expert opinions by gender is nearly balanced. However, all selected experts hold a bachelor's degree (100%). Additionally, all 15 experts (100%) have more than five years of service in their respective schools, qualifying them as experts. Table 2 presents the demographic findings of the respondents.

**Table 2** *Demographic Findings of Respondents*

Demographic	Frequency	Percentage (%)
<b>Gender</b>		
Male	9	60
Female	6	40
<b>Education Level</b>		
Degree	15	100
Master	0	0

Doctor of Philosophy (PhD)	0	0
<b>Term of Service</b>		
Less than 5 years	15	100
More than 5 years	0	0

### 3.2 Analysis of Expert Consensus on the Need for Pedagogical Skills

The calculation of the threshold value (d), expert consensus percentage, and defuzzification is based on a 5-point Likert scale selected by the experts. The data was analyzed using the Fudelo 1.0 software developed by Dr. Ramlan. However, the determination of linguistic variables (values m1, m2, m3) according to the Likert scale and the calculation of the aggregate alpha were performed to obtain these three computed results, and this process is presented accordingly. The expert consensus calculation results are interpreted in Table 3.

**Table 3** Expert Consensus Results

Questionnaire items	Fuzzy Number Triangulation		Defuzzification Process	
	Threshold Value (d)	Expert consensus percentage (%)	Fuzzy Score	Expert consensus status
B1	0.05132	100	0.73	Accepted
B2	0.01437	100	0.78	Accepted
B3	0.06672	100	0.62	Accepted
B4	0.06466	100	0.70	Accepted
B5	0.02669	100	0.77	Accepted
B6	0.06466	100	0.48	Rejected
B7	0.05543	100	0.68	Accepted
B8	0.05748	100	0.70	Accepted
B9	0.08622	86	0.70	Accepted
B10	0.06158	100	0.72	Accepted
B11	0.06158	100	0.64	Accepted
B12	0.08109	100	0.49	Rejected
B13	0.05748	100	0.69	Accepted
B14	0.08314	100	0.68	Accepted

Based on the Fuzzy Delphi analysis conducted, 12 out of 14 items were accepted after meeting all three outlined criteria: a threshold value (d) exceeding 0.2, an expert consensus percentage above 75%, and a fuzzy score exceeding the  $\alpha$ -cut value of 0.5. However, the analysis identified two rejected items as they failed to meet one of the fuzzy criteria, specifically a fuzzy score below 0.5. These items were rejected because experts did not agree that social media skills and the use of artificial intelligence were essential pedagogical skills required for teachers in delivering instruction in the digital TVET era. Moreover, the findings from the Fuzzy Delphi analysis resonate with the broader discourse on the evolving pedagogical skills required in contemporary educational settings. The literature suggests that while technical skills, including those related to technology and artificial intelligence, are increasingly recognized as important, there remains a divide among experts regarding their essentiality in pedagogical frameworks (Avella, 2016). This reflects a growing recognition of the need for educators to adapt to technological advancements, yet it also underscores the necessity for further dialogue and research to clarify the role of such skills in effective teaching practices (Niederberger & Spranger, 2020).

In conclusion, the application of the Fuzzy Delphi Method in this analysis not only facilitated the

identification of essential pedagogical skills but also illuminated the complexities surrounding expert consensus in educational contexts. The rejection of specific items due to insufficient agreement among experts serves as a reminder of the dynamic nature of pedagogical competencies and the ongoing need for research to inform educational practices in the digital age.

### 3.3 Sequence of Pedagogical Skills Needs

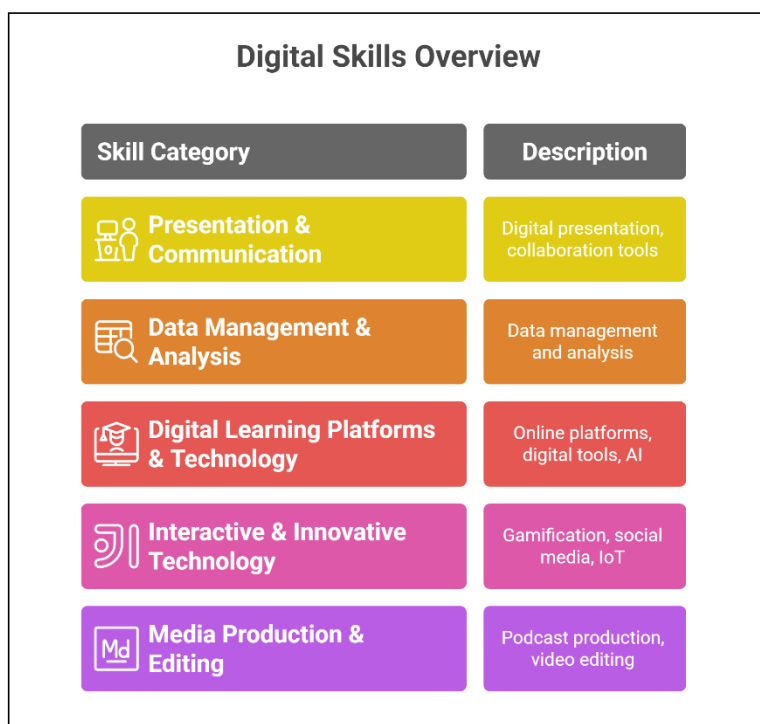
Based on Table 4, the Fuzzy Delphi Method (FDM) was used to rank the pedagogical skill requirements of RBT teachers in delivering instruction in the digital TVET era. This method was chosen for its ability to integrate expert opinions effectively. Therefore, this section discusses the ranking of the key pedagogical skill requirements obtained through FDM analysis. This section is categorized into a single part, which focuses on the ranking of each pedagogical skill requirement.

**Table 4 Ranking for each Teacher's Pedagogical Skill Needs**

Rank	Teachers' Pedagogical Skills Needs	Average Fuzzy Score	Item
1	Digital Presentation Tools	0.78	B2
2	Data Management and Analysis	0.77	B5
3	Online Learning Platform	0.73	B1
4	Use Of Digital Tools	0.72	B10
5	Use Of Collaboration and Communication Tools, Use of Infographics and Data Visualization, Communication Media	0.70	B4, B8, B9
6	Technology Integration "Internet of Things"	0.69	B13
7	Use Of Gamification Tools	0.68	B7
8	Broadcast Audio Revenue	0.64	B13
9	Use Of Video and Video Editing Tools	0.62	B3
10	Use Of Artificial Intelligence (AI)	0.49	B12
11	Social media	0.48	B6

Based on the analysis, the most dominant pedagogical skill requirement is the use of digital presentation tools, with an average fuzzy score of 0.78, followed by data management and analysis (0.77), and online learning platforms (0.73). The differences in fuzzy scores among these three skills are minimal, indicating nearly equal importance. In conclusion, digital presentation tools are the most crucial skill, while artificial intelligence and social media (items B12 and B6) were rejected by experts due to their low fuzzy scores. The analysis of this table provides in-depth insights into the priority of pedagogical skill requirements for teachers in delivering instruction in the digital TVET era. By understanding these priorities, teachers can strategize to enhance teaching effectiveness, select appropriate technological tools, and adapt learning approaches to meet students' needs. These priorities also help teachers manage their time and resources more efficiently, allowing them to focus on the most relevant skills required in the digital era.

Understanding these priorities allows teachers to strategize effectively, focusing on the most relevant skills required in the digital era. By honing their abilities in digital presentation tools, data management, and online learning platforms, educators can better meet the diverse needs of their students, manage their time and resources more efficiently, and ultimately enhance the quality of instruction (Matabane et al., 2022). This approach not only prepares students for the workforce but also contributes to the broader goals of TVET in fostering skilled and adaptable individuals capable of thriving in a rapidly changing technological landscape (Mitchell & Buntic, 2022).



**Diagram 1** *Category of Pedagogical Skills*

Based on the diagram provided, there are five main categories of essential skills for RBT teachers in integrating technology. The discussion for each category is as follows:

**1. Presentation & Communication Tools**

Teachers need to be proficient in using digital presentation tools to deliver information more effectively and engagingly. Additionally, collaboration and communication tools such as Google Meet, Microsoft Teams, and Zoom facilitate better interaction between teachers and students, whether in physical classrooms or online learning.

**2. Data Management & Analysis**

The ability to manage and analyze data is crucial for teachers to track student progress and adjust teaching approaches based on collected information. Software such as Excel, Google Sheets, and other analytical tools assist in systematically monitoring student performance.

**3. Digital Learning Platforms & Technology**

In the digital learning era, teachers must master online learning platforms such as Google Classroom, Moodle, and Edmodo to effectively deliver instructional materials. Additionally, the use of digital tools like interactive quizzes and artificial intelligence (AI) can enhance learning effectiveness and provide a more personalized learning experience for students.

**4. Interactive & Innovative Technology**

Interactive and innovative technology plays a key role in engaging students. Teachers can utilize gamification tools such as Kahoot! and Quizizz to boost learning motivation. Moreover, social media can serve as an informal learning platform, allowing students to interact with educational content more casually. The integration of the Internet of Things (IoT) in education, such as using Arduino or Raspberry Pi, also provides students with opportunities to explore technical aspects in their learning.

**5. Media Production & Editing**

Proficiency in media production and editing enables teachers to create more engaging and interactive learning content. The use of podcasts allows flexible information delivery, while video editing skills using software such as Adobe Premiere Pro and Canva help teachers develop high-quality visual learning materials.

By mastering these five skill categories, RBT teachers can ensure their teaching is more effective and aligned with the current demands of digital learning.

## 4. Conclusions and Recommendations

Understanding the prioritization of pedagogical skills enables teachers to plan more effective instruction, especially in the digital era. Through the TPACK Model, teachers must master three key components: Pedagogical Knowledge (PK), Technological Pedagogical Knowledge (TPK), and Technological Content Knowledge (TCK). In the context of TVET, this means that teachers must leverage technology to enhance teaching and ensure that technology-integrated strategies promote interactive learning while guiding students to become smart technology users. Continuous professional training and technological infrastructure support are also essential in empowering teachers to navigate digital challenges, ensuring a relevant and effective learning experience (Rahmadi, 2019)

### 4.1 Recommendations

Few recommendations have been proposed to the following parties based on the findings of this study.

#### Recommendations to Teachers

Future research can focus on developing a digital pedagogy model for RBT teachers in technical and vocational subjects, using theoretical frameworks such as TPACK or SAMR. This research could involve the design, development, and testing of a model to evaluate its effectiveness in enhancing learning. Additionally, studies can explore key elements within the model, such as the use of digital tools, innovative teaching strategies, and student-centred learning approaches. Secondly, research can be conducted to design a technology-based training program aimed at improving the digital literacy and pedagogical skills of RBT teachers. This may include developing training modules utilizing new technologies such as e-learning platforms and simulation software. The effectiveness of this program can be assessed through quantitative and qualitative approaches, including surveys, observations, and in-depth interviews, to evaluate changes in teachers' attitudes, knowledge, and skills.

#### Recommendations to Students

This research can investigate the impact of digital teaching approaches on students, including learning effectiveness, motivation, and skill mastery. An experimental study could be conducted by comparing two groups of students: one learning through traditional methods and another using digital approaches. This research can also assess how well students adapt to new teaching methods and how these methods prepare them for the digital job market. Secondly, the study can focus on the digital literacy levels of TVET students and how these skills can be enhanced through technology-based teaching. This involves evaluating students' digital literacy skills, such as their ability to search, evaluate, and use digital information effectively. The research can also explore the role of teachers in developing these skills and how the curriculum can be adapted to meet students' digital literacy needs.

#### Recommendations for the Education Sector

This study can focus on the differences between urban and rural schools in the use of teaching technology, comparing factors such as infrastructure, technical support, and digital literacy among teachers and students. This research will help identify the digital divide between areas and provide recommendations to align technology adoption. The findings can also be used by policymakers to allocate resources more strategically. Secondly, the study can investigate the use of advanced technologies such as Artificial Intelligence (AI), Virtual Reality (VR), and Augmented Reality (AR) in RBT teaching. The research will focus on how these technologies enhance interactivity and understanding of technical concepts, while also evaluating logistical challenges and costs in integrating them into education.

#### Recommendation for Further Study

Further research in the field of Technical and Vocational Education and Training (TVET) can be conducted with several different focuses to enhance teaching effectiveness in the digital era. Firstly, advanced studies can compare the pedagogical and technological skill requirements across different TVET subjects, such as Electrical, Engineering, or Business, to provide more tailored recommendations. Secondly, research can evaluate demographic differences such as age, gender, educational background, and work experience, and how these factors influence teachers' pedagogical skill needs. Thirdly, studies can focus on the availability of digital infrastructure in TVET schools and government policy support, providing recommendations to improve both infrastructure and policy.

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## Conflict of Interest

The authors declare that there is no conflict of interest related to the publication of this manuscript.

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