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Issues and Challenges in the Implementation of Professional Development Programs for Design and Technology Teachers

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Abstract. Teacher professional development (PD) is a continuous endeavor aimed at enhancing teachers' knowledge and skills through relevant courses, serving as an initiative to upgrade their expertise and produce high-quality educators. The introduction of the design and technology (D&T) subject aligns with the needs of 21st-century students, necessitating teachers to upgrade their knowledge and skills in accordance with the current needs. However, reports have indicated that teachers' knowledge and skills remain at a moderate level for the D&T subject. This paper aims to identify the issues and challenges in the implementation of PD programs for D&T teachers. In this study, a systematic review was employed using systematic search strategy criteria to guide the study. Three databases were used, namely Web of Science (WoS), Scopus, and Google Scholar. In all, 244 articles published between 2019 and 2023 were acquired through keywords and search strings, with 22 studies related to the topic. The study identified insufficient teacher preparedness toward D&T and inferior quality of teacher PD programs as issues, while constraints in teachers' participation were identified as challenges in implementing PD programs for D&T teachers. These results are expected to assist stakeholders in supervising the implementation of PD programs for D&T teachers, with the aim of maximizing the impact of these programs in enhancing the skills and knowledge of teachers.

Keywords: design and technology (D&T); issues and challenges; professional development

1. Introduction

Professional development (PD) is an effort aimed at assisting teachers in continuously realizing their true potential in accordance with current needs. PD empowers teachers to be prepared by equipping them with knowledge and skills

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that align with the demands of current education. The implementation of the PD program for the design and technology (D&T) subject should be emphasized as a catalyst for achieving more optimal student outcomes (Hsu & Lin, 2020). However, as reported by Kareemee et al. (2019), teachers have articulated concerns over the inadequacy of PD programs. This has resulted in difficulties in their understanding of subject matter requirements, affecting their competency in delivering teaching and learning activities.

Teacher competence plays a significant role in influencing students' academic performance (Popova et al., 2022). The capability of mastering knowledge and skills would help teachers to be more motivated and confident in delivering knowledge to students (Kunter et al., 2013). The impact of the 21st century also affects the sphere of education. Students need to be equipped with skills such as good communication, problem-solving, groupwork, and critical thinking (Bahagian Pembangunan Kurikulum, 2018; Lawati & Khan, 2023).

In line with this, the Ministry of Education (MoE) Malaysia has introduced the subject of D&T to replace the subject of living skills (LS) to meet the demands of the 21st century. Students are expected to be knowledgeable and equipped with and proficient in problem-solving and communication skills (Lawati & Khan, 2023). The introduction of the Primary School Standard Curriculum (KSSR), replacing the Integrated Primary School Curriculum (KBSR), also resulted in the replacement of the LS subject with D&T. D&T was introduced in 2014, initially implemented in Year 4, and later expanded to the secondary level in 2017 (Kementerian Pendidikan Malaysia, 2013a).

The change in curriculum necessitates PD programs to support teachers in aligning their beliefs with the new policies and intended practices. These programs should focus on improving teachers' competence and skills in integrating content (Fives & Buehl, 2016; Hsu & Lin, 2020; Mercader & Gairín, 2020). Appropriate PD programs can enhance teachers' knowledge and skills in accordance with current needs. According to Popova et al. (2022), suitable PD can improve teachers' knowledge and skills and help them become more confident in delivering lessons in the classroom. Teachers are also required to face changes to meet the current demands of students (Lawati & Khan, 2023). The introduction of technology in the D&T syllabus requires teachers to be competent in new knowledge and skills that are different from those required in LS (Bahagian Pembangunan Kurikulum, 2018).

However, existing empirical studies have revealed that the level of teachers' proficiency in terms of both knowledge and skills for D&T remains moderate, despite the availability of PD programs provided to them (Masingan & Sharif, 2019; Sahaat & Nasri, 2020). Thus, the main aim of this study is to thoroughly investigate and clarify the (1) issues and (2) challenges that are closely associated with the implementation and utilization of PD initiatives designed exclusively for D&T teachers.

2. Literature Review

2.1 Design and Technology (D&T)

According to the Division of Curriculum Development in Malaysia (Bahagian Pembangunan Kurikulum, 2018), D&T focuses on four domains, namely design appreciation, technology application, product manufacturing, and product design assessment. The aim of design appreciation is for students to appreciate and value existing designs to gain inspiration for creating more efficient designs, while in technology application planning, students learn and are able to apply technology in design across various disciplines. In product manufacturing, students produce more efficient product designs by following a systematic design process that aligns with current technological advancements. Finally, in product design assessment, students learn to continuously assess the design production process to ensure that the resulting products have good value addition, can solve problems, and are competitive.

The D&T subject will be fundamental in the three activities of ideating, realizing, and critiquing, more commonly referred to as designing, making, and evaluating, with the help of the latest technology (McLain, 2022). All these domains are supported using technology-based applications and tools (Bahagian Pembangunan Kurikulum, 2018). D&T also emphasizes the development of students' skills and understanding of tools and machinery (Mat Nor et al., 2018). The subject helps students to comprehend and apply technical knowledge and design principles in everyday activities (Mohd Ridzuan et al., 2020). According to Mat Nor et al. (2018), D&T assists students in understanding the processes of thinking, planning, and improving their practical skills through hands-on experiences in creating and testing products. This provides opportunities for students to apply their knowledge and skills in relevant and challenging situations.

Furthermore, the subject aids in the development of generic skills such as collaboration, communication, critical and creative thinking, as well as self-confidence (Huei et al., 2019). In the context of design, students are taught to apply their knowledge and skills in the practical and aesthetic design of products. D&T also provides opportunities for students to learn and understand important concepts such as digital technology, automation, and robotics. Students will comprehend the application of these technologies in product manufacturing and their potential impact on lifestyles and society (Sahaat & Nasri, 2020).

Bakar (2018) reported that the D&T syllabus design necessitates teachers being competent not only in content knowledge but also in specific skills to deliver learning objectives. According to Ahmad et al. (2019) and Huei et al. (2019), teachers need to master specific skills and competencies to be competent in the delivery of D&T. This relates to the teachers' ability to master content knowledge, pedagogical content knowledge, instructional skills, proficiency in handling hand tools, and assessment capabilities. The rapid advancements in technology and competencies in the current educational scenario highlight the need for teachers to constantly update their skills and knowledge (McLain, 2022). Therefore, D&T teachers need to be competent in content knowledge to master all topics, and at

the same time, they also need to have skills in handling the tools that will be used in delivering D&T. Table 1 displays the topics covered in the D&T Form 1 to 3 Syllabus, as well as the final project for each topic that students must complete.

Table 1: Summary of Form 1 to 3 Design and Technology Syllabus

No	Topic	Final project
1	Introduction to D&T	Creating a new object based on basic shapes
2	Project Management	Project management paper
3	Design Process	Creating a mock-up based on the project brief
4	Sketching	New sketch with added value
5	Fertigation System Design	Mock-up or new structure of the fertigation system
6	Fashion Design	Fashion design
7	Inventive Problem-Solving	Sketching product modifications
8	Manufacturing Technology	Making a 3D model and finishing the model
9	Mechanical Design	Building a functional mechanical gadget
10	Electrical Design	Building a functional gadget with electrical design criteria
11	Electronic Design	Building a microcontroller-controlled electronic circuit
12	Aquaponic System Design	Creating an aquaponic system design and report
13	Food Design	Producing food design and packaging
14	Product Development	Creating a product and documentation
15	Design as a Marketing Instrument	Creating an advertising design

2.2 Teacher Professional Development

The MoE Malaysia aims at maximizing the capabilities of teachers through the transformation outlined in the Malaysian Education Development Plan (PPPM) 2013–2025, with the goal of enhancing student outcomes (Kementerian Pendidikan Malaysia, 2013b). Empirical studies have consistently demonstrated a positive relationship between teacher quality and student achievement (Channa & Sahito, 2022; Rivkin et al., 2005; Robinson et al., 2008). According to Channa and Sahito (2022), a teacher with a high level of competence could be a positive person, well organized and planned, confident, and concerned about teaching and learning plans, leading to enhancing students' achievement percentages.

Teachers' PD is focused on improving quality; acquiring, enhancing, and mastering competencies; as well as sharing best practices through planned and systematic training (Bahagian Pendidikan Guru, 2016). The purpose of PD is to enhance teachers' knowledge, skills, and expertise, enabling them to effectively meet the diverse needs of students in an ever-evolving educational landscape (McLain, 2022). By providing structured and ongoing opportunities for professional growth, PD empowers teachers to stay abreast of current educational trends and research-based pedagogical approaches, ultimately enhancing their teaching effectiveness and positively impacting student learning outcomes. Through the concerted efforts of the MoE and the implementation of PD programs, the PD of teachers can be optimized, leading to improved educational outcomes for students (Hsu & Lin, 2020; Mercader & Gairín, 2020).

However, according to Tee et al. (2020), D&T teachers reported that they did not have sufficient training in and exposure to teaching D&T. This is in line with Rahman's (2020) study, showing that existing PD failed to adequately provide D&T teachers with the knowledge and skills they need to teach D&T. Chua et al. (2020) and Jamaludin and Rosli (2021) also indicated that teachers' participation in a PD program only had a moderate impact, primarily due to lack of peer commitment. Therefore, the scarcity of systematic reviews that address the concerns of and obstacles to ongoing professional growth, designed for D&T subject teachers, justifies this research. Thus, this paper aims to systematically elaborate on the issues and challenges of the implementation of PD programs for D&T teachers.

3. Methodology

3.1 Systematic Searching Strategies

This study employed a searching strategy consisting of three processes, namely identification, screening, and eligibility (Shaffril et al., 2021). This study commenced with the research aim and related questions as foundation. Terms to be used were established for literature searches and databases were chosen as platforms to find articles. Next, the inclusion and exclusion criteria for the search were determined. During the search, information was extracted and the quality of articles was evaluated. In the end, each piece of data was scrutinized, and an interpretation was drawn based on the research questions.

Identification improves the keywords used in data searches. This study used advanced searching and manual searching on two renowned databases, Scopus and Web of Science (WoS). Both are widely recognized as the most comprehensive journal article sources. Google Scholar was also used in this study to search any related article using the same keywords used in the Scopus and WoS search engine databases. This involved searching techniques including Boolean operators (AND, OR, NOT, or AND NOT), phrase searching, truncation, and wildcard ("*") and field code functions (either combining these search techniques or using them separately).

Table 2 shows the keywords that were used for article searching based on database.

Table 2: Keywords for finding related articles.

Database	Keyword
Scopus	TITLE-ABS-KEY ((("professional development") OR ("teacher professional development") OR ("professional learning community") OR ("in-house training") OR (in-service AND training)) AND (("design and technology") OR (D&T) OR (TVET) OR ("technical subject"))) AND PUBYEAR > 2018 AND PUBYEAR < 2024 AND (LIMIT-TO (SRCTYPE , "j")) AND (LIMIT-TO (PUBSTAGE , "final")) AND (LIMIT-TO (DOCTYPE , "AR")) AND (LIMIT-TO (LANGUAGE , "English"))
WoS	ALL=(((("professional development") OR ("teacher professional development") OR ("professional learning community") OR ("in-

	house training") OR (in-service AND training)) AND (("design and technology") OR (D&T) OR (TVET) OR ("technical subject"))))
Google Scholar	Specific keywords from Scopus and WoS were used, as well as Boolean operators, phrase searches, and field code functions (either together or individually), as only publications from indexed journals were considered appropriate for selection.

Inclusion and exclusion criteria were determined to ensure the relevance of the studies. Table 3 shows additional information, such as literature type, language, and timeline, that served as research criteria.

Table 3: Eligibility and exclusion criteria

Criterion	Eligibility	Exclusion
Literature type	Journal (research articles)	Journal (systematic reviews), book series, books, chapters in a book, and conference proceedings
Language	English and Malay	Non-English
Timeline	2019-2023	Before 2019

A systematic search strategy screening procedure includes or eliminates items from the review. This study excluded papers from other databases that overlap. We imposed a temporal constraint on the publication year, specifically limiting it to the period between 2019 and 2023. This deliberate choice ensured that all studies included in the paper are pertinent to the current context, thereby enhancing the relevance of the findings. Additionally, this timeframe selection guaranteed an ample pool of articles available for review, facilitating a comprehensive analysis of the existing literature. Then, the eligibility process was done using a manual screening process to identify the related articles that would be included in this paper. The procedure involved reading the article titles and abstracts. From the 244 articles identified in the database after the screening and eligibility process, only 22 were selected to be included in the review. The screening process is illustrated in Figure 1.

The flow diagram indicates the general process followed for article selection and lends greater clarity to the narrated process. The diagram shows the number of articles in each process, starting with the number of records identified, records screened, records excluded, and records included to be used in the review study.

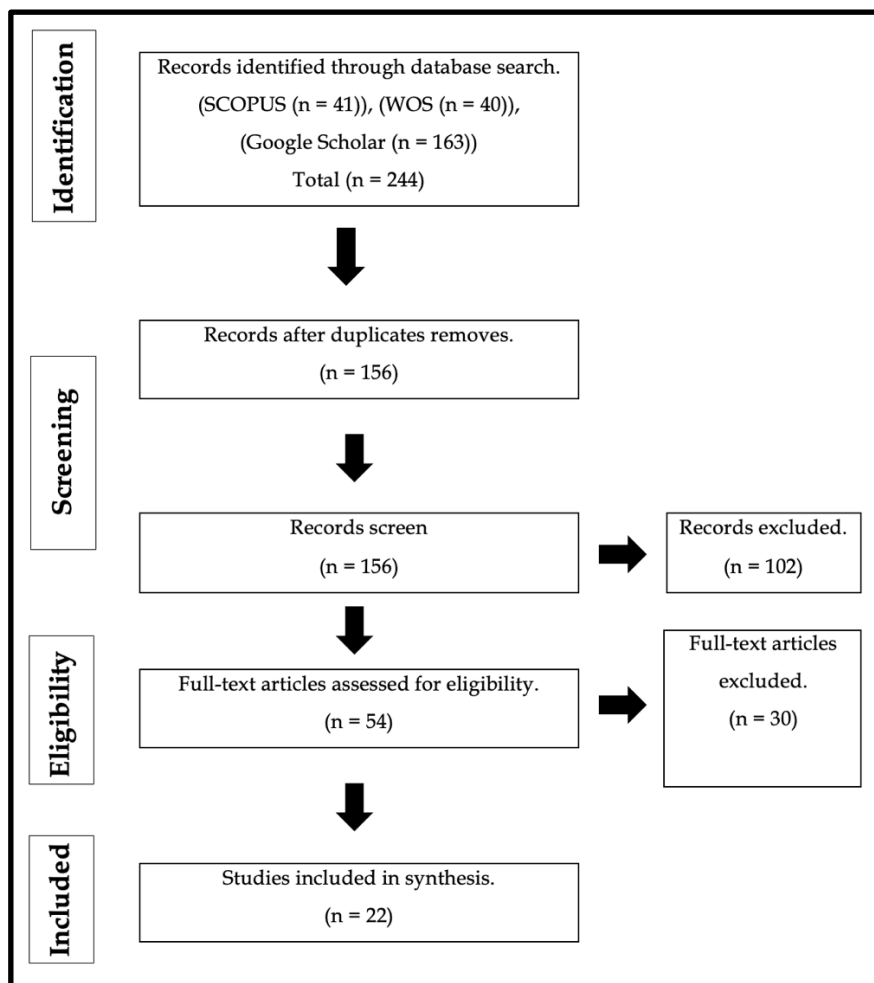


Figure 1: PRISMA diagram for the review in this study

4. Results and Discussion

This section provides a thorough examination of the empirical data gathered in this investigation. The primary goal was to examine and elucidate the issues and challenges related to the implementation and utilization of PD programs specifically tailored for D&T teachers. Despite available PD, empirical research has revealed that teachers have only moderate understanding and skills in teaching the D&T subject. This section will provide a detailed analysis of the results, focusing on the main issues and challenges that D&T teachers face in improving their professional skills through PD initiatives. The discussion will be based on the findings in the current body of literature, offering a detailed understanding of the elements that impact the implementation of PD programs. Furthermore, the possible ramifications for policy and practice will be scrutinized, with the aim to offer pragmatic perspectives that could improve the PD programs for D&T teachers.

The results of the analysis of the 22 articles that were used for this study are shown in the next section. The specifics of the papers that are reviewed in this study are presented in Table 4.

Table 4: Overview of selected studies

Source	Country	Design	Sample	Study focus	Professional development
Rahman (2020)	Malaysia	Qualitative	19 experts	To recognize the components needed for technical and vocational education and training (TVET) teachers' Self-Initiated Professional Development (SI-PD) framework	Self-initiated PD
Mat Jam and Puteh (2022)	Malaysia	Qualitative	7 experts	To identify the indications and components of teaching for Engineering Technology Education 4.0 at Malaysian Technical University Network (MTUN)	PD toward Education 4.0
Chookaew et al. (2021)	Thailand	Quantitative	67 TVET college teachers	To analyze the obstacles encountered by teachers, as well as their pre-workshop expectations and post-workshop satisfaction	Industrial robot training workshop
Jones et al. (2021)	United Kingdom	Qualitative	33 D&T teachers	To examine the level of subject knowledge among D&T teachers in relation to the externally imposed guidelines for technology and engineering education	Mindsets STEM Enhancement Project
Ithnain and Saidin (2021)	Malaysia	Quantitative	173 vocational teachers	To determine the characteristics of PD that serve as significant indicators of teacher competency	Measuring the PD of teachers
Vossen et al. (2020)	The Netherlands	Qualitative	6 D&T teachers	To develop an understanding of how research and design may be related by utilizing a professional learning community (PLC) with teachers, both personally and collectively	PLC
Olelewe et al. (2020)	Nigeria	Quantitative	128 TVET lectures	To explore how TVET instructors view the challenges and potential solutions for the efficient use of social networking sites (SNSs) for collaborative learning in Nigerian tertiary institutions	The use of SNSs for PD
Ahmad et al. (2019)	Malaysia	Quantitative	287 D&T teachers	To determine the problems and requirements that teachers have when applying the D&T subject in secondary schools	NA
Masingan and Sharif (2019)	Malaysia	Qualitative	2 D&T teachers	To explore teacher pedagogical content knowledge for the D&T subject	NA

Source	Country	Design	Sample	Study focus	Professional development
Huei et al. (2019)	Malaysia	Quantitative	100 D&T teachers	To conduct a comprehensive analysis of the difficulties encountered during the implementation of the D&T subject, and the imperative of assessment tools for the D&T subject	NA
Ismail et al. (2019)	Malaysia	Qualitative	15 teachers	To identify challenges in implementing STEM among secondary school science teachers, assess the impact on their performance, and determine required STEM education training	NA
Mohamad et al. (2019)	Malaysia	Quantitative	748 teachers	To determine teacher behavior after obtaining in-house training with regard to higher order thinking skills (HOTS), HOTS evaluation, and HOTS pedagogy	In-house training
Safian et al. (2021)	Malaysia	Quantitative	35 teachers	To determine the frequency and pattern of teachers' online interactions during the Covid-19 pandemic	Online PD
Sandal (2023)	Norway	Qualitative	28 teachers	To investigate whether a continuing education program in assessment for learning might assist in PD for vocational teachers	The continuing education course in assessment for learning
Tee et al. (2020)	Malaysia	Quantitative	367 teachers	To discover how teachers perceive their thinking approach and capacity for creative problem-solving	NA
Sahaat and Nasri (2020)	Malaysia	Quantitative	418 teachers	To determine teacher challenges in the implementation of D&T teaching	NA
Batholmeus and Pop (2019)	South Africa	Qualitative	28 academic staff	To investigate the elements that facilitate the effective incorporation of work-based, work-integrated learning (WIL) in the PD program for pre-service teachers	Industry-based WIL
Asghar et al. (2022)	Pakistan	Mixed methods	781 teachers (survey) and 45 teachers (interview)	To identify the effective combination of face-to-face, online, and offline instructional methods for Pakistan's in-service teacher training	Appropriate blend of face-to-face, offline and online learning PD

Source	Country	Design	Sample	Study focus	Professional development
Lee et al. (2021)	Botswana	Qualitative	30 academic staff	To analyze Botswana TVET PD training instances and derive conclusions utilizing the ADDIE model	Official Development Assistance (ODA) project
Kareemee et al. (2019)	Thailand	Qualitative	17 teachers and 9 experts	To establish a set of principles for the establishment and growth of virtual learning communities within educational institutions, with a specific focus on fostering STEM education	PLC
Njenga (2023a)	Kenya	Quantitative	170 teachers	To examine the continuous professional development (CPD) practices employed by vocational teachers in Kenya, with a particular emphasis on the utilization of formal and informal learning approaches	Formal and informal CPD
Njenga (2023b)	Kenya	Mixed methods	170 teachers (survey) and 16 teachers (interview)	To examine the mentoring practices employed by TVET teachers in Kenya and to identify various possibilities for enhancing the effectiveness and long-term viability of TVET teacher mentoring programs	Mentoring

Based on the data in Table 4, the included studies represent a diverse range of countries, illustrating a global interest in enhancing teacher proficiency in D&T and TVET. Malaysia contributed 11 studies, followed by Thailand with 2, and Nigeria, the United Kingdom, the Netherlands, South Africa, Pakistan, Botswana, and Norway with 1 each. This distribution indicates a widespread recognition of the importance of PD in improving educational outcomes. The studies employed a variety of research designs, with a notable preference for qualitative approaches. Specifically, 12 studies utilized qualitative designs, 8 employed quantitative methods, and 2 adopted mixed methods approaches. The focus areas of the studies are diverse, covering a broad spectrum of topics related to teacher PD. Four studies concentrated on identifying components and frameworks necessary for effective PD, such as self-initiated PD frameworks and components for Education 4.0. Five studies investigated the challenges and barriers faced by teachers, including obstacles encountered during training workshops and difficulties in implementing new curricula. Four studies assessed teacher competency and knowledge, examining factors such as subject knowledge and pedagogical content knowledge. Finally, six studies evaluated the implementation and effectiveness of PD programs, exploring the impact of various training initiatives on teacher performance and satisfaction.

4.1 Issues in Implementing PD Programs in the Design and Technology Subject

4.1.1 Insufficient preparation in the teaching of design and technology

Teachers who possess sufficient knowledge of the subject matter demonstrate their readiness and ability to effectively transfer the knowledge to students (Amran et al., 2020; Rahman, 2020). When teachers are adequately prepared, they experience an increase in confidence when delivering the subject matter (Ithnain & Saidin, 2021). According to Mat Jam and Puteh (2022), a teacher's competency level will have a significant impact on student achievement. This underscores the critical need for teachers to possess subject-specific competence before they can effectively impart knowledge to students, and in this context, they also require proficiency in utilizing the tools that aid in the D&T subject.

Despite this, previous studies have found three key aspects that could contribute to teachers' insufficient preparation for teaching D&T. First Sahaat and Nasri (2020) reported that teachers encounter difficulties in mastering all the topics within the D&T syllabus. According to Huei et al. (2019), half of the 367 D&T teacher participants in their study faced problems in mastering problem-solving skills in inventive topics. This finding aligns with a study by Tee et al. (2020). Mastering D&T subject content knowledge would give teachers confidence in delivering their teaching process, which would lead to successful teaching outcomes.

Second, there have also been reports on the issues associated with teachers using incompatible approaches to teach D&T (Tee et al., 2020). D&T requires students to master specific skills, such as designing, technology application, product manufacturing, and product design assessment, by completing a variety of projects. However, Masingan and Sharif (2019) and Sahaat and Nasri (2020) reported that D&T teachers still rely on traditional teaching methods, such as textbooks and notes, indicating that they use outdated approaches in delivering

the D&T content. Lack of references sources and teaching aids also compels teachers to stick to traditional teaching methods, as they have no other choice (Ahmad et al., 2019). Teachers should make full use of the advantages of technology by using information that can be obtained from the Internet as one of the sources that could enhance knowledge and skills.

Finally, teacher competency in handling tools updated with new technologies is another emerging issue (Ismail & Hassan, 2019). To enhance the teaching process, it is crucial for teachers to acquire the necessary knowledge and develop the required skills. Keeping up with the latest developments in their respective fields exposes teachers to the latest tools that could serve as teaching aids. According to Amran et al. (2020), Razzaq et al. (2019), and Uyub et al. (2021), to become a competent teacher in teaching technical courses, the teacher must have the competence of using tools to strike a balance between knowledge and skill. However, teachers have reported that they have limited exposure to the use of the latest technological tools, resulting in a lack of proficiency in delivering the subject content (Chookaew et al., 2021; Olelewe et al., 2020). This scenario is consistent with McLain's (2022) statement that teachers face a challenge in adapting to new practices and technologies. The use of technologies, tools, and applications was introduced in the D&T subject as one of the domains in which students have to learn and apply technology in design across various disciplines. This necessitates that teachers demonstrate competence in using these tools to effectively teach the D&T subject. However, Ahmad et al. (2019) found that over 86.2% of the 287 participating D&T teachers in their study lacked skills in teaching D&T. This finding is consistent with that of Chookaew et al. (2021) and Huei et al. (2019), who discovered that D&T teachers were unfamiliar with the equipment utilized in the subject.

This study has emphasized three key aspects that teachers encounter when preparing to teach the D&T subject. It is important for teachers to display an understanding of subject knowledge and being well prepared, which will help in the process of effectively transferring knowledge to students. The impact of the teacher's competency level on student achievement is significant. Unfortunately, the challenges of mastering all the topics within the D&T syllabus have led to outdated teaching approaches and a lack of competency in using technological tools. However, PD programs specifically designed to tackle these challenges could provide teachers with an alternative solution to address the challenges they face.

4.1.2 Inferior quality of current teacher PD programs

The absence of adequate PD programs for teachers hinders their progress in acquiring the latest knowledge and skills. Critics have highlighted that the implementation of PD programs fails to sufficiently address the needs of teachers (Batholmeus & Pop, 2019; Olelewe et al., 2020; Rahman, 2020). Previous studies have highlighted the presence of implementation constraints in subject-specific PD programs such as the D&T subject (Ismail et al., 2019; Sandal, 2023). A recent report (PADU, 2020) revealed that only 300 D&T teachers participated in a coding literacy course, representing a mere 3.98% of the total school population of 7782

in Malaysia (Kementerian Pendidikan Malaysia, 2023). The lack of CPD programs is also emphasized in Tee et al.'s (2020) study, which reported that 87.2% of the D&T teacher participants in their study believed that they deserve to have sufficient training to improve their teaching skills. Conducting a needs analysis for PD programs allows authorities to gain insights into teachers' specific needs. Authorities can then use this information to customize the PD programs accordingly, addressing any potential mismatches. Aligning the PD programs with teachers' specific needs enhances their effectiveness, resulting in more impactful PD experiences.

Furthermore, teachers perceive that the execution of PLCs as part of a PD program through peer coaching does not align with their desires and expectations. According to Vossen et al. (2020), the deployment of PLCs typically has a positive impact on PD. PLCs have a significant impact on improving teacher knowledge, as well as on PD. The MoE Malaysia implements the PLC method in PD programs, basing this approach on the cascade model, which serves as the PLC operation model (Mohamad et al., 2019). However, the execution of the PLC program has also been criticized for its failure to sufficiently address the needs of teachers. The irregular execution, teacher resistance toward collaborative sharing, and lack of supervision from administrators are contributing factors to the low success rate in the implementation of PLCs (Njenga, 2023b; Olelewe et al., 2020; Rahman, 2020). Nevertheless, there is a legitimate concern regarding the potential dilution of program messages as they traverse through various levels. Vossen et al. (2020) reported that the outcomes of implementing PLCs showed diverse acceptance among teachers. This viewpoint is supported by Ismail et al. (2019) and Njenga (2023b), who discovered that a portion of the participating teachers in their research either chose not to engage in in-house training after their participation in PD programs or perceived the in-house training delivered by their colleagues as ineffective. The failure of PD programs to meet the knowledge and skill needs of teachers leads to a waste of time and effort for the participating teachers.

In short, this discussion probes into the insufficiencies of existing teacher PD programs and the need for personalized PD programs that cater to their unique needs. The statement underscores the importance of performing a needs assessment to pinpoint the specific domains that require enhancement and to create tailored PD programs. Furthermore, this paper acknowledges the challenges associated with the implementation of PLCs and the lack of congruence with teachers' anticipated outcomes. It is imperative to prioritize the requirements of educators to prevent inefficiencies and undue burdens on their workload.

4.2 Challenges in Implementing PD Programs in the Design and Technology Subject

4.2.1 Constraints related to participation in teacher PD programs

Bakar (2018) indicated that D&T teachers have to be competent with content knowledge and also need to have specific skills to handle tools, yet the existing programs cannot meet the required skills. They believed that authorities must prepare them with a specific tailored program for them. Unfortunately, most PD initiatives are conducted in general or focused on a specific academic subject

(Rahman, 2020; Sandal, 2023). According to Jones et al. (2021), there is a misalignment between existing knowledge and subject knowledge required for D&T, leading to low levels of teacher confidence in the teaching process. This is further compounded by the lack of alignment between PD programs and the specific needs of teachers, which has emerged as a significant obstacle in their efforts to enhance their teaching skills in the field of D&T. Certain teachers in the field of D&T encounter obstacles in choosing PD programs that suit their needs, showing rejection to participate in the PD programs. This observation is consistent with the findings of Jones et al. (2021) and Sandal (2023), which suggest that teachers encounter barriers in obtaining PD opportunities specifically tailored to their requirements. PD initiatives with specific content knowledge to enhance understanding of the D&T subject and which also emphasize skills on handling tools that can be used as teaching aids need to be carried out to help teachers in teaching D&T in the class.

According to Ismail et al. (2019) and Kareemee et al. (2019), one of the factors demotivating teachers to participate in PD is their existing workload. Conversely, according to Amoo et al. (2021) and Iqbal et al. (2020), PD programs and teacher motivation have a substantial effect on job performance. Problems with teacher demotivation could result in the rejection of teachers who wish to enhance their knowledge and skills to teach the D&T subject. Similarly, Jones et al. (2021) reported that teacher workload has been a barrier for teachers to participate in PD. According to Saiful Hizan and Rodzalan (2020), teaching workload is the factor with the highest level of work stress among teachers. In addition to their normal duties, such as preparing lesson plans and teaching aids and checking student worksheets, teachers have additional duties, such as clerical duties, sports coaching, and organization duties. This is supported by Kamarudin and Taat (2020), who stated that there is a significant relationship between teacher workload and stress among teachers. Jones et al. (2021) and Safian et al. (2021) highlighted in their research that teachers feel pressured to engage in PD programs because they assume that doing so will consume a significant amount of their time. The issue that teachers face with regard to the amount of work they have to do and the additional responsibilities they have should be addressed by emphasizing the significance of PD programs that may benefit teachers by having beneficial consequences for their teaching ability.

The previous discussion elucidates that teachers perceive their participation in PD programs as leading to an increase in their time commitments. However, in this context, teachers perceive time constraints in terms of how suitable the allocated time is for executing PD programs that involve practical activities with equipment. According to Chookaew et al. (2021), teachers find it considerably challenging to complete hands-on training involving technological tools within the stipulated timeframe of PD programs. This has led to PD program providers reducing the importance of hands-on and practical training activities (Njenga, 2023a). Jones et al. (2021) and Sahaat and Nasri (2020) argued in their studies that teachers often lack sufficient time to grasp the technological requisites that are to be employed in instructional activities. This predicament can lead to limitations for educators who lack competence in these skills, hindering their ability to

effectively transmit their knowledge to students due to insufficient time to enhance their proficiency.

Additionally, the role of administrators has been identified as another contributing factor that impedes the implementation of PD initiatives among teachers. Administrators supposedly guide teachers to enhance their involvement to make an impact in PD programs that could help them improve their weaknesses. On the contrary, according to Rahman (2020), the involvement of school administrators in the selection process for PD programs has been identified as a factor that can interfere with the decision-making on which teachers should participate. According to Ismail et al. (2019), it has been reported that some administrations implement a rotation system for participating in PD programs, with priority given to the heads of units. This situation often results in teachers who are in need of PD not having the opportunity to participate. The role of administrators should be that of facilitators in conducting PD programs. Administrators, as individuals with authority, can utilize platforms for discussion among teachers prior to the implementation of PD programs.

The implementation of online PD programs might potentially serve as an alternative for initiatives aimed at enhancing teacher competency. Online PD programs are receiving growing recognition due to their capacity to address a range of obstacles related to implementing face-to-face PD programs. The deployment of online PD programs has drawn positive feedback from teachers, as evidenced by studies conducted by Asghar et al. (2022) and Lee et al. (2021). Nevertheless, the implementation of online PD programs also introduces new challenges for teachers as participants. The influence of teacher technology literacy on the success of online PD programs has been identified as a crucial component (Kareemee et al., 2019; Olelewe et al., 2020). Lee et al. (2021) argued in their study that the acquisition of prior familiarity with technology tools and materials is crucial for facilitating the seamless implementation of online PD programs. Internet accessibility influences the deployment of online PD programs. According to Asghar et al. (2022), teachers who have restricted access to the Internet are more likely to engage in face-to-face PD programs. This preference may be due to the difficulties they face in terms of Internet connectivity in their respective regions, as well as the financial burden associated with personal Internet subscriptions. Therefore, it is crucial to consider the technological readiness of teachers and the infrastructure of their Internet connections, given the challenges they face in implementing online PD programs.

In short, teachers have encountered several limitations when engaging in PD initiatives. This sheds light on the difficulties experienced by D&T teachers, including the discrepancy between their existing knowledge and the subject-specific demands they face. The absence of a customized PD program further compounds these challenges. The presence of substantial workload and diminished motivation might impede individuals' engagement, but the active involvement of administrators frequently inhibits the process of selecting effective programs. Online PD programs have emerged as a viable option, receiving praise for their convenience. However, these programs are restricted by

challenges related to technology literacy and limited Internet accessibility. To achieve a holistic solution, it is imperative to implement PD programs that are tailored to certain subjects. These programs should address problems related to workload, involve administrators as facilitators, and prioritize the effectiveness of online efforts by enhancing technological readiness and connectivity.

5. Conclusion

Moderate proficiency among D&T teachers in providing instructional content may have been influenced by the effectiveness of their PD processes. There are initiatives to help teachers, but their impact is limited. This systematic literature review examined D&T teachers' PD program issues and challenges. Two research questions were identified, and 22 papers were analyzed for quality and inclusion/exclusion. Analysis showed insufficient preparation toward the teaching of D&T, with focal points of subject understanding, addressing outdated teaching methods due to mastering difficulties, and countering low tech competency. Additionally, inferior quality of current teacher PD programs is another issue that underlines the inadequacies of the current programs and advocates for personalized approaches, which requires specific needs assessment and customized PD. The implementation of PLCs is one type of PD program, although this approach has yielded incongruent outcomes. While constraints in the participation of teacher PD programs pose challenges to the implementation of PD programs for D&T teachers, this exposes challenges among D&T teachers, demonstrating knowledge gaps and subject shortages. Tailored training focusing on the D&T subject is insufficient, workload and motivation concerns arise, and administrators obstruct selection. Online PD is commended; however, it is hampered by technical and Internet concerns. Therefore, it is essential to implement PD programs specifically tailored for D&T teachers to address the issue of teachers' unpreparedness in delivering the teaching and learning process for the D&T subject. Emphasis should be placed on enhancing teachers' practical skills in executing projects, thereby facilitating the transfer of theoretical knowledge into practice. The integration of technology into project implementation can also help to ensure smooth teaching sessions. This approach is expected to resolve issues related to the quality of PD programs in failing to meet the needs of D&T teachers. Additionally, the barriers faced by teachers in participating in PD programs need to be thoroughly examined. The role of school administrators in providing support to teachers is crucial for enabling them to achieve their full potential in line with current requirements. Consequently, administrators must also be competent in planning and organizing PD programs to avoid placing undue pressure on teachers. This study has shown that it is imperative to address the issues and challenges in the implementation of PD programs and to explore alternative approaches or strategies to optimize delivery and implementation to ensure consistent and high-quality training.

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