Investigation of Classroom Teachers' Technological Pedagogical Content Knowledge in the Context of Mathematics Teaching for Inclusive Students

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ARTICLE INFO

Article History:
Received 04.10.2023
Received in revised form 27.11.2023
Accepted
Available online 15.12.2023

ABSTRACT

Mathematics teaching has a special place in implementing successful inclusion practices (SIP) for students with special needs (SWD). However, while teaching mathematics skills to SWD, various learning problems are experienced for different reasons, and inclusion cannot be fully achieved. In order to eliminate or minimize this problem situation, effective mathematics teaching should be carried out. In order to achieve this goal, it is essential to make adaptations to SWD by using technological pedagogical content knowledge (TPACK) in mathematics teaching. Based on this importance, the study aims to examine the TPACK of classroom teachers regarding their implementation of SIP in teaching mathematics to SWD. The research has a qualitative research paradigm. In this context, the research model was determined as a multiple-case study. The study participants consisted of eight classroom teachers determined by the criterion sampling method. The "Semi-structured Interview Form" developed by the researchers was used as a data collection tool. In this context, the answers given by the participants to the interview questions were subjected to descriptive analysis within the framework of themes, sub-themes, and standard codes created by the researchers. As a result of the analysis, it was concluded that the classroom teachers' competencies in technology and content knowledge (mathematics and special education) varied. There are some positive aspects (advantages) and negative aspects (disadvantages) of using technology in both general education and mathematics education. They include the use of technology in different aspects of the presentation and evaluation processes of mathematics teaching within the scope of SIP, and they also need additional services such as developing TPACK competencies in the mathematics teaching process providing devices, infrastructure, facilities, and training for this purpose. The findings obtained from the study were discussed within the literature framework, and limitations and suggestions for further research were stated.

Keywords:[3]
Students with special needs, successful inclusion practices, technological pedagogical content knowledge, and effective mathematics teaching adaptations.

INTRODUCTION

According to international and national laws, regulations, and strategic plans, it is a priority right for students with special needs (SWD) to benefit from the same educational opportunities as their peers in general education classes by the principle of most minor restrictions, by providing support and additional services to the teacher (Broderick et al., 2005; Forlin, 2010; Kırcaali-İftar, 1992; Ministry of National Education [MoNE], 2012; United et al. Organization [UNESCO]; 1994). It is possible to meet the educational needs of SWD in general education classes within the scope of equality of opportunity in education, which is their legal right, through the implementation of successful inclusion practices [SIP] (Hunt et al., 2002; Otukile-Mongwaketse et al., 2016). Thus, SWD will learn the academic and non-academic skills they need and will be able to achieve a happy life by gaining independent living skills (Kırcaali-İftar, 1992).

In order to implement SIP, it is necessary to adapt schools and classrooms to the needs of SWD within an effective educational process (physical adaptation) and to make necessary adaptations in program (curriculum) objectives, techniques, and evaluation processes for student needs (Broderick et al., 2005). These adaptations should be made for all learning areas, both academic (e.g., Turkish, mathematics, science) and non-academic (e.g., self-care skills, nutrition skills) (Batu & Kırcaali-İftar, 2010).

In this context, it can be said that mathematics skills have an essential place for SWD (McCabe & Tedesco, 2012; Yıkmış et al., 2018). The inability of SWD to acquire mathematics skills fully or partially may negatively affect their academic self-perception (Benavides-Varela et al., 2020). For this reason, the importance of teaching mathematics skills to SWD effectively by including necessary adaptations cannot be denied (Batu & Kırcaali-İftar, 2010; Yıkmış et al., 2018). Utilizing technology in the adaptation process has a special place and importance in teaching mathematics skills for SWD (Bouck et al., 2020).

On the other hand, successful teaching of technology requires constantly creating, maintaining, and re-establishing a dynamic balance between all components. It should be noted that several factors influence how this balance is achieved (Koehler & Mishra, 2009). Rapid technological developments have led to the rapid dissemination of information and the formation of new social networks and have affected areas such as business, profession, and education, which are of interest to all segments of society. Teaching with technology can become more complicated when the challenges that new technologies present to teachers are considered (Koehler et al., 2013). Teachers and educational researchers have adopted the technological, pedagogical, and content knowledge (TPACK) model to address these challenges to understand and design purposeful classroom technology integration across subject areas (Vivian & Falkner, 2019). The term TPACK, which used

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to mean the set of knowledge and skills that teachers use to teach a particular outcome for a particular class, has gradually been replaced by a kind of creative thinking about how technology supports teaching and learning, which is not only a kind of knowledge or skill, but also includes the development of teaching and learning knowledge (Kholid et al., 2023). The TPACK framework suggests that content, pedagogy, technology, and teaching/learning contexts have roles to play separately and together and consist of the components of "Technology Knowledge, Content Knowledge, Pedagogical Knowledge, Pedagogical Content Knowledge, Technological Content Knowledge, Technological Pedagogical Knowledge, Technology Pedagogy and Content Knowledge" (Patalinghug & Arnado, 2022). TPACK can be used as a way of thinking about effective technology integration. This is because technology, pedagogy, content, and context are interdependent aspects of teacher knowledge necessary to effectively teach content-based curriculum with educational technologies (Harris et al., 2009). Teachers need TPACK to acquire new skills, abilities, and competencies and, thus, to develop effective teaching practices (Paidican & Arredondo, 2022). In this context, teachers need i. an overarching understanding of what it means to teach a particular subject by integrating technology into the learning process; ii. Knowledge of teaching strategies and representations for teaching specific subjects with technology; iii. knowledge of students' understanding, thinking, and learning with technology; and iv. knowledge of curriculum and materials integrating technology with learning (Dorian, 2014). At this point, the abstract and cumulative nature of the mathematics discipline makes it necessary to employ different approaches and technologies in the learning-teaching process (Bouck et al., 2020; Chodura et al., 2015; Dowker, 2017). Therefore, teachers are expected to have 21st-century skills and associate them with appropriate technologies and pedagogies (Önal & Çakır, 2016; Stoilescu, 2014).

Effectiveness in teaching mathematics to SWD in learning-teaching environments can be achieved by adequately integrating appropriate technology, pedagogy, and content in mathematics teaching processes during the professional development of classroom teachers in the SIP process (Ananiadou & Claro, 2009). A teacher with high TPACK will be able to use constructive pedagogical techniques that apply differentiated instructional technologies to teach by meeting the individual needs of SWD (Harris et al., 2007). Therefore, teaching mathematics to SWD through technological integration in mathematics teaching has a special place and importance in this regard (Dowker, 2017). The skills required for the use of technology in mathematics teaching are (1) ways of thinking that include creativity and innovation, critical thinking, problem-solving and decision-making, and metacognition or learning, (2) ways of working that include communication and collaboration or teamwork, (3) working tools that address information literacy and information and communication technology (ICT) literacy, and (4) personal and social responsibility with citizenship, living in the world that includes life and career skills (Graham, 2011). In addition, virtual manipulatives also provide a suitable option to support the teaching and learning of mathematics by SWD (Bouck et al., 2020). It is essential to adapt the teaching process by classroom teachers in the context of these components that play a significant role in teaching mathematics to SWD in SIP. In this way, the expectation of realizing easier and more permanent acquisition of the mathematics skills that SWD has the most difficulty in by providing practical teaching through technology integration in inclusive education for the future will be paved (Sarı & Olkun, 2020).

In summary, with the increase in the availability of technology and the importance given to mathematics education, technology-mediated mathematics teaching related to SWD has gained more importance (Kiru et al., 2018; Yıkmış et al., 2018). In the literature, some studies have been found on making adaptations to SWD using TPACK in mathematics teaching (Benavides-Varela et al., 2020; Chodura et al., 2015; McCabe & Tedesco, 2012; Tournaki & Lyublinskaya, 2014; Vivian, & Falkner, 2019), but no study has been found on examining the TPACK of classroom teachers in the context of mathematics teaching for inclusion students in the context of the SIP process. Therefore, this study is expected to provide a basis for future research. In addition, the research predicted that technological integration related to mathematics education for the SWD for SIP would provide essential contributions by putting this situation into practice focused on education-training activities without losing time.

The level of classroom teachers' utilization of their TPACK in teaching mathematics to SWD in the SIP process is severe theoretical knowledge. Classroom teachers can differentiate the teaching by using their TPACK appropriately and improving the mathematics skills of each child. In this way, in a general education classroom with different students, SIP can be provided to SWD in mathematics teaching (Tournaki & Lyublinskaya, 2014). From this point of view, the study aimed to examine the TPACK of classroom teachers

in teaching mathematics to inclusive students. In this framework, answers to the following sub-problems were sought in the study:

1. How was the classroom teachers' pedagogical content knowledge in the SIP process?
2. How was classroom teachers' TPACK in the process of SIP?
3. How was the technology knowledge of primary school teachers in the process of SIP?
4. What were classroom teachers' TPACK related to teaching mathematics to SWD in the process of SIP?
5. What were the expectations/suggestions of classroom teachers about their TPACK for teaching mathematics to SWD in the SIP process and its application?

METHOD

Aim And Methodology of The Research

The research has a qualitative research paradigm. Since the research aims to examine the technological pedagogical content knowledge of classroom teachers regarding the implementation of SIP in teaching mathematics to SWD, the research model was determined as a multiple-case study. In a multiple case study, it is recommended that the researcher use the logic of repetition; that is, the researcher should follow the same procedures for each case (Gerring, 2007; Yin, 2017). The study evaluated the TPACK of classroom teachers in the process of SIP in terms of mathematics teaching for SWD and their utilization of their TPACK in the effective teaching process as a holistic situation and individually. In the research, criterion sampling, one of the sampling types, was used (Yıldırım & Şimşek, 2013).

Study Group

The study participants consisted of eight classroom teachers determined by the criterion sampling method. Since qualitative research is mainly based on observations and interviews, it does not need large and broad participants because, after a particular stage, observations and interviews may repeat themselves (Morse, 2016; Shenton, 2004). The criteria for forming a study group can be listed as having at least one SST in the classroom in the 2022-2023 academic year and before, having a bachelor's degree in classroom teaching, completing preparatory training, and voluntarily participating in the study. Criterion sampling is the creation of a sample that includes individuals, events, objects, or situations that have the qualifications to be determined about the problem to be investigated (Büyüköztürk et al., 2022). Demographic information about the participants is given in Table 1.

Table1. *Demographic information about the participants*

Participant	Age	Gender	Education Level	Inclusive Practice Experience (Year)	Inclusion Training at the Undergraduate or Graduate Level	Inclusion Training at the In-Service Level
P1	30	Male	Licence	8	Yes	No
P2	30	Female	License	8	Yes	No
P3	37	Male	Master's Degree	15	No	No
P4	37	Female	License	15	No	No
P5	25	Female	License	3	Yes	Yes
P6	42	Male	Master's Degree	8	No	Yes
P7	40	Male	Master's Degree	16	No	Yes
P8	39	Male	License	2	Yes	Yes

According to Table 1, 62.5% of the participants were female, and 37.5% were male. 62,5% of the participants received a bachelor's degree, and 37,5% received a master's degree. While 75% of the participants had less than 10 years of inclusive practice experience, 25% had more than 10 years of inclusive practice experience. 50% of the participants received inclusion training during their undergraduate and graduate

education, while 50% did not receive inclusion training during their undergraduate education. 50% of the participants received in-service inclusion training, and 50% did not receive in-service inclusion training.

Data Collection Process

"Semi-structured Interview Form" developed by the researchers was used as a data collection tool. The first semi-structured interview question form, prepared by consulting expert opinion, consists of 11 questions and sub-questions. In line with the feedback received from the experts, arrangements were made for some semi-structured interview questions. In this context, explanatory probes were added to some semi-structured questions.

The study's data were collected through online, voluntary interviews. During the research process, semi-structured interview questions were sent to the participants via e-mail before the interviews were conducted. The participants were instructed to inform the researchers if they could not understand the interview questions. After the interviews were completed in one month, the data obtained were transcribed and turned into written documents.

Analyzing the Data

The data obtained from the research were subjected to content analysis. The basic process in content analysis is to bring together similar data within the framework of specific concepts and themes and to interpret them by organizing them in a way that the reader can understand (Yıldırım & Şimşek, 2013). The answers given by the participant classroom teachers to the interview questions were evaluated within the framework of the themes and sub-themes created by the researchers. The standard codes were expressed descriptively with direct quotations from the opinions of the classroom teachers under the headings of themes and sub-themes and presented in the findings section.

Limitations of the Study

The study has some limitations. The documents used in the research were selected from those that were accessible. The number of women thinkers/educators in the data analysis process is limited to nine. The opinions of women thought to be more prominent in the sources accessed within the scope of the study were included in the study.

Limitations of the research and suggestions for further research can be listed as follows:

- The study group of the research is limited to classroom teachers. Further research can be applied to include other branch teachers.
- Further research can be carried out specific to unique newlyweds.
- Further research can cover the process of TPACK teaching practice for classroom teachers.

FINDINGS

In this part of the research, which was carried out to examine the technological pedagogical content knowledge of classroom teachers regarding the implementation of SIP in the process of teaching mathematics to SWD, the themes and codes obtained as a result of content analysis are given.

Pedagogical Content Knowledge Competence of Classroom Teachers

The opinions of the classroom teachers about the adequacy of their field knowledge regarding the implementation of SIP in teaching mathematics to SWD are given in Table 2.

Table 2. *Pedagogical Content Knowledge Competence of Classroom Teachers*

Code	Participant
Pedagogical Knowledge Competence	P1, P2, P3, P4, P5
Mathematics Content Knowledge Competence	P1, P2, P3, P4, P6, P8
Special Education Field Knowledge Competence	P2, P3, P4, P8
Mathematics Content Knowledge Competence for People with Special Needs	P1, P2, P3, P4, P5

In Table 2, the most striking opinions of the classroom teachers about teaching mathematics to SWD in the SIP process under the titles of "Pedagogical Knowledge Competence, Mathematics Content Knowledge

Competence, Special Education Content Knowledge Competence, and Mathematics Content Knowledge Competence for Special Needs" are given below:

> "*When I evaluate my pedagogical content knowledge, I can say the following: I am a classroom teacher working in the private sector. Of course, working in the private sector for many years has some benefits. In order to work successfully as a classroom teacher in the private sector. We need to stay more dynamic and improve ourselves from different angles. Suppose we consider the components of pedagogical content knowledge, for example, teaching methods, knowledge about students, the curriculum, and knowledge of assessment and evaluation strategies. I had the opportunity to attend many different workshops in these areas. I participated in training abroad. I also participated in different trainings in Turkey. I attended symposiums. In this sense, I can see myself as sufficiently developed in the pedagogical field*." (P4).
>
> *"I make my plans and programs according to the children's level and carry out my activities according to the children's level. I advocate the simple-to-complex method in mathematics, as in every program in every lesson. In other words, I attach great importance to teaching the basic concepts first and then getting into complex concepts. This is already planned in this way. If these steps are missing, achieving success in children is impossible."* (P3).

Use of Technology in the Teaching Process

The opinions of classroom teachers on the use of technology in the teaching process are given.

Table 3. *Using of Technology in the Teaching Process*

Code	Participant
Teachers' Skills in Using Technology	P1, P2, P3, P4, P5, P6, P7, P8
Skills of SWD in Using Technology	P1, P2, P3, P6, P8

Sample statements in the category of "Classroom teachers' skills of using technology" in Table 3 can be stated as follows:

> *"I love to use technology in my life and my work. When I say technology, I try to have my computer, projection, and printer in the classroom. The smart board has not come to our school. I am in the central school, but I try to do everything possible with the computer and projection. I have been a teacher for many years, but I follow technological applications, and I can say that we also took in-service training seminars. There was an Education Academy here. I guess they have nothing, but we participated a lot in its training."* (P8).
>
> *"Web 2.0. designs. As we see these from our other teacher friends, we try to apply them in our class, and the children like them very much. In this way, I can say that we use technology completely."* (P6).
>
> *"I do not know flash animation. There are ready-made training platforms on flash animation. I use these. Before, graphic design was something I learned completely with my effort. I learned this from the information I learned there in a digital channel printing center I worked at during my university years. It was something that stayed with me. Throughout the years, I have always used it. For example, I designed and used the student-on-duty card myself. When an event was to be held, I made the poster A3 design for it. I used it when preparing a board about certain days and weeks. I did not receive any in-service training on this."* (P1).

The sample expressions in the scope of "Skills of using the technology of SWD" in Table 3 can be stated as follows:

> *"There are interactive boards, sir, in terms of technology, for example, we can prepare games for children with 2-0 tools, we can change the options here and present them with the ready-made options on the internet, again, for example, you have some Photoshop knowledge, you know, I have graphic design knowledge, sometimes I can easily create a material I want myself in this regard, so I can easily create a material I want myself, so I use educational platforms and flash in my mathematics applications and use them to prepare materials for them when necessary."* (P1).
>
> *"You know, I had full-time inclusion students at a mild level, and they loved to do it. I mean, some in the classroom were collecting apples from the tree, and they loved to press the number they found in that tree. They loved using that apple and looked forward to coming to that lesson."* (P2).

Advantages and Disadvantages of Using Technology in Mathematics Teaching

The opinions of classroom teachers about the advantages and disadvantages of using technology in education in SIP for SWD are given in Table 4.

Table 4. *Advantages and Disadvantages of Using Technology in Mathematics Teaching Process*

Code	Participant
Advantages	P1, P2, P3, P4, P5, P6, P7, P8
Disadvantages	P1, P2, P3, P5, P7, P8

The sample statements within the scope of "Advantages of Using Technology in Mathematics Teaching Process" in Table 4 can be stated as follows:

> *"With technology integration into education, perfect things started to happen. By appealing to children's multiple senses, our classroom management and my lectures became easier. Children's learning abilities have also increased. This has become an advantage because today is the age of technology."* (P7).

The sample statements in the "Disadvantages of Using Technology in Mathematics Teaching" topic in Table 4 can be stated as follows:

> *"As a disadvantage, I think it is because it gamifies it too much for the child; the child may break away from the lesson and think we are playing a game at some point. However, apart from that, it can also distract the child's attention. If there are too many visual stimuli, the child's interest in the lesson can be lost at some points."* (P5).

Using Technology in The Process of Mathematics Teaching

As a result of the analyses, the sub-themes and participants under the theme of "*Using Technology in the Process of Mathematics Teaching*" are given in Table 5.

Table 5. U*sing Technology in the Process of Mathematics Teaching*

Sub-Theme	Participant
Use of Technology in the Instructıonal Adaptations	P1, P2, P3, P4, P5, P6, P7, P8
Use of Technology in the Assessment of Instruction	P1, P2, P3, P4, P6, P7, P8

Using Technology in the Instructional Adaptations

Table 6 presents the codes of the classroom teachers about the "Use of Technology in the Presentation of Instruction" for SWD in the process of mathematics teaching in SIP.

Table 6. *Use of Technology in the Instructıonal Adaptations*

Code	Participant
Use of Web 2.0 Tools	P1, P2, P3, P4, P5, P6, P8
Smart Board, Computer, Projection Use	P1, P2, P3, P4, P5, P8
Microsoft Office Programmes	P1, P3, P4, P5, P7
Use of Education Platforms	P1, P2, P4, P5, P6
Using Flash Animation Applications	P1, P2, P3, P4, P6

Examples of participant expressions of the codes "Use of Web 2.0 Tools, Use of Smart Board, Computer, Projection, Use of Microsoft Office Programmes, Use of Educational Platforms, Use of Flash Animation Applications" in Table 6 about the use of technology in the presentation of the teaching of mathematics in the process of teaching mathematics in SIP can be stated as follows:

> *"Afterwards, I use WordWall a lot, and when I look at the ready-made ones, I continue to edit the subjects that are not suitable for the class level, or that I want to add something, or that I want to remove myself. Since there is internet in schools, I do not have any problems in this regard."* (P2).

"We do not use Web 2.0. tools in mathematics very often in our school. Because there is a program in my school and all the classes, all the other same schools in this city have to use this program." (P5).

"In other words, we use teaching sites on the internet such as 'Okulistik' and 'Morpa Kampüs Derslik,' which are used by everyone; of course, here, we can choose the grade level according to the grade level of our student. Although Morpa Kampüs does not allow this, you can choose the class you want in Okulistik. For example, my student is in grade 4, but when we look at his level, his maths level requires him to start from grade 2. In this context, I open the second-grade activities on the board, I provide a second-grade book parallel to the subject we will cover on the board, and in this way, I first explain the support education. Of course, in support of education, we do the activities on the smart board with the child. He completes the activities on the touch screen by touching himself. We ask him to do all the work we did that day at home, all of which is in the book, so that the information he does becomes permanent when he does it at home again. The next day we try to complete the teaching from where we left off again, sometimes through smart board applications, sometimes through activities such as puzzles, sometimes through competitions, sometimes through fairy tales." (P6).

"It was very effective in our class when I was doing distance education. I was opening that 'Classdojo.' Those who did the reading today got one point each." (P8).

"I think I use technology effectively in mathematics teaching presentations. While presenting these activities, I use Office programs, Excel, and Word effectively while presenting these activities. I can make effective presentations that they can understand." (P7).

"When I think in terms of students with special needs, I think of it as an extra for them in mathematics lessons and technology, but for example, sometimes these students may be uninterested in the lessons, and when we play a game on the smart board, for example, this child can be very eager for the lesson, for example, this time he wants to participate in the lesson, which means that he is motivated to use such a technology in the mathematics lesson." (P1).

"One of our school's chances was the installation of smart boards in our classrooms in the second semester this year. As I explained, we tried to do this with projections and computers. We have made good progress in this area. So we started to see the benefits of this." (P3).

"I can say that in the fourth grade, each student has an iPad of his/her own, and I can say that I continue the lessons by using some technological platforms on these iPads." (P4).

Using Technology in the Assessment Process

Table 7 shows the codes of the classroom teachers in SIP about the use of technology in assessment in the process of mathematics teaching for the SWD.

Table 7. *Use of Technology in the Assessment Process*

Code	Participant
Using Web 2.0 Tools	P1, P2, P3, P4, P5, P6, P8
Using Flash Animation Applications	P1, P3, P6, P7
Microsoft Office Programmes	P2, P3, P4
Use of Education Platforms	P4, P6
Smart Board, Computer, Projection Use	P6

Examples of participant expressions of the codes of "Use of Web 2.0 Tools, Use of Flash Animation Applications, Use of Microsoft Office Programmes, Use of Educational Platforms, Use of Smart Board, Computer, Projection" in the process of mathematics teaching towards SWD of classroom teachers in SIP in Table 7 can be stated as follows:

"In this evaluation process, of course, we also use Flash applications and Web 2.0. tools. It attracts the attention of the class in general and the inclusion student in particular. In this way, we can use them both in the education and evaluation processes." (P6).

"I can say this, for example, I think that I can get feedback from a child with whom I have communication problems with a program I have organized. I mean, I may also have a problem somewhere. However, I think that maybe our student can express himself more comfortably and easily with a flash animation we have made or software belonging to him, or an application that he can make on a tablet, a picture manipulation that he can show on the internet. We cannot provide communication with every student. These friends are special education students, and if we think that communication is weak at some points, I think we must make an evaluation by establishing alternative communication. How to do this, as I said, by providing him with the environments where the child can express himself most easily. We should have to use this." (P7).

"At the evaluation stage in the mathematics teaching process for special needs. Again, I make use of technological technology. I can evaluate with exams suitable for the level of the children I prepared in the World and questions suitable for their IEPs. We use the office effectively here. Apart from that, I try to make competitions like quiz shows with slide shows. Again, to evaluate the subjects." (P3).

"Teacher, we mostly make observations during the evaluation process. We take into consideration the child's participation in the lesson. As a result, we also give exams in the 4th grade. Exams are mostly on paper. Of course, we make use of Word programs." (P2).

"Well, to ensure successful inclusion practices, we usually use an application to evaluate the learning and learning levels of students with special needs, especially in mathematics. We have an application. This application is a web-based program that families can participate in from time to time, and students can access it from different environments. We can use it to create a portfolio of students' portfolios. We also use it to identify, observe, and record students' development levels. Here, we can upload various activities. When children perform the activities, we try to see the level of development there. This is one of the applications we especially use. In addition, of course, we can also use various office programs. It can be useful to use Excel tables to keep the development records of Excel students. Using the different features and formula structures in Excel, we can use the Excel program to follow the students' development, see the averages, and convert them into colorful graphics. At the same time, we can also ensure that students are involved in different evaluation processes. In other words, this application that we use is an application that can reveal the learning levels of students in the field of mathematics. Therefore, from this point of view, I think we were able to integrate this program into our assessment system." (P4).

RESULTS, DISCUSSION, and SUGGESTIONS

Nowadays, educational institutions are generally better equipped with technology than in the last century, and more and more teachers can easily use e-mail, web, and word processors. Despite these developments, classroom teachers generally do not use technology or very little in their classrooms to teach SWD mathematics in the SIP process (Hewitt, 2008; Quaicoe & Pata, 2020; Shin et al., 2019). It is globally recognized that the limitations caused by the unique needs of SWD, including inequalities in access to and use of technology, is a multifaceted problem. For this reason, within the "Education Sustainable Development Goals 2030" framework, all children are called for an inclusive, equitable, and quality education by 2030 (United Nations, 2015; UNESCO, 2016). This situation requires academics and education policymakers to evaluate educational inequalities from multiple perspectives (Quaicoe & Pata, 2020). From this perspective, one of the most essential academic skills required for SWD is the acquisition of mathematics skills by SWD. However, SWD experiences various problems in learning most of the skills in the field of mathematics. Educational technology-based adaptations to provide effective and permanent mathematics teaching to SWD will minimize the learning problems they experience by increasing their academic self-concept in mathematics (Chodura et al., 2015; Kiru et al., 2018).

Based on the findings obtained because of the content analysis carried out in line with the research purpose, it was determined that the use of technology in teaching mathematics to SWD in the SIP process is advantageous in terms of effective teaching because it supports fun learning, saves time, reduces misconceptions, attracts attention, provides feedback, provides concretization in mathematics, and appeals to multiple senses. Like this result, Benavides-Varela et al. (2020) concluded that digital-based interventions

positively affected the mathematics achievement of SWD. Therefore, it would be beneficial to implement an alternative technological instruction to SWD. On the other hand, it has been determined that the use of technology in SIP is disadvantageous in the process of teaching mathematics to SWD due to the possibility of creating technology addiction and increasing technology addiction, distracting if it cannot be used in a controlled manner, and being no different from direct instruction if it is used continuously. Tournaki and Lyublinskaya (2014) examined the TPACK development of pre-service special education teachers in mathematics and science through a course. They found that the participants' ability to use TPACK in technology integration in mathematics and science teaching increased, and they were able to make practical mathematics and science teaching adaptations at this rate.

It was concluded that the participants considered the use of technology in teaching mathematics to the SWD in the SIP a valuable process for implementing effective teaching. For this purpose, it was determined that the participants included the use of Flash animation applications, web tools, Microsoft Office programs, web-based education platforms, smart boards, computers, projections, tablets, and projections for both teaching and assessment purposes in line with the needs of the SWD. Similar to this result, McCabe and Tedesco (2012) found that the content prepared by using web tools for teaching mathematics to SWD and which can be repeated at home with the help of mobile devices reinforces what students learn in the classroom, mobile devices motivate students to do mathematical activities in various non-traditional environments, increase their communication with classroom teachers and increase family involvement. Similar to this result, Sarı and Olkun (2020) conducted a study to improve approximate number system acuity in primary school students with low mathematics achievement. They observed an increase in the experimental group's estimation accuracy and mathematics achievement. In addition, with the digital games played during the research process, it was found that both the teaching of spatial representation of size and the increase in mathematics achievement were achieved.

The study's findings showed that most classroom teachers considered themselves average or above average in terms of pedagogical content knowledge competence. More specifically, it was determined that the participants generally saw themselves as average regarding TPACK. In this regard, it can be said that some of the participants graduated from the numerical department in secondary education, which influenced them to be more competent in mathematics content knowledge competence. In addition, it was determined that some participants felt at an average level in terms of "Special Education Content Knowledge Competence." Some felt below the average level in terms of "Mathematics Content Knowledge Competence for SWD," and some participants felt sufficient. Some did not feel sufficient in terms of "Mathematics Content Knowledge Competence for SWD." It was determined that some participants tried to improve themselves by learning through workshops, in-service training, various courses, and their means of acquiring TPACK in mathematics teaching to SWD. Similar to this result, Patalinghug and Arnado (2022) conducted a study to determine the TPACK level of primary mathematics teachers and students' achievement. They found that teachers had high knowledge about TPACK and obtained the highest average in technological pedagogical knowledge in direct proportion to students' mathematics achievement level. Despite this, the research suggests that teachers need support in TPACK, and in order to provide this support, teachers should be directed to technology-related conferences, seminars-workshops, and training.

In the light of the results obtained from the findings, to be able to implement the SIP, the suggestions that include the needs of the participants to acquire TPACK in mathematics teaching and to use it effectively in the teaching process can be stated as follows:

- TPACK-based teaching processes for pre-service teachers should be carried out by academicians working in higher education institutions.
- Necessary and sufficient internet infrastructure services should be provided to educational institutions.
- Necessary technological devices should be provided to educational institutions and teachers.
- Web-based educational game applications should be developed for SWD.
- Digital book applications for SWD should be developed in quality and number to meet the requirements.
- Laws and regulations should be reorganized on the axis of technology-based teaching in inclusive education for teachers' SWD.
- Families should be more supportive of the teacher and SWD and open to cooperation.

- Activities for developing TPACK of classroom teachers in teaching practical mathematics skills to SWD should be initiated and disseminated synchronously and asynchronously by establishing cooperation protocols between universities and MoNE.

Declarations

Conflict of Interest

No potential conflicts of interest were disclosed by the author(s) concerning this article's research, authorship, or publication.

Ethics Approval

The Social and Human Sciences Research and Publication Ethics Committee of Sakarya University granted the formal ethics approval. We conducted the study by the Helsinki Declaration in 1975.

Funding

No specific grant was given to this research by funding organizations in the public, commercial, or not-for-profit sectors.

Research and Publication Ethics Statement

At this moment, we as the authors consciously assure that for the manuscript "Investigation of Classroom Teachers' Technological Pedagogical Content Knowledge in the Context of Mathematics Teaching for Inclusive Students," the following is fulfilled:

- This material is the author's original work, which has not been previously published elsewhere.
- The paper reflects the author's research and analysis wholly and truthfully.
- The results are appropriately placed in prior and existing research contexts.
- All sources used are adequately disclosed.

Contribution Rates of Authors to the Article

The authors provide equal contributions to this work.

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