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Putantro, S.; Marsigit; Arliani, E.; Ratnasari, G.I. (2024). Differentiated mathematics instruction: perception, readiness, and practice of Indonesian teachers. *Aula de Encuentro*, volumen 26 (1), Investigaciones pp. 24-52

DIFFERENTIATED MATHEMATICS INSTRUCTION: PERCEPTION, READINESS, AND PRACTICE OF INDONESIAN TEACHERS

APRENDIZAJE DIFERENCIADO DE MATEMÁTICAS: PERCEPCIONES, PREPARACIÓN Y PRÁCTICAS DE LOS DOCENTES EN INDONESIA

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Recibido: 27/3/2024. Aceptado: 3/06/2024

AULA DE ENCUENTRO
educación investigación intercambio reflexión experiencias
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ABSTRACT

Differentiated Mathematics Instruction (DMI) can facilitate students' diversity. This research explores teachers' perceptions, readiness, and practices for implementing DMI in Indonesia. This is qualitative research with a phenomenological approach. A total of twenty mathematics teachers participated through purposive sampling. Semi-structured interviews were conducted for data collection. Data analysis was done by the Bogdan and Biklen techniques, including data reduction, finding themes and inter-themes, and concluding. The results show that teachers understand the concept, benefits, and roles of DMI. However, there are still many unprepared teachers, and there are many barriers to implementing DMI. Some of the barriers include difficulty in time management, difficulty in drawing up a learning plan, and limited examples of DMI that can be adapted. Another barrier is that teachers feel stressed by using different methods and media, and have to perform different evaluations. Teachers' professional training related to DMI and teacher collaboration is expected to be conducted as a solution to various barriers.

KEYWORDS: Differentiated mathematics instruction, teacher, perception, readiness, practice.

RESUMEN

La instrucción diferenciada de matemáticas (DMI) puede facilitar la diversidad de los estudiantes. Esta investigación explora las percepciones, la preparación y las prácticas de los docentes para implementar DMI en Indonesia. Se trata de una investigación cualitativa con enfoque fenomenológico. Participaron un total de veinte profesores de matemáticas mediante muestreo intencional. Para la recolección de datos se realizaron entrevistas semiestructuradas. El análisis de los datos se realizó mediante las técnicas de Bogdan y Biklen, incluida la reducción de datos,

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la búsqueda de temas e intertemas y la conclusión. Los resultados muestran que los docentes comprenden el concepto, los beneficios y las funciones del DMI. Sin embargo, todavía hay muchos docentes no preparados y existen muchas barreras para implementar DMI. Algunas de las barreras incluyen dificultad en la gestión del tiempo, dificultad para elaborar un plan de aprendizaje y ejemplos limitados de DMI que pueden adaptarse. Otra barrera es que los profesores se sienten estresados al utilizar diferentes métodos y medios, y tienen que realizar diferentes evaluaciones. Se espera que la formación profesional de los docentes relacionada con DMI y la colaboración docente se lleve a cabo como una solución a diversas barreras.

PALABRAS CLAVE: Aprendizaje diferenciado de matemáticas, docentes, percepción, preparación, práctica.

1. INTRODUCTION

Every student is a unique individual. They have diverse learning needs due to differences in abilities, interests, learning styles, and cultural backgrounds (Chamberlin, 2011). It is challenging for teachers to be able to address the diverse needs of each student in the mathematics classroom (Hackenberg et al., 2021; Holzäpfel & Bardy, 2019; Maulana et al., 2020). To address and facilitate student diversity, teachers can use differentiated instruction (DI). Previous research has proven that DI supports the needs of diverse students in the mathematics classroom (Aliyeva, 2021; Hackenberg et al., 2021). DI is learning based on individual student differences that are used as the basis for lesson planning (Fatimah et al., 2022; Hunter et al., 2020). DI is varied and adapted by adjusting student abilities using systematic procedures for viewing academic achievement, progress monitoring, and

data-based decision-making (Roy et al., 2013). The key to success in differentiation includes tiered tasks, scaffolding, and adaptive learning materials (Guay et al., 2017; Ziernwald et al., 2022). DI can be implemented by having students work in groups, using visual or auditory support, controlling the pace of teaching, reteaching multiple times, and having students practice more (Herner-Patnode & Lee, 2021).

Previous research has shown that differentiated mathematics instructions (DMI) have many benefits in overcoming various learning difficulties and improving students' academic achievement. DMI makes students try to utilize their abilities and interests to learn new material. This allows students to learn about the mathematical reasoning process and demonstrate their ability to connect ideas or concepts in mathematics with mathematical problems that need to be solved (Kamarulzaman et al., 2022). In addition, DMI helps students increase their mathematics understanding (Bobis et al., 2021; Lai et al., 2020). In other words, DMI is an effective approach as a solution to students' difficulties in learning because it will affect academic performance as well as social integration (Papanthymou & Darra, 2022).

DI in Indonesia has been mandated in the National Education System. The latest curriculum, Kurikulum Merdeka (Merdeka Curriculum), focuses on the student's potential development and characteristics as mandated in The Ministry of Education, Culture, Research, and Technology Regulation numbers 5, 7, 16, and 21 in 2022. The Merdeka Curriculum clearly states that learning must adapt to student needs and prioritize student learning progress over the scope and completeness of the curriculum content provided. DMI practices in Indonesia have been proven to provide various benefits in developing student competencies at elementary school (Afilin, 2023; Aprima & Sari, 2022), junior high school (Jamil et al., 2024; Muslimin et al., 2022; Syarifuddin & Nurmi, 2022), and senior high school levels (Bahari et al., 2023; Kamal, 2021; Silvana et al., 2023). However, data shows that most

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Indonesian teachers still use conventional learning with the one-size-fits-all principle in mathematics learning instead of DMI (Afilin, 2023; Ariso et al., 2023; Gusteti & Neviyarni, 2022). This shows that there is a gap between expected mathematics learning and the practices carried out by teachers.

Teachers play an important role in the implementation of DMI. This is because the success of DI practice depends on the teacher (Bi et al., 2023). Teachers have the authority to organize classroom learning, including group division, whole-class discussion, time management, content materials, and classroom arrangement. This helps teachers to differentiate content, learning processes, or learning products (Chamberlin, 2011). In implementing DI, teachers have a responsibility to monitor students' progress to identify students' needs and facilitate appropriate learning (Prast et al., 2018). To be skilled in conducting DMI, teachers require extensive knowledge such as diagnostic, didactic, and pedagogical management skills. Teachers with a lack of knowledge and skills will find it difficult to implement DI (Shareefa, 2023). Teachers need to think, plan, and design learning for the diverse needs of individual students to maximize their growth and potential (Lai et al., 2020). To produce effective learning, teachers need to develop insights and awareness of diversity, which also needs space to grow (Hasanah et al., 2022). In addition, teachers' confidence in their abilities affects student performance, which will shape students' attitudes toward the task (Wan, 2016). This shows the importance of exploring teachers' understanding of DMI, their readiness, and the practices in the classroom.

Based on the description, this research aims to explore the implementation of DMI in Indonesia. It will be described in three aspects, as follows:

a. Describe teachers' perceptions and understandings of DMI;
b. Describe teachers' readiness in DMI; and
c. Describe DMI practices and barriers faced by Indonesian teachers.

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2. METHODS

This is qualitative research with a phenomenological approach. Qualitative research was chosen because it is appropriate to provide feedback on the perceptions, beliefs, and experiences of groups (McDuffie & Scruggs, 2008). Phenomenological research was chosen to describe in depth and detail an individual's explanation and understanding of their experience. Through this research, it is possible to develop an impartial view and outline rational reasons (Husserl, 1970).

This research involved twenty mathematics teachers (coded G1 to G20) from elementary, junior high, and senior high school levels in Indonesia who were selected through purposive sampling. This technique is used to select individuals and places for understanding the central phenomenon (Creswell, 2012). Participants have a minimum bachelor's degree in mathematics education and have teaching experience in schools for at least one year. The detailed demographics of the participants are presented in Table 1.

This research used semi-structured interviews to collect data due to their flexibility, which allows for more in-depth data. In phenomenological research, interviews are a key element in data collection (Creswell, 2007; Kvale & Brinkman, 2009). The questions in the interviews have been evaluated by three experts through pilot interviews. The experts are two professors in mathematics education and one associate professor in education evaluation. This pilot interview is important to ensure the validity of the instrument (Majid et al., 2017). Pilot interviews are used to detect possible errors in early-stage studies that may require adjusting instruments (Aung et al., 2021). The interview consists of six key questions to answer the first research question, eight key questions to answer the second research question, and eight key questions to answer the third research question. There were no serious modifications

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Table 1. Participants Demography

Category	Frequency	Percentage
Gender		
Male	2	10%
Female	18	90%
Educational Qualifications		
Bachelor degree	13	65%
Master degree	7	35%
Teaching Level		
Elementary school	3	15%
Junior high school	7	35%
Senior high school	10	50%
Teaching Experience		
1-3 years	4	20%
4-6 years	6	30%
7-10 years	7	35%
>10 years	3	15%
DMI Experience		
0 year	10	50%
≤1 years	8	40%
≥2 years	2	10%

were needed after the pilot interview. It indicates that the semi-structured interviews can be considered valid and can be used for the real study.

Each participant was interviewed for 30 to 50 minutes, either face-to-face or by telephone. All participants were interviewed in Indonesian to share their perspectives, readiness, and DMI practices. The interviews were conducted by the first researcher, assisted by the fourth researcher. All the interview processes were audio recorded by the fourth researcher based on agreement with the participants.

The data was analyzed using the Bogdan and Biklen technique, with the stages of data reduction, finding themes and relationships between themes, and

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concluding. The transcribed data was sent to the participants to be confirmed and get feedback. This member-checking strategy was used to ensure the credibility of the research (Creswell & Miller, 2000). Moreover, this research provided a detailed description of the data collection procedures and data analysis to show transferability and confirmability (Algolaylat et al., 2023). Meanwhile, an internal audit of the entire research process was done to demonstrate dependability.

3. RESULTS AND DISCUSSION

The implementation of DI as a criterion for quality teaching is important to consider at all school levels (Letzel et al., 2023). DMI provides opportunities for all students with differentiated experiences that are adapted to their needs (Krishan & Al-Rsa'I, 2023). DI has been officially recognized and implemented in Indonesia since the government utilized the Merdeka Curriculum in 2022. Not all schools have implemented this curriculum yet. This can be seen from the results of interviews showed that from eighteen schools only two have implemented the Merdeka Curriculum. Meanwhile, out of twenty teachers from different schools, ten have implemented DMI. The ten participants were teachers from elementary, junior high, and senior high school levels. The research findings regarding the perception, readiness, and practice of DMI are described as follows.

3.1. Teachers' Perceptions of DMI

This research explores teachers' perceptions about their knowledge of DMI, the differences between traditional instruction and DMI, and the needs to be considered in DMI. This kind of research has been carried out by previous researchers (Onyishi

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& Sefotho, 2020), however, such research in Indonesia has rarely been conducted. Besides, it is important to explore the Indonesian teachers' perspective because even though DMI has been proven to be effective, most teachers in Indonesia have not implemented it (Afilin, 2023; Ariso et al., 2023; Gusteti & Neviyarni, 2022).

Based on the interviews, it was found that all teachers, both those who have implemented DMI and those who have not, have understood the concept of DMI. The majority of participants explain that DMI is learning that facilitates students' needs so that they are given different treatment because each student has different characteristics. G8 and G12 explain that DMI is instruction appropriate to students' abilities. Meanwhile, G13 and G18 explain that DMI is instruction appropriate to students' learning styles. This variety of teacher perspectives related to DMI is based on the mathematics learning practices that have been carried out by teachers. This is in line with Papanthymou and Darra (2022) who suggested perceptions and DMI practice are related variables: teaching experience, school organization, teachers' qualifications, and training on DI. G11 explains that teachers provide DMI based on students' prior knowledge. This statement is in line with Grecu (2023) that teachers use various strategies to differentiate instruction based on students' prior knowledge.

DMI in Indonesia is related to the implementation of the Merdeka Curriculum. Although not all schools have implemented the Merdeka Curriculum, all teachers agree that DMI has benefits for students. Based on the results of the interviews, two themes emerged that were most frequently mentioned by participants, namely (1) optimizing students' abilities and (2) increasing students' self-efficacy (details are presented in Table 2). G17 as a teacher who has implemented DMI explained that when teachers carry out learning appropriate to students' styles and give them flexible final projects, the majority of students show better mathematics abilities development.

Table 2. Teachers' Perception of DMI Benefits

DMI Benefits	Theme
Students' abilities develop optimally because students can adjust their learning needs according to their development (G1, G2, G3) and learning style (G7, G11, G17)	Optimizing students' abilities
Learning becomes more meaningful so that students can understand the material and develop their mathematics abilities (G4, G6)	
Student potential is optimized (G5)	
Learning objectives are achieved because students have well-developed mathematical abilities (G10, G18, G19)	
Students understand the material and develop their abilities better (G13, G20)	
Students are more valued so they show confidence to express their opinions during learning (G3), especially during discussions (G12, G16)	Increasing students' self-efficacy
Create equality so that each student is more persistent and actively involved in the project (G8, G9, G14, G15)	
Students are more confident in their abilities (G2, G4, G10)	

Self-efficacy can be interpreted as individuals' beliefs about their ability to carry out future tasks (Bandura, 1997). The teacher's perception that DMI provides benefits for increasing student self-efficacy is in line with Cholsakorn and Piamsai (2022) research. This is possible because the practice of DMI is not only limited to adapted student needs but also has a certain quality (Maulana et al., 2020) and effective learning that seeks to ensure equity and justice in educational practices (Lindner & Schwab, 2020) This quality and effective learning leads to student progress, thus increasing learning motivation. This learning motivation is one aspect that can maintain student self-efficacy (Schunk, 1991).

This research also explored how mathematics teachers' perspectives relate to the differences between traditional instruction and DMI. G4 explains that in DMI, teachers differentiate learning media and learning evaluations, while in traditional instruction, everything is equalized. The research findings explore that the difference between traditional and DMI can be seen in the methods and learning media and in the fulfillment of student needs based on mapping. Based on these instructions, the

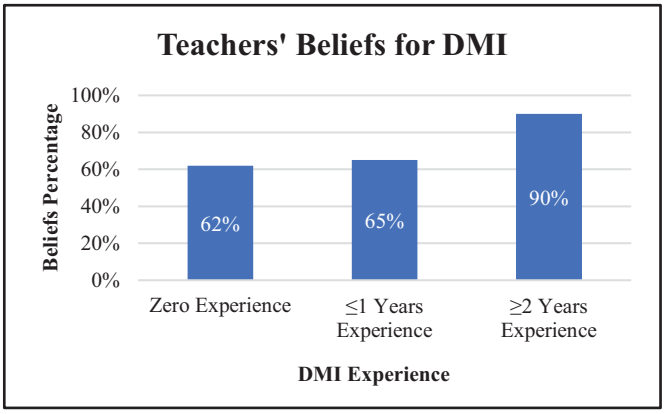
teacher's role as a facilitator is needed. In DMI, the teacher's role is to identify the characteristics of students in the class and design appropriate instructions as a guide, motivator, and evaluator. The findings of this study are in line with previous research, which explored that in DI, teachers are responsible for every decision made, learning objectives, learning content, didactical strategies, learning media, evaluation, and organization such as grouping and time management (Suprayogi et al., 2017).

3.2. Teachers' Readiness Implementing DMI

The second theme explored is the teachers' readiness for implementing DMI in Indonesia. Teacher readiness in this study can be seen from their beliefs about implementing DMI. It is important to explore because the successful implementation of learning in the classes depends on teachers' beliefs and how students learn effectively (Pak et al., 2020; Way et al., 2020). DMI does not only translate into the implementation of adaptive strategies but rather into a reflected process where teachers have an accurate view of students' learning needs (Pak et al., 2020). During the interview, teachers were asked about their beliefs to implement DMI on a scale of 1 to 5. The results are then averaged for each participant's classification (DMI experience) and converted into a percentage of teachers' beliefs (details are presented in Figure 1). The interview showed that the average teacher's belief level who has never implemented DMI is the lowest compared to teachers who have implemented it.

Figure 1 shows significant differences in beliefs between teachers who have implemented DMI and those who have not. Teacher readiness for implementing DMI can be seen in the teacher's knowledge about it, starting with mapping, strategic planning, and assessment. Based on interviews, many teachers understand these

Figure 1. Teachers' Beliefs for Implementing DMI



three aspects, such as the G20. He can describe the three aspects even though he has never implemented DMI. According to the G20, for implementing DMI, teachers need to: (1) map the learning needs based on three aspects: readiness, interests, and learning profiles through interviews, observations, or questionnaires; (2) develop learning plans based on the results of learning strategies, materials, and methods; and (3) evaluate and reflect on the learning process that has been taken.

3.3. DMI Practice

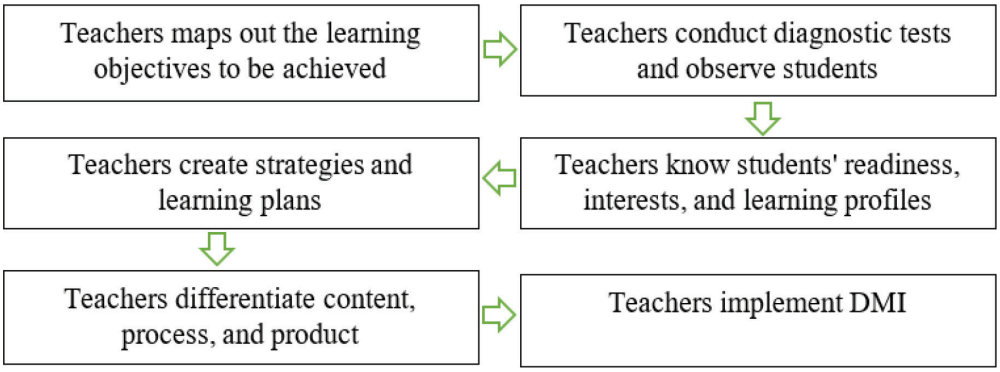
DMI has become an important aspect of teaching practice as part of the education reformation. According to the G7, DMI begins with mapping out learning objectives, and then teachers find out students' readiness, interests, and learning profiles through diagnosis tests. Diagnostic tests include learning achievement levels, learning interest questionnaires, learning styles, and background profiles of learners. This was conducted through interviews, observations, or surveys using questionnaires. The results of the diagnostic test are used to develop a learning

plan and differentiation techniques that will be carried out in the process, content, or product. Needs assessment is based on three aspects: willingness to learn, interest in learning, and learning profile. After reviewing the needs assessment, teachers plan appropriate learning strategies according to students' needs. One of the strategies teachers can use is to differentiate content, materials, processes, and products. The practice of DMI conducted by participants is illustrated in Figure 2.

DMI is different from traditional instructions. G9 explains that DMI learning media are based on student's needs, while in traditional instructions, only one is used for all students. According to G18, there is no difference in the content, process, or products when using traditional instructions, while in DMI there are differences in the content presented. Furthermore, DMI considers the different characters and needs of students, as well as creating a comfortable class for them. It can build mutual respect as well as create an environment of mutual support and mutual assistance between students. After that, diverse evaluations are also carried out according to the achievements of each student's abilities.

DMI practice faced several barriers, as experienced by G5, G11, and G12. The problems included classroom management, developing learning materials

Figure 2. DMI Flow of Teacher Practice in Indonesia



and media, and the challenge of facilitating each group. In addition, G7 and G8 suggested that teachers must be more creative and work hard. DMI requires extra preparation to create learning tools. Sometimes they need to spend extra energy in the classroom because they have to organize different materials among students. Moreover, DMI needs high costs.

3.3.1. Teachers' Practice in Content Differentiation

The participants were twenty Indonesian teachers, but only eight teachers had implemented DMI for less than one year and two teachers had implemented DMI for more than two years. Based on interviews, content differentiation refers to the teacher's strategy for distributing learning content. In this case, content is the knowledge, concepts, and skills that students need to learn based on the curriculum. All teachers who have implemented DMI explain that the form of content differentiation that is often carried out is providing enrichment material (advanced level) for students who have a learning speed that exceeds their peers. However, the teacher has not differentiated regarding the sequence of the material. G17 stated, "I will provide enrichment material that challenges students with above-average abilities. Apart from that, I usually also provide practice on high-order thinking skills (HOTS) questions as an exercise to improve their skills."

Content differentiation is also carried out by teachers when dealing with struggling students with below-average abilities. G3 and G20 provide simpler problems in problem-based learning carried out in class. G3 explained "In the DMI problem-based learning that I have done, I provided three different problems with three levels of difficulty. Students who are below average will be given the simplest problems and students who are above average will be given the most complex problems."

3.3.2. Teachers' Practice in Process Differentiation

The research also found that teachers differentiated processes in mathematics learning. Learning begins by carrying out cognitive and non-cognitive diagnostic assessments through tests and observations. This diagnostic assessment aims to provide assistance or carry out peer tutoring for students who have learning difficulties. The purpose is to achieve students' highest learning achievements. The learning process carried out by the teacher adjusts the students' abilities, or the teacher plans the students' learning together with colleagues. This is important because each student is unique and has a different level of understanding and struggles with certain knowledge and disciplines (Aziz, 2019).

Some of the differentiation processes practiced by the teacher include compiling student worksheets that can accommodate students according to their learning styles, such as students who are taciturn and students who tend to be kinetically active (implemented by G2). On the other hand, the worksheets developed can be adjusted to suit students' abilities and interests (implemented by G3). To support the differentiation process, teachers also often use tactical aids (implemented by G2). G2 explained that "I provide tactile media "geometric shape brick" while studying three-dimensional space. Students can make various shapes, take them apart, and put them back together. Students who like tactile activities will be happy to carry out investigations with the existing media. Meanwhile, other students learn by observing pictures or videos provided by the teacher."

3.3.3. Teachers' Practice in Product Differentiation

Product differentiation can be facilitated by student projects (Papanthymou & Darra, 2022). This is in line with the statement of G3, G5, G17, and G20, that product differentiation in mathematics learning is mostly done through project-based

learning. The majority of teachers stated that students were given the optional final project. G5 explains that in DMI, the teacher gives students project assignments that will make students learn optimally, giving students opportunities to discuss, carry out simulations, and learn through social media. Learning evaluations carried out by teachers can also be used to differentiate learning products. In the learning process, teachers carry out evaluations through observations, tests, and self-assessment (Brevik et al., 2018). Teachers also use self-reflection by conveying what they have learned in the learning process, and teachers also reflect on themselves to see whether their learning objectives have been achieved.

3.3.4. Teachers' Barriers in DMI Practice

Teachers faced some barriers when implementing DMI, such as difficulties in time management (G3, G14, and G17), difficulties in preparing lesson plans (G15, G17, and G19), and limited examples of DMI application (G4, G10, G15, G19, and G20). Meanwhile, another barrier is that teachers need more energy and are stressed to prepare various learning media (G3, G5, and G17). This finding is in line with previous research, which revealed that using various methods, various media, and facilitating different evaluations for each student makes teachers stressed (Stollman et al., 2019). Other research also reveals that teachers do not implement DMI because it is difficult to facilitate a large number of students, many standards must be met, it is difficult to design different lesson plans, it is time-consuming, and it is expensive (Xiang et al., 2019).

The other problem shown in this research was that only two teachers had received training related to DMI. G2, G3, and G8 explained that access to DMI training is still limited. This condition shows the importance of providing professional training related to DMI. This is in line with previous research, which reveals that teachers need to receive training and implement DI strategies more widely (Whipple, 2012).

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Even though DMI faces many barriers, teachers believe that it is beneficial. The various barriers become a challenge for teachers to provide learning opportunities to all students in the class, create educational settings that are suitable for students, design teaching activities, know the most effective methods needed to teach, and apply different teaching approaches in the teaching process (Levy, 2008). DMI practice makes students freer and more active in learning because it is adjusted to their abilities. In addition, students become creative, and learning mathematics becomes more interesting.

4. CONCLUSION

DMI is learning based on individual student differences. This learning is varied and adapted based on students' abilities and interests. In implementing DMI, teachers have an important role, namely monitoring student progress to identify students' educational needs and adapting teaching to each student's needs. The research explores how teachers understand the concept, benefits, and role of DMI. However, there are still many teachers who are not ready, and various barriers have been faced in implementing DMI. Some of the barriers include difficulties in time management, difficulties in preparing lesson plans, and limited examples of DMI that can be adapted. Another barrier is that teachers feel stressed by using various methods and media and facilitating different evaluations for each student. Professional training related to DMI and collaboration between teachers can be pursued as solutions to various barriers.

Based on the research findings, it is reasonable to propose DMI courses through pre-service mathematics teacher education programs. Therefore, Colleges and Universities in Indonesia should prioritize the provision of facilities for the proper

application of DMI. Besides that, teachers need access to supplementary materials, like modules or practical guides. Thus, researchers recommend holding professional development activities, for example, workshops or training for teachers on how to implement the DMI strategy. These activities can provide them with supplementary materials and practical models for the application of DMI that are easy to implement.

This research is limited to mathematics teachers in public schools affiliated with the Ministry of Education in Indonesia, where the majority of subjects are women. Therefore, future research is expected to involve more diverse participants, so the findings will be more comprehensive. Besides, interviews served as the only source for data collection in this study. Future studies may adopt a mixed-method design or use triangulation in data collection. The research is also limited to teachers' perceptions, readiness, and practices in DMI. Further research could explore students' perceptions regarding DMI. It is important to provide a more comprehensive picture so that DMI can be developed and implemented more optimally. Furthermore, research related to the implementation of DMI also needs to be done. It is important to provide examples for teachers that can be adapted.

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