Implementation, Principles and Stages of Differentiated Instruction in Mathematics Learning: A Systematic Literature Review

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Abstract **– The Systematic literature review aims to explore implementation, principles, and stages of Differentiated Instruction (DI) in recent research in mathematics education. The PRISMA steps were used to find research articles that studied the stated matter. In the data collection stage, the thirteen articles published in Scopus-indexed journals between 2008-2023 were selected. After selecting the research articles to be systematically reviewed, the reviews were done to identify three aspects. The first was identifying the dominant research topics on differentiated instruction (DI) in mathematics learning. The review suggests that the dominant research topics on DI are how teachers and prospective teachers implement DI and teachers' competence development in implementing DI. The second was to find the principles used in implementing DI in mathematics learning. These principles identified students' learning readiness, interest, and learning profile; differentiation of content, process, product; quality tasks; and continuous assessment. Lastly, the stages of DI in mathematics learning in the selected studies were identified. It was found that DI was conducted in several stages, with the first being to provide a diagnostic assessment to detect students' learning readiness, interest, and learning profile. Then, the teacher provided differentiation of content, process, or product. The teacher also gave formative assessments during the learning process. Lastly, the teachers gave summative assessments following the completion of a specific scope of learning materials by the students. The findings of the Systematic Literature Review provided knowledge that will make teachers develop a mature instructional design and feel more confident in implementing mathematics learning using DI.**

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1. Introduction

Differentiated Instruction (DI) is a crucial learning approach in education. Teachers must adopt this approach when the curriculum requires meeting the diverse needs of students [1], [2]. This is the case since differentiation in learning and instruction is considered important, and this can be explained by the stages of cognitive development. Piaget divided intellectual or cognitive development into four periods, namely: sensorimotor, preoperational, concrete operational, and formal operational. Although these four periods are the same for every child, the speed of the development process of each period is likely to be different [3]. Therefore, teachers must design learning that can accommodate these differences. In addition, each child's ZPD(Zone of Proximal Development) is unique due to the variation in the distance between the actual and potential levels of ability [4], [5], [6]. Teachers must also pay attention to students' actual ability levels, potential ability levels, what students can do independently, and what they can do with help from other people or more advanced adults. This philosophy is the basis for teachers' need to respond to students' needs.

Each student gains knowledge when taught according to his ability, thus allowing students to benefit from their strengths and improve their weaknesses [7], [8], [9].This educational approach significantly enhances pupils' critical thinking abilities.

Students engage in mathematics actively when they exhibit curiosity, pose enquiries, uncover new concepts, think about a topic, seek solutions, and utilise existing knowledge to address problems. This method can be implemented from several angles, hence fostering critical thinking [3], [10], [11], [12]. The principles and customization of DI also demonstrate several of these activities. This learning facilitates the formation of procepts as composite mental entities comprising processes and concepts [10], [13]. Some students fail in mathematics because they do not see the learning process packaged as a *procept*. These students who see the process merely as a procedure tend to focus only on how to solve the current task procedurally. On the other hand, students who cultivate procepts have greater flexibility due to their mental constructs that enable them to analyse and manipulate symbols perceived as objects [14], [15].

DI can be effective when learning is student-centered. The characteristics of this approach is focusing on students' needs by building their knowledge through tasks [16], [17]. Continuous assessment of student's understanding ensures affective learning and teaching. It also helps studets with building understanding and recognising the relevance and usefulness of what they are learning, fostering collaborative learning management, and promoting an active engagement in the learning process [18], [19]. Teachers have many choices using various instructional strategies and scaffolding learning approaches in a student-centered classroom. These processes ensure that each student is strongly connected to essential knowledge necessary for understanding [18].

In some countries, teachers or lecturers have applied DI in mathematics learning. Recent research has explored this matter in the last five years [3], [20], [21], [22]. The researchers examined teachers' problems or difficulties using DI and researched prospective teachers in responding to students' needs [20], [21]. In their two-year study, they investigated mathematics teachers' differentiation tactics and teacher's approaches to students' academic and cultural disparities. The result was that teachers' skills in designing differentiation processes improved [21]. The study in Malaysia involving gifted students [3]. The statistical analysis showed that DI significantly affected students' mathematical thinking due to differentiation activities in mathematics learning [3]. In Africa, research showed that rigorous and appropriate application of DI favorably impacted students' algebraic thinking [23]. Tiered Tasks and flexible grouping supported this impact in the mathematics learning process [22].

As for recent literature reviews on DI, the reviewers pointed out the increased research on DI in education for the last decades [24].

This increase is shown by the number of studies of DI, which comprised 100 Scopus-indexed articles published between 1990 and 2018. This number of studies is highly likely to increase if combined with other articles outside Scopus [24]. Additionally, the need for more high-quality studies is an essential concern due to the increasing interest in using DI in mathematics learning [8]. Other than that, there are also some critical research results or recommendations that have been suggested by the literature. There needs to be a follow-up to address the complexity of DI implementation issues in mathematics learning [20]. It has also been suggested that future researchers must explore the factors that make DI successful or unsuccessful in mathematics learning [13], [25].

To effectively apply differentiated instruction in mathematics education, teachers must have a mature instructional design. Teachers would be able to design instructional designs appropriately using their extensive knowledge and insights about DI [21]. This knowledge will make teachers feel more confident in implementing mathematics learning using DI [26], [27]. The knowledge needed should be based on theory and concrete implementation results in mathematics learning [28], [29], [30]. Therefore, the present study aimed to review the application of DI in learning mathematics in recent empirical research through the way of systematic literature review (SLR).

This review was driven by three overarching research questions:

Q1: What is the most dominant research topic on DI in mathematics learning?

Q2: What principles are used in applying DI to mathematics learning?

Q3: What are the stages of DI in mathematics learning?

2. Research Method

The current systematic literature review (SLR) aimed to identify the dominant research topics conducted by researchers, the principles used in DI, and the stages of DI applied in mathematics learning. The criteria for the articles were that the articles used clear literature on DI, presented the relationship between DI and mathematics learning, used scientifically sound research methods, and used valid and reliable research instruments. In addition, the published articles that were selected to be included in the review were those which had undergone peer-review process to ensure their quality. For that reason, only documents that come from Scopus database were selected.

This SLR used the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) steps for databases and registers [31].

The steps consisted of (1) identifying the topics for relevant studies, (2) screening documents, and (3) including the documents for analyzing, synthesizing, and describing the selected studies. The document search from the Scopus database was done using Publish or Perish (PoP) software.

At the beginning, the search was set for articles published between 2008-2023 using Publish or Perish (PoP) software. This time limit was chosen because studies conducted in the last 15 years are considered to be current. In generating the research articles, the keyword “Differentiated Instruction” was used. The keyword generated 319 articles about Differentiated Instruction. Then, the identification process continued by identifying whether there were duplicate articles. The result showed there were ten duplicate articles.

After the in-depth identification process, there were 309 articles about DI. Then, other article searches were explicitly on DI in mathematics learning. The search results in this stage provided 18 articles on Differentiated Instruction in mathematics learning. To ensure the accuracy of these results, we also conducted article searches explicitly using Boolean operators on DI in mathematics learning with the keywords (Differentiated) AND (Instruction) AND ("math" OR "mathematical" OR "mathematics" OR "maths" OR "mathematic"). The document search was also set for the years 2008-2023. The search results in this stage provided 18 articles on Differentiated Instruction in mathematics learning. Figure 1 illustrates the process for data tracing using the Publish or Perish (PoP) software.

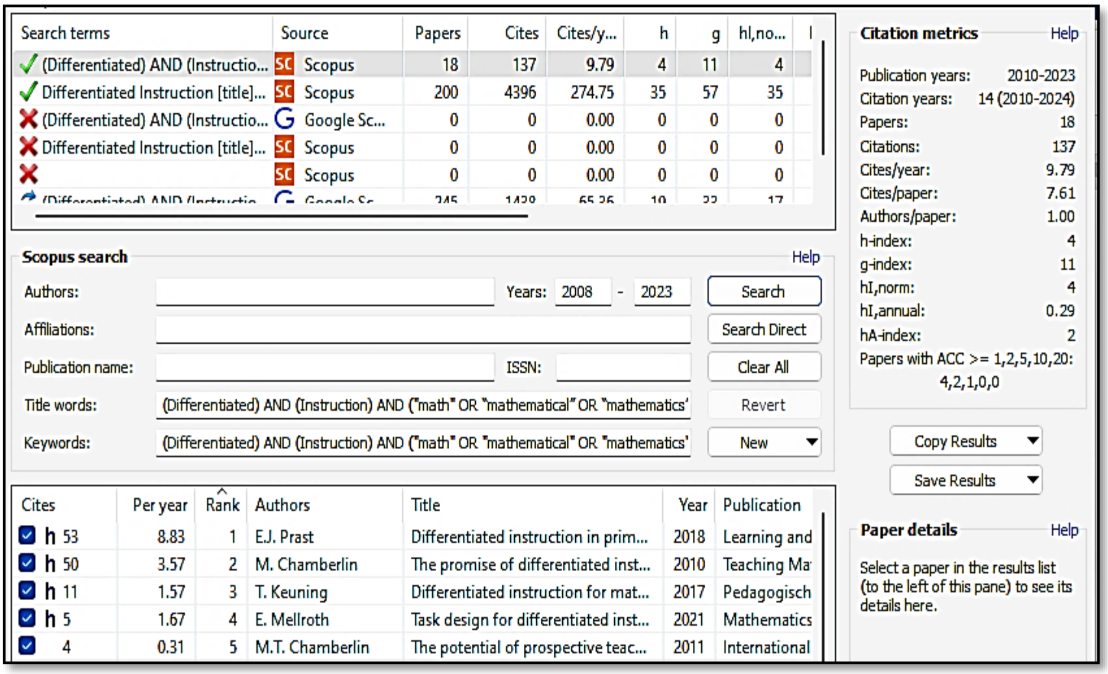

Figure 1. The process for data tracing using the Publish or Perish (PoP) software

In the next step, the screening process was conducted using several inclusion and exclusion criteria. The inclusion criteria for answering the problem formulation were the articles from scientific journals and proceedings. Book chapters did not meet this criterion, so they were excluded. (e.g J.H.Y. Kim (2016) with title “Professional development for technology integration into differentiated math instruction” and B.H. Choy (2020) with title “Differentiated instruction in our mathematics classrooms”.

The articles must be written in English and made openly accessible. Additionally, the articles should present research that is analyzed either quantitatively or qualitatively. This criterion described the answers to research questions precisely, specifically, and clearly. Articles failing to satisfy the inclusion criteria were categorised under the exclusion criteria. The screening process included 13 articles. Figure 2 presents the processes of identification, screening, and inclusion.

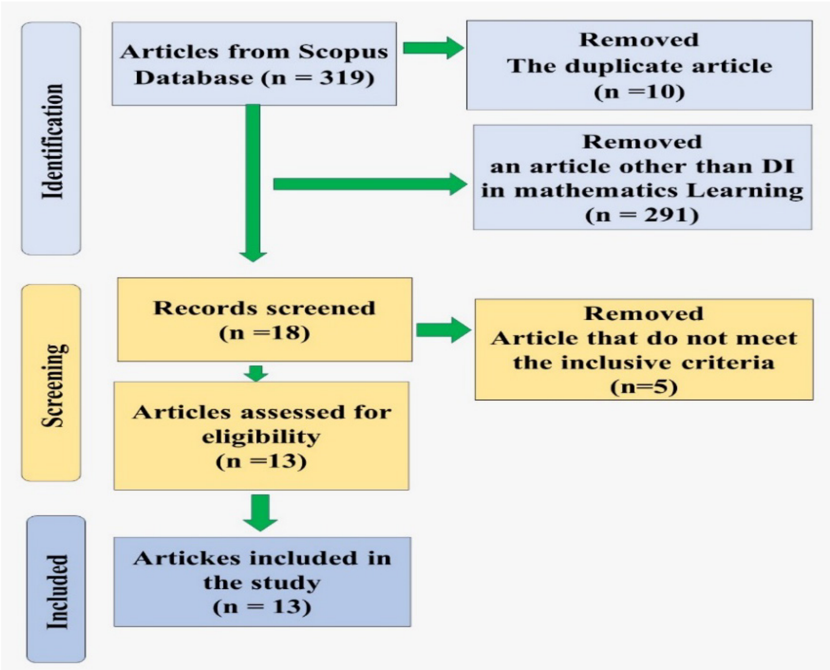

Figure 2. The document selection process through the steps of PRISMA

The process of comparative analysis of the 13 selected articles used the following steps:

- Several important properties were determined to guide the review of the selected articles. Table 1 lists the properties that correspond to the research questions.

Table 1. Properties that guided the review of 13 articles

No	Property	Research question
1	Research Abstract	Q1
2	Basic DI theory used in the article, results and discussion and research conclusions in the article	Q2
3	Basic DI theory used in the article, results and discussion, conclusions and research recommendations in the article	Q3

- The objectives and research subjects were identified in the abstract section to find out the research topics in each article. Then, the dominant research topics conducted by researchers will be determined.
- After determining the dominant research topic, the researcher traced the ideal principles in DI. This process began with tracing the DI theories used in the article. The tracing process aims to find the ideal principles of DI in the theories used. Then, the researchers searched in the article's results and discussion section and research conclusions. This process aims to discover the use of these principles in learning mathematics and detect other principles besides those in the theory.
- After tracing the ideal principles of DI, the researchers traced the stages of doing DI in mathematics learning. This process began with tracing the DI theories used in the article. The tracing process aims to find the stages of DI in the theories used. Furthermore, the tracing process was also carried out based on the research's results, discussion, conclusions, and recommendations. This process aimed to determine the use of these DI stages in mathematics learning and the characteristics of their use in mathematics learning.
- The data was combined, analyzed, and concluded after the search.

Visual representations were also made using VOS version 1.6.19 on SCOPUS data in RIS format. Figure 3 shows that DI is dominantly correlated with the teacher component. This correlation indicates that teachers have an essential role in implementing DI in mathematics learning. This figure also shows the number of studies that correlate teachers with several components. These components include teaching, achievement, mathematics classroom, differentiated instruction mathematics and students. If these correlations are connected, then teachers need to have a thorough knowledge of DI so that they can implement DI and have an impact on improving students' mathematics achievement. Therefore, the principles and stages of DI implementation in mathematics learning are essential to explore in this study.

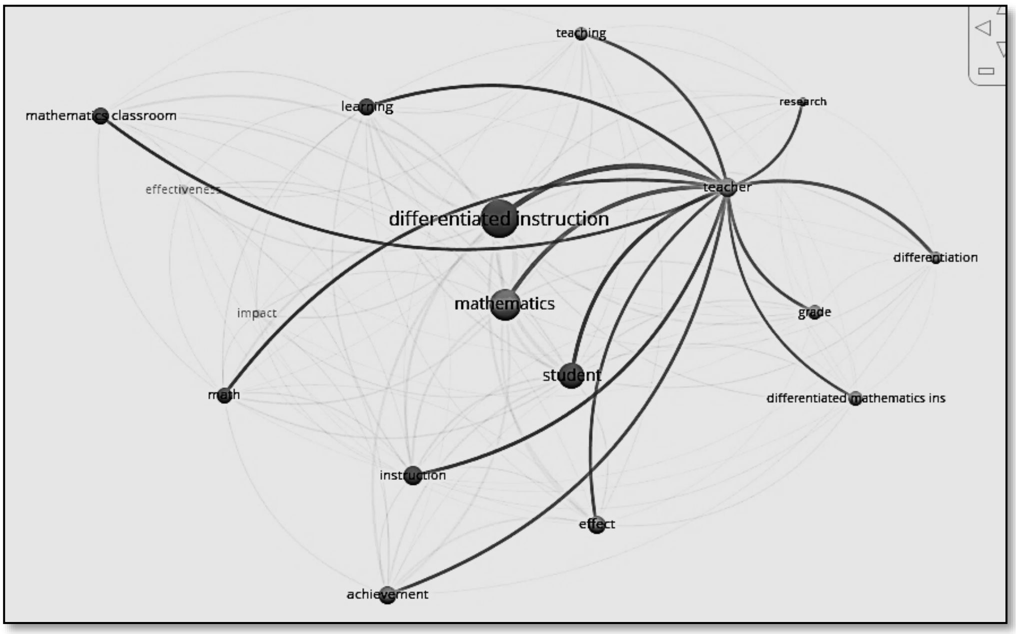

Figure 3. DI and teachers in graphical analysis of VOSviewer

3. Results

The literature review attempted to answer the three questions, which were presented in previous section. To answer the first research question, the review began with a search for DI (Differentiated Instruction) research in general. This search compared DI research regarding mathematics learning and DI research in general. The total number of studies on DI from 2008-2023 was 309 research articles. In 2008-2010, there were few research articles on DI, but since 2010-2023, the number had increased. This increase may show the increasing interest of DI in mathematics. In 2021-2023, the number of articles reached 119. This number further proves that there had been hundreds of articles on the application of DI in learning in the span of just three years.

Although there were articles about DI from 2008 to 2010, there were no articles that specifically discussed DI in mathematics learning. Articles on DI in mathematics learning began to appear in 2010. Furthermore, it is noteworthy that articles on DI in mathematics learning increased every five years. However, articles on DI in mathematics learning from 2008-2023 were minimal, with only 18 when compared to the total number of DI articles. In percentage, the number of articles about DI in learning mathematics is only 5,82%.

After the screening process, thirteen articles were selected to answer Q1, Q2 and Q3. The 13 articles are as follows:

Table 2. Description of 13 articles

No	Author and year of publication	References	Research objectives	Method	Participant
1	Chamberlin and Powers (2010)	[32]	Assesses the efficacy of DI to address the varied demands of college mathematics students and thereby improve their mathematical comprehension.	Qualitative and Quantitative study	College matthematics students
2	Prast, Weijer Bregsma, Kroesbergen, and Luit (2018)	[25]	Analyzes the impact of teacher professional development (PD) programs on DI regarding the mathematics achievement of primary school children.	Qualitative and Quantitative study	primary school students.
3	Chamberlin (2011)	[33]	Describes the experiences of prospective teachers when DI is applied in lectures and their plans to apply DI to students.	Qualitative and Quantitative study	prospective teachers
4	Hapsari, darhim, and Dahlan (2018)	[34]	analyzes Students' responses to the application of DI in learning and the process of its application in learning.	qualitative study	Junior High School Students
5	Herner Patnode and Lee (2021)	[21]	Investigating preservice teachers' differentiation methods and approaches to address their pupils' academic and cultural requirements in mathematics.	qualitative study	preservice teachers
6	Mellroth, Nilsson, and Bergwall (2021)	[35]	Investigating task design for DI in mathematics in a professional learning community (PLC) by eight mathematics teachers in a secondary school (Sweden)	Qualitative study	secondary school teachers
7	Nurasiah, B A Priatna and N Priatna (2020)	[17]	analyzes students' mathematical communication skills before and after using DI and to see the difference in communication skills between students who follow DI and Conventional.	Quantitative study	Junior High School Students
8	Hidayati (2020)	[36]	Describes the performance of 30 high school mathematics teachers in implementing DI in mathematics learning.	Qualitative descriptive	Secondary School teacher
9	Bal (2023)	[37]	Assessing the effects of DI on Junior high school student's Mathematics Achievement and Attitude towards learning.	Qualitative and Quantitative study	Secondary School students
10	Marks, Woolcott, and Markopoulos (2021)	[2]	Exploring the relationship between several DI theories and practices. These theories are pedagogical, knowledge, teacher efficacy, formative assessment, and teacher confidence. This research also describes the application of DI for groups with heterogeneous abilities.	Qualitative study	Secondary Mathematics Classroom Teachers
11	Kamarulzaman, Kamarudin, Sharif, Esrati, Saali, and Yusof (2022)	[3]	Analysing the advantages of DI on the mathematical thinking of gifted students and talented students in Malaysia.	Quantitative study	Gifted students and talented students
12	Rasheed and Wahid (2018)	[38]	Simplifying DI concepts for easy implementation by maths teachers	Qualitative study	Mathematics teachers
13	Patalinghug and Arnado (2021)	[39]	Determining teacher development training in DI to improve primary school teachers' instructional strategies in Butuan North District, Butuan City Division, Agusan del Norte.	Quantitative study	Elementary School Teachers

3.1. Q1: What is the most dominant research topic on DI in mathematics learning?

The systematic review of the 13 selected articles showed that the majority of the articles discussed the ways teachers and prospective teachers implement DI, with a percentage of 61.5% of the total number. Teachers and prospective teachers involved in this research ranged from various educational levels, which were early childhood education, elementary school, junior high school, high school, and university. The studies were related to the form of DI application by teachers in mathematics learning and the development of teacher education in improving the competence of applying DI in mathematics learning. In one of the research, the researcher simplified the many concepts of DI so that teachers can implement them in learning mathematics [38]. At the same time, the other four articles discussed the impact of DI implementation on enhancing students' mathematics learning outcomes. Two articles examined students' responses or attitudes toward implementing DI in mathematics learning [34], [37]. Therefore, the most dominant topic studied was teachers and prospective teachers' ways in implementing DI and developing their competence in implementing DI.

3.2. Q2: What principles are used in applying DI to mathematics learning?

To answer the second research question, the present systematic review specifically searched the literature, discussion, and conclusion sections of the selected articles. This process began by identifying the DI theory used in the articles.

Almost all articles used the DI theory developed by [40], and only one article used the DI cycle developed by .441]. Before analyzing all the articles, the DI theories developed by Tomlinson and by Prast, Weijer-Bergsma, Kroesbergen and Luit were consulted first to obtain the DI principles that were very relevant to both theories. Then, these principles guided the analysis and synthesis of the 13 articles.

In order to conduct effective DI, teachers have to focus on the needs of learners within the cognitive framework set by them. Teachers also need to focus on enhancing the student knowledge, consistently evaluating their comprehension and skills, emphasising learners' sense-making, and assisting students in recognising the relevance and usefulness of what they are learning. Moreover, student choice must align with the teacher's framework, collaborative learning management, and students must actively engage in the learning process [18], [42]. Teachers focus on implementing DI learning and must have a cognitive framework accommodating various DI principles. This framework can be a learning plan to apply in learning.

Tomlinson also stated that teachers must be able to differentiate content, process, product, learning environment, and affect [19], [41]. The differentiation process must be tailored to the learning readiness, interest, or learning profile of students who are different from one another. Teachers must also pay attention to several other principles when implementing DI, for instance by providing quality tasks, flexible group students, supportive curriculum, growth levels, and continuous assessment. Besides Tomlinson, [25] also presents DI in a cycle which is shown in Figure 4 [25].

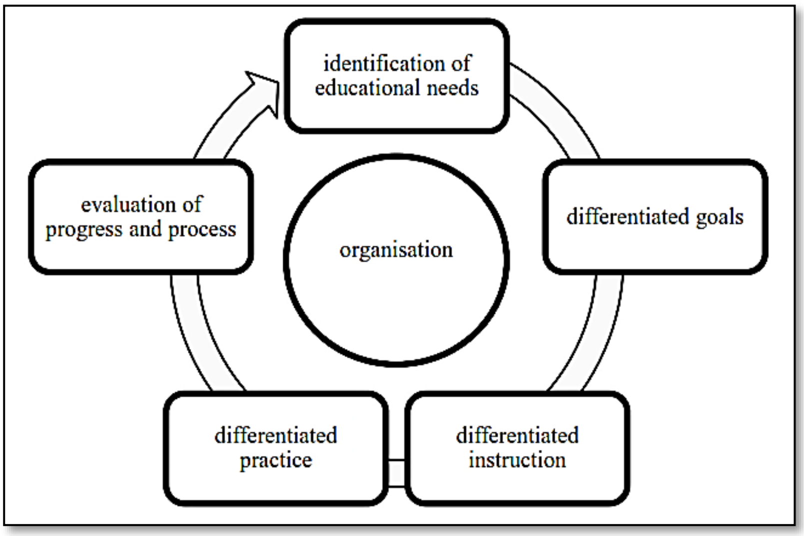

Figure 4. Differentiation cycle (source: [25]*).*

Identification of educational needs is the first step in the differentiation cycle. Next, teachers set differentiated objectives.

Following this, teachers differentiate instruction through whole-class teaching. Practice tasks should be qualitatively and quantitatively different.

Finally, teachers must evaluate if students have met the objectives and if the instructional adjustments implemented have yielded the intended outcomes. The DI cycle has similarities with the DI developed by Tomlinson. The DI cycle emphasizes differentiated learning tailored to student achievement or learning outcomes [25]. Flexible groups and various assessments are also present in this DI cycle to help teachers see students progress and differentiate further learning accordingly.

Further analysis of the selected articles revealed that they used these ideal principles. The principles used were identification of students' learning readiness, interests and learning profiles, differentiation of content, process, product, quality tasks, and continuous assessment.

3.2.1. Identification of Students' Learning Readiness, Interests, and Learning Profiles

The selected articles provided a similar picture of the need to identify students' learning readiness, interest, and learning profile before differentiating in mathematics learning. However, only five articles explicitly explained students' learning readiness, interest, and learning profile. Students' learning readiness can be seen from students' mastery of prerequisite knowledge. In addition to mastering students' prerequisite knowledge, teachers must also be aware of students' existing knowledge of the mathematics content to be instructed [2], [37]. Students' learning readiness can also be looked at based on materials that are either comprehensible or challenging for them, as well as by analysing student errors or misconceptions [32].

Interest is stated to stimulate students' curiosity and understanding of a topic in learning [43], [44]. The researchers grouped students based on similar interests in his research [33]. Students were given a maths project with a choice of topics. Students were also given a choice of a range of final projects that they can choose according to their interests, for example, a written report, poster, website, radio interview, or other appropriate projects. Although learning was customized to students' interests, the choice of tasks was made slightly above students' current skills, allowing them to develop new skills in their areas of interest.

Learning can also be tailored to the student's learning profile. The term student learning profile refers to a student's favoured way of learning. This way of learning is influenced by several factors: learning style, thinking style, culture, and gender. The learning profile that tends to be used in the selected articles is learning style. One example is a study of elementary school pre-service teachers [33].

This research implemented DI according to pre-service teachers' learning styles. In the implementation, pre-service teachers with kinesthetic learning styles did kinesthetic activities by using manipulative objects, such as base ten blocks, Cuisenaire rods, pattern blocks, and pasting fractions physically on the number line. Pre-service teachers with visual learning styles used pictures, photos, films, diagrams, and PowerPoint slides. One of the study participants revealed that doing things on paper helped it. Meanwhile, pre-service teachers with auditory learning styles were asked to listen to exciting lectures about mathematics materials and discuss them with other pre-service teachers and lecturers. This implementation encouraged them to do learning activities [33].

In general, these studies suggested that teachers focus only on one thing when differentiating, i.e., learning readiness only, interest only, or student learning profile only. Teachers can differentiate learning with a good scenario and avoid messy mathematics learning [36].

3.2.2. Differentiation of content, process, and product

Based on the theory of Tomlinson and other experts, DI applies to content, process, product, learning environment, and affect distinctions. This review revealed that all the articles differentiated content, process, and product in learning mathematics. The differentiation processes were based on students' learning readiness, interest, and learning profile.

Various strategies, such as cooperative learning, are able to accompany differentiating content. Students can be grouped to discuss different mathematical topics and then share what they have learned in groups. In groups, students can use a variety of texts or materials that are tailored to the needs of the students according to one of the studies reviewed [32].

The differentiation of process can also involve groups with similar interests, for example, the teacher can choose the same material topic for all students and then use different activities to learn the topic according to students' interests. This process was applied to different learning readiness and styles in the selected research papers [21], [25], [32], [33]. Process differentiation can also be done by giving more attention to concrete reasoning to build abstract understanding for low-achieving students and emphasizing abstract understanding accompanied by more challenging tasks for high-achieving students [25]. Process differentiation can also be tailored to students' interests. For example, when students are given two projects, they are afforded the autonomy to select topics for both projects.

This differentiation process ends with product differentiation customized to the student's interests.

Product differentiation involves allowing students to produce products that combine design, artistic, oral, and written products. Another way of differentiating the process of learning mathematics is by tailoring the learning profile of the students. For instance, in one of the reviewed studies, students were allowed to represent decimal numbers using kinesthetic and visual learning styles. Students with kinesthetic learning styles illustrated decimals using manipulative objects such as base ten blocks. On the other hand, students with a visual learning style illustrated a picture of a decimal box. After completing the activities in groups according to their learning styles, students formed new groups with members from at least two learning styles. In this group, students solved additional problems with two different ways of representation [33]. Process differentiation can also be done when students interpret mathematical problems, i.e., understanding the problem in multiple ways or using other methods. Therefore, students could choose the most reasonable method or the most efficient or straightforward, and a variety of different ways that help students understand standard algorithms [21], [33].

3.2.3. Quality tasks

Regarding the tasks given, some articles mentioned the form of tasks used in mathematics learning [25], [34], [35], [36], [38]. The tasks given were quantitative and qualitative. In the articles, the tasks were also adjusted to students' learning readiness, interests, and learning profiles. Furthermore, the assignments were given as homework, quizzes, tests, writing assignments, and projects. The given homework in the research consisted of a core problem that all students completed, and several different problems were given to students. Students performed three to four writing tasks that required them to respond to mathematics questions in a two-page essay. For some of the writing prompts, students could answer the prompt question. For some assignments, students could revise and regain any percentage points missed. Teachers did not give students unequal workloads or preferential tasks but rather tasks that maximize students' capabilities based on their current abilities.

Some articles also pointed out some important points for teachers when designing a task. First, the tasks should be made suitable for introducing or enriching students' knowledge of specific mathematical content. It should also encourage students' mathematical creativity and find specific patterns or generalizations. In addition, the tasks given were complex for students to complete easily or comfortably [25], [34], [35], [36], [38].

One unique thing about these articles was that the tasks given were not only in quantitative form but also in qualitative form. Although calculations dominate mathematics, students could also explore mathematics qualitatively.

3.2.4. Continuous Assessment

50% of the articles analyzed mentioned that one of the principles of DI is continuous assessment, meaning that everything students do and say is a potential source of assessment data. In the selected articles, assessment was conducted before, during, and after learning [19], [38], [45]. If the common practice is for teacher to only focus on conducting assessments at the end of learning, then DI requires teachers to conduct assessments before, during, and after learning according to the selected articles [2], [25], [32], [33], [37].

A pre-learning assessment is also a diagnostic assessment. This assessment must first identify students' learning readiness, interest, and learning profile. Furthermore, the results can be used by educators as a reference in planning learning according to students' learning readiness, interests, and learning profiles. The assessment process can use written or oral tests, skills, or observation [37], [38]. Moreover, this diagnostic assessment can be intended to design learning differentiation, not as part of assessing learning outcomes on student report cards [2], [25], [37].

After conducting the diagnostic assessment, the teacher could set specific learning objectives, which are the desired competencies of the students or the teacher's expectations for the pupils' knowledge, comprehension, and competencies. In addition, formative assessment (on going assessment) refers to the learning objectives. In the selected articles, assessments are also needed to be conducted throughout the learning process, aiming to provide feedback for students, thus providing new learning opportunities that ensure continuous academic growth [2], [25], [32], [33], [37]. Teachers can also evaluate students' progress through these assessments. Some examples of formative assessment are when students are asked to write down three things they have just learned and one thing they have not understood, a discussion related to the process and results of the experiment, the teacher gives written questions, and students answer the questions. After that, the answer key is given as a reference for students to conduct self-assessment, peer assessment, and peer feedback. The researchers further stated that formative assessment can be evaluated through homework, quizzes, examinations, writing assignments, and projects. All students should do identical formative assessments [33].

Homework typically comprises fundamental questions completed by all students, followed by two to three varied questions tailored for various students. Students complete three to four writing tasks that require them to respond to mathematics questions in a two-page essay. Students had the option of answering the prompted questions. For some tasks, students can complete revisions and regain any missed points.

After completing one scope of material in a certain period, the teacher could also give a summative assessment at the end of the semester and at the end of the phase. This assessment is the basis for determining report cards, where teachers will compare the achievement of student learning outcomes by the learning achievement criteria. This assessment also aims to determine the learning process at the next level.

This assessment can use a variety of assessments, not only in the form of tests but also through practical, product, project, or portfolio assessments.

DI uses the 3-P assessment (Performance, Process, Product) for report card assessment [18], [19]. Learning also ends with a reflection process. Reflecting on students' performance aims to determine students' achievement of learning objectives. This reflection is useful for students to see their growth, not their grades. Therefore, all students from various ability categories become more motivated for further learning. They are also given the chance to reflect on the process regarding students' habits of mind and work. Consequently, it can be beneficial for students in developing productive attitudes and practices [2]. Based on the analysis of the 13 articles, the schema of DI in mathematics learning is as follows. Figure 5 illustrates the schema of DI in mathematics learning.

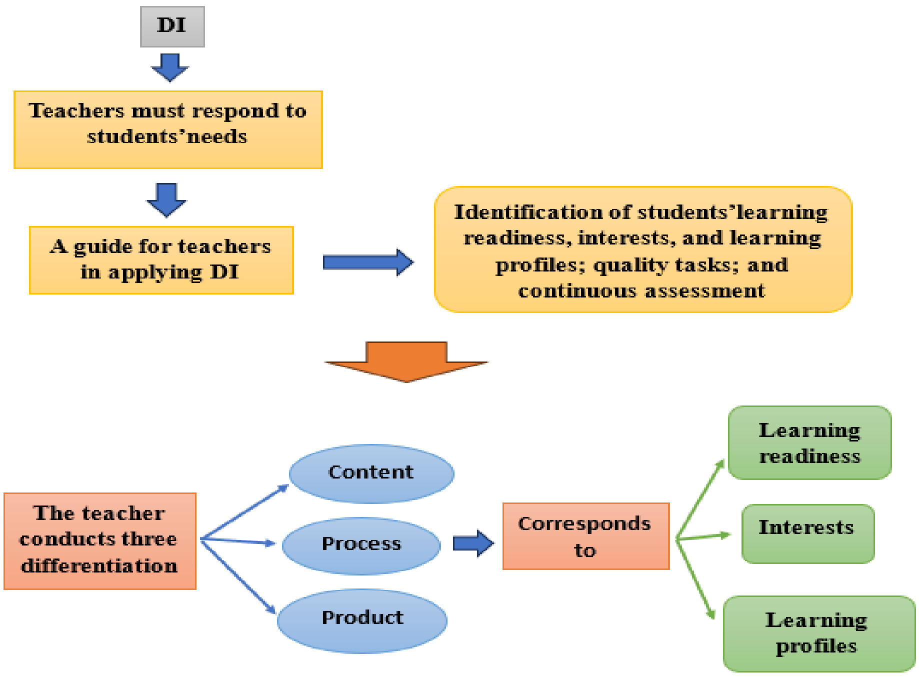

Figure 5. The schema of DI in mathematics learning

3.3. Q3: What are the stages of DI in mathematics learning?

The review of 13 articles also provided an idea of the stages of DI in mathematics learning. DI is an instructional approach that requires teachers to be responsive to students' needs. Therefore, diagnostic assessments are conducted before learning. This assessment should be done in advance to identify students' learning readiness, interest, and learning profile. The results are used by educators as a reference in planning learning according to students' learning readiness, interests, and learning profiles [37], [38].

Furthermore, this diagnostic assessment is intended to design learning differentiation, not as part of assessing learning outcomes on student report cards [2], [25], [37].

After conducting the diagnostic assessment, teachers set specific learning objectives, which are the desired competencies of students or what teachers want students to know, understand, and be able to do. Then, teachers could design differentiation in content, process, and product aspects. Learning differentiation can be done in one or two or even using 3 aspects, by first differentiating content and process, ending with differentiating the product.

Based on the 13 articles, such a choice could avoid mathematics' unstructured and disorganized learning. During the learning process, teachers conduct formative assessments.

This assessment aims to provide feedback for students to provide new learning opportunities that ensure continuous academic growth [2], [25], [32], [33], [37]. Teachers can evaluate student development through such assessments.

After completing one scope of material in a certain period, the teacher gives a summative assessment at the end of the semester and the end of the phase.

This assessment becomes the basis for determining the report card score, where the teacher will compare the achievement of student learning outcomes by the learning completeness criteria. This assessment also aims to determine the learning process at the next level. This assessment can use a variety of assessments, not only in the form of tests but also through practical, product, project, or portfolio assessments. DI uses the 3-P assessment (Performance, Process, Product) assessment for report card assessment. Figure 6 illustrates the stages of DI implementation in mathematics learning.

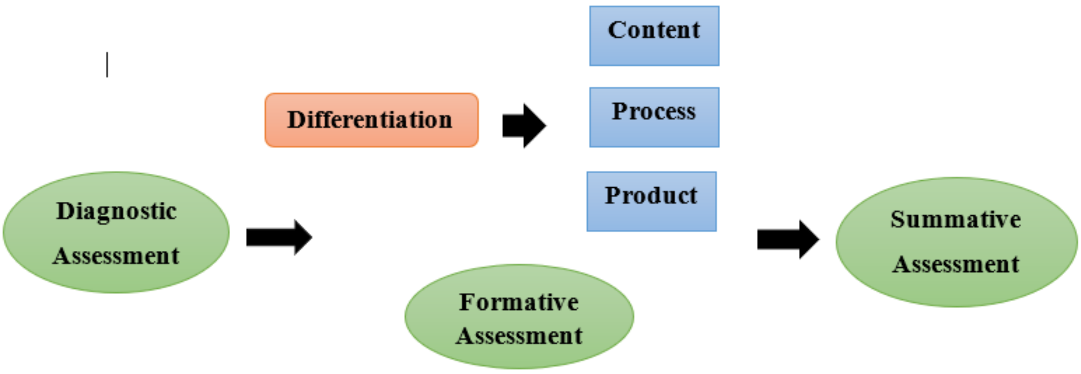

Figure 6. The stages of DI in mathematics learning

4. Discussion

The systematic review of the 13 selected articles demonstrates that DI (Differentiated Instruction) has a good effect on mathematics learning. Moreover, DI is not only for students in elementary and secondary education, but it can also be extended for students in universities [21], [23], [24], [32], [33]. In its implementation, differentiation in DI is not done throughout the whole learning process but only in certain situations. However, differentiation must be done well in order to accommodate the needs of students and impose a significant effect on the learning process. The results also show that the curriculum needs to support teachers or lecturers in conducting DI in the classroom. When the curriculum is supportive, teachers or lecturers can implement DI regularly in the classroom [2], [36], [37]. The implementation of DI also needs to be supported by the curriculum in schools and universities and by the teacher's professional development curriculum [20], [21], [38]. Teacher professional development programs in implementing DI which are supported by the government can support the improvement of mathematics learning achievement [26], [33], [39]. Thus, teachers not only make spontaneous adaptations in the classroom but can also plan carefully and systematically [25], [32], [36].

These studies also show that distinctions tend to be made only on three components: content, process, and product [25], [34], [35], [36], [38].

Differentiation can be done on other components, namely the learning environment and effect [26], [35], [45]. In addition, the results showed that the distinction was only adjusted to learning readiness, interest, or learning profile [28], [46], [47], [48]. No distinction has been found that is adjusted to a combination of two or three things.

The analysis of 13 articles also shows that the main principles of implementing DI in mathematics learning are the identification of students' learning readiness, interests, and learning profiles; differentiation of content, process, and product; quality tasks; and continuous assessment. In addition to these principles, teachers should also use flexible groups when implementing DI in mathematics learning. DI is not the same as individualized learning where the teacher provides different teaching for each student during the learning process. This process can be time-consuming, so flexible grouping should be utilized. The differentiation process can be done in a third or half of the time. Teachers must also consider another principle, namely growth rates [49], [50], [51]. Growth rate can determine the position of students in mathematics learning. When the teacher knows the position of the students, it allows the students to move between groups and provide a new approach according to their new growth rate.

Furthermore, the literature review that has been conducted has also several limitations. Firstly, the exploration process is only on three aspects, namely the most dominant research topic on DI in mathematics learning, principles used in applying DI to mathematics learning, and the stages of DI in learning mathematics. Secondly, the empirical studies on the effectiveness of DI are only limited to those who studied on specific mathematics skills improvement, such as critical thinking, creative thinking, or other mathematics skills. Moreover, the review has yet to study the role of schools in supporting the implementation of DI in learning mathematics. These limitations may serve as a foundation for more literature research to furnish a thorough understanding of the application of differentiated instruction in mathematics education and to enhance the efficacy of DI in this domain.

The systematic review of the 13 articles can provide appropriate knowledge in implementing DI in mathematics learning. Teachers become more aware of the philosophy underlying the implementation of DI, the appropriate principles in implementing DI, and the systematic stages when implementing DI in mathematics learning. Some of this knowledge can help teachers create a well-thought-out and quality lesson plan. In addition, this knowledge can also increase teachers'confidence in implementing DI in mathematics learning. Teachers feel comfortable and enthusiastic about learning, which impacts improving students' understanding of mathematics concepts.

5. Conclusion

The results of the systematic literature review of the 13 selected articles revealed several important findings. This study found that the most dominant topic in the implementation of Differentiated Instruction (DI) is the way teachers and prospective teachers develop their competence in implementing DI. Furthermore, this study also identified several principles used by researchers in developing or implementing DI in mathematics learning, such as identifying students' learning readiness, interests, and learning profiles, differentiating content, process, and product, and providing quality tasks and continuous assessment. This study also found that the stages of implementing DI in mathematics learning involve several key steps. Teachers conduct a diagnostic assessment before the lesson to identify students' learning readiness, interest, and learning profile. Then, they set specific learning objectives that outline the desired competencies of students. Next, teachers implement differentiation in content, process, or product aspects. Formative assessments are conducted during the learning process to provide feedback for students.

Finally, summative assessments are administered at the end of the semester or phase to determine student learning outcomes and inform future instruction. This literature review can serve as a suitable guide for mathematics teachers in developing a mature instructional design and feeling more confident in implementing DI in learning. Teachers should pay attention to the essential principles of DI so that learning can proceed according to the DI approach.

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