



A Literature Review: Application of Differentiated Instruction to Improve Mathematics Learning

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Abstract. Every student has differences in terms of abilities, learning styles, interests, and cultural backgrounds. For some students who have good ability in understanding Mathematics, Mathematics is a fun learning and very easy to learn. On the other hand, for some students who do not have good mathematical abilities, they will define mathematics as an unpleasant and very difficult lesson to learn. There are several factors that cause some students to experience difficulties in learning mathematics, among others, the learning challenges given by the teacher are not proportional to the students' abilities, the learning methods provided by the teacher are not in accordance with the student's learning style, and the students' low interest in learning. Mathematics learning should be carried out interactively, fun, challenging, motivating, and providing enough space for initiative, creativity, and independence according to the talents and interests of students. This is in line with the concept of Differentiated Instruction. Differentiated Instruction is a learning method in which the teacher must provide instructional instruction in the classroom, so that students can learn according to their interest and needs. The purpose of writing this literature review is to (1) explain the application of differentiation, (2) explain the results of the application of differentiation, (3) analyze the opportunities for applying a differentiated approach in learning Mathematics. The research method used in this study is a literature review in the form of journals and articles that are searched through Google Scholar. This journal search yielded 90 findings in the period 2007–2022. In addition, researchers carried out an inclusion and exclusion process by considering the criteria that had been set. The results of the inclusion process obtained as many as 30 findings and exclusion as many as 60 findings. So this study uses 30 articles that are used as a source of literature review data. The results obtained from the literature review of this study include: DI can meet the diversity and learning experience student, improve self-efficacy in mathematics learning, increase motivation student to learn mathematics, improve mathematic skills, and improve mathematics learning achievement.

Keywords: Differentiated Instruction · Learning Ability · Mathematics

1 Introduction

Mathematics is a branch of science that can play an important role in human life. Mathematics in general can also be defined as a field of science that can study patterns of structure, change and space. Mathematics is a means of communication in science about patterns that can be useful in order to train critical, creative, logical and innovative thinking. Mathematics can also be seen as a way of reasoning, because in it there is valid or valid evidence, as well as processes in systematic mathematical reasoning [1]. Mathematics is also often considered as a tool to find a solution to various kinds of problems. Mathematics also consists of several components including axioms and theorems. There are things that can be communicated through mathematics, for example, presenting problems into a mathematical model that can be transformed in the form of diagrams, mathematical equations, or in the form of graphs and tables. One of the goals in learning mathematics is to have the skills and an ability to communicate mathematically. Through communication in mathematics, students can organize their mathematical thoughts both verbally and in writing, besides that student can also provide appropriate responses between students and the media when they want to start the learning process.

According to the Ministry of National Education [2], one of the goals in learning mathematics in schools is for students to be able to develop their mindset and reasoning, drawing conclusions, problem solving, and to develop the abilities in providing information and communicating. Ideas through an oral, written, drawing, map, graph and diagram. According to [3] Mathematics is also often considered by students as a difficult subject. [4] stated that mathematics is still considered as a difficult subject and students perceive mathematics as their least favorite. There are many factors to the problems, such as the students to think that mathematics is a difficult and boring lesson, and the teacher's way of teaching is not appropriate. According to [5] the low learning outcomes in mathematics are not only caused by one factor but there are several factors, namely the students themselves, the teacher, the approach of learning, and also the learning environment that is interconnected one another.

Differentiated Instruction (DI) is a learning approach that maximizes the potential of each student by paying attention to the basic needs of students ([6]. Differentiated Instruction (DI) is also referred to as learning that pays attention to individual differences in students. Although this teaching model is oriented towards individual differences in students, it does not mean that teaching must be based on the principle of one teacher and one student [7]. States that Differentiated Instruction (DI) in particular also responds to a student's continuous learning progress, what they already know and also what they want to learn so that in DI learning, each student can get learning according to their needs [8]. [9] states that in DI, learning is designed in such a way that students can also enjoy learning with learning objectives that can be achieved. [10] stated that every student must have a different character. In dealing with these character differences, the DI approach is used in mathematics learning based on varied learning and tailored to the needs of each student, in order to maximize the potential and success of each student in the scope of learning mathematics. [11] There are several ways to make DI learning, namely by using (1) Teacher Based Method, which is based on the curriculum, content, process, and also the product. (2) Student Based Method, which is based on student learning readiness, interests and learning styles.

According to [12] that is based on the student's character, DI can be done with three things: (1) readiness in learning, if the learning task given is in accordance with the student's learning abilities, (2) interest, if the given learning task can provide stimulation in a sense of curiosity, and passion in student learning, (3) learning style, if the learning task can encourage students to work in a way that they like. [13] states that in DI learning if it is done with group work, then the learning will be more effective. [13] defines differentiated instruction (DI) as a way of thinking or a philosophy in dealing with the differences of each student and adapting to the learning way according to student needs to maximize their potential. In some cases that exist in school life, that students often complain because they find it difficult to complete the assignments, cannot understand, and terrified to have low test scores. Through the application of differentiated instruction, students are expected to be able to carry out a more effective learning process and not feel burdened by doing things that are too difficult or feeling beyond the capacity of the student. Therefore, teachers or schools can apply the differentiated instruction in the learning process in schools. After looking at the phenomenon and background, this research aim to understanding the role of Differentiated Instruction in increasing mathematics abilities. The purpose of this research is that it can be used as an additional information about the application of differentiated instruction to increase mathematics learning ability.

2 Methods

2.1 Study Design

This study uses a literature review as the research design in this paper. Literature review is the process of identifying, assessing, and interpreting all research evidence from existing research with the aim of providing answers to specific research questions [14]. This is based on the purpose of writing, namely to analyze the application of differentiated instruction to mathematical abilities. Through this literature review, the researcher conducts a descriptive analysis which will re-explain the information that has been obtained through an explanation based on the researcher's understanding.

2.2 Literature Criteria

In the literature search process, there are several criteria that must be set to ensure the quality of the literature and the results to be obtained later. There are two literature criteria, which are inclusion and exclusion criteria.

The inclusion criteria obtained in this study include:

- The published literature is in the range of 2007–2022.
- Literature based on journals, scientific works, or scientific articles.
- The literature describes the differentiated instruction variable or the role of differentiated instruction on the ability to learn mathematics with complete and clear information.
- The literature uses English and Indonesian. The exclusion criteria in this study include:
- The literature does not have clear information regarding the application of differentiated instruction to the ability to learn mathematics.

2.3 Literature Search Strategy

This study yielded 90 findings of the literature in the 2007–2022 range in Indonesian and English. From these journals and articles, researchers carried out an inclusion and exclusion process through considerations related to predetermined criteria. The results of the inclusion process obtained as many as 30 findings and exclusion as many as 60 findings. Therefore, this study uses 30 articles to be used as a source of literature review data.

2.4 Literature Review Process

This literature review was processed in accordance to the direction of [15], namely: (1) designing a review, (2) conducting a review, (3) analyzing and (4) writing a review:

Stage 1: Designing the review. In this case, the design points include: “Why is a literature review necessary?”; “What are the objectives and research questions to be discussed?”; “What analytical method is most appropriate to use?”; and “What data search strategy is appropriate for this activity?”. After having a research theme and purpose, the next thing to do is to explore for appropriate journals or articles to obtain information about the application of differentiated instruction to mathematical abilities. The search is carried through electronic databases such as Google Scholar.

Stage 2: Conduct a review. The next stage carried out by the researcher was to follow up on stage 1 by carrying out the process of analyzing the literature one by one according to the details of stage 1. In this case, the researcher carried out the process of selecting and sorting the journals that had been collected. Researchers evaluate the suitability of titles and abstracts in each literature to see whether an article is relevant or not. Then, the researcher saves several articles or journals that are considered in accordance with the research theme. Next, the researcher analyzes the research from each literature and decides which articles or journals will be used as research material.

Stage 3: Analysis. At this stage the researcher performs the process of sorting out the information to be discussed, comparing the information in the journal, reviewing and ensuring the quality of the literature analysis process is in accordance with the research theme, and analyze the result based on the research question of this study. In other words, after conducting the literature selection process, the researcher will draw conclusions regarding the information from each journal or article that has been obtained.

Stage 4: Write a review. At this stage, the researcher presented the results of the literature review based on the information that had been obtained previously. In accordance with the characteristics of the systematic literature review approach chosen in this study, the results of the analysis are described in a form and synthesized using a narrative method by grouping similar extracted data according to the results measured to answer the research objectives.

3 Results and Discussion

Based on the inclusion and exclusion process, we determined a total of 30 articles to be used in the literature review study. The article can be seen in Table 1.

Table 1. Inclusion Journals

No	Article References
1	Defitriani, E. Developing Students' Mathematical Connection Ability Through Differentiated Instruction Approach. <i>ANARGYA: Scientific Journal of Mathematics Education</i> , 1(2), 72–76, 2018.
2	Fatimah, A. E, Improving Mathematical Problem-Solving Ability and Learning Independence of SMK Negeri 1 Percut Sei Tuan Students Through Differentiated Instruction Approach. <i>MES: Journal of Mathematics Education and Science</i> , 2(1), 2016.
3	Fatimah, A. E, Improving Students' Mathematical Resilience in Basic Mathematics Courses through Differentiated Instruction Approach. <i>Journal of Didactic Mathematics</i> , 2(1), 42–49, 2021.
4	Lailiyah, E. Differentiated Instruction Approach to Improve Mathematical Critical Thinking Ability of Junior High School Students. <i>Nabla Dewantara</i> , 1(2), 55–64, 2016.
5	Mawaddah. & Simanjuntak, E., Differences in Students' Mathematical Communication Ability through Open Ended Learning Approach with Wingeom Assisted Differentiated Instruction Learning Approach at SMP Negeri 1 Tanjung Morawa. <i>Jurnal Inspiratif</i> , 4(2), 2018.
6	Ditasona, C. Application of Differentiated Instruction Approach in Improving Mathematical Reasoning Ability of High School Students. <i>EduMatSains: Education Journal, Mathematics and Science</i> , 2(1), 43–54, 2017.
7	Fatimah, A. E., & Purba, A. The development of student activity sheets (SAS) using a differentiated instruction approach to improve the mathematical problem-solving abilities of SMK students. <i>MES: Journal of Mathematics Education and Science</i> , 4(1), 1–9, 2018.
8	Iskandar, R. S. F, Application of Differentiated Instruction Approach to Develop Students' Mathematical Problem-Solving Ability. <i>Alphamath: Journal of Mathematics Education</i> , 2(2), 2016.
9	Simanjuntak, S. S., & Listiani, T. Application of Differentiated Instruction in Improving the Understanding of Mathematics Concepts for Grade 2 Elementary School Students. <i>Scholaria: Journal of Education and Culture</i> , 10(2), 134–141, 2020.
10	Harmini, T. The Effectiveness of Using Differentiated Instruction-Based Modules to Improve Students' Ability to Understand Mathematical Concepts. <i>Journal of Didactic Mathematics</i> , 6(2), 2019.
11	Yuliana, N. The differentiated instruction (DI) approach in improving learning outcomes and mathematical activities of class XI MIPA-2 students at SMAN 1 Koba. <i>Indonesian Digital Journal of Mathematics and Education</i> , 4(6), 370–378, 2017.
12	Arviana, N. N, the application of the differentiated instruction approach to develop mathematical problem-solving abilities of eighth grade junior high school students on cube and block material. <i>MATHEdunesa</i> , 3(3), 2014.
13	Defitriani, E., & Hidayat, A. F, Design of Learning Planning Based on Differentiated Instruction (DI) in Aljabr Course. <i>PHI: Journal of Mathematics Education</i> , 5(1), 7–18, 2021.

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Table 1. (continued)

No	Article References
14	Chen, J. & Chen, Y. Differentiated Instruction in a Calculus Curriculum for College Students in Taiwan. <i>Journal of Education and Learning</i> , 7(1), 2018.
15	Julak, J. Implementation of Differentiated Learning in Efforts to Improve Activities and Learning Outcomes of Mathematics Students of class XI MIPA SMA Negeri 8 Barabai. <i>Syamsir Kamal</i> , 1(1) 2021.
16	Harmini, T. Differential Calculus Learning Using Modules with Differentiated Instruction Approach. <i>Mathematic Education and Application Journal</i> , 3(1), 41–47, 2021.
17	Suprihatiningsih, S. Mathematics Learning Experiment using Mobile Learning with Differentiated Instruction Approach. RIEMANN: Research of Mathematics and Mathematics Education , 4(2), 34–42, 2022.
18	Onyishi, C. N. & Sefotho, M. M, Differentiating Instruction for Learners Mathematics Self-Efficacy in Inclusive Classrooms: Can Learners with Dyscalculia also Benefit? <i>South African Journal of Education</i> , 41(4), 2021.
19	Lupita, L., & Hidajat, F. A, Differentiated Instruction Design in Statistics Materials for Junior High School Students: Alternative Learning for Gifted Students. <i>Griya Journal of Mathematics Education and Application</i> , 2(2), 388–400, 2022.
20	Muthomi, M. W., & Mbugua, Z. K, Effectiveness of differentiated instruction on secondary school students' achievement in mathematics. <i>International Journal of Applied</i> , 4(1), 116–128, 2014.
21	Chamberlin, M. T, the potential of prospective teachers experiencing differentiated instruction in a mathematics course. <i>International Electronic Journal of Mathematics Education</i> , 6(3), 134–156, 2011.
22	Ellis, D. K., Ellis, K. A., Huemann, L. J., & Stolarik, E. A, Improving Mathematics Skills Using Differentiated Instruction with Primary and High School Students. <i>Online Submission</i> , 2007.
23	Reilly, E. Moving All Students towards Mathematical Success: Teachers' Perceptions of Learning and Implementing Differentiating Instruction. <i>Journal of Mathematics Education Vol. 9, No. 1, pp. 16–28</i> , 2016.
24	Burriss, L. A. A Case Study of Differentiated Instruction in Upper Elementary Mathematics and Reading Classrooms. <i>Walden University ProQuest Dissertations Publishing</i> , 2011.
25	Donovan, S. C. Using the guided math framework to provide differentiated instruction. <i>Sophia, the St. Catherine University</i> , 2013.
26	Herner-Patnode, L., & Lee, H. Differentiated Instruction to Teach Mathematics: Through the Lens of Responsive Teaching. <i>Mathematics Teacher Education and Development</i> , 23(3), 6–25, 2021.
27	Odicta, G. L. Effects of Differentiated Instruction on Mathematics Achievement and Critical Thinking Skills of Students. <i>WVSU Research Journal</i> , 6(1), 17–26, 2017.

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Table 1. (continued)

No	Article References
28	Hapsari, T. Understanding and responding the students in learning mathematics through the differentiated instruction. <i>Journal of Physics: Conference Series</i> , 2018.
29	Eaddy-Busch, M. The Impact of Differentiated Instruction in Mathematics on African American Students. <i>Walden University ProQuest Dissertations Publishing</i> , 2014.
30	Magayon, V. C. Learning Mathematics and Differentiated Instruction in the Philippines: A Phenomenographical Study on Struggles and Successes of Grade 7 Students. <i>International Journal of Educational Studies in Mathematics</i> , 3(3), 1–14, 2016.

Based on the 30 articles that the have been reviewed, we grouped the findings of the analysis into 5 themes, which are: 1. Meet the diversity and learning experience of students, 2. Improve Self Efficacy, 3. Increase motivation to learn mathematics, 4. Improve mathematics skills, 5. Improve learning achievement.

From these five themes, we compiled the findings as shown in Table 2.

Based on the results of the analysis of the 30 journals above, it shows that the application of differentiated instruction can have a significant influence on students' mathematics learning. This can be seen based on the first findings which say that differentiated instruction can meet the diversity and learning experience of students. Basically, every student has different learning characteristics, which is certainly a challenge for a teacher to meet their learning needs. In the research of [16] it was found that there are 22% of new students who have failed to meet the performance level for mathematics courses and only 40% are ready to undergo mathematics learning in college. This study suggests that this diversity of student characteristics is a difficult problem to address as some students report that their math classes are impersonal, not in line with their interests, and not intellectually stimulating. Then, through the application of differentiated instruction, it proves that DI has provided a positive experience for students. This can be seen through the results of research conducted by [17] which applies modified learning activities. This

Table 2. Results of Literature Review

Theme	Frequency	Article Title
1. Meet the diversity and learning experience student	2	21, 30
2. Improve self-efficacy student	2	18, 23
3. Increase motivation student to learn mathematics	5	14, 23, 25, 28, 29
4. Improve mathematic skills	15	1, 2, 3, 4, 5, 6, 7, 8, 12, 23, 24, 25, 26, 27, 30
5. Improve learning achievement	15	4, 11, 13, 15, 16, 17, 19, 20, 22, 23, 24, 25, 26, 27, 30

modified learning activity makes students think that this activity is fun, interesting, helps them in solving problems, and challenges them to do more in the activity.

Then, in the second finding which says that differentiated instruction can increase students' self-efficacy. In the research of [18] it was noted that 67% of students' poor performance in learning mathematics in Nigeria was caused by poor pedagogical approaches used by teachers because they rarely paid attention to students' needs, but had high expectations for them. Students who have low self-efficacy in mathematics are often found to be difficult to persist in studying the subject and unable to achieve success. Low self-efficacy is shown when students do not believe that they can succeed in math tasks because of their lack of ability. Through the application of differentiated instruction, it proves that DI is effective in reducing the negative effects of previous poor performance on the self-efficacy of low-achieving students and for students with dyscalculia. This can be seen through the results of research conducted by [19] which uses the method of difference in instructions in order to help increase self-efficacy. In this difference in instructions, teachers are asked to change the concept of learning mathematics which only uses one repetitive teaching style so that learning becomes less effective from time to time. This learning activity received positive comments from various students who said that differentiated instruction could help them to understand better, make problem solving fun and challenging, and make them impatient to wait their turn to learn.

Furthermore, in the third finding, it is said that differentiated instruction can increase students' motivation in learning mathematics. This is evidenced by one of the results of research conducted [20] which uses the group competency method to help increase student learning motivation. This group competency activity greatly influences students' interest in following calculus. In addition, team grouping also increases students' learning autonomy, thereby creating intrinsic motivation. The teachers explained that through the application of differentiated instruction, students can gain confidence in mathematics, feel empowered, respect freedom of choice, and show active involvement so that this can be a reason why differentiated instruction can increase students' motivation in learning mathematics.

Then, the results of the fourth finding also show that differentiated instruction can improve students' abilities in learning mathematics. In this case, the increased ability is obtained both in terms of understanding, critical and systematic thinking, as well as ease in solving mathematical problems. Some students said that differentiated instruction had a positive influence on their learning process, such as, being able to help them understand mathematics easily, making them aware of their respective learning needs, and being able to adapt it to their understanding.

The latest findings show that differentiated instruction can improve learning achievement in learning mathematics. As evidenced by the research [21] on improving student achievement is obtained by using aspects of an active role, as well as cooperation and responsibility. Students also responded positively to the application of DI during the learning process. Students said they felt fun learning activities by grouping different students. From this study, it was found that, overall, in improving student achievement, students who received DI learning were better than students who only received ordinary learning.

Based on the journals that have been reviewed by researchers, it can be seen that the problems that are often experienced in learning mathematics are because students are too focused on problem solving. So this makes most teachers provide teaching methods by emphasizing procedures rather than conceptual understanding. This teaching method makes teachers believe that when students practice solving math problems, students can develop an understanding of the concepts on which the problems are based. This problem of learning mathematics without understanding has become commonplace in some schools and has been a persistent problem since the 1930s [22]. This causes many students to tend to memorize facts and problem-solving strategies rather than develop their conceptual understanding. In addition, another problem found based on existing journals was that the students in the class were very diverse, both in terms of abilities and characteristics. So, it is a challenge for a teacher to develop different learning methods for students that allow teachers to build an environment that makes students learn mathematics with the right support and acceptance.

By reviewing the background of this research, differentiated instruction can be said to be one method that is quite effective in overcoming problems that occur in learning mathematics. This is supported by the results of existing research which says that differentiated instruction has a positive impact on the progress of students' mathematics learning, both from learning characteristics, self-efficacy, learning motivation, systematic reasoning abilities, and learning achievement. In addition, the results of the study also prove that the application of differentiated instruction can assist teachers in making changes to the teaching paradigm that only focuses on procedural approaches and problem solving to a more conceptual approach to meet the diverse needs of students. Several positive comments were also said by some students regarding the application of differentiated instruction, including: 1) this method makes learning fun, 2) makes problem solving a challenging and fun thing, 3) can help to more easily understand learning, and 4) helps to be more confident in contributing to learning. Based on the positive results revealed by several findings, this certainly provides new opportunities and hopes for the development of the education system in the future. Although some teachers say that this differentiated instruction approach requires a lot of time and effort to plan and implement it, teachers also identify the benefits and success of learning.

This research is the result of a review of journals and articles obtained in the period 2007–2022 using electronic databases such as Google Scholar. Finding these journals and articles is not a difficult thing for researchers because there have been many articles that discuss the implementation of differentiated instruction on the ability to learn mathematics. However, due to time constraints in the process of making this research, it is difficult for researchers to review several other journals that also look interesting. If this research is continued, the researcher hopes that future researchers can review journals with more specific targets, such as the application of differentiated instruction to students with disabilities. In addition, further researchers can search for and analyze higher quality journals through the latest and most up-to-date journals.

4 Conclusion

This study is the result of a literature review that aims to 1) explain differentiated instruction, 2) explain the results of the application of differentiation, and 3) analyze the opportunities for applying differentiation in mathematics learning. The results of this study indicate that differentiated instruction can improve mathematics learning. This can be seen from the results of the analysis of the data collected that differentiated instruction can meet the diversity and learning experience of students, improve student self-efficacy, increase student learning motivation, improve students' mathematical skills, and improve learning achievement. This differentiated instruction approach is a promising approach because it is proven to be able to support a variety of student learning needs to give positive results in influencing student achievement. The conclusion of this study can encourage the use of differentiated instruction methods in the future because it has provided many benefits for students who may have difficulties in learning mathematics due to differences in abilities with other students.

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