Reflective pedagogical paradigm approach in mathematics learning

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Abstract. This study aimed to describe the trends of the reflective pedagogical paradigm approach in mathematics learning in Indonesia that could give a better recommendation of mathematics learning in the future. This study literature was taken through some of the open-access websites such as ERIC, Google Scholar, JSTOR, and Springer for 6 years latest. The researcher took the limitation in exploring the literature review by determining the sources’ keys such as Reflective Pedagogical Paradigm in Mathematics, Reflective Pedagogy, and Ignition Pedagogy. The study results of the trends of the reflective pedagogical paradigm approach in mathematics learning were research methodologies trends, the students’ learning impacts, and the relationship between Indonesian curriculum and the reflective pedagogical paradigm application in 21st century learning.

1. Introduction
Mathematics learning is a learning process of procedural practice to answer mathematical problems [1]. More Fundamentally, Widada, Herawaty, & Lubis [2] state that mathematics learning emphasizes a student’s understanding of facts, concepts, principles, and operations in mathematics. The student’s understanding is used in mathematics learning so that our brains are accustomed to solving systematic problems [3]. On the other hand, mathematics learning is considered a spiral learning because the failure factors in understanding knowledge in previous learning experiences make the students afraid and refuse to participate in the next learning [4]. This statement is supported by Koehn [5] which states that the student’s achievement in mathematics learning is a crucial condition to fight for the challenges of mathematics learning and success in the future.

In the 21st century, the challenges of mathematics learning are increasingly developing. These learning challenges include the use of technology, globalization and the need for innovation that have impacts on the needs of students in developing relevant abilities and competencies [6]. Related to that statement, Gasser [7] states that there are 5 ideas for developing mathematics learning in the 21st century that include problem-based instruction, student-led solutions, fun, risk taking, and collaboration time. Some of these ideas are part of 4 main problems in the 21st century learning framework, namely knowledge, skills, character, and metacognition [8]. This learning framework is integrated to create skills in the 21st century that include creativity, critical thinking, communication, and collaboration [9,10]. However, it seems that the learning framework has not been implemented properly in mathematics learning for students in Indonesia, which is shown by Indonesian students’ achievement in International programs that are still low.
The Indonesian students’ achievement for the age of 15 years and over in the Program for International Student Assessment (PISA) 2012 reached a score of 375. It was in the below category of Organisation for Economic Cooperation and Development (OECD) average, which was 494 and this result also stated that Indonesia rank was in 62nd out of 65 participating countries [11]. The same result was obtained by Indonesian students when they participated in the PISA 2015 which obtained the score below of the International average in the mathematical aspect with a score of 386 with an OECD average of 490 [12]. This result indicated an increase in the average score that is obtained by Indonesian students. However, the result of the PISA 2015 was still low and it was ranked 64th out of 72 participating countries. The other achievement was shown by the result of the Trends in International Mathematics and Sciences Study (TIMSS) 2011 that stated Indonesia rank of 59th out of 62 participating countries with the average achievement of 8th grade mathematics achievement of 386 students and it was lower than the TIMSS scale CenterPoint 2011 of 500 [13]. The average increase in mathematics achievement of Indonesian students occurred in the implementation of TIMSS 2015, which was 397. However, this result was still relatively low and it made Indonesia rank of 44th out of 49 participating countries [14].

The low achievement of Indonesian students in the PISA implementation was in the mathematical modelling process that consisted of several aspects, namely 1) understanding the problem; 2) making the mathematical model; 3) using the completion steps in mathematics; and 4) making the conclusion that related to real conditions [15]. The different problem was found in the achievement of Indonesian students in participating in TIMSS, namely that Indonesian students were less familiar to the forms of problems that were presented because one of the mathematical topics that was tested (Data and Chance topic) was not contained in the Indonesian curriculum [13]. Related to these studies results, it could be stated that students were not accustomed to solving mathematical problems that were related to the real world. This statement was supported by Rotherham & Willingham [16] which stated when the students first discovered a new problem or idea, their knowledge of the new problem or idea was shallow and would only be fixed on the example that had been specifically given.

Students need the explanation of various examples before accepting more abstract mathematical concepts and they finally can apply their understanding to the new problems [16]. Related to that statement, teachers have to provide intensive guidance and remedial teaching (optional) in the classroom and parents play a role in assisting students to learn at home so they know and can overcome the difficulties that the students have [17]. However, Riccomini, Smith, Hughes, & Fries [18] state that it is necessary for teachers to know the various difficulties that become students’ challenges in learning, find strategies and learning activities so that they can help to overcome students difficulties. This means the importance of the teacher’s role in learning mathematics.

The teacher is a model in learning that is committed to assisting and enhancing student understanding in learning and obtaining individual knowledge and skills by applying appropriate learning methods [19]. This statement is supported by Murphy [20] who states that the methods used by teachers in the classroom can have a large impact on the student understanding level. The teacher tries hard to apply a new method or approach in teaching the subject so that the students obtain good results [21]. One of the learning approaches is the Reflective Pedagogical Paradigm approach.

The reflective pedagogical paradigm approach is a learning approach that is implemented by teachers to assist students’ learning development so that they become smart and good individuals [22]. The learning development was also supported by the role of the reflective pedagogical paradigm that could increase the enthusiasm of students in mathematics learning [23]. In line with this statement, Pratini [24] stated that the reflective pedagogical paradigm improved the aspects of students' competence, conscience, and compassion. This statement is supported by Guthrie [25] who stated that the application of reflective pedagogical paradigm created meaningful learning. The meaningful learning achievement included increasing students' critical attitudes, having a high enthusiasm for learning, and caring for the others in learning [26–28]. These statements state that the reflective pedagogical paradigm application has a good impact on mathematics learning. Therefore, this research aims to describe the trends of the application of the reflective pedagogical paradigm approach in
mathematics learning in Indonesia based on the previous studies’ results. The research results are expected to provide recommendations for future research and learning so that mathematics learning becomes better and more effective.

2. Method

This research was a literature review research. The data source in this research was an electronic database of research results that specifically addresses issues in mathematics education in Indonesia. This research was limited to the publication of research results between 2014 and 2019 for all types of researches with research subjects at the elementary school to higher education. Data was collected through open-access websites, which include ERIC, Google Scholar, JSTOR, and Springer with the keywords Reflective Pedagogical Paradigm in Mathematics, Reflective Pedagogy, and Ignition Pedagogy.

Based on the exploration results of research trends regarding the reflective pedagogical paradigm application in mathematics learning in Indonesia, 33 articles had been published. These results were obtained through a search using predetermined keywords and 15 articles do not fit the context of mathematics learning. The following are the screening results of research trends in the reflective pedagogical paradigm in mathematics learning in Indonesia, presented in Figure 1.

Figure 1 shows that there were a number of articles that were appropriate and did not fit the context in this research. The appropriateness criteria of the exploration results of the reflective pedagogical paradigm application trends in mathematics learning in Indonesia were shown in Table 1.

| Criteria                  | Relevant to the Study                                                                 | Irrelevant to the Study                                                                 |
|---------------------------|----------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------|
| Contexts                  | Mathematics Learning Contexts                                                           | Other than Mathematics Learning Contexts such as Pharmacy, Science, Religious, and Management Study |
| Reflective Pedagogical Paradigm Syntaxes | Using reflective pedagogical paradigm syntaxes namely contexts, experiences, reflection, action, and evaluation [22,29] | Did not use reflective pedagogical paradigm syntaxes but implementing specifically only about reflective and pedagogical contents |
3. Results and Discussion

The reflective pedagogical paradigm application in mathematics learning in Indonesia is a learning application that can be categorized as new. It can be seen from Figure 1 that shows the research trends that have not been widely published in Indonesia. Nevertheless, Table 1 shows that the research trends on the reflective pedagogical paradigm in Indonesia since 2014 until 2019 are not only implemented in mathematics learning but are also implemented in other disciplines. Based on the data reduction results from 18 articles by following the reflective pedagogical paradigm application in mathematics learning, it would be described about research methodologies trends, the students’ learning impacts, and the relationship between Indonesian curriculum and the reflective pedagogical paradigm application in 21st century learning.

3.1 Research methodologies trends

The research of the reflective pedagogical paradigm application in mathematics learning in Indonesia had varied methodologies. Figure 2 shows that explained the percentage of research methodologies trends showed it.

![Figure 2. Percentage of research methodologies trends.](image)

Based on Figure 2, the most frequently implemented research methodology in the reflective pedagogical paradigm application in mathematics learning in Indonesia was qualitative research. The research focused on several aspects namely describing learning process using reflective pedagogical paradigm [30-32], students’ reflection [33,34], and the learning models characteristics that were appropriate to the reflective pedagogical paradigm application in mathematics learning [27,35]. To reach the results, researches collected the data by students’ contexts documentation, questionnaire, interview [27,31-33,35], and students’ reflection sheet [30,34].

Figure 2 also stated that there were three research methodologies that had the same percentage below qualitative research namely quasi-experimental, quantitative descriptive, and mix method research. The quasi-experimental research focused on examining the effectiveness of reflective pedagogical paradigm in mathematics learning. The research results stated that the reflective pedagogical paradigm applications in mathematics learning were effective to improve students’ reasoning [36], students’ character [37], students’ understanding and interest [38]. The quantitative descriptive research focused on describing how the implementation of reflective pedagogical paradigm in mathematics learning could improve students’ competence, conscience, compassion and enthusiasm [24,39]. The mix method provided the different focus that included improving students’ critical stance and care for each other [26], describing how students (prospective teacher) should prepare for teaching process [41], and describing students’ responsibility in mathematics learning [42].

The implementation of reflective pedagogical paradigm in mathematics learning in Indonesia had been implemented for several level of education. It was started from primary school students to higher education students. The research subjects’ majority of reflective pedagogical paradigm application in mathematics learning in Indonesia was higher education students. The percentage of research subjects
based on research methodologies trends in reflective pedagogical paradigm application in mathematics learning in Indonesia were shown in Figure 3.

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**Figure 3.** Percentage of research subjects.

### 3.2 Students' learning impacts

The reflective pedagogical paradigm application in higher education focuses on the student’s preparation in the future, especially to become a mathematics teacher. This statement is supported by Pratini [24] who states that students have the abilities that are needed as prospective teachers such as the ability to manage learning, confidence in teaching material to others, and being able to respond well to other people's questions. It happens because students have high enthusiasm for developing teaching skills by implementing an Exelsa Moodle-based on reflective pedagogical paradigm (Learning Website) [28]. In addition, the application of the Reciprocal Teaching Strategy helps students increase their responsibilities in learning and high awareness in completing the given tasks and explore knowledge more independently [42].

Related to learning achievement, learning that uses the reflective pedagogical paradigm can improve critical attitude [26,27], mathematical reasoning abilities [36], and students' concern for one another [26,28,30,34]. One of the factors that cause some of these conditions occurs because students are more enthusiastic about learning [23,27]. On the other hand, Julie [41] found the different results related to the students’ achievement in learning participating with the reflective pedagogical paradigm, as many as 27 students did not finish writing concepts that had been studied and did not describe the relationship between concepts correctly and as many as 29 students got grades below 7. Furthermore it was conveyed that the problem of the students lies in the horizontal and vertical mathematics processes, namely the difficulty in making mathematical models of the given real problems (horizontal mathematics) and the difficulty in implementing mathematical concepts to solve the problems that have been given (vertical mathematics).

Teachers need to know the students’ characteristics and context before learning. Julie [31] mentioned that teachers can explore information about students' contexts through academic information systems and provide questionnaires related to student contexts at the beginning of learning. The contexts of these learners such as student origin, Academic Achievement Index obtained by documenting student SIA's, and students' initial abilities related to learning material [32]. This statement is supported by Apriani [35] which states that the context of students helps teachers in choosing learning strategies which include 1) can be implemented for students who have heterogeneous skills; 2) can make students more active and cooperative; 3) creating learning that challenges knowledge, behaviour, and competence in solving problems; 4) facilitate students' problem-solving abilities, communication, cooperation, and interpersonal skills; 5) able to help students construct their knowledge.

The implementation of reflective pedagogical paradigm in mathematics learning in primary and secondary schools in Indonesia focuses on learning process. This pedagogical practice provides a mechanism for teachers to help students overcome misconceptions and make students develop critical
thinking skills. The most essential thing in this learning is that students become more active in doing the mathematical process [43]. In line with this opinion, Putri, Nugraheni, and Pratini [33] stated that the reflective pedagogical paradigm can foster feelings of pleasure, encourage interest in learning, make students focus on learning, and make students more active in participating in learning. This statement is in accordance with the research results by Iswari, Muhtar, and Akip [44] which stated that students' cognitive competencies and cognitive abilities increase with learning based on reflective pedagogical paradigms in the learning of thematic mathematics and social science. These conditions are supported by the effectiveness in developing pedagogical reflection using reflective learning and the application of technology that enable teachers to be at their professional level, learn the basics of pedagogical reflection, and apply them in learning [45].

3.3 The relationship between Indonesian curriculum and the reflective pedagogical paradigm application in 21st century learning

The competencies have been formulated in a curriculum implemented in Indonesia, namely the 2013 Curriculum with graduates’ competency standards covering 3 dimensions, namely attitudes, knowledge, and skills [46]. In more detail it is formulated that the 2013 curriculum implementation aims to accommodate Indonesian people to develop the ability to live as individuals and citizens who are faithful, productive, creative, innovative, and effective and able to contribute to the life of society, nation, state and world civilization [47,48].

The facts found were that teachers had difficulty applying assessment to the 2013 curriculum which included 1) developing attitude instruments; 2) applying authentic judgment; 3) formulating indicators; 4) making assessment rubrics for aspects of skills; and 5) collecting the value of the results of the evaluation of learning [49]. In addition, the 2013 curriculum has not been optimally implemented in the teaching and learning process due to various difficulties including the application and learning content that has not yet developed Higher Order Thinking Skills (HOTS) [50]. This happens because the teacher still cannot classify HOTS as a skill, ability, learning method, or learning strategy [51].

Based on the revised Taxonomy bloom, the cognitive processes included in HOTS include analysis, synthesis, and evaluation [52]. In learning, HOTS cannot be taught to students directly but students must be trained first about HOTS as a skill through student-centered learning activities [51]. In addition, efforts must be made to improve students' HOTS by involving students in solving non-routine problems, facilitating students to train analytical abilities, critical thinking, and creative thinking, and encourage students to build their own knowledge so that learning becomes more meaningful [53]. This needs to be done because HOTS can train critical thinking, creativity, and skepticism as well as train students' problem-solving abilities, logic, reflection, and metacognition of problems faced in the 21st century [51,54,55].

The application of mathematics learning in improving HOTS students can use several student-centered approaches one of which is the reflective pedagogical paradigm approach. Mauri, Figueiredo, & Rashford [56] argue that the reflective pedagogical paradigm approach enables students to reach the highest level in Bloom's Taxonomy. This happens because the reflective pedagogical paradigm approach helps students connect what is already understood about concerning facts, feelings, values, and knowledge to new information and how to develop that knowledge [57]. In addition, the application of reflective pedagogical paradigms also improves critical thinking skills [26,43,58] and creative thinking [24]. In line with this statement, Jailani et al. [59] argue that the dimensions of cognitive processes in HOTS such as "analyzing" and "synthesizing" are part of the aspects of critical thinking and "creating" is part of the aspects of creative thinking. Therefore, it can be concluded that the reflective pedagogical paradigms application in mathematics learning can improve students' HOTS.
4. Conclusion
Research trends regarding the reflective pedagogical paradigm application in mathematics learning in Indonesia are still relatively a bit. This is indicated by the results of exploration article publications for the last 10 years that have not been encountered. However, some published articles already have several research variations such as qualitative, quasi-experimental, quantitative-descriptive, mix method, development, and action research.

The articles that have been traced are then analyzed by performing data reduction to find relevant themes. The research trends regarding the reflective pedagogical paradigm application in mathematics learning in Indonesia after going through the process of data reduction besides research methodologies trends are divided into two things, namely the students’ learning impacts and the relationship between Indonesian curriculum and the reflective pedagogical paradigm application in mathematics learning in 21st learning century. The impacts of the reflective pedagogical paradigm application in mathematics learning occur more for higher education students such as preparing the student’s readiness in becoming agents of change in the future. Students are equipped with the ability to be applied in the world of work.

Different conditions are found in the impacts of the reflective pedagogical paradigm application for primary and secondary schools students. The reflective pedagogical paradigm is implemented to help overcome the student’s difficulties in learning. Therefore, the reflective pedagogical paradigm in mathematics learning in Indonesia currently mostly focuses on the learning process. This process is carried out to obtain an evaluation of experiences that have been obtained previously to overcome student difficulties. The hope is that students will have good learning outcomes.

On the other conditions, several research results state that the application of the reflective pedagogical paradigm has been able to increase students’ HOTS. This ability is very important for students because it is part of the skills that is needed in the 21st century, namely creativity, critical thinking, communication, and collaboration [6].

Based on these results, the researches recommend that the implementation of the reflective pedagogical paradigm application in mathematics learning in Indonesian combine the technology integration and other learning methods in the learning process. That implementation should also be run in primary and secondary schools so that we will know more impacts of the reflective pedagogical paradigm in mathematics learning in Indonesia. In addition, there is a need for further investigation about teachers' understanding of the abilities that have to be had in the 21st century so that the teachers can create learning that is more meaningful.

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