

Research Article

Development of mathematics learning media for lessons related to pyramids using reflective pedagogy paradigm

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ABSTRACT

At schools, many teachers generally applied a conventional way of teaching mathematics. Students were only required to achieve cognitive learning success. This study aimed to develop mathematics learning media for lessons related to pyramids using the Reflective Pedagogical Paradigm (RPP) and Van Hiele theory, including the development steps and student and teacher responses to the learning process. The researchers used the research and development procedures by Borg and Gall that include (1) Preliminary studies; (2) Planning Research; (3) Design Development; (4) Limited Trial; (5) Revision of Limited Field Test Results. The learning tools developed were syllabus, lesson plans, modules, worksheets, formative tests, and attitude assessments. The data collection techniques used were observation, distributing questionnaires, interviews, and tests. Based on the validation results, the learning media got 4.19, thus categorized as "good," and students' response to the learning process reached 128.23, thus categorized as "good" as well. Students and teachers carried out learning happily and actively.

Keywords: Learning media; Reflective pedagogy paradigm; Van Hiele theory; Pyramid

1. INTRODUCTION

Mathematics teachers usually conduct their teaching process conventionally, namely through lectures and discussions; (Oyebanji & Idiong, 2021; Rahmatina & Zaid, 2019; Rind & Mughal, 2020; Winarso, 2018). They only focus on the concepts they prepared without involving students to be active in the learning process, making learning seem monotonous, and students only focus on completing their cognitive values without developing their characters and soft skills during the learning process in class (Akmalia et al., 2021; Joseph, 2020; Nazirah et al., 2021; NWOKE, 2021; Setiawaty et al., 2018; Sholli et al., 2020; Zaiyar et al., 2020). Observations in schools found that students are not accustomed to reflecting on the learning process because their teachers rarely train them to reflect on the learning experiences. Besides, geometry is a difficult subject for them (Adnan et al., 2019; Fonna & Mursalin, 2019; Hodiyanto & Santoso, 2020; Jehadan et al., 2020; Kartika et al., 2020; Patsiomitou, 2019; Primasatya & Jatmiko, 2018; Puspitasari et al., 2019; Saputra & Fahrizal, 2019; Wahidah et al., 2020; Yani & Rosma, 2020). They do not understand the characteristics of polyhedrons, feel confused when looking for the difference between cubes and blocks, and find it difficult to distinguish prisms and pyramids and the relationship between the polyhedrons. This phenomenon occurs because, in geometry lessons, many teachers only focus on explaining the characteristics or parts of polyhedrons and providing formulas without connecting the material with students' daily lives contextually. Students tend to memorize formulas when working on geometry problems. They do not understand how to prove the formulas. As a result, they find it difficult to solve problems more applicable (Akmalia et al., 2021; Chanafi et al., 2020; Mengistie, 2020; Mulyono et al., 2019; Nazirah et al., 2021; Prihatin et al., 2022; Puspitasari et al., 2019; Ruslimin et al., 2019; Sirait et al., 2020).

Such a phenomenon shows the need for a balance between students' cognitive values and soft skills and a method to make it easier for teachers to deliver geometry lessons. The Reflective Pedagogical Paradigm (RPP), which comprises five elements, namely context (teaching materials and student backgrounds), experience, reflection, action, and evaluation, can fulfill these needs. This paradigm refers to student success in 3 aspects, namely Competence, Conscience, and Compassion (3C). This shows that the development of students' conscience in making decisions and their compassionate attitude towards their friends and environment are also learning objectives other than cognitive values. On the other hand, the application of lesson plans in the classroom is expected to help students reflect on the learning experiences provided by their teachers and take concrete actions at the end of the learning process.

In addition to applying the Reflective Pedagogical Paradigm (RPP), this research also used the Van Hiele learning phase, by which the teachers can find out the stages of students' geometric thinking. The Van Hiele learning phase is considered suitable for geometry lessons. According to Van Hiele's theory, a person will go through five stages of thinking development in learning geometry (Crowley in Nur'aeni, 2008: 126). The five stages of Van Hiele's thinking development are 0

(visualization), stage 1 (analysis), stage 2 (informal deduction), stage 3 (deduction), and stage 4 (rigor). This confirms that each student has different stages of thinking in geometry. Crowley, in Nur'aeni (2008: 126), stated that the Van Hiele learning phase includes information, guided orientation, explicitation, free orientation, and integration. It makes it easier for teachers to design and implement the geometry learning process with clear stages and for students to understand the learning process, not just memorize formulas. The media of learning polyhedron that would be developed in this research were related to pyramids.

The application of the reflective pedagogical paradigm was also tested in economics learning to increase competence, conscience, and compassion for students of grade X-5 at SMA Kolese De Britto, Yogyakarta, by Nurul Kurnianingsih. She found that conscience values increased by 21.52% from the pretest score and 12.1% from the posttest score; conscience average score increased from 3.48 to 3.94 (before and after implementing RPP, respectively); and compassion values increased from 4.11 to 4.32 (before and after implementing RPP, respectively). The data showed that after applying PPR during learning, the students' 3C aspects increased. Another relevant research was conducted by Zahra Chairani (2013) on the implementation of Van Hiele's theory in geometry learning. Children's thinking stages in geometry are facilitated by applying the Van Hiele learning phase. The above results were found in the study. The problems in our study are 1) How is the quality of the mathematics learning media for lessons related to pyramids using RPP that accommodates the Van Hiele learning phase? and 2) What are the responses of teachers and students regarding learning lessons related to pyramids using the mathematics learning media that apply RPP and accommodate the Van Hiele learning phase? Meanwhile, the objectives to be achieved through this research are 1) to determine the quality of the mathematics learning media for lessons related to pyramids using RPP that accommodates the Van Hiele learning phase and 2) to describe the responses of teachers and students regarding learning lessons related to pyramids using the mathematics learning media that apply RPP and accommodate the Van Hiele learning phase.

Development, according to Sugiyono (2011: 407), is the steps for implementing research and development strategies carried out to produce a particular product and to test its effectiveness. Sukmadinata (2008: 164) explained that research and development (R & D) is a strategy or research method that is powerful enough to improve practice. Research and development is a process or steps to develop a new product or improve an existing product, which can be accounted for. In addition, according to Borg and Gall (1991: 772), a strategy used to improve the quality of education is called research-based development. Some objectives of R&D are to develop and validate educational tools and acquire new knowledge or to answer specific questions related to practical problems. Learning media that apply RPP by accommodating the Van Hiele learning phase were the products developed in this research. Learning media are those used in the learning process and needed to assist the teaching and learning process. They include syllabus, lesson plans, student worksheets, evaluation instruments or formative tests, learning media, and student textbooks (Trianto, 2011: 201). Learning integrates learning a particular subject with the development of human values. Learning a subject must be developed according to the context of students. Meanwhile, the development of human values is carried out in the stages of experience, reflection, and action. This learning process ends with an evaluation. The learning pattern is the PPR-patterned learning, according to the Kanisius Publishing Team (Kanisius Publishing Team, 2008), while the Van Hiele learning phase introduces geometry from the simplest to the complex levels. This study used the Van Hiele learning phase, which includes five stages, namely information, directed/integrated orientation, explicitation, free orientation, and integration.

2. RESEARCH METHOD

This study was categorized as research and development. The researchers preferred the concept suggested by Borg and Gall. In practice, this research was limited to a limited trial to determine the quality of the learning media developed and the achievement of the learning process designed following the contents of the lesson plans, which would later be tested on a wider target.

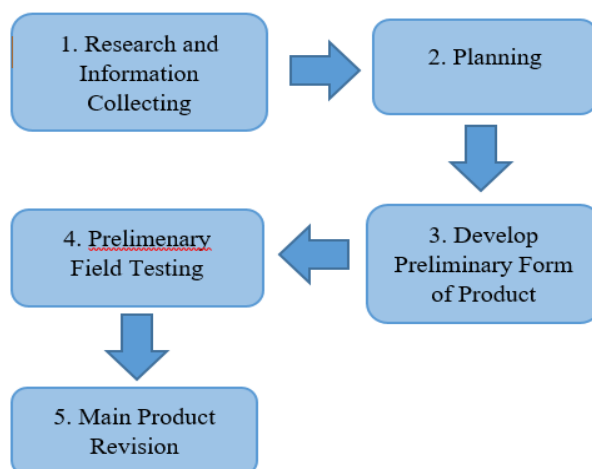


Figure 1. Learning Media Development Design Model

Grade VIII students of one of the public junior high schools in Yogyakarta were the subjects of this study. The entire learning media developed by the researchers became the research object. The research was carried out for 3-4 months. The development stage began with the research and information collecting stage through classroom observations and interviews with teachers about the condition of students and the learning model carried out by the teachers as an analysis of needs. Following up on information obtained, the researchers looked for research and reviewed journals that matched the school's conditions. The second stage included formulating research objectives, compiling the research schedule, and designing products. The third stage was developing the products designed, namely syllabus, modules, lesson plans, worksheets, and formative tests, including written tests and assessments of conscience and compassion. The learning media were developed to accommodate RPP and Van Hiele's theory. The design development process then underwent experts' validation, the results of which were then revised so that they deserved to be tested limitedly.

The fourth stage was a preliminary field testing. The revised learning media would be piloted limitedly. The trial was carried out to ensure that the products developed were suitable for use to facilitate learning activities, even though on a limited scale. The fifth stage was main product revision. The researchers revised back after the trial. Revisions were made based on criticism and suggestions from students and mathematics teachers of grade VIII of a state junior high school in Yogyakarta on the trial when they found shortcomings in the learning media. The data were collected through observation, interviews, questionnaires, and formative tests. The research instruments, based on the data collection techniques used, comprised observation sheets, interview guidelines, questionnaires, and formative test sheets. Data analysis techniques were divided into quantitative and qualitative data analyses. The former was used to analyze observation and interview data, while the latter was employed to analyze the results of expert validation, formative test score data, and questionnaire data.

3. RESULTS AND DISCUSSION

Results

Description of Learning Device Development Stage

Development of learning media for lessons related to pyramid using reflective pedagogy paradigm with the following details:

1. Description of the defining stage

This section describes the initial stages of the development procedure, where researchers found several problems in the learning process in the field, such as that the learning model was still conventional: teacher-centered learning. The lack of teaching aids for students was also an obstacle during the learning process. Teaching aids were only used by the teachers while the students were asked to pay attention. The results of interviews with teachers implied that the learning process had been adjusted to the levels of the students' understanding and needs. When viewed from the material being taught, students did not have specific constraints on the characteristics of polyhedrons. Students still had difficulty painting a pyramid and distinguishing its height from the height of its upright side. For the whole polyhedron material, students found difficulty in understanding the relationship between polyhedrons. The teachers had assessed the knowledge, skills, and attitudes of each student. However, the teachers could do the assessment optimally in assessing skills and attitudes since they experienced confusion when making rubrics and grading scales.

2. Description of the developing stage

Based on the research and information collecting, there were several potentials for students and teachers to develop the mathematics learning process in the classroom: most students were being active, willing to ask questions, and being critical when they find interesting phenomena and, from the teacher's point of view, the teachers wanted to learn to know RPP and understand Van Hiele's theory in detail. They had the willingness to practice the learning media made by the researchers enthusiastically. The researchers also collected data on students' scores and personalities to determine the score range and those who need special help. Thus, students were expected to be able to follow the mathematics learning process by accommodating RPP and Van Hiele's theory well to achieve the 3C values (Competence, Conscience, and Compassion) as learning objectives. The development of learning media was also based on the results of interviews with teachers and notes on observation sheets to strengthen the results of observations in the field. This part was critical to determine the learning media to be developed. The next stage was to design a research plan to facilitate the manufacture and development of the required learning media. The development included the syllabus, lesson plans, student worksheets, modules, and assessments that include competence scores obtained from formative tests and rubric for assessing conscience and compassion.

Description of the Validity Learning Media & Test Results

The next stage was validating the learning media by experts who had experience in their fields. It aimed to determine the suitability of the learning media designed with the indicators to be achieved. In this study, validation was carried out by 1 (one) lecturer and 1 (one) mathematics teacher who taught lessons related to pyramids. The results of the validation showed an average score of 4.19, indicating that the developed media was categorized as "good." The results of the validation are as follows.

Table 1. Learning Media Validation Results

No.	Learning Media	Average score	Category
1.	Syllabus	4.06	Good
2.	Lesson plan	4.23	Excellent
3.	Worksheet 1	3.93	Good
4.	Worksheet 2	4.23	Excellent
5.	Modules	4.4	Excellent
6.	Formative Test	4.08	Good
7.	Conscience assessment	4.31	Excellent
8.	Compassion assessment	4.25	Excellent
Total average		4.19	

The next stage was doing a limited trial. This stage was carried out 4 times, namely 2 (two) times in the classroom, 1-time formative test of limas, and 1-time remedial test. Learning was carried out with a time allocation of 5 lesson hours, while formative and remedial tests needed 90 minutes. In this limited trial, the learning process was carried out by the teacher as usual. The trial process was supported by the following facilities: PowerPoint, pyramid learning videos, LCD, and teaching aids in the form of small pyramids to help identify the characteristics of pyramids and make pyramid nets to determine the surface area of the pyramid. In addition, the teacher also prepared several small pyramids and cubes to determine the volume of the pyramid. In the second meeting of the limited trial, an evaluation of the first meeting was held. Students evaluated their first learning by doing a formative test that included the whole material they had got before. The following are the results of the students' learning evaluation, which included competence, conscience, and compassion. Based on the formative test, 13 (37.14%) of 35 students did not achieve MMC, while the remaining others (62.8%) did.

Description of the evaluation on conscience and compassion

The results of the student evaluation on conscience and compassion can be seen in **Table 2**.

Table 2. Conscience Assessment Results

Self-confidence			Hard Work		
Assessments	Number of Students	Percentages	Assessment	Number of Students	Percentage
KB	-	0.00 %	KB	-	0.00 %
C	5	14.2%	C	5	14.29 %
B	30	85.7%	B	30	85.71 %

Accuracy			Precision		
Assessment	Number of Students	Percentages	Assessment	Number of Students	Percentage
KB	4	11.43 %	KB	-	0.00 %
C	9	25.71%	C	7	20.00%
B	22	62.86%	B	28	80.00 %

Table 2 shows that the conscience scores for self-confidence and hard work are in the "good" category with a percentage of 85.71%, while students' accuracy is classified as good with a percentage of 80.00%. For students' accuracy, only 62.86% are included in the "good" category, showing that students' accuracy, especially when working on FORMATIVE TESTS, still needs to be developed. For compassion, data were obtained as presented in the **table 3**.

Table 3. Compassion Assessment Results

Able to work together			Care		
Assessment	Number of Students	Percentage	Assessment	Number of Students	Percentages
KB	-	0.00 %	KB	-	0.00 %
C	3	8.57 %	C	1	2.86 %
B	32	91.43 %	B	34	97.14 %

Table 3 shows that the compassion score, which includes being able to work together and care, is classified as good with a percentage > 90.00%. Students also filled out the questionnaire about the response to the designed learning process after evaluating the 3C learning (See **Table 4**).

Table 4. Questionnaire Results about Student Responses

Scores	Category	Number of students
138 – 162	Excellent	8
113 – 137	Good	26
88 – 112	Neutral	1
63 – 87	Poor	-
38 – 62	Very bad	-

Based on the observation data made by the observers, the implementation of the pyramid learning process by accommodating RPP and the Van Hiele learning phase was classified as "very good" because the first and the second meeting got 4.55 and 4.83, respectively. The results indicated that the teachers had succeeded in practicing the pyramid learning activities according to the lesson plan well.

Discussion

The discussion of the results of research and development of this learning media sought to answer the problem formulations posed earlier. The first problem formulation was "How is the quality of the pyramid-topic mathematics learning media using PPR that accommodates the Van Hiele learning phase?" The learning media designed by the researchers had been validated by 2 (two) experts to determine their quality. The validation included both quantitative data and qualitative data. The former showed an average value of 4.19 with the "good" category, bringing the media to be feasible to be tested on a limited basis. Qualitatively, the data were in the form of criticism and suggestions from the experts. The revisions made were improvements to the typing of worksheets and modules that experienced typos, changing sentences to be effective, and highlighting the suitability of pyramid images and other spatial shapes.

The second problem formulation was "How are the responses of teachers and students regarding the pyramid learning process using mathematics learning media that apply RPP and accommodate the Van Hiele learning phase?" Students were enthusiastic and happy to follow the pyramid learning process. Students were excited during the discussion and found the formula for the volume of a pyramid after they were facilitated with props. Social attitudes between students were seen during learning, as shown by them helping each other when there was a student who could not understand the teacher's explanation well. Students filled out a questionnaire about their response to learning seriously and honestly. Based on the data processing of the questionnaires filled out by students, the average score was 128.23, thus included in the "good" scale. This shows that students had good responses and had an interest in participating in pyramid learning well. From the teacher's point of view, the researchers assessed that the teachers had carried out the learning well, following the lesson plans and the designed learning media. Based on the results of the interview, the teachers felt that they had succeeded in implementing learning that accommodated RPP and Van Hiele's theory. They carried out teaching happily and naturally without feeling burdened.

4. CONCLUSION

Based on the research that has been done, it can be concluded that the researchers have developed learning media that applies PPR and accommodates the Van Hiele learning phase in studying lessons related to pyramids with the following development procedures: a) Research and information collecting through observation and interviews; b) Planning Research, by designing research schedules and determining research subjects; c) Design Development (Developing the Preliminary Product) of pyramid learning media including syllabus, lesson plans, worksheets, modules, and competence assessment in the form of formative tests and rubrics for assessing conscience and compassion. The validation process of the learning media was carried out by experts to determine whether they are feasible to be tested on a limited basis; d) Preliminary Field Testing, the learning media were tested on a limited basis in grade VIII E of the State Junior High School 1 of Yogyakarta, with the aim of proving if the learning media designed were suitable for use in the learning process; e) The Main Product Revision, where the results of the limited trial were revised by improving the learning media based on the criticisms and suggestions of the users (in this case the teachers). The quality of the learning media for studying pyramids got a value of 4.19, with the "good" category, based on the expert validation results. The percentage of students' completeness reached 62.86%. The responses of students and teachers to the learning process are that a) Students were happy and enthusiastic about participating in the learning process, based on the results of the student response questionnaire which reached 128.38, in the "good" category; b) Teachers felt successful and facilitated in teaching with these learning media. Teachers were happy to gain new knowledge about the application of RPP and Van Hiele's theory.

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AUTHOR'S CONTRIBUTIONS

The author discussed the results and contributed to from the start to final manuscript.

CONFLICT OF INTEREST

There are no conflicts of interest declared by the author.

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