



## VAN HIELE-BASED LEARNING TO ACCELERATE PUPIL S' UNDERSTANDING OF QUADRILATERAL

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### Abstrak

Menurut National Council of Teachers of Mathematics (NTCM), siswa harus memiliki kemampuan geometri. Akan tetapi, kemampuan siswa dalam memahami geometri masih terlalu rendah, yang menyebabkan pemahaman konsep dan keterampilan. Kemampuan geometri siswa dalam pemecahan masalah masih sangat lemah, dan geometri kurang diajarkan kepada siswa yang memiliki kemampuan. Menurut Van Hiele, pembelajaran geometri memiliki tiga unsur utama yaitu waktu, materi, dan metode pengajaran. Penelitian ini bertujuan untuk mendeskripsikan pengembangan perangkat pembelajaran berdasarkan teori Van Hiele yang dapat mempercepat pemahaman siswa terhadap materi geometri. Penelitian ini merupakan penelitian pengembangan. Perangkat pembelajaran yang dikembangkan, RPP dan buku siswa dibuat dengan menggunakan model ADDIE. Subjek dalam penelitian ini adalah siswa kelas VII UPT SMP Negeri 11 Gresik. Teknik pengumpulan data menggunakan catatan lapangan, angket, dan tes pemahaman geometri. Kualitas hasil pengembangan perangkat pembelajaran harus memenuhi tiga kriteria yaitu kevalidan, kepraktisan, dan serta keefektifan. Berdasarkan hasil analisis data, dapat disimpulkan bahwa: 1. valid (rata-rata total validitas RPP sebesar 4,17 dan rata-rata total validitas buku siswa sebesar 4,29); 2. praktis (nilai rata-rata A (dapat digunakan tanpa revisi) untuk aspek teori, dan rata-rata persentase tanda respon siswa yaitu 90,6% (sangat positif) untuk aspek praktik; 3. efektif (persentase ketuntasan keseluruhan siswa sebesar 92,59%). Perangkat pembelajaran berbasis teori Van Hiele yang dikembangkan dapat mempercepat pemahaman siswa pada materi geometri dan memenuhi kriteria valid, praktis, dan efektif.

**Kata kunci:** Buku siswa; Geometri; Perangkat pembelajaran; Van Hiele

### Abstract

According to the National Council of Teachers of Mathematics (NTCM), students must own geometry capabilities. However, the ability of students to understand geometry is still too low, which causes understanding concepts and skills. Students geometry ability in breakdown problems are still very weak, and geometry is taught less to students with abilities. According to Van Hiele, learning geometry has three main elements: time, materials, and teaching methods. This study aims to describe the development of learning devices based on Van Hiele's theory that can accelerate students' understanding of geometry material. This research is a development research. The learning tools developed, lesson plans, and student books were created using the ADDIE model. Subject in study this is student class VII of UPT SMP Negeri 11 Gresik. Data collection techniques use notes field, questionnaire, and test



understanding geometry. Quality results development device learning must fulfill three criteria that are validity, practicality, and effectiveness. Based on the results of data analysis, it can be concluded that: 1. valid (average total validity of RPP is 4.17 and average total validity of book student by 4.29); 2. practical (average value A ( can used without revision ) for aspect theory, and average percentage mark response student, namely 90.6% (very positive ) for aspect practice ; 3. effective (percentage completeness all over student by 92.59%). The developed Van Hiele theory-based learning device can accelerate students' understanding of geometry material and meet the valid, practical, and effective criteria.

**Keywords:** Students' Book; Geometry; Lesson plan; Van Hiele.

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## INTRODUCTION

The teacher has a decisive role in constructing knowledge and understanding material for students, as has been poured out in the national curriculum. However, the lack of teacher knowledge can cause a slow student to understand the material or the concept that the teacher has delivered. It can result in difficult, serious academics and successful studies (Trisnawati & Riana, 2022). There are many ways that the teacher can help increase the understanding knowledge students through the usage of integrated learning with theory learning certain for the learning process (Verawati et al., 2023) and can help students Study faster with more perspective-wide (Rizos & Foykas , 2023), and increase effectiveness teaching, fun student because own experience learns more good (Kuniasih et al., 2022).

In learning mathematics in schools, one of the subtopics taught is geometry, and even implementation from geometry is already often found in the environment (Sudarsono et al., 2021). During the learning process of mathematics, students need active thinking to develop ideas or new knowledge. Likewise, in learning geometry, students need to do activities to think about and understand geometry concepts. Not all students have the same way of thinking about geometry



concepts because participants' abilities and understanding of draft geometry are also different (Nafiah et al., 2022).

Geometry material is still considered difficult for students to learn mathematics (Pittalis & Drijvers, 2023). Mathematics is a field of science that is still considered difficult for students because it is related to calculation abstracts (Zanabazar et al., 2023). In learning mathematics in school, the goal of learning geometry in general is for students to gain confidence in their mathematical abilities, break good problems, communicate in a way mathematics, and reason mathematically (Hoffer, 2020). Implementation material geometry is often found in the environment (Hidayati & Sugeng, 2021). Many students experience difficulty in learning material geometry. Based on the (Budiarto, 2022) obtained, it is pointed out that 64% know that a rectangle long is a row parallelogram; problem geometry presented visually is more liked than problem geometry presented verbally. Silmi Juman et al., (2022) disclose that students have more difficulties learning geometry, like drawing a diagram for a problem geometry. In addition, the results of experiment teaching show that approach learning based on students is more effective than the conventional method of teaching geometry. Shows that the ability of students to understand geometry is still low.

The low ability of students to understand geometry due to understanding concepts and skills geometry in students in breakdown problems is still very weak. Motivation for students to study mathematics is still shallow because there are not enough teachers to plant the right concepts and strategies in teaching mathematics. Teachers must change the learning process in class by using appropriate models, methods, and strategies to direct students to study independently and understand what is being learned. One root problem is the lack of device learning, like teaching materials, in every learning process. Therefore, an alternative for repair condition learning is to repair device learning. One of the alternatives for repair condition learning is repair device learning.



In addition to developing device learning, it can also develop teaching materials for repair condition learning. Teaching materials are created to teach students to study independently and be more active in learning, and teachers are used as facilitators. Compiled teaching materials based on Van Hiele's theory can help students improve their understanding of the material geometry, particularly quadrilateral. With this, teachers can know how quickly students understand the material. This role from the teacher is very important in the process of understanding geometry in students because treatment given by the teacher in applying models, methods, and approaches to learning tends to be the same for every student, even though students' methods of learning and thinking differently (Al-Roomy, 2023).

Teaching good geometry must be based on the ability of the child. The ability of a child can be seen from the process of thinking and applying skills in breakdown problem geometry. Application Van Hiele's theory is believed to overcome the difficulty students have in breaking down problems in geometry. Van Hiele's theory explains students' development in geometry (Sudarsono et al., 2021; Waziana et al., 2022). According to Van Hiele, there are three ways to learn geometry: time, material teaching, and methods applied (Naufal et al., 2021). If the third element can be passed with good, it can increase the ability of students going to stages to think more highly. Van Hiele's theory consists of 5 stages in understanding geometry, namely (1) stage introduction, (2) stage analysis, (3) stages Sequencing, (4) stages deduction and (5) rigour stage. Phases learning geometry, according to Van Hiele, include namely (1) phase information, (2) phase orientation, (3) phase explanation, (4) phase orientation free and (5) integration phase (Silmi & L, 2022). Through development, device applied learning phases, Van Hiele's learning for material geometry can be taught in a way sorted by level of thinking and will increase students' understanding of geometry.

The purpose of the study is (1) to describe steps in the process of development device learning by applying Van Hiele's theory to practice



understanding student class VII junior high school on the material geometry, (2) to describe the validity results of development device learning mathematics material geometry with apply Van Hiele's theory can practice understanding students, (3) for describe practicality results development device learning mathematics material geometry with apply Van Hiele's theory can practice understanding students, (4) for describe effectiveness results development device learning mathematics material geometry with apply Van Hiele's theory can practice understanding student.

## **METHOD**

This research investigates the development of an instructional product utilizing the ADDIE model, consisting of five sequential stages: analysis, design, development, implementation, and evaluation (Putra et al., 2023; Syafmen & Wati, 2021).

Devices learning developed mathematics in the form of (1) a learning plan (RPP) and (2) books for students for material geometry. Development device learning uses Van Hiele's theory to help speed up understanding material geometry, specifically rectangular. The study was conducted at UPT SMP Negeri 11 Gresik with subject research 1 class. The applied trial was limited to the main discussion geometry in the semester year 2022/2023 academic year.

This study employed a mixed-methods approach for data collection, utilizing the following techniques: (1) field notes, (2) questionnaires, and (3) tests. Data collection instruments included (1) field notes, (2) a validation sheet for lesson plans and student workbooks to assess the validity of the developed learning devices, (3) a questionnaire to gather feedback from students and teachers on the trial implementation of the developed product, and (4) a geometry understanding test to evaluate student learning outcomes.

To ensure quality, the developed learning models and devices must meet three essential criteria: validity, practicality, and effectiveness. Data analysis in this study encompassed several key aspects: (1) analysis of field notes, (2) assessment of the learning devices' validity, including analysis of lesson plans and student



workbooks, (3) evaluation of the learning devices' practicality, considering both theoretical and practical aspects, and (4) assessment of the learning devices' effectiveness, which involved analyzing student test results, categorizing results as complete or incomplete, and determining the percentage of complete results.

Study this is study development with the ADDIE model. The ADDIE development model consists of of five stages, namely (1) analysis stage, (2) design stage, (3) planning stage development, (4) stages implementation, and (5) stages evaluation (Choiroh et al., 2022; Syafmen & Wati, 2021).

Devices learning developed mathematics in the form of (1) learning plan (RPP) and (2) books student for material geometry. Development device learning use Van Hiele's theory for help speed up understanding material geometry specifically rectangular .

Study carried out at UPT SMP Negeri 11 Gresik with subject research 1 class For applied trial limited for main discussion geometry in even semester year 2022/2023 academic year.

## RESULT AND DISCUSSION

### *Development Process Devices Learning with Applying Van Hiele's Theory*

This study employed the ADDIE development model, a systematic approach to instructional design that involves five distinct phases: Analysis of learner needs and existing resources, Design of instructional objectives and strategies, Development of instructional materials, Implementation of the instructional plan, and Evaluation of the effectiveness of the instruction.

Stage Analysis is done to analyze the development device/model/ method, learn new requirements, and define what is needed. Students will study it, including analysis needs and performance. On Analysis The needs analysis carried out by researchers at UPT SMPN 11 Gresik shows that students are still not active enough in learning mathematics and are more enthusiastic about studying with play or using interesting books. After the pandemic covid 19 happened less than one year ago, they underwent learning that is starting to return to normal. Naturally, this is one of



the factors that cause the decline in the spirit of students in learning. Likewise, the understanding of students lacking from the mark end of learning mathematics is still low. In performance analysis, the aim is to know if ongoing problems experienced by students can be solved by using device learning. This researcher analyzes several things, starting from the effectiveness of the learning method and resources used at SMPN 11 Gresik. Based on interviews conducted by researchers with eye teacher lesson mathematics, it is known that student class VII SMPN 11 Gresik is still tending different each his son because of no existence distribution class by level understanding students so that in each his class found lots difference understanding. Students must learn interesting things to increase understanding while minimizing boredom and building return spirit. Participants are educated to learn mathematics.

The on-stage design aims to design device learning in lesson plan (RPP) and the student's book will apply Van Hiele's theory. Design device developed learning namely (1) design lesson plan (RPP), at the stage this is the RPP that was designed customized with activity Van Hiele's theory with implementing five phases learning, namely phase information, phase orientation direct, phase explanation, phase orientation free, and phase integration. Materials used that is material quadrilateral. This lesson plan consists of 3 meetings: (2) Design student's book, at this stage, design book students developed in study customized with apply Van Hiele's theory to increase understanding of mathematics students. Components of the book Student are cover, foreword, table of contents, basic competencies, concept map, material description, questions and conclusion.

On stage development, activity development device learning has been designed at the stage design in the form of a lesson plan (RPP) and student's book. The RPP developed notice steps learning based on Van Hiele's theory. Students' books that are developed contain rectangular material geometry, along with exercise questions and games, which apply phases learning on Van Hiele's theory to increase understanding of mathematics students. Devices learning that has been



finished. Furthermore, the validation process is carried out by validators who are competent in their field and capable of giving directions and suggestions for producing product-good learning. In the validation process, three validators consist of one lecturer in education mathematics, one math teacher at junior high school/MTs equivalent level and one design teacher.

During the Implementation stage of the on stage application, the researcher conducted a trial of the developed learning devices, which included a lesson plan (RPP) and student's book. This trial was implemented with students in class VII-C at UPT SMPN 11 Gresik.

***Validity Devices Geometry Material Learning with Applying Van Hiele's Theory***

The evaluation validity of the validator's lesson plan (RPP) includes several aspects: objective learning, steps learning, time, and language. Result data, the validity of the RPP can be seen based in Table 1 as follows.

**Table 1. Analysis Results Validity of RPP**

Aspect Evaluation	Indicator	Validator			Average
		1	2	3	
Learning objectives	a. Accuracy explanation about objective inherited learning from indicator	4	4	4	4
	b. Using verbs operational that can observed / measured	4	4	4	
Steps Activity Learning	a. Learning with apply Van Hiele's theory and approach <i>scientifically</i> compiled in accordance with indicator	4	5	4	4.49
	b. Steps Learning with apply Van Hiele's theory and approach <i>scientific</i> written complete in RPP	4	5	5	
	c. Steps Learning with apply Van Hiele's theory and approach <i>scientific</i> load the role of teachers and participants educate with clear	4	5	5	
	d. Steps Learning with apply Van Hiele's theory and approach <i>scientific</i> can implemented by teachers	4	5	4	
Time	a. Distribution time at each step stated with clear	4	4	4	4
	b. Compliance time in every step implementation learning	4	4	4	





Language	a. Use rules appropriate Indonesian language with Correct Spelling (EYD )	4	4	4	4.22
	b. Language used simple and easy For understood	4	5	5	
	c. Use Language systematic and consistent	4	4	4	
Average				4,17	

Based on the data analysis validity of the RPP, the average total validity of the RPP is 4.17. Indeed, lesson plans (RPP) were developed by applying Van Hiele's theory to increase students' understanding of mathematics. This can be said as "Very Valid".

Evaluation validity Student's Book by validator include several aspects, namely eligibility content, language and presentation. Result data validity student's book can seen based on Table 2 as follows.

**Table 2. Validity Data Analysis Student's Book**

Aspect Evaluation	Indicator	Validator			Average
		1	2	3	
Content Eligibility	a. Material in the book student in accordance with indicator achievement material	4	4	5	4.33
	b. Material in the book student customized with phases Van Hiele's learning	4	4	4	
	c. There is a number of example questions and answers related material studied	4	5	5	
	d. Practice questions in the book student support understanding participant educate	4	5	4	
Language	a. Book student use appropriate Indonesian language with Correct Spelling (EYD )	4	4	4	4.11
	b. Language used simple and easy For understood	4	5	4	
	c. Terms or symbol mathematics used right and proper	4	4	4	
Presentation	a. cover illustration depicts Contents	4	4	5	4.44
	b. Type and size of font used interesting and not monoton	4	5	5	
	c. Book design and layout student interesting with fusion nice picture and color	4	5	4	



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Average	4,29
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Based on the results of the data analysis validity of the student's book obtained, the average total validity of the book student is 4.29. Indeed, students' books are developed with applied Van Hiele's theory to increase the understanding of mathematics students. This can be said to be "Very Valid."

### ***Practicality Devices Geometry Material Learning with Applying Van Hiele's Theory***

The validator develops and evaluates the practicality of device learning in the form of RPP and student's book. Device learning can be practical if it has stated practical in a way theory worthy using without revision or with A minor revision, and practical in a way practice if the results response student categorized as positive or very positive. If one aspect is not fulfilled, then device learning cannot be stated as practical. The results of the validator's assessment of the practicality of device learning can be seen in Table 3 below.

**Table 3. Practicality Data Devices Learning by Validator**

Devices Learning	Validator	Score/Value	Information
Plan Implementation Learning (RPP)	1	A	Can used without revision
	2	A	Can used without revision
	3	A	Can used without revision
Book Student	1	A	Can used without revision
	2	A	Can used without revision
	3	A	Can used without revision

Practicality device learning based on the aspect of the theory in Table 3 can be known as qualitative evaluation given by the validator, namely in category value A. It means device learning through lesson plans and books that are student-worthy to use without revision. So, the device learning researchers have developed is worthy of being used in the field and can be said practically in a way theory. Next, practical data based on questionnaire responses from students can seen in Table 4 below.



**Table 4. Practicality Data Based on Questionnaire Response Student**

No.	Aspects / Questions	Amount Students who choose					% NRS
		1	2	3	4	Total	
1.	I feel easy understand material rectangular with use Book Student This	3	3	2	3	11	91.7%
2.	Presentation Book Student This interesting	3	3	2	3	11	91.7%
3.	I with easy understand sentence in Book Student This	3	3	2	3	11	91.7%
4.	Various practice questions in Book Student This make I more understand material	3	3	3	3	12	100%
5.	Learning with use Book Student This practice I in find draft rectangular	3	3	2	2	10	83.3%
6.	With use Book Student This I more easy finish problems with the material rectangular	3	3	3	2	11	91.7%
7.	I feel helped during learning with existence book student This	3	2	3	3	11	91.7%
8.	After follow learning this , understanding material I increase	2	3	3	2	10	83.3%
Average							90.6%

Practicality device learning in a way practice seen based on results questionnaire response students by four students class VII C SMPN 11 Gresik against use of student's book. Based on the results of data response students in Table 4, we can see the average as 90.6%. Indeed, device learning is a very positive category. Therefore, student's books can be practical in a way practice.

Based on the results of data analysis on aspects of theories and aspects of practice, it can concluded that device learning in the form of RPP and Books Students apply Van Hiele's theory to increase their understanding of mathematics student can be said: " Practical ”.

***Practicality Devices Geometry Material Learning with Applying Van Hiele's Theory***

Evaluation effectiveness device learning in the form of RPP and student's book developed by researchers seen based on results test understanding carried out by students Class VII C SMPN 11 Gresik consisting of 27 students at the end meeting fourth after implementation device learning with apply activity Van Hiele's theory. Test results from student class VII C can seen in Table 5 below.



**Table 5. Test Result Data Student**

No.	Name	Question Score to-i					Final Score	Information
		1	2	3	4	5		
1.	AAP	7	0	0	0	20	27	NOT COMPLETE
2.	AC	20	20	20	18	20	98	COMPLETE
3.	ADD	20	20	20	18	20	98	COMPLETE
4.	ADD	20	20	18	20	20	98	COMPLETE
5.	AFF	16	20	18	19	20	93	COMPLETE
6.	AFZA	19	20	17	18	20	94	COMPLETE
7.	AHF	7	15	20	18	20	80	COMPLETE
8.	ANF	20	20	20	18	20	98	COMPLETE
9.	ANL	17	20	20	18	20	95	COMPLETE
10.	ASF	16	15	20	18	20	89	COMPLETE
11.	DAY	20	20	20	18	20	98	COMPLETE
12.	DSH	18	20	20	18	20	96	COMPLETE
13.	DSR	18	20	20	18	0	76	COMPLETE
14.	HK	20	20	20	18	20	98	COMPLETE
15.	IFS	17	20	18	18	20	93	COMPLETE
16.	KS	20	20	20	18	20	98	COMPLETE
17.	MAF	20	20	18	18	20	96	COMPLETE
18.	MAPN	16	20	20	18	19	93	COMPLETE
19.	MFAS	0	20	20	18	0	58	NOT COMPLETE
20.	MNAAH	18	20	20	18	20	96	COMPLETE
21.	MRA	16	20	20	20	20	96	COMPLETE
22.	MVDN	16	10	20	18	20	84	COMPLETE
23.	MY	20	20	20	19	20	99	COMPLETE
24.	NAA	18	20	20	18	20	96	COMPLETE
25.	NL	18	20	20	18	20	96	COMPLETE
26.	NRA	16	17	20	18	20	91	COMPLETE
27.	UAF	20	20	20	20	20	100	COMPLETE

Effectiveness student's book with applied activity Van Hiele's theory with five phases learning For practice understanding geometry, students can know based on the data test results. Understanding student class VII C SMPN 11 Gresik is shown in Table 5. The data shows that 25 students received “ Complete ” results, and two got “Not Complete ” results. Thus, it is said that students who have completed Far More Lots than participants who have not completed it. Here, the analysis percentage results for the student's overall test were served. Percentage Completion is 92.59%. From the results percentage, It can be known that the percentage completeness results test from overall students is 92.59% and can stated in the category finished because of exceeding the minimum percentage limit



completeness. It can be concluded that device learning can apply Van Hiele's theory to increase student understanding. It is said, “ Effective ”.

**Revision Product**


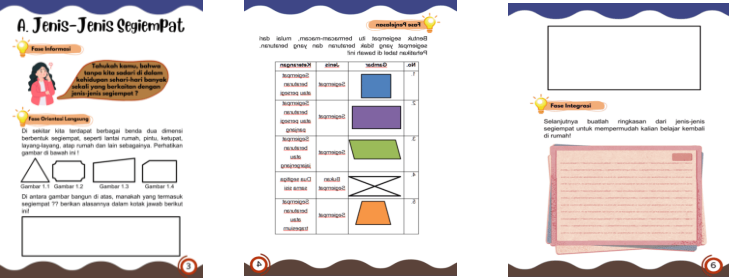

At the stage of development of device learning in the study, several inputs and suggestions for improvement to device learning have been developed. Then, the researcher revised device learning so that device learning can be applied to learning mathematics. The revisions of device learning are presented in Table 6 and Table 7.

**Table 6. List of RPP Revisions**


No.	RPP Section	Revision
1	Learning materials	<b>Before Revision :</b> _Not loading facts , concepts , principles and procedures . <b>After Revision :</b> _Learning materials Already load facts , concepts , principles and procedures
2	Learning Steps	<b>Before Revision :</b> _There are steps learning that is not in accordance with steps approach scientific at the meeting second and meeting third <b>After Revision :</b> _Delete step learning “ listening ” point in core activities of friendship second and third
3	Evaluation	<b>Before Revision :</b> Indicators evaluation covering attitudes , knowledge and skills <b>After Revision :</b> Delete evaluation attitudes and skills because in this RPP more focused For assessor understanding material participant educate and replace criteria evaluation
4	Assessment Attachment Test Written	<b>Before Revision :</b> Contains only three fruit unanswered questions covers all material rectangular . <b>After Revision :</b> Added four question so that the test instrument written complete in accordance with indicator achievement competence every the material includes : types quadrilateral , properties quadrilateral , circumference rectangle and area rectangular .
5	RPP attachments	<b>Before Revision :</b> RPP attachments include : attachments evaluation attitude , attachment evaluation skills , attachments evaluation knowledge, and guidelines scoring . <b>After Revision :</b> Delete attachment evaluation attitudes and skills and replace attachment of assessment instrument and rubik instrument evaluation



**Table 7. Revision List Textbook**

No	Part Book Student	Revision
1.	Type of Material-Type Rectangular	<p><b>Before Revision</b>                      No There is information phases learning VanHiele</p>  <p><b>After Revision</b>                      Adding descriptions of learning phases Van Hiele, including: information phase, orientation phase direct, phase explanation, phase orientation free and integration phase.</p> 
2.	Exercise Question	<p><b>Before Revision</b>                      No There is exercise Which shaped games</p> <p><b>After Revision</b>                      Adding practice questions in the form of games phase orientation free in each sub chapter the material.</p> 



3	Closing	<p><u>Before Revision</u> Not yet There is part cover on student book</p> <p><u>After Revision</u> Added part closing on student book</p> 
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### CONCLUSION

Based on the results, the study can conclude that (1) The development process of device learning applies Van Hiele's theory to speed up understanding mathematics students by using the ADDIE to design device learning in the form of the lesson plan (RPP) and student's book with apply activity Van Hiele's theory; (2) Device learning mathematics with apply Van Hiele's theory for speed up understanding student can state "Valid". Indeed, it can be seen from the results of the validator assessment, which shows an average total validity of the RPP of 4.17 and an average total validity of book student of 4.29; (3) Device learning mathematics with apply Van Hiele's theory for speed up understanding student can state " Practical " with an average grade of A for aspect theory, which means can use without revision and get the average percentage mark response student namely 90.6%, which means can it is said in the very positive category ; (4) Device learning mathematics with apply Van Hiele's theory for speed up understanding geometry student can state " Effective " with percentage completeness all over student by 92.59% meaning implementation device learning This stated effective.

The suggestions for the researcher are (1) Device learning developed mathematics with application Van Hiele 's theory can develop more carry on For addition main more discussion area, for example, squares and triangles, (2) In the Book, Student can give more apperception lots and interesting, (3) Practice



questions in the book Student can multiply For make it easier student finish questions.

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