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## Basic Mathematical Literacy Skills Ability by Van Hiele Project Based Learning Theory

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### Abstract

Mathematical literacy is a person's ability to formulate, apply, and interpret mathematics. The fact that Mathematical Literacy Skills is the main challenge in learning basic mathematics and can also be used as a key to explore mathematics learning. This article aims to analyze basic mathematical skills related to Van Hiele's project-based learning theory. The following type of research is qualitative research. The subjects of this research are fourth grade students at SDN 2 Korowelanganyar Cepiring Kendal. The instruments used in the study were tests and interviews. The results of the following research show that SDN 2 Korowelanganyar improves students' geometric reasoning abilities and the characteristics of fourth grade geometric reasoning by learning basic mathematical knowledge related to Van Hiele's theory. This shows that learning basic mathematical knowledge by van Hiele's project-based learning theory can improve students' ability to solve geometry problems.

### Abstrak

Literasi matematik ialah kemampuan seseorang untuk merumuskan, menerapkan, serta menafsirkan matematika. Fakta bahwa literasi matematika adalah tantangan utama dalam pembelajaran matematika dasar serta juga bisa digunakan sebagai kunci untuk mengeksplorasi pembelajaran matematika. Artikel ini bertujuan untuk menganalisis keterampilan matematika dasar yang terkait dengan teori pembelajaran berbasis proyek Van Hiele. Jenis riset berikut ialah penelitian kualitatif. Subyek riset berikut ialah peserta didik kelas IV SDN 2 Korowelanganyar Cepiring Kendal. Instrumen yang digunakan dalam penelitian ialah tes serta wawancara. Hasil riset berikut menunjukkan bahwa SDN 2 Korowelanganyar meningkatkan kemampuan penalaran geometrik peserta didik serta karakteristik penalaran geometrik kelas IV dengan mempelajari pengetahuan matematika dasar yang berkaitan dengan teori Van Hiele. Ini menunjukkan bahwa dengan mempelajari pengetahuan matematika dasar oleh teori pembelajaran berbasis proyek van Hiele mampu meningkatkan kemampuan peserta didik dalam menyelesaikan soal geometri.

**Keywords:** Literasi Matematika; Teory Van Hiele; Project Based Learning.

## INTRODUCTION

Mathematics is one of the exact sciences that plays an important role in daily activities. Although mathematics plays an important role in daily activities both in the school environment and in the community, some students consider mathematics as one of the most difficult subjects to understand (Angateeah, 2017; Sholihah & Afriansyah, 2018). The difficulty of the process of learning mathematics from the beginning was introduced as an abstract science, without relating it to everyday life (Kadarisma et al., 2020; Kariadinata, 2020). Mathematics itself is a logically structured subject, divided into levels from the simplest to the most complex. Therefore, teachers need to teach the most appropriate learning methods depending on the level of development of students.

In the process of learning mathematics, students also need to be introduced to problems and their solution or way out of the problem, so that the following subjects can be used as exercises for students to solve problems in real life. The following is in line with the mathematical concepts introduced to students must be related to real life: (Basibas, 2020).

The ability to apply concepts in mathematics related to everyday life is called Mathematical Literacy Skills. Mathematical Literacy Skills seems foreign to some people, even previous research explained that Mathematical Literacy Skills is still very foreign to some people, but it is important for society, especially in the era of the industrial revolution 4.0 (Rizki & Priatna, 2019). From the existing facts, Mathematical Literacy Skills is a major challenge in learning basic mathematics and can even be used as a key in research in the process of learning mathematics.

The mathematical literacy skill has implications for the ability of the person to formulate, use and interpret mathematics in a variety of situations. This includes explaining, explaining, and predicting phenomena using mathematical procedures, concepts, facts, and tools. (OECD, 2014). The following can guide students to understand the role of mathematics in their daily lives, both in making decisions and in making decisions. The Mathematical Literacy Skill is the ability to effectively use mathematical knowledge and understanding to address the challenges of everyday life. (Turner, 2007). In other words, those with contextual skills can not only use their knowledge and understanding of mathematics, but also use it effectively in their daily lives. Therefore, by mastering basic mathematics, you can reflect his mathematical logic and play an effective role in his life, society and society effectively.

One part of good Mathematical Literacy Skills is that a person can produce in-depth solution or way out of the problem to a complex problem as long as the thinking emerges from a realistic context (Stacey K and Turner R, 2015). Someone who has good Mathematical Literacy Skills also has sensitivity in mathematical concepts that are appropriate to the problem (Ojose, 2011). In addition, someone who has good Mathematical Literacy Skills will be able to guess, interpret data, reason, solve everyday problems, and communicate with mathematics. Mathematical Literacy Skills are not only limited to the arithmetic aspect of mathematics, but are broader, namely spatial, numerical, and quantitative abilities (Lange, 2006). There are four objects that are important in Mathematical Literacy Skills, namely space, form, quantity, change, relationship, and uncertainty. The four objects are then grouped again into three important abilities, namely

spatial literacy, numerical literacy, and quantitative literacy.

In mathematics learning, lessons with the subject matter of geometry are material that becomes a problem for students, because the discussion is very diverse and very complex. Geometry is a branch of Mathematics is a very important subject that is often used, both in daily life at school and in society (Sudarsono et al., 2021), so that the education curriculum in Indonesia at all levels contains geometry content. Therefore, having adequate knowledge and skills in the field of geometry is very important for students at the elementary, junior high, high school, and higher education levels to prepare for higher education and the future careers of these students, and can make them a better person. professionals in the real world (Russel, 2018).

Facts in the field currently show that student achievement in the field of geometry is still relatively low. Based on the absorption capacity of the Final Semester 1 Assessment in Class IV SDN 2 Korowelanganyar, it shows that the geometry material is still low, namely 49% of students who meet the minimum completeness criteria. A study revealed the lecture method in delivering material is one of the reasons students tend to be passive, because at the time of learning students only listen to the teacher's explanations, edit questions, and follow the discussion of questions suggested by the teacher, so that practical mathematics learning is still focused on the teacher and does not focus on the teacher. focused on students (Sopiah, 2019).

This fact makes people aware that there is a need for learning innovations that can make students interested, motivated, and improve their ability to work on geometry problems. In a In geometry material, we can know an educational expert who pays attention to the level of

ability of students, namely Pierre Marie Van Hiele and Dina Van Hiele.

Van Hiele's model of geometric thinking (van Hiele, 1984) also frames the focus and design of the following research. Based on the opinion of this theory, students' individual geometric thinking develops through five levels. At Level 0 (Visualization), students can recognize each shape by its appearance alone, and at Level 1 (Analysis), they can see shapes as a collection of properties. Learners at Level 2 (informal deduction) begin to feel the connection of traits both within forms and between forms. Learners at Level 3 (deduction) can construct proofs, understand the role of axioms and definitions, and derive necessary and sufficient conditions from form classes. Finally, at Level 4 (Rigor), students can work in different axiomatic systems.

Based on the opinion of the theory, the level of geometric thinking above is sequential and hierarchical, where students must master skills at a lower level before advancing to a higher level sequentially (Hoffer, 1981). Each level has its own language, set of symbols, and network of relationships, so that students at lower levels cannot understand teachers who reason at higher levels (van Hiele, 1984).

From the explanation above, the quality of learning Mathematical Literacy Skills in terms of Van Hiele's theory, as well as knowing the description of the geometric thinking characteristics of fourth grade students at SDN 2 Korowelanganyar in learning is very important to know.

## METHODS

The following research uses qualitative methods. The research subjects were 30 fourth grade students at SDN Korowelanganyar who were selected using a *purposive sampling technique*.

To determine the following research subjects, the researcher gave Van Hiele geometry questions to 30 grade IV students of SDN 2 Korowelanganyar in the 2021/2022 school year to group them based on Van Hiele's geometric thinking level. The test is used to find out how well the students can answer the questions that have been given. Where the validation results show questions that are feasible to use, including the results of the validity analysis, as well as the reliability of the level of difficulty. The results of the questions given were that 8 students analyzed were at stage 0 (Visualization), 18 students were analyzed at stage 1 (Analysis), while 4 students analyzed were at stage 2 (Informal Deduction). The following research subjects consist of 9 students with the distribution of 3 students from each stage.

In addition, based on other considerations, students who have active communication are selected for interview purposes. The type of interview used in this study is an unstructured interview. The order of questions, sentences, and the way they are presented is the same for each research subject. In addition, unstructured interviews were also used to find non-standard information. Interviews in this study used an interview guide instrument. Interviews were conducted to ask directly, using audio recording evidence of the answers given. Interviews were carried out by researchers to research subjects related to the results of students' answers to questions about the geometry of Van Hiele's theory.

There are seven indicators of Mathematical Literacy Skills skills that students need to have (Dossey TR, Blum WJ, 2013). These indicators include, 1) communication skills; 2) mathematical ability; 3) representation ability; 4) reasoning and argumentation skills; 5) the ability to

develop strategies to solve problems; 6) the ability to use symbols; and 7) using mathematical aids.

In this study, there are 3 ways to analyze data, 1) data reduction, 2) data delivery, and 3) drawing conclusions (Miles, 1992). Power reduction means summarizing, choosing the main things, focusing on the things that are important and discarding those that are not used. So that by doing data reduction, researchers will get a clearer picture and make it easier to carry out further data collection. After data reduction, the next step is the presentation of the data, the presentation of the data in this study is in the form of a brief description. Through the presentation of data in the form of a brief description, the data will be organized, well structured so that it will be easier to understand. Presentation by researchers will make it easier to understand what will happen and plan next steps. After presenting the data, the data analysis step carried out by the researcher is making conclusions, the conclusions in this study are in the form of a description or description of previous research that is still unclear, then examined to be clearer. The results of the entire analysis process are then simulated descriptively by looking at the data found during the research process (see Figure 1).

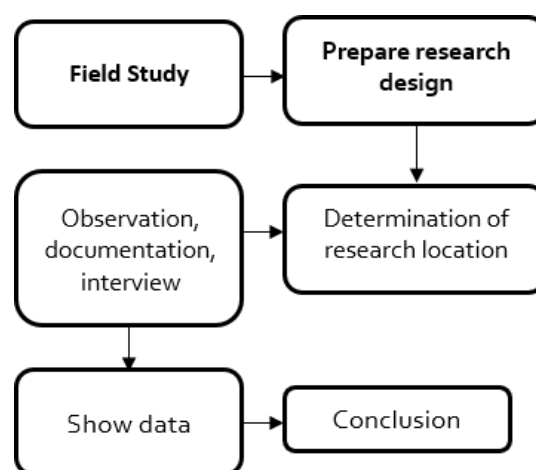


Figure 1. Research Stages

Based on the picture, the first step is to conduct a field study, in the field study the researcher conducts interviews with fourth grade teachers in Cepiring District to find out the activity problems experienced by students in each school. After conducting a field study, the next step is to prepare a research design that will be used. The next step is to determine the research location. From the information obtained from the field study, the researcher determines the research location, observes learning in the classroom at the research location, documents and conducts interviews with students.

## RESULTS AND DISCUSSION

### Research result

The results of the research evaluation are presented in table 1. Based on the results of the assessment that has been carried out, the quality of learning Mathematical Literacy Skills when viewed from Van Hiele's theory is considered effective in improving students' geometric thinking abilities. This quality can be seen from careful teacher planning, effective learning implementation, and good category assessments.

Table 1. Results of research evaluation

Score	Many Students	Percentage
60	1	3.33%
70	1	3.33%
80	16	53.33%
90	7	23.33%
100	5	16.67%
<b>Amount</b>	<b>30</b>	<b>100%</b>

Table 1 data shows that 3.33% of students scored 60 and 70. Students who get scores of 60 and 70 are known to have immature Mathematical Literacy Skills so that in answering the questions that have been given by the researchers find

obstacles, students who get scores of 60-70 are also in improving their geometry skills based on the project-based van Hiele theory. visualization stage. Stages of visualization students can recognize each form by appearance alone.

53.33% of students get a score of 80, students who get a score of 80, most of them already have good enough Mathematical Literacy Skills so that they are able to understand the questions that have been given by the teacher even though they do not understand perfectly, the level of geometry ability based on van theory Project-based Hiele is also good enough. In accordance with van Hiele's level, students who get a score of 80 are in stage 1 (analysis) in this stage students can show the characteristics of geometric thinking and are able to explain the properties of the requested geometry based on specific images including shapes, sizes. length, or angle measure, but students have not been able to explain the relationship between various types of transformations. 23.33% of students get a score of 90, students who get a value of 90 basically have good Mathematical Literacy Skills skills and good project-based van Hiele geometric thinking skills but the accuracy and thoroughness in answering these students did not get the maximum value. and 16.67% of students get a score of 100. Students who get a score of 100 already have good literacy skills and van Hiele thinking skills based on projects.

Based on data analysis, 28 out of 30 students have met the threshold value set by the school, which is 75, but 6.67% or 2 students still have scores below the threshold. The following shows that learning basic mathematics by using geometry material in the sense of Van Hiele's theory can be assessed as good. The level of Van Hiele Theory lessons in the 2013 curriculum will bridge students in

understanding geometry (Mapilindo *et al.*, 2020).

In addition, the constructivist approach based on van Hiele theory can increase the level of conceptual understanding of students in learning geometry (Cintang & Nurkhasanah, 2017), There are significant differences related to the learning outcomes of SMP in Solo City when using Van Hiele theory and not (Fatmasari *et al.*, 2020), There is a significant increase related to the level of self-confidence and mathematics learning outcomes when viewed from Van Hiele's theory (Priyanto & Yudhanegara, 2018), there is an increase in the results of the evaluation of class IVA students at SDN Kepatihan 05 Jember after using the theory van Hiele (Pratiwi *et al.*, 2020).

## Discussion

Based on the results of the research data analysis that has been carried out, the data are grouped based on students' Mathematical Literacy Skills abilities and Van Hiele thinking levels. Van Hiele's thinking levels consist of visualization, analysis, and informal deduction, deduction, and rigor stages.

The following is a description of the indicators of Mathematical Literacy Skills ability. There are seven indicators of Mathematical Literacy Skills skills that students need to have (Dossey TR, Blum WJ, 2013). These indicators include, 1) communication, in this case students are able to understand a problem such as reading, translating, and interpreting a statement so that solution or way out of the problem can be presented and presented appropriately; 2) mathematics, students are able to compose, make mathematical concepts and conjectures, formulate mathematical models, and solve problems using mathematical solution or way out of the problem; 3)

representation, students are able to represent mathematical objects and situations by involving interpretation and translation using various forms of representation such as graphs, tables, pictures, and others so that problems are easier to understand; 4) reasoning and argumentation, students are able to involve or use logical processes to reason and argue in exploring a problem in order to draw a conclusion or seek the truth of a statement; 5) develop strategies to solve problems; 6) using symbols, students are able to use their understanding to interpret, manipulate, and utilize symbolic expressions by understanding definitions, rules, and algorithms; 7) using mathematical aids, students are able to use mathematical aids in the process of solving mathematical problems.

In the following research, the indicators for Van Hiele's geometric thinking level are also explained, which can be seen in Table 2.

Table 2. Indicators of Van Hiele's Geometric Thinking Level

Thinking Level	Indicator
Level 0 (visualization)	a. Based on the complete appearance of the geometry, students can identify correctly. b. In different positions or in complex geometric shapes, students can identify well.
Level 1 (analysis)	a. Based on the existing geometry, students can identify the properties of the geometry correctly. b. Based on the properties of geometry, students can draw it correctly.
Level 2 (Informal deduction)	a. With pictures of different geometries, students can identify the related relationships of the shapes correctly. b. Based on geometric drawings, students can draw deductive conclusions well.
Level 3 (deduction)	a. Students have understood the terms of the definition of base,



Thinking Level	Indicator
	definition, axioms, and theorems in geometry.
	b. Students can compile evidence formally.
Level 4 (rigor)	a. Students already understand the axioms or theorems.
	b. Students can analyze the manipulation of the definition of an axiom, which is a statement where the statement is accepted as a truth and is general in nature and does not need proof.

Based on the results of the evaluation that has been carried out, a result is obtained that Class IV students at SDN 2 Korowelanganyar are in stage 2 (informal deduction). The results of these stages can be obtained as follows:

#### *Characteristics of Thinking Geometry Visualization Level*

At this level the child can identify the type of geometry requested, but the child has not been able to explain the properties of the requested geometry.

In the following research, data was found to be analyzed, related to the children's answers based on the questions given by the teacher.



Figure 2. Example of answers for level 1 children.

Figure 2 shows that students are able to make the requested shapes, but students cannot mention the nature of

the geometry, this is in accordance with the indicators of Mathematical Literacy Skills, namely communication, in this case students are able to understand a problem such as reading, translating, and interpreting a text. statements so that solution or way out of the problem can be presented and presented appropriately; and mathematically, students are able to compose, make mathematical concepts and conjectures, formulate mathematical models, and solve problems using mathematical solution or way out of the problem; and indicators from level 0 (visualization) of the van Hiele level, namely based on the complete appearance of the geometry, students can identify correctly and in different positions or in complex geometric shapes, students can identify well.

The following is supported by the results of interviews with interview excerpts such as the following.

---  
 G : Can you draw the shape I asked for?  
 N : Yes sir, but I have a hard time determining the nature of the shape.  
 G : Why the trouble?  
 N : The shape is almost the same and I forgot the name.  
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Students have trouble in determining the properties of geometry due to various factors, one of which is the teacher teaches directly without identifying what level the students in the class have reached. In addition, the material delivered tends to be monotonous, without the direct involvement of students.

The following research is in line with the results which state that at level 0 (visualization) geometric shapes are made based on physical appearance as a whole (Crowley, 1987). Therefore, at level 0 (visualization) it is not possible to sketch geometric shapes only based on

the description of the problem.

In the planning step, level 0 students (visualization) cannot mention the properties of geometric bodies. This is because the ability of students at level 0 (visualization) is still only identifying shapes based on their appearance as a whole, so students at level 0 (visualization) have not determined geometric properties correctly (David Fuys, 1986).

### *Characteristics of Thinking Geometry Level of Analysis*

At this stage, students can show the characteristics of geometric thinking and are able to explain the properties of the requested geometry based on specific images that include shape, length, or angle size, but students have not been able to explain the relationship between various types of transformations.

In this level, data is found for analysis can be seen in Figure 3.

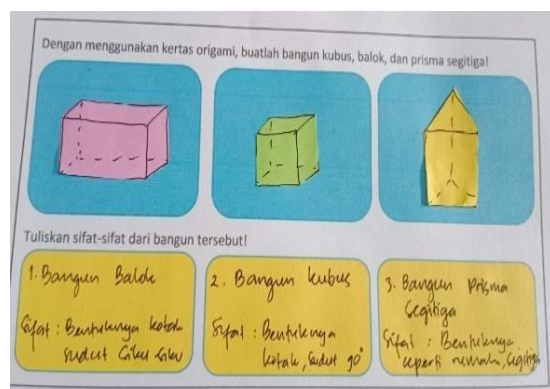


Figure 3. Example of a level 2 child's answer

Figure 3 shows that students are able to make geometric shapes and mention the properties of the geometry, but have not been able to explain the relationship between geometry and its nature, according to the indicators of Mathematical Literacy Skills ability, namely representation, students are able to represent mathematical objects and situations involving interpretation and translation uses various forms of representation such

as graphs, tables, pictures, etc. so that problems are easier to understand; 4) reasoning and argumentation, students are able to involve or use logical processes to reason and argue in exploring a problem in order to draw a conclusion or seek the truth of a statement; and van Hiele's level of thinking indicator which is at level 1 (analysis) from the van Hiele level, namely based on the existing geometry, students can identify the geometric properties correctly and Based on the geometric properties, students can draw them correctly.

The following is reinforced by the following interview results.

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G : How, is there a problem in completing today's task?

D : No sir, I can, but I'm confused about the characteristics that he wants, is it like this?

M : Why are you confused?

D : I was confused about the shape, length and angle, sir, so I wrote it according to my understanding.

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Based on the results of the interview, it is very clear that the students are only at the analysis level or level 1 at the Van Hiele theory level.

At level 1 (analysis) students can identify the elements that are known and those that are asked. Level 1 students (analysis) can also compose a mathematical model although it is not complete, the following can be seen from the ability of level 1 students (analysis) to sketch geometric shapes but has not been equipped with known elements. The following is in line with the results of research which states that level 1 students (analysis) can identify and draw shapes that are given verbally or given their characteristics in writing (Crowley, 1987), as well as other research which states that stage 1 students (analysis) has been able



to construct images according to the characteristics given (Ayuningtyas et al., 2019). So that students at level 1 (analysis) can sketch geometric shapes if the properties of the shapes are known. The results of the analysis of students' answers, it can be concluded

### *Characteristics of Thinking Geometry Informal Deduction Level*

At level 2, it shows the characteristics of geometric thinking that can classify and determine the type of transformation in each image based on the properties of the geometric shape, so it can be seen in the Figure 4.

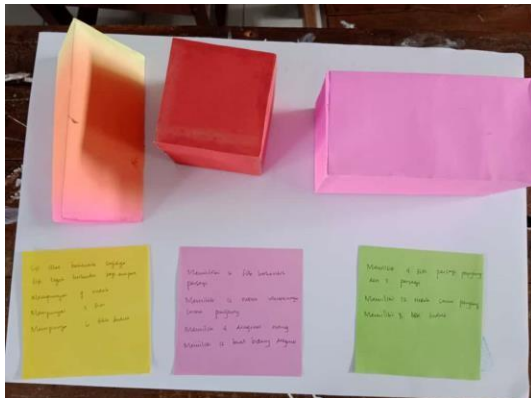


Figure 4. Example of a level 3 child's answer.

In Figure 4, the child can make geometry and correctly mention its properties. With the application of the PjBL (*Project Based Learning*) model in the application, introducing properties and geometry can help children understand them according to indicators. Students are able to represent mathematical objects and situations involving interpretation and translation using various forms of representation, such as graphs, tables, pictures, and others, so that problems are easier to understand; 4) Reasoning and argumentation: students can use logical processes to reason and argue about a problem in order to reach a conclusion or determine the truth of a statement; 5) Create problem-

solving strategies; 6) Interpret, manipulate, and apply symbolic expressions by understanding definitions, rules, and algorithms; 7) Using mathematical aids, students are able to use mathematical aids in the process of solving mathematical problems and the van Hiele level 2 geometric ability indicator (informal deduction) from the van Hiele level, namely, with different geometric images, students can identify the related relationships of the shapes correctly and, based on geometric images, students can draw deductive conclusions well.

The following is also supported by the results of interviews as follows.

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G : How about O, did you encounter any problems?

O : No sir, I understand it and can finish it well.

G : Good. O, the spirit of learning, yes.

O : Ok sir, thank you.

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Based on the research results, it can be said that the highest level that can be achieved by fourth grade students at SDN 2 Korowelanganyar is level 2 (Informal Deduction). Several previous studies on the level of geometric thinking of students also said that the level of thinking that could be achieved by elementary school students was at 3 stages of understanding geometry, namely level 2 (informal deduction) (Shaughnessy, 2016), (Abdullah & Zakaria, 2013).

Based on the findings of this study, the authors recommend that teachers should be able to understand the characteristics of students, this is very useful because it can be used as a basis for providing appropriate treatment to students. Learning carried out in the classroom must be student-centered or *student-centred learning* where students are able to actualize themselves with direct experience, thereby increasing the

enthusiasm of students' learning. With the findings of this study, the authors hope that they can be used as the basis for further research, to create new experiences or knowledge as the basis for further research.

## CONCLUSIONS

Based on the results of the study, several conclusions were obtained. 1) learning Mathematical Literacy Skills in terms of Van Hiele's theory, which can improve students' geometric thinking skills. 2) the geometric thinking characteristics of fourth grade students at SDN 2 Korowelanyar in *Project Based Learning*, the highest level is at level 3, namely informal deduction, in the informal deduction stage students can make conclusions and make conclusions.

Based on the results of the research, suggestions that can be given are that because the geometric thinking characteristics of students are different, it is necessary for teachers to understand the characteristics of students by giving a pretest to find out what level the student is at. a tool to determine the next step of the process of learning mathematics.

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