JPPMS, Vol. 5, No. 1, 2021
Jurnal Penelitian Pendidikan Matematika dan Sains
http://journal.unesa.ac.id/index.php/jppms/

Cognitive Function of Junior Junior school students in Solving Geometry Problems Based On Verbalizer and Visualizer Cognitive Style

Oleh:
Paramita Intan[1], Ika Kurniasari[2]
[1,2]Departement of Mathematics, Universitas Negeri Surabaya

[1]paramita.17030174083@mhs.unesa.ac.id
[2]ikakurniasari@unesa.ac.id

Abstrak — Pada penelitian ini, peneliti ingin mengeksplorasi bagaimana fungsi kognitif siswa SMP dalam menyelesaikan masalah geometri ditinjau dari gaya kognitif. Tujuan dari penelitian ini adalah untuk menggambarkan fungsi kognitif siswa SMP menyelesaikan masalah geometri ditinjau dari gaya kognitif yakni gaya kognitif *verbalizer* dan *visualizer*. Metode penelitian yang digunakan dalam penelitian ini adalah penelitian deskriptif kualitatif dan menggunakan dua siswa SMP kelas IX di Surabaya sebagai responden yang masing-masing memiliki gaya kognitif *verbalizer* dan *visualizer*. Hasil penelitian ini menunjukkan bahwa siswa PRM bergaya kognitif *verbalizer* berada pada level ketiga (berpikir rasional abstrak) dari fungsi kognitif *rigorus mathematical thinking* dan subjek telah menerapkan semua fungsi kognitif pada level pertama dengan indikator yang menonjol yaitu pembandingan dimana subjek mencari karakteristik yang sama dan berbeda antara persegi dan persegi panjang dalam menyelesaikan masalah geometri. Sedangkan siswa LDH bergaya kognitif *visualizer* berada pada level ketiga (berpikir rasional abstrak) dari fungsi kognitif *rigorus mathematical thinking* dan hanya menerapkan sebagian besar fungsi kognitif pada level pertama dalam menyelesaikan masalah geometri dengan indikator yang menonjol yaitu visualisasi dimana subjek memberikan simbol pada gambar bangun yang disajikan dalam menyelesaikan masalah geometri.
Kata kunci: Fungsi kognitif, Gaya kognitif, Masalah geometri, *Verbalizer*, *Visualizer*.

Abstract — In this article, we explore how the cognitive function of junior junior school students in solving geometry problems based on cognitive style. The purpose of this study was to describe the cognitive functions of junior junior school students solving geometry problems reviewed from verbalizer and visualizer cognitive style. The research method used in this research is descriptive qualitative research. This research used two students of IX grade in Surabaya as respondents who each student have a cognitive style of verbalizer and visualizer. The results of this study indicate that PRM students with cognitive verbalizer style are at the third level (abstract rational thinking) of the cognitive function rigorous mathematical thinking and the subject has applied all cognitive functions at the first level with a prominent indicator is comparison where the subject looks for the same and different characteristics between square and rectangle in solving geometry problems. Whereas LDH students with cognitive visualizer style is at the third level (abstract rational thinking) of cognitive function rigorous mathematical thinking and apply most cognitive functions at the first level with a prominent indicator is visualization where the subject provides symbols on the image in solving geometric problems.
Keywords: Cognitive function, Cognitive style, Geometry problems, Verbalizer, Visualizer.

Introduction

Education is one of the important sectors in the life of a country, therefore the education sector receives special attention in Indonesia. Today, we live in an era of globalization and the progress of science and technology which is increasingly advanced, marked by increasingly fierce competition among nations, and competitiveness which is determined by the quality of human resources. In preparing quality human resources to face the coming era of global competition, increasing the competitiveness of quality education is a key condition (Rezeki 2020) . Competition is very tight in all aspects of life, we are required to have reliable abilities, including the ability to obtain, analyze, and process information carefully as well as creative problem- solving abilities. Thus, to master and create future technology requires a strong mastery of mathematics from an early age (Wulandari 2015). Mathematics is a branch of education that has an important role and is related to the development of science and technology. Mathematics itself is given to students starting from elementary school to college. One that affects the development of mathematical knowledge in Indonesia is the competence of teachers in providing knowledge and students in receiving knowledge and understanding from these individuals. Individual understanding of the process of gaining knowledge and manipulating knowledge through the activities of remembering, analyzing, assessing, reasoning, and imagining is called cognition (Jaunuddin 2016) . One of the fields of science in mathematics studied by junior school students in geometry. Geometry has an important meaning for students because geometry is a tool that can be used to train students' thinking skills in solving problems related to daily life (Hendrayana 2017). By studying geometry, students are expected to be able to have good reasoning abilities, logical, critical, systematic, and creative thinking skills that are very necessary for life, because it is very much needed an understanding of the concept of geometry in students (White 2001) . The diversity of students in solving mathematical problems can be influenced by many things, one of which is cognitive style.

Cognitive style is an individual character in the use of cognitive functions (thinking, remembering, solving problems, making decisions, organizing, and processing information) that are consistent and last long (Detlev Leutner 2000) . Numerous studies have researched about The Cognitive Process of Students Solving Mathematical Problems, for some research groups have been researched for example The Thinking Process of Students' Field Dependent and Field Independent Cognitive Style in Solving Mathematical Problems (Widodo 2016) and Profile of Cognitive Functions of Grade V SD Students with Low Mathematics Ability to Solve Problems (Wulandari 2015) . Cognitive styles can be divided into several types, namely visualizer & verbalizer cognitive styles, field-dependent & field-independent cognitive styles, impulsive & reflexive cognitive styles, and intuitive-inductive & logical-deductive cognitive styles. Therefore, students with different cognitive styles will also have different thought processes.

Cognitive style affects the ability to reason students, so cognitive style also affects the cognitive function of students, this is because reasoning is an activity of thinking in making a decision and cognitive function is also included as a type of thinking activity (Fitriyani and Khasanah 2017) . Then, Usodo (Komarudin 2014) argues that cognitive style is an individual character in the use of cognitive-thinking functions, remembering, solving problems, making decisions, organizing, processing information, and so on that are consistent and last long. Cognitive style (cognitive style) is one of the new ideas from the study of developmental and educational psychology. Cognitive style is an attitude or behavioral tendency that is relatively stable in students in accepting, understanding, remembering, and solving problems (Lumbantoruan 2010) . Based on the explanations of various experts above, it can be concluded that cognitive style is a characteristic of students in receiving, and remembering information, thinking, and solving problems that are consistent and enduring.

Cognitive function is a process of perception, attention, memory, decision making, and language skills (Nouchi R 2014). (Kinard 2008) States that cognitive function as a mental process has a special meaning. Furthermore, Kinard said that certain acts of thought were needed to describe the abstraction and generalization of geometry directly. (Aan 2020) Pointed out that the ability to think mathematically rigorous mathematical thinking has a contribution to developing the ability to solve a problem. Therefore in solving geometry problems, a cognitive function is needed. (Kinard 2008) says that rigorous mathematical thinking requires three levels of cognitive function. In his theory, Rigorous Mathematical Thinking states that one of the main claims of the RMT approach is that students difficulty with mathematical tasks often stems not from a lack of certain mathematical

knowledge but from the absence of more general cognitive preconditions which means that in solving problems students need to obtain correct information input during exploration and elaboration activities.

In this study, we aimed to describe the cognitive function of students based on verbalizer and visualizer cognitive style in solving geometry problems. Based on the explanation above, the researcher is interested in doing the research entitled Cognitive Functions of Junior High School in Solving Geometry Problems based on Verbalizer and Visualizer Cognitive Style.

Method

The subject of this study consisted of two students from IX grade of junior high school in Surabaya as respondents who each of student have a cognitive style of verbalizer and visualizer. This research is research that used a descriptive qualitative approach because the research aim is to describe the profile of the cognitive function of junior school students' mathematics problem solving on geometry reviewed from verbalizer and visualizer cognitive style. This is following the definition of qualitative research by Bogdan & Taylor in (Siswono 2019) qualitative research is a research procedure that produces descriptive data, namely speech or writing, and the observable behavior of the subject itself.

The data in this study were collected through three stages, namely carrying out a cognitive style classification test (TPGK), carrying out a geometry problem test (TMG), and interviews. The cognitive style classification test is used to classify the cognitive style of the visualizer and verbalizer. This cognitive style classification test is given to one of the classes in IX grade which has 30 students as respondents. The geometry problem test is used to determine the cognitive function of students. Furthermore, the geometry problem test is given to two students who were selected each one has the cognitive style of visualizer and the other one has the cognitive style of verbalizer by considering the students' communication skills based on the recommendations of the class teacher.

This research instrument consisted of the cognitive style classification test, geometry problem test, and interview guidelines compiled and then consulted with the supervisor before conducting validation. The cognitive style classification test consists of 10 statement items and will be answered by students according to their respective statements. The cognitive style classification test is arranged based on the *Verbalizer Visualizer Questionnaire* (VVQ) (Detlev Leutner, 2000) as follows.

Table 1. Cognitive Style Classification Test Indicators

Variable	No.	Indicator
Visualizer Cognitive Style	1	Receive information in the form of images/graphics
	2	It is easier to remember what was seen than what was heard
	3	Think with illustration pictures
	4	Read the questions aloud, quickly, and underline information that is considered important
	5	Answer questions with short answers
Verbalizer Cognitive Style	6	Receive information in text / written form
	7	It is easier to remember what was heard or discussed than what was seen
	8	Has difficulty when faced with visual-related tasks
	9	Read the problem silently while moving the lips
	10	Answer questions at length and express in own language

The geometry problem test is a test that contains one problem in the geometry material in the form of a description problem. After giving a geometry problem tests that have been validated, revised, and made it possible to describe the cognitive function carried out by the subject. After that the interview activity is carried out using a reference to the interview guidelines, then the results of the TMG and the interview are analyzed based on the cognitive function of rigorous mathematical thinking indicators (Kinard 2008) as follows.

Table 2. Cognitive Function Indicators

Function Level	Cognitive Function	Indicator	Code
Level 1: Qualitative thinking	Comparing	Look for similarities and differences (in terms of characteristics or critical attributes) between two or more objects.	KL3
	Searching systematically to gather clear and complete information	Pay attention (eg pictures) carefully, organized and full of plans to gather and complete information	KL4
	Using more than one source of information	Work mentally with more than one concept at the same time (color, size, shape, or situation from various points of view)	KL5
	Encoding	Interpret objects in code/symbol	KL6
	Codebreaking	Interpret a code/symbol of an object	KL7
Level 2: Quantitative Thingking	Preserving constant	Identify what remains the same in terms of attributes, concepts, or relationships while several others change	KN1
	Spatial measurement and relationship	Use internal/external references as a guide for organizing, analyzing spatial relationships, based on whole to partial relationships	KN2
	Analyzing	Solve a whole or decompose a quantity into critical attributes or their arrangement	KN3
	Integrating	Build the whole by combining the critical parts or attributes	KN4
	Generalizing	Observe and describe the nature of an object without reference to specific details or critical attributes	KN5
	Accuracy	Conclude/decide with focus and appropriate	KN6
Level 3: Rational abstract thinking	Activating prior mathematically related knowledge	Gather previous knowledge to connect and adjust aspects that are being thought with aspects of previous experience	RA1
	Providing mathematical logical evidence	Provide supporting details, instructions, and reasonable evidence to prove the truth of a statement	RA2
	Articulating mathematical logical evidence	Build guesses, question, search for answers and communicate explanations following the rules of mathematics	RA3
	Defining the problem	Look at problems by analyzing and looking at relationships to know exactly what needs to be done mathematically	RA4
	Hypothetical thinking	Form a mathematical proposition or conjecture and look for metastasis evidence to support or refute the proposition or conjecture	RA5
	Inferential thinking	Develop valid generalizations and evidence-based on several mathematical events	RA6
	Projecting and restructuring relationships	Making connections between visible objects or events and establishing the existence of relationships between objects or events to solve new problems	RA7
	Formation of proportional quantitative relationship Forming proportional quantitative relationship)	Establish quantitative relationships that connect concept A and concept B by determining some of the many concepts of A and their relationship to concept B	RA8

Function Level	Cognitive Function	Indicator	Code
Level 3: Rational abstract thinking	Mathematical inductive thinking	Take aspects of various mathematical details given to form patterns, categorize into the relationship of public attributes, and arrange the results to form general mathematical rules, principles, guidelines.	RA9
	Mathematical deductive thinking	Apply general rules or formulas to specific situations	RA10
	Mathematical relational thinking	Consider a mathematical proposition that presents the relationship between two mathematical objects, A and B with a second mathematical proposition that presents the relationship between concepts A and C and then concludes the relationship between B and C.	RA11
	Elaborating Mathematical cognitive	Reflecting and analyzing mathematical activities.	RA12

Geometry problem test data and the results of interviews that have been obtained, then the analyzed using data analysis techniques. Data analyzed are into a pattern, choosing what is important and what will be studied, and making conclusions so that it is easily understood by oneself and others. Data analysis techniques used in geometry problem test data and interview data refer to the analysis steps according to (Sugiyono 2014) including three stages, namely data reduction, data presentation, and drawing conclusions

Analysis and Discussion

Analysis of Students with Verbalizer Cognitive Style

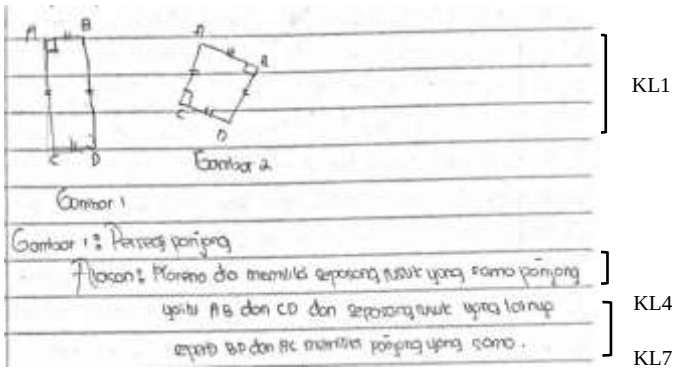

Figure 1. Subject Verbalizer's answer to geometry problem number 1

From Figure 1. it can be seen that the PRM subject used cognitive functions which are included in the criteria for cognitive function level 1 (qualitative thinking), including :

KL1 (Labeling) where the verbalizer cognitive style subject gives the name of the shape presented to the questions based on the characteristics of the shape; KL4 (Search systematically to collect and complete information) where subjects pay attention to images in an organized and full plan to collect and complete information; KL7 (Code breaking) where the subject interprets a code/symbol of an object.

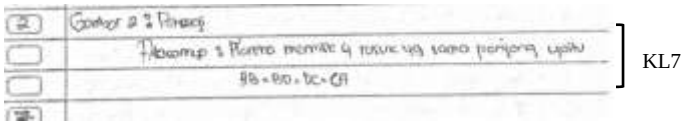

Figure 2. Subject Verbalizer's answer to geometry problem number 2

From Figure 2 it can be seen that the PRM subject uses cognitive functions that are included in the criteria for cognitive function level 1 (qualitative thinking), including :

KL7 (Code breaking) where the subject interprets a code/symbol of an object.

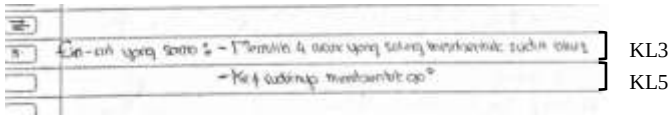

Figure 3. Subject Verbalizer's answer to geometry problem number 3

From Figure 3 it can be seen that the subject used the cognitive functions that are included in the criteria for cognitive function level 1 (qualitative thinking), including:

KL3 (Comparison), that is, the subject looks for the same and different characteristics between square and rectangle; KL5 (Use of more than one source of information), that is, the subject works with more than one concept (in this case, edges and angles)

KL7 (Code breaking) where the subject interprets a code/symbol of an object.

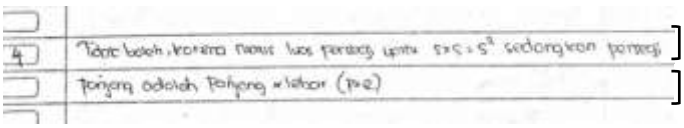

Figure 4. Subject Verbalizer's answer to geometry problem number 4

From Figure 4. the PRM the subject used cognitive functions that are included in the criteria for cognitive function level 2 (quantitative thinking), including:

KN2 (Measurement of space and spatial relationships) where the subject used the formula that he gets from previous mathematical knowledge, namely the formula for the area of a square and the area of a rectangle as a guide for analyzing the relationship of the whole shape to its parts. KN3 (Analysis), the subject describes the shapes in the problem (square and rectangle) into their arrangement.

The rest of the explanation regarding the PRM settlement can be seen from the following interview excerpt.

Table 3. Interviewing Excerpt of PRM in Solving Geometry Problem

Interview Code	Interview Excerpt
PVB1	*"Setelah kamu menerapkan strategimu atau cara yang kamu gunakan dalam menjawab soal itu, coba jelaskan bagaimana kamu menyelesaikan soal itu"*
SVB1	*"Jadi, pertama aku namain dulu bangunnya, biar lebih mudah nyebut rusuknya buat mendeskripsikan ciri-ciri bangun itu"*
PVB2	*"Kemudian, bagaimana kamu tahu kalau itu termasuk ciri-ciri bangun persegi dan persegi panjang"*
SVB2	*"Dari kelas 7 sebelumnya kan udah pernah dapet ciri-ciri bangun datar itu terus aku gunain ciri-ciri itu buat ndeskripsikan bangun itu tadi"*

Based on the interviews conducted, in the stage of solving geometry problems, the first step carried out by PRM was labeling the solutions. Then he revealed the mathematical concepts associated with shapes. The subject remembers the concepts he got from previous mathematical knowledge that he got while sitting in grade 7.

In the comparison stage, he uses labeling as a settlement strategy so that it is easier to mention which side he describes as the characteristics of a flat shape.

At the stage of measuring space and spatial relationships where this stage is included in the criteria for level 2 cognitive function (quantitative king), where the subject uses the formula he from previous mathematical knowledge, mely the formula for the area of a square and the area of a rectangle as a guide for analyzing the relationship between the two shapes. And the last is in the analysis stage, where the subject describes the shapes in the problem (squares and rectangles) into the arrangement or characteristics of the two shapes.

Analysis of Students with Visualizer Cognitive Style

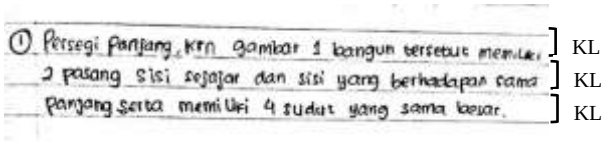

Figure 5. Subject Visualizer's answer to geometry problem number 1

From Figure 5. it can be seen that the LDH subject used cognitive functions which are included in the criteria for cognitive function level 1 (qualitative thinking), including :

KL7 (Code breaking) where the subject interprets a code/symbol of an object; KL4 (Search systematically to collect and complete information) where subjects pay attention to images in an organized and full plan to collect and complete information; KL5 (Use of more than one source of information), that is, the subject works with more than one concept (in this case, edges and angles).

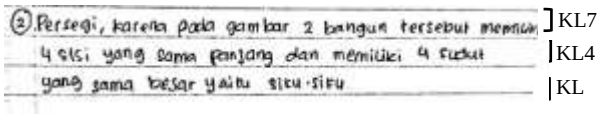

Figure 6. Subject Visualizer's answer to geometry problem number 2

From Figure 6. it can be seen that the LDH subject used cognitive functions which are included in the criteria for cognitive function level 1 (qualitative thinking), including :

KL7 (Code breaking) where the subject interprets a code/symbol of an object; KL4 (Search systematically to collect and complete information) where subjects pay attention to images in an organized and full plan to collect and complete information; KL5 (Use of more than one source of information), that is, the subject works with more than one concept (in this case, edges and angles).

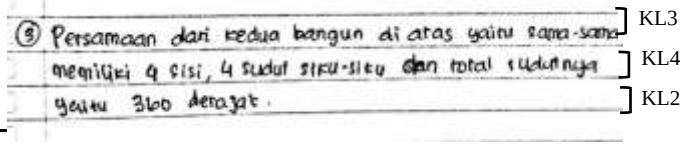

Figure 7. Subject Visualizer's answer to geometry problem number 3

From Figure 7., it can be seen that the LDH subject used cognitive functions which are included in the criteria for cognitive function level 1 (qualitative thinking), including :

KL3 (Comparison), that is, the subject looks for the same and different characteristics between square and rectangle; KL4 (Search systematically to collect and complete information) where subjects pay attention to images in an organized and full plan to collect and complete information; KL2 Constructs an image (awakens) in the mind or produces an identifiable construct of an object whose name is given.

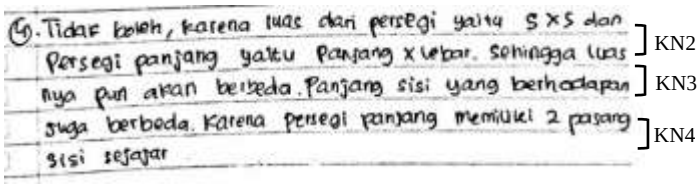

Figure 8. Subject Visualizer's answer to geometry problem number 4

From Figure 8., it can be seen that the LDH subject used cognitive functions which are included in the criteria for cognitive function level 2 (quantitative thinking), including :

KN2 (Measurement of space and spatial relationships) where the subject uses formulas that he gets from previous mathematical knowledge, namely the formula for the area of a square and the area of a rectangle as a guide for analyzing the relationship of the whole shape to its parts; KN3 (Analysis), namely the subject decomposes the shapes in the problem (square and rectangle) into their arrangement; KN4 (Integration), namely the subject builds the whole structure on the problem by combining its parts or characteristics.

The rest of the explanation regarding the PRM settlement can be seen from the following interview excerpt.

Table 4. Interviewing Excerpt of LDH in Solving Geometry Problem

Interview Code	Interview Excerpt
PVS1	*"Setelah kamu menerapkan strategimu atau cara yang kamu gunakan dalam menjawab soal itu, coba jelaskan bagaimana kamu menyelesaikan soal itu"*
SVS1	*"Dari gambar kan udah diketahui kalau ada tanda garis sejajar dan tanda kalau bangun itu memiliki sudut siku-siku dari situ aku langsung sebutin aja ciri-cirinya"*
PVS2	*"Kemudian, bagaimana kamu tahu kalau itu termasuk ciri-ciri bangun persegi dan persegi panjang"*
SVS2	*"Dulu pernah diajarin ciri-ciri persegi itu punya 4 rusuk yang sama panjang, terus kalau persegi panjang itu punya 2 pasang sisi sejajar yang sama panjangnya aku pake itu"*

Based on the interviews conducted, it is in the stage of solving the geometry problems above. The first step taken by LDH is solving the code in solving it, where the subject interprets a code/symbol for an object. Then he did a systematic search to gather and complete the information he got from cracking the previous code by looking at the drawings in an organized and full plan to gather and complete the information revealing mathematical concepts associated with shapes.

At the stage of using more than one source of information, the subject works using more than one concept, in this case, he mentions the edges and angles.

At the stage of constructing an image (wake up) in the mind or producing an integrated construct of an object whose name is given, in this case, the LDH student constructs in his mind that the two shapes have the same 4 angles, namely right angles.

In the comparison stage, the subject looks for the same and different features between squares and rectangles by remembering the concepts he got from previous mathematical knowledge.

At the stage of measuring space and spatial relationships where this stage is included in the criteria for cognitive function level 2 (quantitative thinking), where the subject uses the formula he got from previous mathematical knowledge, namely the formula for the area of a square and the area of a rectangle as a guide to analyzing the relationship between the two shapes. In the analysis stage where the subject describes the shapes in the problem (squares and rectangles) into the arrangement or characteristics of the two shapes.

And finally, in the integration stage, the subject builds the whole structure on the problem by restating and combining its parts or characteristics.

Discussion

The discussion based on the theory of stages of cognitive function rigorous mathematical thinking

(Kinard 2008), includes 3 levels of cognitive function, namely level 1 qualitative thinking, level 2 quantitative thinking, and level 3 abstract rational thinking.

Cognitive Function Profile of Verbalizer Student

During solving the geometry problem that has been given, the verbalizer subject only uses several cognitive functions that are included in the cognitive level 1 function (qualitative thinking) including:

Labeling where the subject gives the name of the shape that is presented in the problem based on the characteristics of the shape; visualization where the subject during the interview he has constructed an image (wake) in his mind then he visualizes it by giving the name that image 1 is a square and image 2 is a rectangle; comparisons where the subject looks for similarities and differences between the features possessed by Figure 1 and Figure 2; systematic search to collect and complete information where the subject pays attention to the two images then collects information on each image; the use of more than one source of information where the subject uses more than one concept at the same time, namely edges and angles; solving the code where the subject interprets the symbol "/, //, ///, ¬" contained in the problem. While the cognitive function level 1 that has not been seen to be used by the verbalizer cognitive style subject is visualization and coding.

At cognitive level 2 (thinking quantitatively) the verbalizer cognitive style subject has used several criteria including:

Measurement of space and spatial relationships where the subject uses internal/external references in this case he uses the formula for the area of a square and the area of a rectangle as a guide for analyzing spatial relationships, based on whole-to-part relationships; Analysis in which the subject describes all the characteristics of each shape. While the level of cognitive function 2 that has not been seen to be used by verbalizer cognitive style subjects is integration, generalization, and thoroughness.

And at the cognitive level 3 function (abstract rational thinking) from interviews that have been conducted by the verbalizer, cognitive style subject only uses the criteria of activating previous mathematical knowledge where the subject collects previous knowledge, namely the characteristics of flat shapes to connect and adjust the images contained in the problem with previous experience about the characteristics of a flat shape.

Cognitive Function Profile of Visualizer Student

During solving the geometry problem that has been given, the visualizer cognitive style subject has used all the cognitive functions of rigorous mathematical thinking which are included in cognitive level 1 functions (qualitative thinking) including:

Labeling where the subject names the shapes that are presented in the questions based on the characteristics of the shapes the; visualization where the subject during the interview he has constructed an image (wake up) in his mind then the subject visualizes by giving the name that image 1 is a square and image 2 is a rectangle; comparisons where the subject looks for similarities and differences between the features possessed by Figure 1 and Figure 2; systematic search to collect and complete information where the subject pays attention to the two images then collects information on each image; the use of more than one source of information where the subject uses more than one concept at the same time, namely edges and angles; coding in which the subject gives a code, namely by giving symbols A, B, C, D; solving the code where the subject interprets the symbol "/, //, ///, ¬" contained in the problem.

At cognitive level 2 (thinking quantitatively) the cognitive-style visualizer subject has used several criteria including:

Measurement of space and spatial relationships where the subject uses internal/external references in this case he uses the formula for the area of a square and the area of a rectangle as a guide for analyzing spatial relationships, based on whole-to-part relationships; Analysis in which the subject describes all the characteristics possessed by each shape; Integration in which the subject constructs the overall information building up on the problem by restating and combining its parts or characteristics. While the level of cognitive function 2 that has not been seen to be used by the cognitive-style visualizer subject is generalization and thoroughness.

And at cognitive level 3 functions (abstract rational thinking) from interviews that have been conducted by the visualizer cognitive style subject only uses the criteria for activating previous mathematical knowledge where the subject collects previous knowledge, namely the characteristics of flat shapes to connect and adjust the images contained in the problem with previous

experiences about the characteristics of a flat shape.

Conclusion

Based on the analysis process that has been carried out in the study, it can be concluded that the cognitive function profile of the verbalizer cognitive style students has used all the criteria at cognitive function level 1 (qualitative thinking) but at level 2 (thinking quantitatively) and level 3 (abstract rational) there are several functional criteria. The cognitive style that is not used by the subject's cognitive style verbalizer. Whereas for the cognitive function profile of the cognitive- style visualizer students at the cognitive function level 1 (qualitative thinking), there are criteria that are not used such as coding. And at level 2 (thinking quantitatively) and level 3 (abstract rational), several cognitive function criteria are not used by the visualizer cognitive style subject.

References

Aan, Etika K, Yustika N. 2020. Analisis Kemampuan Pemecahan Masalah Matematis Siswa SMP Melalui Pendekatan Rigorous Mathematical Thinking ditinjau dari Kemampuan Awal Matematis dan Gaya Belajar Matematis. *Jurnal Penelitian Pembelajaran Matematika Volume 13 Nomor 1 Tahun 2020*.

Detlev Leutner, Jan L. Plass. 2000. Measuring Learning Styles with Questionnaires Versus Direct Observation of Preferential Choice Behavior in Authentic Learning Situations: The Visualizer/Verbalizer Behavior Observation Scale (VV-BOS). Jerman.

Fitriyani, and Khasanah. 2017. Student's rigorous mathematical thinking based on cognitive style. *Journal of Physics: Conference Series.*

Hendrayana, Aan. 2017. "Pengaruh Pembelajaran Pendekatan Rigorous Mathematical Thinking (RMT) terhadap Pemahaman Konseptual Matematis Siswa SMP. *http://journal.uny.ac.id/index.php/jrpm.*

Jaunuddin. 2016. "Tesis: Profil Berpikir Aljabar Siswa SMP kelas Terpisah dalam Menyelesaikan Masalah Matematika Ditinjau dari Gaya Kognitif Visualizer dan Verbalizer. Surabaya: Universitas Negeri Surabaya.

Kinard, J.T. dan Kozulin, A. 2008. *Rigorous Mathematical Thinking: Conseptual Formation in the Mathematics Classroom.* New York: Cambridge University Press.

Komarudin. 2014. Proses Berpikir Kreatif Siswa SMP dalam Pengajuan Masalah Matematika Ditinjau dari Gaya Kognitif Siswa: (Studi Kasus pada Siswa Kelas VIII SMP Negeri 1 Sukaharjo Tahun Pelajaran 2012/2013). Surakarta: Universitas Negeri Sebelas Maret.

Lumbantoruan, Manaek. 2010. Pengaruh Strategi Pengorganisasian Pembelajaran dengan Gaya Kognitif Spasial Terhadap Hasil Belajar Siswa SMA Kelas XI IPA Pada Pokok Bahasan lkatan Kimia. Medan: Universitas Negeri Medan.

Nouchi R, Kawashima R. 2014. *Improving Cognitive Function from Children to Old Age: A Systematic Review of Recent Smart Ageing Intervention Studies.* Hindawi Publishing Corporation Advances in Neuroscience.

Rezeki, Robby. Sitompul, Harun. Situmorang, Julaga. 2020. The Effect of Learning Strategies and Cognitive Styles on Learning Outcomes of Mathematics after Controlling Intelligence. *Budapest International Research and Critics in Linguistics and Education (BirLE) Journal* 1151-1163.

Siswono, Tatag Yuli Eko. 2019. *Paradigma Penelitian Pendidikan: Pengembangan Teori dan Aplikasi Pendidikan Matematika.* Bandung: Remaja Rosdakarya.

Sugiyono. 2014. *Metode Penelitian Pendidikan Pendekatan Kuantitatif, Kualitatif, dan R&D.* Bandung : Alfabeta.

White, R. H Coop & Kinnard. 2001. *Psychological Concept in The Classroom.* New York: Harper & Row Publisher.

Widodo, Bangkit Joko. 2016. "Analisis Epistemic Cognition Peserta Didik dalam Memecahkan Masalah Matematika Ditinjau dari Gaya Kognitif Field Dependent dan Field Independent Kelas XI SMA Negeri 1 Karanganam Tahun Ajaran 2015/2016." 18.

Wulandari, Fitria. 2015. "Profil Fungsi Kognitif Siswa Kelas V Sd Berkemampuan Matematika Rendah Dalam Memecahkan Masalah." *Fakultas Keguruan dan Ilmu Pendidikan Universitas Muhammadiyah Sidoarjo* 116.