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The Abstraction Task Design of Pre-Service Teachers to Constructing Relationships among Quadrilaterals

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Abstract
Abstraction is an essential aspect of mathematical thinking for students because, through abstraction, students will construct their knowledge to make learning more meaningful. This research aims to generate abstraction tasks in constructing relationships among quadrilaterals, which can create a construction in constructing them. The research method used in this study is the instrument development method adapted from Cohen et al. [1], [2]. *The stages of task development by* [1], [2]*contain five stages: test conceptualisation, test construction, test tryout, item analysis, and test revision. The subject-taking technique was purposive sampling. The subject of this study was a pre-service teacher of the mathematics education study program who had taken a geometry course in IKIP PGRI Pontianak West Kalimantan Indonesia. Data collection tools used were tasks, interviews, and video recordings. At the test construction stage, the researchers had three task drafts, and the third draft was a proper draft to proceed to the test tryout stage. The results of the tryout test were analysed, and it was found that the pre-service teacher could construct relationships among quadrilaterals.*

Index Terms— ***Abstraction, Constructing, Instrument Development, Relationships among Quadrilaterals.***

1. INTRODUCTION

Abstraction is one of mathematical thinking [3], [4], which is undoubtedly important to be mastered by students and pre-service teachers [5], [6], [7], [8] because, through abstraction, students will find or construct the knowledge learned. However, some students still have difficulty with abstraction [9]. This is because the object of study of mathematics itself is abstract. Students should always carry out abstraction activities with the guidance and direction of teachers in learning mathematics so that learning is more meaningful [8]. This fits the view of Gravemeijer [10] that mathematics is seen as an activity, a way of working. Learning math means doing math, and solving everyday problems is essential. Dreyfus [11] and Hershkowitz et al. [12] *define abstraction as an activity vertically reorganising mathematics that was previously built into a new mathematical structure*. Thus, student abstraction activities will work well if they already have prior knowledge as a condition for discovering or constructing new, more complex knowledge.

Abstraction activity can be studied from epistemic action. Epistemic action is a mental action used to construct knowledge [12]. These actions can be observed in the speech and actions of students with artefacts, gestures used, and others [13]. The epistemic actions are RBC, *recognising, building-with* and *constructing* [12]. The research was then developed independently by Dreyfus et al. [14], which uncovers the essential elements of the three epistemic acts and adds +C *consolidation*. This epistemic action is known as RBC+C.

Recognising occurs when a person realises that a previously constructed and stored memory structure is related to the current problem [15]. *Building-with* combines existing elements to fulfil a purpose, such as solving a problem or justifying a statement [15], [16]. *Constructing* is the restructuring of knowledge, which is the goal [15], or the processes of restructuring and reorganisation that are recognised and known to construct new meanings [17]. So, constructing is the essence of this abstraction process, allowing students to construct new structures they did not have before. *Consolidation* is a process that always continues where students are aware of the constructs that are carried out with constructs that are carried out quickly and clearly [14]. One branch of mathematics whose object of study is abstract is geometry.

Geometry is one of the bare branches in the field of mathematics education. Students must be able to master geometric concepts to support their understanding of more complex mathematics in the future, especially those related to geometry. One geometric concept that still needs to be solved for students is quadrilaterals or relationships among quadrilaterals [18], [19], [20]. Research results show that junior high school students still struggle to make relationships among quadrilaterals based on quadrilateral shapes [21]. In addition, when finding relationships among shapes, students begin with rectangles and squares. This happens because the teacher always starts learning quadrilaterals from squares and rectangles [21]. Pre-service teachers also encountered the difficulties experienced by students. They were misconceptions, especially in the relationship among quadrilaterals [22], [23], [24].

Quadrilateral concepts and relationships among quadrilaterals are essential for undergraduate students because quadrilaterals are one of the requirements for studying spatial material. The difficulties experienced by students in understanding the relationships among quadrilaterals need to be followed up, especially in studying abstraction in constructing relationships among quadrilaterals. There has been previous research related to the construction of relationships among quadrilaterals [21], [25], [26], [27], but the researchers did not include what kind of auxiliary instrument used. Apart from that, researchers have yet to find any articles in Indonesia or foreign regarding abstraction tasks in relationships among quadrilaterals.

In constructing a concept, there must be an instrument that helps students construct the concept. The development of the instrument needs to be done to provide an overview to the researcher of whether the task given triggers constructing the concept. This research is a preliminary study in a dissertation that researchers will carry out. The results of this preliminary research become a record and evaluation in conducting further research related to abstraction, especially in developing instruments. Thus, this preliminary research aims to create an abstraction instrument for constructing the relationship among quadrilaterals and to determine whether the tasks made by the researcher can bring out the abstraction of students in constructing them.

2. Research Method

A. *Research Procedures*

The research method used in this study adapted the instrument development research proposed by [1], [2]: *test conceptualisation, test construction, test tryout, item analysis, and test revision.* The stages in the development of the instrument proposed by Cohen et al. [1], [2] can be seen in Figure 1.

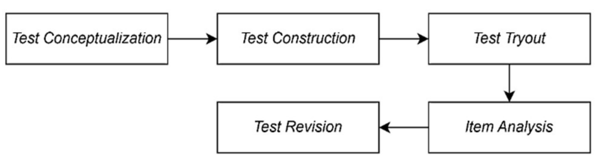


Figure 1. Instrument development Stages by Cohen et al. [1], [2]

Test conceptualisation is studying the importance of developing abstraction tasks. At the conceptualisation test stage, the researcher can answer one of the questions: "What tasks are they designed to measure?" what is the purpose?". Also, at this stage, the researcher reviews the literature to produce conceptual and operational definitions. Furthermore, from the operational definition, a task grid is created. *Test construction*: At this stage, the researcher makes tasks and validates them. The task validator in this study was the researcher's supervisor himself. After the instrument is valid, the tasks are tested on research subjects. *Test tryout*: After the tasks are validated, the tasks are tested on the subject. *Item analysis*: After the results of this trial, the researcher analyses the results to determine whether the tasks trigger the emergence of abstractions. *Test revision*: At this stage, the researcher will see the item analysis results, which need to be revised. The instruments are arranged based on operational definitions of epistemic actions: *recognising, building-with*, *constructing*, and *consolidation* (RBC+C).

B. *Participants*

In this case, the researcher tested it on a pre-service teacher from IKIP PGRI Pontianak, Indonesia. This subject-taking technique uses a purposive technique in which the subject-taking is based on the criteria of the researcher: participant who has taken basic geometry courses and is willing to be interviewed. When testing the task, the researcher used interviews to assist the tasks in constructing the relationships among quadrilaterals. The Interview was conducted in the form of task-based interview.

3. Results and Discussion

This research aims to determine whether the instrument created can trigger the emergence of abstractions in constructing relationships among quadrilaterals. The stages in this development adapt to the steps of task development proposed by [1], [2].

Conceptualisation test

At this stage, researchers reviewed the abstraction and epistemic action literature. Epistemic action is a mental action used to construct knowledge [12]. These actions can be observed in the speech and actions of students with artefacts, gestures used, and others [13]. The epistemic actions are RBC: recognising, building-with, and constructing [12]. Dreyfus et al. uncover the essential elements of the three epistemic actions and add +C consolidation (Dreyfus et al., 2015). The operational definition of RBC+C epistemic action can be seen in Table 2.

Table 1. Operational Definitions of RBC+C Epistemic Action Used in Research [8]

No	Epistemic Action	Operational Definition
1	*Recognising*	Remembering the previous construct (properties/definition of each quadrilateral) related to the task given (relationships among quadrilaterals)
2	*Building-with*	Combining existing elements (properties/definitions of each quadrilateral) to develop a new concept (relationships among quadrilaterals).
3	*Constructing*	Reorganising previous constructs (properties/definitions of each quadrilateral) into a new structure/producing a new concept (relationships among quadrilaterals).
4	*Consolidation*	Strengthen the knowledge that has been formed and provide convenience in further activities.

Test Construction

After the operational definition was made according to Table 1, the researcher compiled the tasks. The following is a draft of task 1 made by the researcher.

1. Make definitions of parallelograms, rectangles, rhombuses, squares, trapezoids, and kites using the side attribute!
2. Make definitions of parallelograms, rectangles, rhombuses, squares, trapezoids, and kites using the diagonal attribute!
3. Make a relationship among the quadrilaterals in the picture or Venn diagram using the side attributes: parallelogram, kite, rectangle, trapezoid, square, and rhombus!
4. Make a relationship among the quadrilaterals in the picture or Venn diagram using the diagonal attributes: parallelogram, kite, rectangle, trapezoid, square, and rhombus!

Based on input from the validator, the tasks must be structured by recognising, building-with, and constructing. Tasks should also be made individually from parallelograms, rectangles, rhombuses, squares, kites, and trapezoids. In addition, the validator also requested a task to prove the equivalence of the two definitions made by the subject so that the 2nd task draft was formed.

Table 2. 2nd Draft Task in Constructing Inter-Quadrilateral Relationships

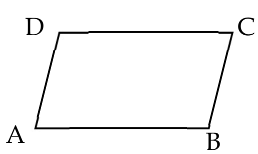
A	1.	a.	Make a definition of a parallelogram using the side attribute!
		b.	Make a definition of a parallelogram using the diagonal attribute!
		c.	Show that the two definitions are equivalent!
	2.	a.	Define a rectangle using the side attribute!

b. Define a rectangle using the diagonal attribute!

3. a. Make a rhombus definition using the side attribute!
   b. Make a definition of a rhombus using the diagonal attribute!
4. a. Define a square using the side attribute!
   b. Define a square using the diagonal attribute!
5. a. Make a kite definition using the side attribute!
   b. Make a kite definition using the diagonal attribute!
   c. Show that the two definitions are equivalent!
6. a. Make the definition of a trapezoid using the side attribute!
   b. Make the definition of a trapezoid using the diagonal attribute!
   c. Show that the two definitions are equivalent!

B. 1. Make a relationship among the quadrilaterals in a chart or Venn diagram using the side attributes: parallelogram, kite, rectangle, trapezoid, square, and rhombus!
   2. Make a relationship among the quadrilaterals in a chart or Venn diagram using the diagonal attributes: parallelogram, kite, rectangle, trapezoid, square, and rhombus!

C. Show that determining the area of the shape below can be solved by using the trapezoid formula!



The validator corrected the second draft of the task in Table 2. He gives suggestions to make tasks structured so that the subject would be easier to construct later—for example, starting with remembering the shapes of quadrilaterals. Next, get to know the properties of parallelograms from the sketches made. In the next rectangle task, the subject is asked to relate the properties of a rectangle and a parallelogram so that the subject can later construct that a rectangle is a parallelogram—likewise, others such as rhombus, square, kite, and trapezoid. The results of the revised draft of task 2 can be seen in Table 3 (draft 3). This 3rd task draft is a draft that will be tested on the subject. Draft 3 contains R for recognising, B for building-with, C for constructing, and +C for consolidation. One task is to include RB, RBC, and RBC+C because in constructing (C), a concept must pass through R and B, but RBC is not hierarchical. This means that after B, it might return to R [13].

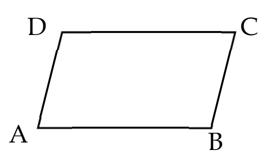
Table 3. 3rd Task Draft to Construct Relationships among Quadrilaterals

1. a. What do you know about quadrilaterals? (R)
   b. Define a quadrilateral based on the diagonal attribute! (B)
   c. Name the types of quadrilaterals! (R)
2. a. What do you know about parallelograms? (R)
   b. Sketch a parallelogram and label it! (R)
   c. Based on the sketch you made, state the properties of the parallelogram! (RB)
   d. Make another definition of a parallelogram using the side attribute! (RB)
   e. Show that the two definitions are equivalent! (RBC)
   f. Make a definition of a parallelogram using the diagonal attribute! (RBC)

	g.	Show that the two definitions (side attribute and diagonal attribute) are equivalent! (RBC)
3.	a.	What do you know about rectangles? (R)
	b.	Sketch a rectangle and label it! (R)
	c.	Based on the sketch made, state the properties of the rectangle! (RB)
	d.	Define another rectangle using the side attribute! (R)
	e.	Define a rectangle using the diagonal attribute! (RBC)
	f.	Mention the properties of a rectangle that a parallelogram has! (RB)
	g.	Is a rectangle a parallelogram? Explain! (RBC)
4.	a.	What do you know about rhombus? (R)
	b.	Sketch a rhombus and label it! (R)
	c.	Based on the sketch, state the properties of the rhombus! (RB)
	d.	Make a rhombus definition based on the side attributes! (R)
	e.	Make a definition of a rhombus using the diagonal attribute! (RBC)
	f.	Mention the properties of a rhombus that a parallelogram has! (RB)
	g.	Is a rhombus a parallelogram? Explain! (RBC)
5.	a.	What do you know about the square? (R)
	b.	Sketch a square and label it! (R)
	c.	Based on the sketch, state the properties of the square! (B)
	d.	Define a square using the side attribute! (R)
	e.	Define a square using the diagonal attribute! (RBC)
	f.	Mention the properties of a square that a rhombus has! (RB)
	g.	Is a square a rhombus? Explain! (RBC)
6.	a.	What do you know about the kite? (R)
	b.	Sketch a kite and label it! (R)
	c.	Based on the sketch, state the properties of the kite! (RB)
	d.	Make a kite definition using the side attribute! (R)
	e.	Make a kite definition using the diagonal attribute! (RBC)
	f.	Show that the two definitions (side attribute and diagonal attribute) are equivalent! (RBC)
	g.	Mention the properties of the kite that the rhombus has! (RB)
	h.	Is a rhombus a kite? Explain! (RBC)
7.	a.	What do you know about the trapezoid? (R)
	b.	Sketch a trapezoid and label it! (R)

c. Based on the sketch, state the properties of the trapezoid! (RB)
d. Make the definition of a trapezoid using the side attribute! (R)
e. Make the definition of a trapezoid using the diagonal attribute! (RBC)
f. Show that the two definitions (side attribute and diagonal attribute) are equivalent! (RBC)
g. Are there any properties of a trapezoid that have a parallelogram? (RB)
h. Is a parallelogram a trapezoid? Explain! (RBC)

8. Make connections among parallelograms, rectangles, rhombuses, squares, kites, and trapezoids in Venn diagrams or a chart! (RBC)
9. Show that determining the area of the shape below can be solved by using the trapezoid formula! (RBC + C)



Test Tryout

Furthermore, the question was tested on a pre-service teacher of Mathematics Education at IKIP PGRI Pontianak Indonesia. The subject-taking technique used a purposive technique in which the subject-taking was based on the criteria of the researcher: the student to be selected was one student who had taken a basic geometry course and was willing to be interviewed.

Item Analysis

The following is an excerpt from the results of interviews between a researcher and a participant on the given tasks. The researcher only partially describes the results of answers or participant interviews in this paper, but only a few research data support the development of the task. The following is an excerpt from the researcher (S) interview results with the student (P). The purpose of developing tasks is to determine how the participant can construct relationships among quadrilaterals based on the tasks given and assisted by interviewing. Therefore, the analysis results in this article are only the final results of the task, namely questions 8 and 9, because questions 1 to 7 must be answered to solve questions 8 and 9. Furthermore, the participant (S) can construct relationships among these quadrilaterals in the task trials' final result. The results of the S abstraction in constructing relationships among quadrilaterals can be seen in Figure 2.

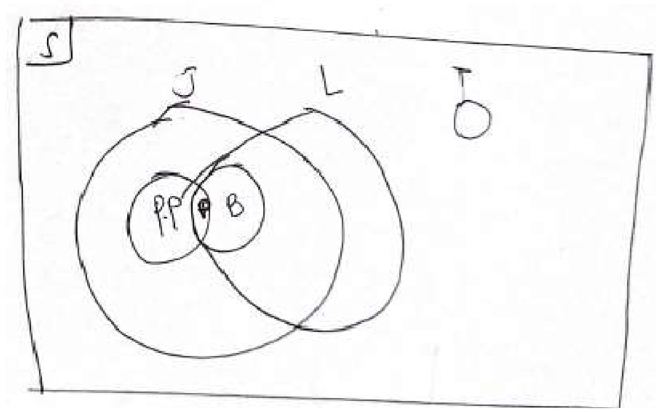


Figure 2. The results of the construction of the relations among the quadrilaterals

Based on Figure 2, S constructs by saying that a rhombus (B) is a parallelogram, a rectangle (PP) is also a parallelogram and a square (P) is a rhombus or rectangle. But kites and trapezoids are not parallelograms. Thus, based on Figure 2, square, rectangle, and rhombus are parallelograms. Square and rhombus are kites. This S construction result is obtained if a trapezium is defined as a quadrilateral with a pair of parallel sides. A trapezoid is a quadrilateral with exactly one pair of parallel opposite sides [28], [29]. Following are some excerpts from the results of task-based interviews that researcher (P) conducted with S. The construction made by the S in Figure 2 is the same as the construction produced by previous research [8] and several expert opinions related to the relationship between quadrilaterals [30], [31].

1. P: Based on the picture you made, is the parallelogram a trapezium?
2. S: yes (C)
3. P: Is a kite a trapezoid?
4. S: no (C)
5. P: Is a kite a trapezoid?
6. S: No (C)
7. P: Are squares, rectangles, rhombuses and parallelograms trapezoids?
8. S: yes
9. P: Figure 2 is the construction result if the definition of a trapezoid is a quadrilateral with a pair of parallel opposite sides. What if a trapezium is defined as a quadrilateral with one pair of opposite sides parallel?
10. S: I have yet to meet such a definition.
11. P: What is the construction result if a trapezium is defined as a quadrilateral with a pair of parallel opposite sides?
12. S: (Student draws a figure, and the result is in Figure 3)
13. P: Based on Figure 3 you made, can you use the trapezoid formula to find the area of a parallelogram?
14. S: Yes, it does
15. P: It can be shown!
16. S: (the participant proves that to find the area of a parallelogram can use the trapezoid formula, and the results can be seen in Figure 2) (+C)
17. P: Do you hypothesise that all of the following apply?
18. S: Yes (+C)

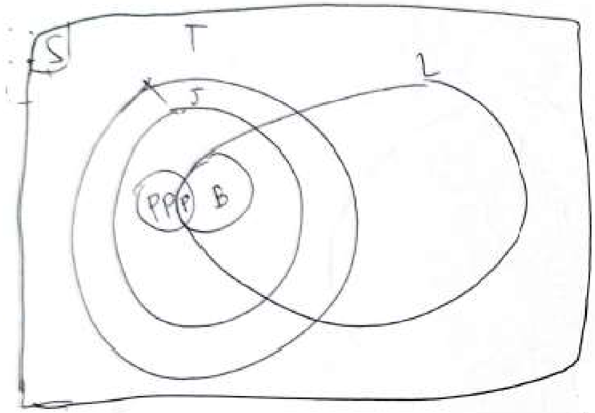


Figure 3. The results of the construction of the relations among the quadrilaterals

Based on Figure 3, S constructs by saying that a parallelogram (J) is a trapezoid (T), a rhombus (B) is a parallelogram, a rectangle (PP) is also a parallelogram and a square (P) is a rhombus, rectangle, and kite (L). Thus, based on Figure 3, square, rectangle, rhombus, and parallelogram are trapezoids. Square and rhombus are kites. This S construction is obtained if a trapezium is defined as a quadrilateral with a pair of parallel sides. A trapezium is a quadrilateral with two parallel opposite sides [28]. The construction made by the subject in Figure 3 is also the same as the construction produced by previous research [8] and several expert opinions related to the relationship among quadrilaterals [30], [31].

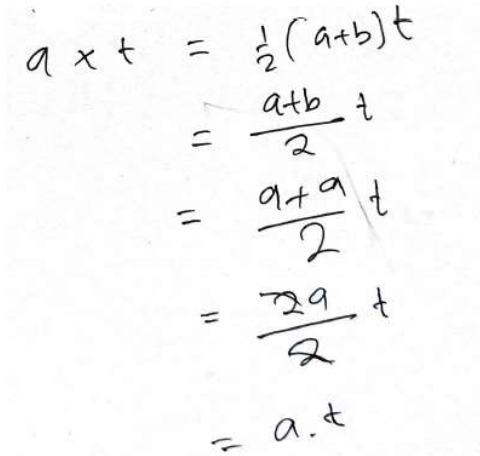


Figure 4. Participant Consolidation Result

After S can construct relationships among quadrilaterals, S can also apply the new concept to the next problem to strengthen what S has previously constructed. S said that a parallelogram is a trapezoid, and S could show that the area of a parallelogram can be found using a trapezoid, and the results can be seen in Figure 4. This activity is included in the consolidation. *Consolidation* is characterised by reorganising previous constructs with higher confidence while utilising earlier constructs in new activities [32]. The construct formed by students should provide an opportunity to consolidate knowledge [32], [33]. Therefore, construct results made by S can be used for further abstraction or problem-solving.

Test Revision

The *test tryout* results show that the developed tasks trigger the abstraction in constructing relationships among quadrilaterals. The abstraction task developed can bring up RBC+C epistemic actions. Participants in the study were not seen based on the geometry ability of the participants. Therefore, it is necessary to do further research by testing it on participants' low, medium, and high geometry abilities to obtain suitable tasks. A good abstraction task can trigger high, medium, and low student abstractions, especially in constructing relationships among quadrilaterals.

4. Conclusion

Based on the research results, discussion, and stages in the development of this task, the abstraction task developed to construct relationships among quadrilaterals can trigger pre-service teacher abstraction. However, the challenging task must be assisted by interviews as an auxiliary instrument. These results indicate that the tasks developed can generate abstractions in constructing relationships among quadrilaterals. The epistemic action of RBC+C is also seen when students construct the relationships among these quadrilaterals.

5. Recommendation

Subsequent trials need to pay attention to the level of pre-service teacher ability, such as high, medium or low ability, so that the results of this task can be studied in more depth based on participant abilities. The development of abstraction task instruments in constructing relationships among quadrilaterals can be continued by testing them on senior or junior high school students. Still, the tasks must be revised based on their curriculum. Besides that, further research can be done to develop abstraction tasks on other mathematical concepts.

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REFERENCES

[1] R. J. Cohen, M. E. Swerdlik, and E. D. Sturman, *Psychological Testing and Assessment An Introduction to Tests and Measurement (Eighth Edition)*. United States of America: The McGraw-Hill Companies, 2013.

[2] R. J. Cohen, W. J. Schneider, and R. M. Tobin, *Psychological Testing and Assessment An Introduction to Tests and Measurement (Tenth Edition)*. United States of America: The McGraw-Hill Companies, 2022.

[3] M. Isoda and S. Katagiri, *Mathematical thinking: How to develop it in the classroom*, vol. 1. World Scientific, 2012.

[4] R. Yilmaz and Z. Argun, “Role of visualization in mathematical abstraction: The case of congruence concept,” *Int. J. Educ. Math. Sci. Technol.*, vol. 6, no. 1, pp. 41–57, 2018, doi: 10.18404/ijemst.328337.

[5] E. Kiliçoğlu and A. Kaplan, “An examination of middle school 7th grade students’ mathematical abstraction processes,” *J. Comput. Educ. Res.*, vol. 7, no. 13, pp. 233–256, 2019, doi: 10.18009/jcer.547975.

[6] M. F. Ozmantar and J. Monaghan, “A dialectical approach to the formation of mathematical abstractions,” *Math. Educ. Res. J.*, vol. 19, no. 2, pp. 89–112, 2007, doi: 10.1007/BF03217457.

[7] D. S. Memnun, B. Aydın, Ö. Özbilen, and G. Erdoğan, “The abstraction process of limit knowledge,” *Kuram Ve Uygulamada Egitim Bilim.*, vol. 17, no. 2, pp. 345–371, 2017, doi: 10.12738/estp.2017.2.0404.

[8] Hodiyanto, M. T. Budiarto, R. Ekawati, G. Susanti, K. Jeonghyeon, and E. Bonyah, “How abstraction of a pre-service teacher in constructing relationships among quadrilaterals,” *J. Math. Educ.*, vol. 15, no. 2, pp. 337–360, 2024, doi: https://doi.org/10.22342/jme.v15i2.pp339-362.

[9] B. Van Oers and M. Poland, “Schematising activities as a means for encouraging young children to think abstractly,” *Math. Educ. Res. J.*, vol. 19, no. 2, pp. 10–22, 2007, doi: 10.1007/BF03217453.

[10] Gravemeijer, *Developing Realistic Mathematics Education*. Utrecht: Kluwer Academic Publishers, 1994.
[11] T. Dreyfus, "Processes of abstraction in context the nested epistemic actions model," *J. Res. Math. Educ.*, vol. 32, no. 2, 2007.
[12] R. Hershkowitz, B. B. Schwarz, and T. Dreyfus, "Abstraction in context: epistemic actions," *J. Res. Math. Educ.*, vol. 32, no. 2, pp. 195–222, 2001, doi: 10.2307/749673.
[13] A. Bikner-Ahsbahs, "The research pentagon: a diagram with which to think about research," In Compend., Cham: Springer, 2019, pp. 153–180.
[14] T. Dreyfus, R. Hershkowitz, and S. Baruch, "The nested epistemic actions model for abstraction in context: theory as methodological tool and methodological tool as theory," in *Approaches to qualitative research in mathematics education: examples of methodology and methods. Advances in mathematics education series*, no. March, A. Bikner-Ahsbahs, C. Knipping, and N. Presmeg, Eds., Dordrecht: Springer, 2015, pp. 185–217. doi: 10.1007/978-94-017-9181-6.
[15] T. Dreyfus, R. Hershkowitz, and B. Schwarz, "Abstraction in context: The case of peer interaction," *Cogn. Sci. Q.*, vol. 1, no. 3, pp. 307–368, 2001.
[16] D. Jirotková and G. H. Littler, "Classification leading to structure," in *Building structures in mathematical knowledge*, CERME 4, 2005, pp. 321–331.
[17] A. Bikner-Ahsbahs, "Towards the emergence of constructing mathematical meaning," *Proc. 28st Conf. Int. Group Psychol. Math. Educ.*, vol. 2, pp. 119–126, 2004.
[18] H. L. Ma, D. C. Lee, S. H. Lin, and D. B. Wu, "A study of Van Hiele of geometric thinking among 1 st through 6 th Graders," *Eurasia J. Math. Sci. Technol. Educ.*, vol. 11, no. 5, pp. 1181–1196, 2015, doi: 10.12973/eurasia.2015.1412a.
[19] D. Wu and H. Ma, "a Study of the Geometric Concepts of Elementary," *Proc. 29th Conf. Int. Group Psychol. Math. Educ.*, vol. 4, pp. 329–336, 2005.
[20] D.-B. Wu and H.-L. Ma, "The distributions of van Hiele levels of geometric thinking among 1st through 6th graders," *Proc. 30th Conf. Int. Group Psychol. Math. Educ.*, vol. 5, pp. 409–416, 2006.
[21] S. Agustan, "Analyzing Student's Understanding The Relationship Between Quadrilateral at The Early Formal Stage," in *Proceeding of ICERD*, 2015, pp. 501-508.
[22] A. Braconne-Michoux, "Which Geometrical Working Spaces for the for the Primary School Preservice Teachers ?," in *Proceedings of the 28st Conference of the International Group for the Psychology of Mathematics Educationthe EightŠ Congress of the European Society for Research in Mathematics Education*, Ankara, Turkey: Middle East Technical University, 2013, pp. 1–11.
[23] T. Fujita and K. Jones, "Primary trainee teachers' understanding of basic geometrical figures in Scotland," *Proc. 30th Conf. Int. Group Psychol. Math. Educ.*, vol. 3, pp. 129–136, 2006.
[24] T. Fujita, "Learners' level of understanding of the inclusion relations of quadrilaterals and prototype phenomenon," *J. Math. Behav.*, vol. 31, no. 1, pp. 60–72, 2012, doi: 10.1016/j.jmathb.2011.08.003.
[25] M. T. Budiarto, "Profil Abstraksi Siswa SMP dalam Mengkontruksi Hubungan antar Segiempat," (Disertasi tidak diterbitkan), Universitas Negeri Surabaya, Surabaya, 2006.
[26] M. T. Budiarto, E. B. Rahaju, and S. Hartono, "Students abstraction in re-cognizing, building with and constructing a quadrilateral," *Educ. Res. Rev.*, vol. 12, no. 7, pp. 394–402, Apr. 2017, doi: 10.5897/ERR2016.2977.
[27] E. Turnuklu, "Construction of Inclusion Relations of Quadrilaterals: Analysis of Pre-Service Elementary Mathematics Teachers' Lesson Plans," *Egitim Ve Bilim-Educ. Sci.*, vol. 39, no. 173, pp. 198–208, 2014.

[28] Z. Usiskin, *The classification of quadrilaterals: A study in definition*, no. 93. United States of America: IAP, 2008.
[29] D. C. Alexander and G. M. Koeberlein, *Elementary Geometry for College Students, Seventh Edition*. United States of America: Cengage, 2020.
[30] Hodiyanto, M. T. Budiarto, and R. Ekawati, *Abstraksi dan Semiotik (Kajian Abstraksi dalam Perspektif Semiotik) [Abstraction and Semiotics (Study of Abstraction in a Semiotic Perspective)]*. Pontianak: PT. Putra Pabayo Perkasa, 2023.
[31] A. A. Popovici, "Relation of Carl Menger's philosophy of economics to Auguste Comte's positivism," *J. Philos. Econ. Reflect. Econ. Soc. Issues*, vol. 15, no. 1, pp. 158–195, 2021, doi: 10.46298/JPE.10033.
[32] H. K. Güler and Ç. Arslan, "Consolidation of Similarity Knowledge via Pythagorean Theorem: A Turkish Case Study," *Acta Didact. Napoc.*, vol. 10, no. 2, pp. 67–80, 2017, doi: 10.24193/adn.10.2.6.
[33] M. Tabach, R. Hershkowitz, and B. Schwarz, "Constructing and Consolidating of Algebraic Knowledge within Dyadic Processes: A Case Study," *Educ. Stud. Math.*, vol. 63, no. 3, pp. 235–258, 2006, doi: 10.1007/s10649-005-9012-2.