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Didactic Design on the Circumference and Area of Plane in Grade 4 Elementary Education

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Abstract. Geometry becomes very important material for students in elementary school, because it can encourage students to be able to think critically and solve problems in everyday life. One of the geometry materials taught in 4th grade elementary school is understanding about the circumference and area of plane. This study aims to develop a didactic design on the circumference and area of plane in grade 4 elementary school. This research used the research design method with the development method of didactical design research (DDR), the researcher conducted an obstacle learning test for students to see the obstacles experienced by students in understanding the circumference and area of plane, learning obstacle is used as material in making a learning trajectory which can then be used in developing didactic designs, so this research resulted in a hypothetical didactic design of the circumference and area of plane in grade 4 elementary school

Keywords: didactic design, *learning obstacle*, *learning trajectory*, circumference and area of plane

INTRODUCTION ~ Mathematics is one of the most important subjects to learn, even mathematics has been taught starting from basic education to higher education (Sumartini, 2018), this is needed to enable children to obtain the knowledge and skills needed in everyday life (Deringol, 2018), even in achieving 21st century educational goals, mathematics is one that must be taught to students (Gravemeijer et al., 2017), because every human being will not be separated from mathematical activities (Sutisna & Subarjah, 2016). Mathematics is also seen as a problem solving and this will train students' creativity (Novita & Putra, 2016). According to Baykul in (Unlu et al., 2017) that mathematics is a very important

tool learned by students which is used to solve problems in the fields of science and various fields in daily life.

The learning objectives of mathematics according to (Kemendikbud, 2013) are 1) improving intellectual abilities, especially students' higher-order thinking skills, 2) forming students' abilities in solving problems systematically, 3) obtaining high learning outcomes, training students in communicating ideas, especially in writing scientific papers, and 5) developing student character. One way to achieve the goals of mathematics learning is to create an effective learning process that allows students to be able to build their knowledge independently. However, some students still view



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mathematics as a very complicated subject and difficult to understand (Markovits & Forgasz, 2017; Sundari, 2019), this is based on the fact that most mathematical concepts and procedures contain many rules and algorithms (Akhter et al., 2015), coupled with learning mathematics at school so far delivered informatively, meaning that students only get information from the teacher so the degree of attachment can also be said to be low. This is what causes mathematics learning to be less meaningful because students as subject of learning are less involved in discovering the concepts of the lesson that must be mastered (Turmudi, 2008), whereas according to (Reys et al., 2014) there are three main principles applied in imparting knowledge, among them are as 1) knowledge is not received passively, 2) Students create new mathematical knowledge through reflection on physical and mental activities, and 3) Learning is a social process where students engage in discussions with themselves and others.

Geometry is one of the fields taught in mathematics that studies about points, lines, fields and space, as well as the properties, measurements, and linkages with one another (Nur'aini et al., 2017). According to Cherif et al (2017) that geometry is not only an important part in mathematics, but is an important part in everyday life, the basis of geometrical knowledge and understanding has

been taught starting from elementary school (Stumbles, 2018), even geometry becomes an important material in the mathematics curriculum (Gracin & Kuzle, 2018), it can be proven from the presentation of the 2013 curriculum basic competencies that the percentage of geometry material in elementary schools ranges from 40-50%. But geometry is a material that is difficult for students to understand, especially in the circumference and area of plane (Maryam et al., 2016), the material is taught in a flat structure in grade 4 elementary school, the circumference and area of a plane become prerequisites in understanding geometry material another.

According to (Goda et al., 2017) that in facing the challenges of the 21st century, teachers must find the right formula to be applied to students, this formula is related to the way students obtain knowledge in the learning process. The success of a student in understanding the context of the material being taught depends on the extent to which the learning process can be carried out well. The learning process involves various activities between students, the teacher and the learning environment itself, which then is controlled in the learning plan. The more mature the teacher plans the learning plan, the better the learning process. Callahn & Clark (Zendrato, 20016) state that teaching without written

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preparation will result in ineffective learning, this is based because the teacher does not think in detail about what will be done and how to do it. According to Suryadi, (2013) explained that teachers need to develop learning plans that view the learning situation as a whole and as a whole as a real object, so that it can create the dynamics of didactic or pedagogical changes in accordance with the capacity, needs, and acceleration of student learning processes. The reality is in the field that the learning design used by the teacher in the learning process is considered to be incompatible with the real conditions of students (Widya Saputri & Mawardi, 2018).

Didactical design research (DDR) is seen as a paradigm of learning innovation in providing solutions to the problem of the difficulty of teachers in making learning plans that fit the needs of students in the classroom, besides that didactical design research. According to Suryadi (2013) explained that to create an effective learning process, there are several things that should be the focus of attention, including students, teachers and material, these three things are the basic elements in learning activities, the three elements are described in a didactic situation.

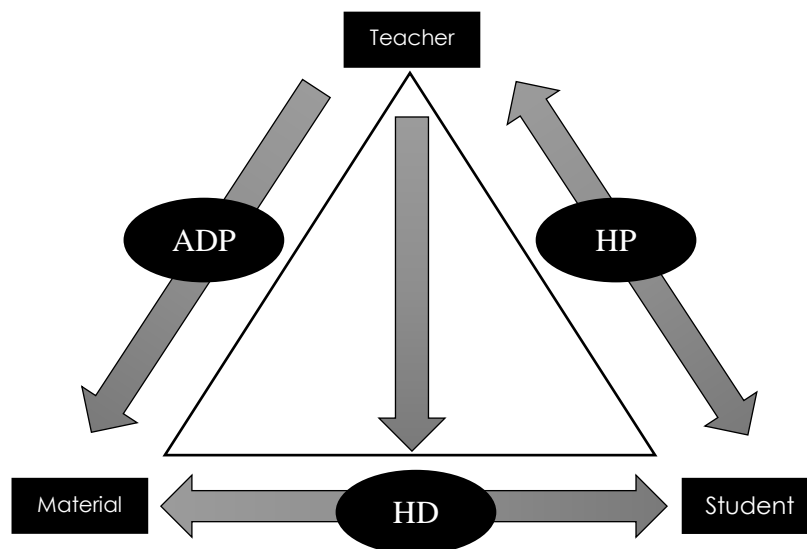


Figure 1. Three basic elements in learning

Information:

HD: Didactic relationship

HP: Pedagogical Relations

ADP: Anticipation of Pedagogical Didactic



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According to Mulyana et al (2014) that the main role of a teacher in the context of the didactic triangle above is to create a didactic situation so that the learning process occurs within students. According to NCTM (Yurniwati, 2019) explains that there are seven standards of mathematics teachers that must be mastered including 1) knowledge of mathematics and pedagogy, 2) knowledge of how to learn, 3) mathematical assignments, 4) learning environment, 5) learning process, 6) learning reflection students, and 7) reflection on the learning process. The seven standards are important mastered by the teacher in making learning plans, so that the results of the plan are very comprehensive.

This study will discuss didactic design on the circumference and area of plane in grade 4 elementary school based on learning obstacle and learning trajectory that appears on students, this research is expected to facilitate students to understand the material circumference and area of plane well without experiencing learning obstacle found in this study, besides this research is expected to be a reference for teachers in planning, implementing and evaluating mathematics learning, especially on the circumference and area of plane in grade 4 elementary school.

METHOD

This study uses a qualitative method with design development, according to Lestari & Mokhamad Ridwan Yudhanegara (2015) that qualitative research is methods to explore and understand the meaning by a number of individuals or groups of people ascribed to social or humanitarian problems, this method is used to express in detail about obstacle learning and student trajectory learning on the material of circumference and area of plane in grade 4 elementary schools, which subsequently become the basis for making didactic designs.

Development research (development research) is an inseparable part of design research (design research) which is used as one of the scientific methods in the world of education. design research aims to design / develop an intervention (such as programs, strategies and learning materials, products and systems) with the aim to solve complex educational problems and to develop knowledge (theory) about an characteristic of the intervention and the design and development process (Akker et al., 2013). The design developed in this study refers to the Didactical Design Research (DDR) stage.

This research was conducted at Elementary School Asmi 033 in Bandung. Participants in this study were grade 4

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students, totaling 26 students. Data collection is carried out as follows (1) Students are asked to answer individual obstacle learning test questions, (2) student workmanship in the form of scribbles in the form of supporting data written test results, (3) researchers take some answers students who experience obstacles learn to be interviewed. The

data that has been obtained is used as a basis in identifying learning obstacles, after that researchers can map learning trajectories that emerge so that they become material in the preparation of didactic designs on circumference and area of plane material in grade 4 elementary schools. The flow in this study is explained in the figure below.

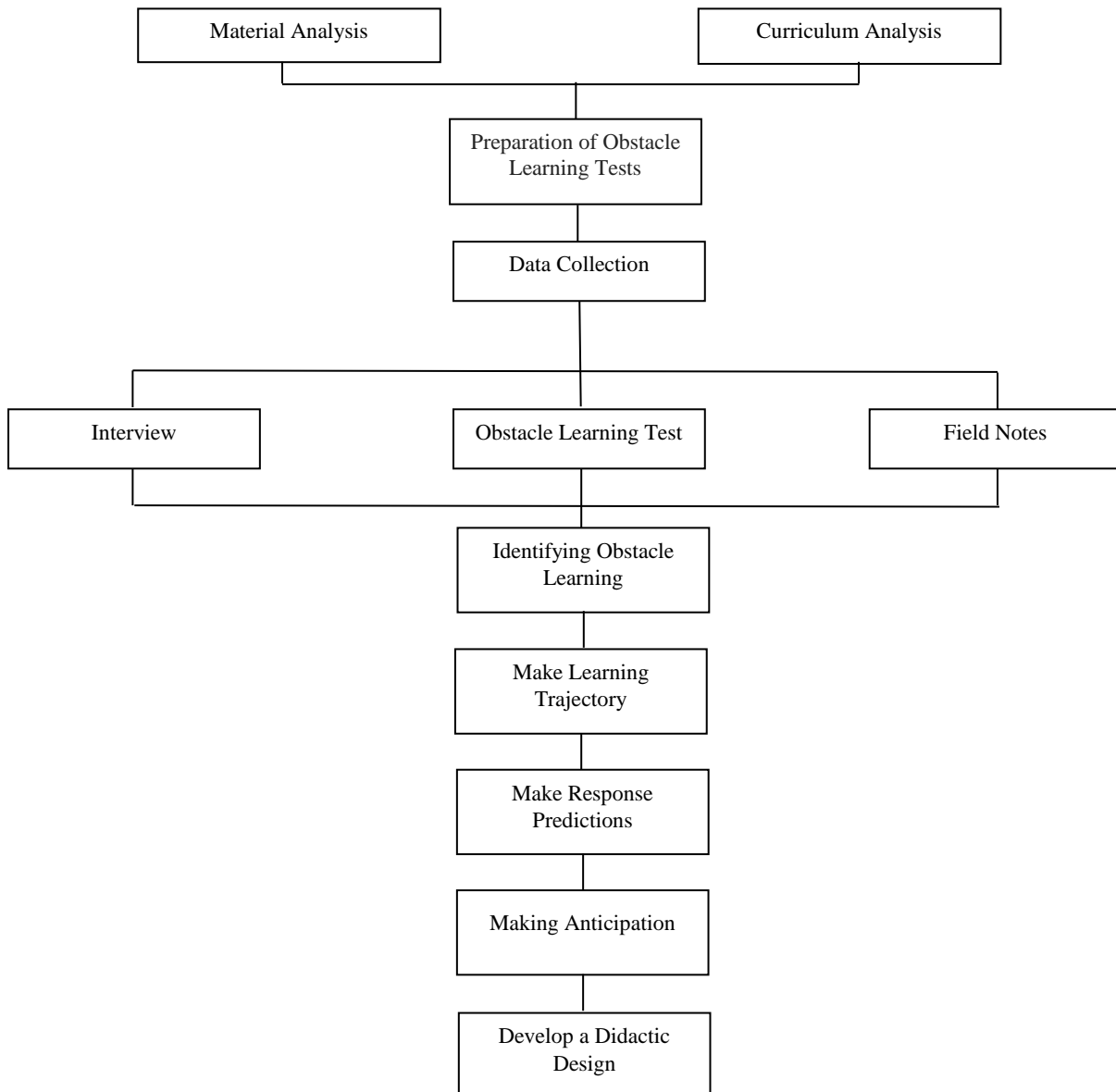


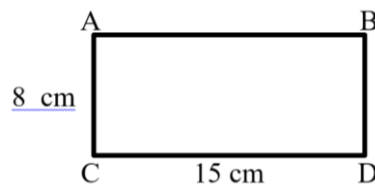
Figure 2. Research Flow

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RESULTS AND DISCUSSION

The results of interviews conducted with the 4th grade teacher of Elementary School Asmi 033 in Bandung that (1) geometry material has a lot of formulas so that this is difficult for students to understand, (2) Students whose understanding is still at a concrete operational stage must be taught complex geometry material within which there are many formal symbols and operations, this is the difficulty of students in understanding the material

geometry. This is the reason why it is difficult for students to understand geometry, especially the circumference and area of plane.

Meanwhile, to see the results of student obstacle learning, it will first be presented in the form of questions on the circumference and area of plane material. The first problem, students are given problems that they often get both in books and presented by the teacher in class, students are asked to find the circumference and area of plane.

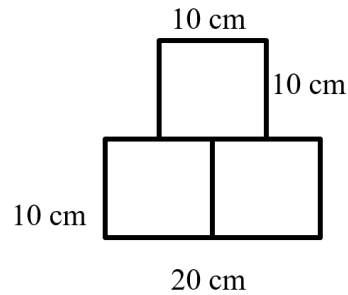


From the questions above, it shows that students who answer the circumference appropriately by using the standard unit for circumference are 9 students out of 26 students, while students who answer appropriately by using the standard unit for area are 2 students from 26 students. The obstacles experienced by students when answering the questions above are as follows:

1. Most students already understand the rules that apply, but when answering questions, there are still many students who do not list the default units or there are students who include the units but are reversed ie when students include centimeters (cm) as units of area.

2. Students are still fixated on the rules/formulas given by the teacher, this is seen when students forget the given rules, students use the wrong formula. This can be seen from the students' answers when answering the circumference of a plane using the rules of length times sides ($K = p \times s$), or there are also students who answer that the circumference of a plane is 2 times length times width ($K = 2 \times (p \times l)$).
3. Students are still constrained by calculating multiplication operations both in solving circumference and area of plane problem.

Meanwhile, the questions presented both related to finding a combination of flat shapes.



From the questions above, it shows that students who answer the circumference appropriately by using the standard unit for circumference are 4 students out of 26 students, while students who answer the area appropriately by using the standard unit for area are 1 student out of 26 students. The obstacles found in the problems above are almost the same as the obstacles in the first problem, while the other obstacles found are:

1. Students do not understand the concept of the circumference of a rectangle as a whole, students are still fixated on the formula ($K = 2(p + l)$), whereas in answering the circumference, students only add to the outer edge of the flat shape
2. Some students are not able to decipher into each flat shape separately to be able to solve the problem
3. Some students have been able to decipher into each flat shape separately to find area, but in the final stage, students are not able to deduce the actual answer.
4. Students are not able to understand the context of the questions

presented, this has an impact on students' inability to answer the questions.

The second question is made to see the extent to which students' understanding of the circumference and area of plane material, and the questions given to students are non-routine or that they do not usually find. According to Suryadi (2010) that when students are faced with problems that are different from usual, then most likely unexpected difficulties will arise.

After the learning obstacle is discovered, the researcher make the learning trajectory will be developed in the learning planning, while the learning trajectory that appears is:

1. Considering the properties of a plane
2. Teach the concept of the circumference and area of a plane using a tiling pattern
3. Find a formal formula from circumference and area of plane
4. Solve problems circumference and area of a plane

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The learning trajectory on the material of circumference and area of a plane can

be seen in the picture below:

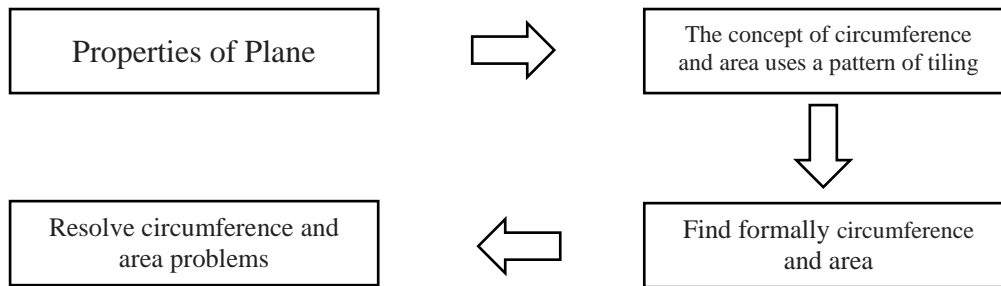
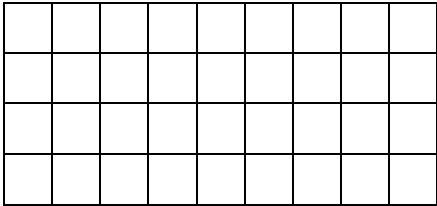



Figure 3. Patterns of Student Learning Trajectory on the Material of the circumference and area of a plane

The learning trajectory that has been formed is outlined in a lesson plan, while the lesson plan for the the material of circumference and area of plane in

grade 4 elementary school based on learning obstacle and learning trajectory is as follows:

Table 1. Lesson Design on Material of circumference and area of a plane

<i>Learning Objectives</i>	<i>Activity Description</i>	<i>Conjectors Students' Thought</i>
Students can mention the properties of plane	The teacher shows a plane paper, then asks students to name the properties of the plane	Students mention the properties of plane
Students can find concepts around and broad using patterns of change	The teacher encourages students to find the concept of the circumference and area of a plane using a patterning 	<ol style="list-style-type: none"> 1. Students count tiles that have been marked by the teacher 2. Students draw a tile pattern that is in a grid book 3. Students calculate the length of the outer edges and the inside of the tile 4. Students find the concepts circumference and area of rectangles
Students can find a formal formula for the crcumference and area of a plane	The teacher encourages students to formally formulate the circumference and area of a rectangle 	<ol style="list-style-type: none"> 1. Students draw a collection of squares that form a plane 2. Students develop ways to find the right answers to find the circumference and area of a plane

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		<p>3. Students find the circumference formula ($K = 2(p + l)$) and area ($L = p \times l$)</p>
<p>Students can solve problems of circumference and area of a plane</p>	<p>The teacher gives the context of the questions about the circumference and area of plane</p>	<p>1. Students look for relationships from these picture patterns 2. Students find the relationship between picture patterns that have been presented Students solve problems in various ways</p>

CONCLUSION

Didactic design was created to overcome emerging learning obstacles. Before making a lesson plan, there are several steps that must be done, one of them is to analyze the learning obstacle that appears and then compile a learning trajectory as material in making lesson plans. Lesson design that has been made into the material in the teacher's consideration in teaching in class, this lesson design is hypothetical and can be refined by various parties to be able to teach the circumference and area of the plane in grade 4 elementary school according to the capacity and needs of students, so students do not experience learning obstacle that appears in this study.

REFERENCES

Akhter, N., Akhtar, M., & Abaidullah, M. (2015). The Perceptions of High

School Mathematics Problem Solving Teaching Methods in Mathematics Education. *Bulletin of Education and Research*, 37(1), 55–77.

Akker, J. van den, Bannan, B., Kelly, A. E., Nieveen, N., & Plomp, T. (2013). *Educational Research: An Introduction* (T. Plomp & N. Nieveen (eds.)). SLO • Netherlands institute for curriculum development.

Cherif, A. H., Gialamas, S., & Stamati, A. (2017). Developing Mathematical Knowledge and Skills through the Awareness Approach of Teaching and Learning. *Journal of Education and Practice*, 8(13), 108–132. www.iiste.org

Deringol, Y. (2018). Primary School Students' Mathematics



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- Motivation and Anxieties. *Cypriot Journal of Educational Sciences*, 13(4), 537–548.
<https://doi.org/10.18844/cjes.v13i4.3462>
- Goda, Y., Yamada, M., Hata, K., Matsukawa, H., & Yasunami, S. (2017). Effects of Flipped Jigsaw Collaborative Learning on English as a Foreign Language Learning Anxiety Yoshiko. *Springer International Publishing AG 2017*, 10108, 225–239.
<https://doi.org/10.1007/978-3-319-52836-6>
- Gracin, D. G., & Kuzle, A. (2018). Drawings as external representations of children's fundamental ideas and the emotional atmosphere in geometry lessons. *Center for Educational Policy Studies Journal*, 8(2), 31–53.
<https://doi.org/10.26529/cepsj.299>
- Gravemeijer, K., Stephan, M., Julie, C., Lin, F. L., & Ohtani, M. (2017). What Mathematics Education May Prepare Students for the Society of the Future? *International Journal of Science and Mathematics Education*, 15, 105–123.
<https://doi.org/10.1007/s10763-017-9814-6>
- Kemendikbud. (2013). *Materi Pelatihan Guru Implementasi Kurikulum 2013*. Jakarta: Kementerian Pendidikan dan Kebudayaan.
- Lestari, K. E., & Mokhamad Ridwan Yudhanegara. (2015). *Penelitian Pendidikan Matematika*. Bandung: Refika Aditama.
- Markovits, Z., & Forgasz, H. (2017). "Mathematics is like a lion": Elementary students' beliefs about mathematics. *Educational Studies in Mathematics*, 96(1), 49–64.
<https://doi.org/10.1007/s10649-017-9759-2>
- Maryam, S., Hasbi, M., & Hamid, A. (2016). Penerapan Model Pembelajaran Kooperatif Tipe Course Review Horay Untuk Meningkatkan Hasil Persegi Panjang Di Kelas Vii Smp Negeri 2 Marawola. *Jurnal Elektronik Pendidikan Matematika Tadulako*, 4(1), 116–130.
- Mulyana, E., Ph.D., T., & Juandi, D. (2014). Model Pengembangan Desain Didaktis Subject Specific Pedagogy Bidang Matematika Melalui Program Pendidikan Profesi Guru. *Jurnal Pengajaran Matematika Dan Ilmu Pengetahuan Alam*, 19(2), 141.
<https://doi.org/10.18269/jpmipa.v19i2.454>
- Novita, R., & Putra, M. (2016). Using Task



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- Like PISA'S Problem to Support Student's. *Journal on Mathematics Education*, 7(1), 33–44.
- Nur'aini, I. L., Harahap, E., Badruzzaman, F. H., & Darmawan, D. (2017). Pembelajaran Matematika Geometri Secara Realistis Dengan GeoGebra. *Jurnal Matematika*, 16(2), 1–6. <https://doi.org/10.29313/jmtm.v16i2.3900>
- Reys, R., Lindquist, M., Lambdin, D. V., & Smith, N. L. (2014). *Helping Children Learn Mathematics, 11th Edition*. USA: Jhon Wiley & Sons.
- Stumbles, R. (2018). Dynamic Geometry Software within the Van Hiele Teaching Framework. *Australian Primary Mathematics Classroom*, 23(1), 25.
- Sumartini, T. S. (2018). Peningkatan Kemampuan Pemecahan Masalah Matematis Siswa melalui Pembelajaran Berbasis Masalah. *Mosharafa: Jurnal Pendidikan Matematika*, 5(2), 148–158. <https://doi.org/10.31980/mosharafa.v5i2.270>
- Sundari, S. (2019). Meningkatkan Hasil Belajar Siswa Dalam Pembelajaran Matematika Melalui Pendekatan Savi Pada Siswa Kelas Vb Sdit Al-Izzah Sorong. *Qalam: Jurnal Ilmu Kependidikan*, 5(2), 44. <https://doi.org/10.33506/jq.v5i2.260>
- Suryadi, D. (2013). *Didactical Design Research (DDR) dalam Pengembangan Pembelajaran Matematika* (A. Nurjaman, R. S. Ningsih, I. P. Sari, & G. Kadarisma (eds.); pp. 3–12). STKIP Siliwangi Bandung.
- Suryadi, D. (2010). *Menciptakan Proses Belajar Aktif: Kajian dari Sudut Pandang Teori Belajar dan Teori Didaktik*. 1–16. <https://doi.org/10.1016/j.solmat.2005.04.015>
- Sutisna, A. P., & Subarjah, H. (2016). Meningkatkan Pemahaman Matematis Melalui Pendekatan Tematik Dengan RME. 1(1), 31–40. <https://doi.org/10.23819/pi.v1i1.2929>
- Turmudi. (2008). *Landasan Filsafat dan Teori Pembelajaran Matematika (Berparadigma Eksploratif dan Investigatif)*. Leuseur Cipta Pustaka.
- Unlu, M., Ertekin, E., & Dilmac, B. (2017). Predicting Relationships between Mathematics Anxiety, Mathematics Teaching Anxiety, Self-efficacy Beliefs towards Mathematics and Mathematics



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- Teaching. *International Journal of Research in Education and Science*, 636–636.
<https://doi.org/10.21890/ijres.328096>
- Widya Saputri, A. T., & Mawardi, M. (2018). Pengembangan Desain Pembelajaran Tematik Integratif Berbasis Pendekatan Contextual Teaching and Learning (CtI) Kelas 4 Sekolah Dasar. *Jurnal Ilmiah Pendidikan Dasar*, 4(2), 104.
- <https://doi.org/10.30659/pendas.4.2.104-114>
- Yurniwati. (2019). *Pembelajaran Aritmatika di Sekolah Dasar*. Bandung: PT Remaja Rosdakarya.
- Zendrato, J. (2016). Tingkat Penerapan Rencana Pelaksanaan Pembelajaran di Kelas Suatu Studi Kasus di SMA Dian Harapan Jakarta. *E-Jurnal UKSW*, 6(2), 58–73.