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Development of Handout Media to Facilitate the Problem-Solving Abilities of Algebraic Functions Derivative for Class XI High School Students

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Abstract
The aim of this study is to develop valid, practical, and handout media effectof. This type of study is research and development. This research uses Plom model which consists of five phases, namely preliminary investigation, design, realization/construction, test, evaluation and revision, and implementation. Subject in this study includes experts, teachers and 15 students of class XI Mathematics and Natural Sciences at one of the Senior High Schools in Kefamenanu city, Indonesia. The data collection techniques used were questionnaires and tests. The validator consists of one lecturer in mathematics education and one mathematics teacher who assessed the quality of the handout media and the results of the assessment were declared valid. The level of practicality after being tested on students obtained a presentation score 83.49% so it is categorized as very practical, and also based on effectiveness test results obtained 81% of student grades in the very effective category. Thus, you can It was concluded that the handout media developed could facilitate solving ability's algebraic function derivative problems are very valid, very practical, and very effective.

Keywords: Problem-Solving Ability, Media Handout; Algebraic Functions Derivation

1. INTRODUCTION

Mathematics needs to be studied by everyone, because mathematical knowledge is very necessary in solving the problems they face (Zulfiah, 2017). Mathematics is a universal science that underlies the development of modern technology, has an important role in various disciplines and advances human thinking (Kasri, 2018). This is also supported by Sholikhah et al., (2018) who state that education has a very important role in creating humans who have the quality of new innovations with advances in science and technology. Mathematics subjects need to be given to all students starting from elementary school to equip students with logical, analytical, systematic, critical and creative thinking skills, as

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well as the ability to work together. Therefore, learning mathematics must go from a simple process to a more complex one.

Mathematics learning aims to develop all students' mathematical abilities in obtaining maximum mathematics learning outcomes. An important target in achieving these learning outcomes is to maximize learning on problem-solving abilities. According to Silalahi (2021), one of the abilities that is very necessary in learning mathematics is problem-solving abilities which are still the center of attention in mathematics learning (Yustianingsih, Syarifuddin & Yerizon, 2017). This was also stated by Siregar et. al., (2021) that problem-solving ability is the heart of mathematics. This suggests that the heart is the core of mathematics, so it cannot be separated from the mathematics learning process. Problem-solving is also a form of mental activity which consists of various kinds of skills and cognitive treatment of students (Sampini, et. al., 2021). Polya stated that problem-solving is an effort to resolve a problem, to achieve a goal (Anita et. al., 2021). Problem-solving abilities related to learning material are derivatives of algebraic functions. Derivation of algebraic functions is one of the materials that presents many in-depth and abstract concepts. According to Delyana (2015), problem-solving ability is the ability to apply previously acquired knowledge to new, unknown situations. More than that, problem-solving is the main goal of learning mathematics (Son & Fatima, 2020)

Previously, students had received knowledge from the teacher, so that students who had problem-solving abilities were able to apply appropriate strategies when solving mathematical problems. Students need to master problem-solving skills because they can find patterns in mathematics, apply rules in mathematics through problem-solving activities. According to Indriani & Maryati (2021) mathematical problem-solving ability is the ability of students to solve or solve problems in the form of non-routine questions. Problem-solving abilities not only require students to solve problems in the usual way according to existing formulas, but more so on the ability to simplify

The information that researchers found through interviews conducted with a mathematics teacher and one of the students at one of the high schools in Kefamenanu was that mathematics learning in high schools generally uses textbooks. Apart from that, there are still many students who are not interested in studying mathematics, students find mathematics difficult to understand, students have difficulty memorizing and using formulas, teachers only give questions in textbooks without explaining the material being studied, and students still take notes on the material. in books, as well as incomplete teaching materials, students want to have teaching materials that are more interesting and easier to understand without having to re-note the material studied. This situation causes students not to be able to learn optimally during class and has an impact on decreasing their learning achievement.

One of the mandatory material topics at high school level is the derivative of algebraic functions. The students who were observed also had difficulty learning on this material topic. Because the topic of this material is subject matter that has just been studied by high school students. This problem has been proven through research by Prihandika, Hidayah, Susilo & Dewi (2023) that most students still make mistakes in solving algebraic function derivative problems.

Based on this problem, a handout was developed in the hope that it can help students understand the material and can help students obtain alternative handbooks other than the current textbooks. Handouts must have form, content and method presentation of material that attracts students' interest in viewing, opening and then reading the teaching material. The handouts developed are very important to support the academic achievement of students and can influence the quality of teaching during learning carried out by teachers. In creating this learning situation, you must pay attention to the components of the learning system, including: objectives, materials, methods or strategies, media and evaluation. The components of this system cannot be separated so they must be one unit. The existence of media and learning resources in learning is one of the learning components that must exist. Without media and learning resources students cannot learn. In addition, media or learning

resources are able to make learning more meaningful and as a means to make it easier for students to learn.

According to Rozalia, et al (2018) Handouts are printed teaching materials that are used in learning to make it easier for students to learn. The content of the material is developed in accordance with learning objectives and is presented concisely. So, handouts are made with the aim of expediting the learning process, as material for students to use and to support the delivery of material from the teacher. The packaging of the handout material is presented concisely and clearly according to the learning objectives so that students can easily understand and remember it. Handouts as teaching materials are unique compared to other teaching materials. This uniqueness is based on its characteristics, namely: 1) handouts are printed materials capable of presenting information to students, 2) they are closely related to learning materials and 3) their substance can be in the form of complete notes or conceptual frameworks, tables, diagrams, maps and supporting materials. Another unique thing about handouts compared to other printed teaching materials is their structure, namely that they only have 2 (two) elements or components. First, the identity of the handout at least includes the name of the educational institution, class, name of the learning unit, handout to -, meeting to -, and validity of the handout. Second, the main material or supporting material that will be delivered (Febrianto, 2018). Furthermore, the substance of the handout contains an explanation of the main material, exercises and/or activities for students, feedback on follow-up steps. In this way, the arrangement in learning is able to arouse enthusiasm for learning.

Based on the description of the problem, research was conducted with the aim of 1) developing valid handout media, 2) developing practical handout media, and 3) developing effective handout media to facilitate the ability to solve problems derived from algebraic functions.

2. METHODS

This type of research is development research (R&D) to develop teaching materials based on Handout media on functionally derived materials. The product resulting from this type of research can be a handout.

This development uses the Plomp model. The Plomp model is seen as more flexible than other models, so researchers chose to use this development model. The Plomp model consists of 5 phases, namely: preliminary investigation phase, design phase, realization/construction phase, and test, evaluation and revision, and implementation phases (Plomp, 1997). The initial investigation stage includes Curriculum analysis, Student Analysis, Material Analysis. The design stage includes creating an initial design for learning media handouts. The Realization/Construction stage includes the initial design in the second stage and also the instruments in research activities. The Test, Evaluation and Revision stages include validation activities for handout media devices and trial activities for handout media. The trial stage is carried out on students in the learning process. The evaluation stage includes processes evaluating student response questionnaires and student learning achievement test questions to determine the practical level of effectiveness of handout media.

The research instrument used was a handout validation sheet which included media expert and material expert validation. The handout practicality sheet is used to obtain the level of use of mathematics handout media for solving problems that will be developed. The test is carried out after testing the learning device with the instrument used in the form of test questions. Test used to determine the students problem-solving ability.

The data analysis techniques carried out are validity analysis, practicality analysis, and effectiveness analysis using criteria such as tables 1, 2, and 3.

Table 1. Validity Data Interpretation

No	Interval	Criterion
1	$80\% < x \leq 100\%$	Very valid
2	$60\% < x \leq 80\%$	Valid
3	$40\% < x \leq 60\%$	Fairly valid
4	$20\% < x \leq 40\%$	Less valid
5	$x \leq 20\%$	Invalid

Sugandi, et al. (2021)

Based on Table 2, the handout developed is declared valid if it has a percentage value > 60%, so the handout is ready to be implemented.

Table 2. Practicality Data Interpretation

No	Interval	Criterion
1	$80\% < x \leq 100\%$	Very practical
2	$60\% < x \leq 80\%$	Practical
3	$40\% < x \leq 60\%$	Quite practical
4	$20\% < x \leq 40\%$	Less practical
5	$x \leq 20\%$	Inpractical

Sugandi, et al. (2021)

Based on Table 3, the handout developed is declared practical if the questionnaire results have a percentage value of ≥ 60%.

Table 3. Classification Mathematical Problem-Solving Ability

No	Interval	Criterion
1	$80\% < y \leq 100\%$	High
2	$60\% < y \leq 80\%$	Medium
3	$y \leq 60\%$	Less

Sugandi, et al., (2021)

Based on the classification criteria table for students' mathematical problem-solving abilities, the researcher determined that if the average test results were in the minimum medium category, namely 60%, then it could be said that handout media could facilitate students' mathematical problem-solving abilities.

3. RESULTS AND DISCUSSION

Initial Investigation Stages

At this stage, curriculum analysis, student analysis, and handout material analysis are carried out. Then the results obtained were that based on the analysis of students' current needs, it was handout media. The curriculum used in class The basic competencies in the class 2) solve problems related to derivatives of algebraic functions.

Based on the achievement indicators that have been formulated, they have been adapted to the demands of basic competencies in the 2013 curriculum. Learning tools with Handout media are designed to refer to the results of this formulation.

Design Stage

At this stage, learning tools are designed by taking into account systematics, curriculum content standards and materials. This initial design is a presentation of the learning tools that will be developed for the Derivative sub-material. The device development carried out was adapted to the approach used, namely Handout media.

After that, research instruments were also designed which included: Handout media validation instruments, device practicality instruments consisting of the teacher's ability to manage learning and observation sheets of student activities in learning; effectiveness instrument consisting of student response questionnaires and learning outcomes tests: and a readability questionnaire for Handout materials to determine the readability level of Handout materials before they are used in field trials.

Realization/Construction Stage

At this stage, prototype 1 has been produced, namely a learning device in the form of Handout media on Derivative material using Handout material. The resulting media handout refers to several preparation components and has been adapted to the material and aspects of the instrument to measure the validity and practicality of the learning tool. Media handout was produced for 2 meetings.

Evaluation, test and revision stages

At this stage, two activities are carried out, namely validation of learning devices that have been produced at the realization/construction stage and testing of learning devices.

1.Validation of Learning Tools

The learning device that has been produced, namely Handout media, is validated by a validator. This is done to obtain information on whether the device is suitable for testing. The following are the results of the validation and revisions carried out.

Table 4. Validator assessment results

No	Validators	Number of Scores	*Ideal Score*	%
1.	V_1	24	28	85%
2.	V_2	26	28	93%
	Average (%)			89%
	Category			Very valid

The validation results show that the development of handout media is valid with the validator's assessment of the teaching materials being 89%. The results of the validator assessment at the interval $80\% < x \leq 100\%$ are in the very valid category (Fitriani, et al., 2021). So, validator results of the developed handout are in the very valid (very good) criteria.

Validation and Revision of Media Handouts

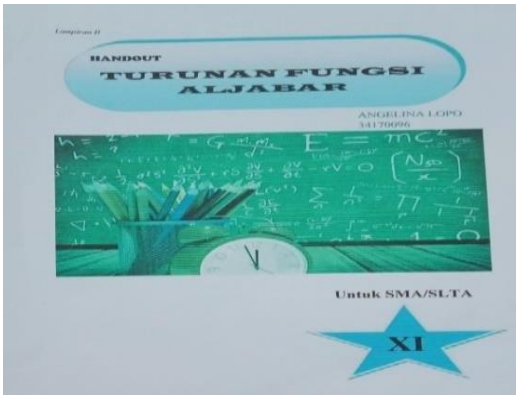
Aspects assessed in the Handout media validation process include language format and content. By knowing the level of validity of the learning tools being developed. Learning outcome test data was obtained through learning test results after lessons using learning tools developed by researchers for two meetings. Student response data was obtained from the results of filling out response questionnaires by students after carrying out the learning outcomes test.

Below are presented the results of data analysis on the practicality and effectiveness of learning tools based on the data that has been obtained.

a. Desan Cover Media Handout

The results of the revision of the Handout media are described as follows: 1. Improvements to the Handout media cover. In improving the cover of the Handout media, it is written in the book title, material, author's name, and what class the students are for. Handout media writing is too large; therefore, the researcher changed the size of the letters on the cover. More details can be seen in Figure 1.

Before revision



After revision

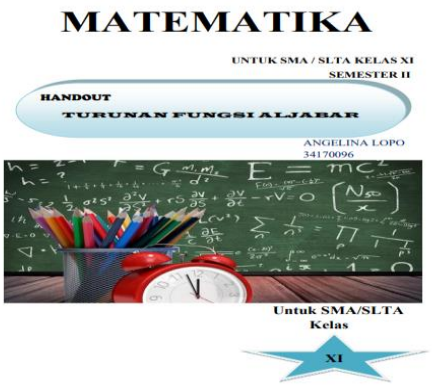
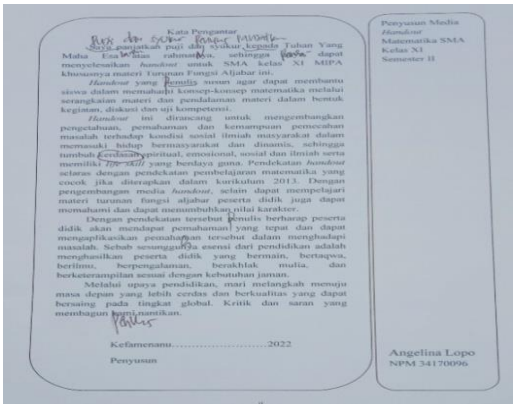


Figure 1. Media Handout Cover

b. Foreword

The foreword contains thanks to God Almighty, the author's goals in using Handout media and the author's hopes for using Handout media. The following is a display of the foreword contained in the Handout media which can be seen in the display in Figure 2.

Before revision



Before revision

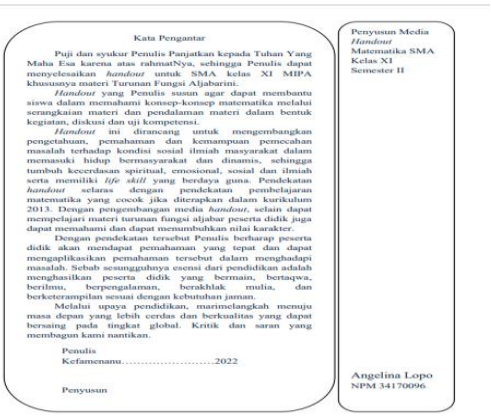
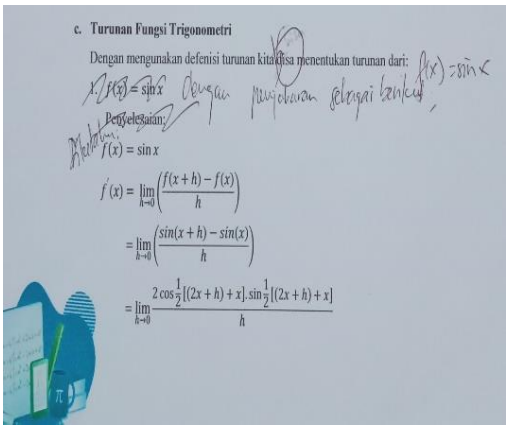


Figure 2. Foreword

c. In the material section on the derivatives of trigonometric functions.

In the section on the derivatives of trigonometric functions it is not explained in detail and here the validator gives suggestions to add explanations regarding the questions to be worked on, which can be seen from figure 3.

Before revision



After revision

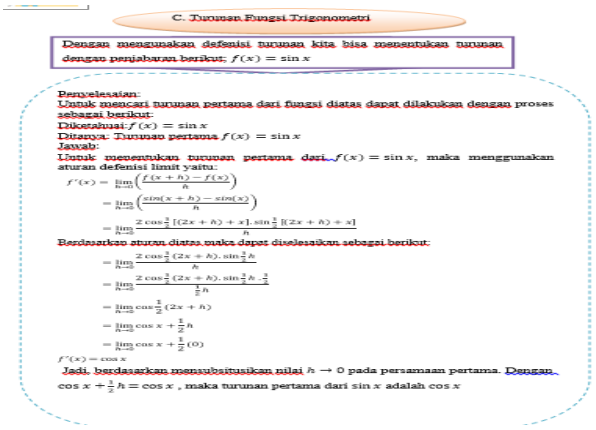
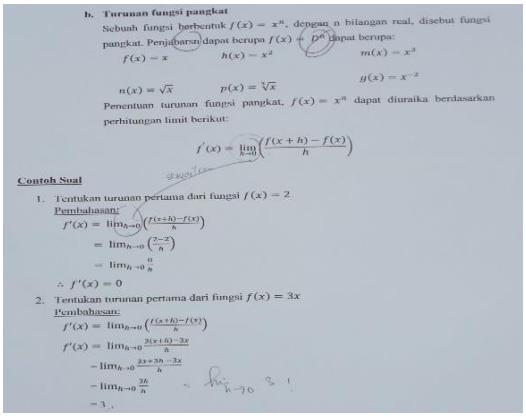


Figure 3. Material for derivatives of trigonometric functions.

d. Derivatives of Rank Functions

In this section, suggestions are given by the validator to improve the correct way of writing or placing the limit calculations as seen in Figure 4.

Before revision



After revision

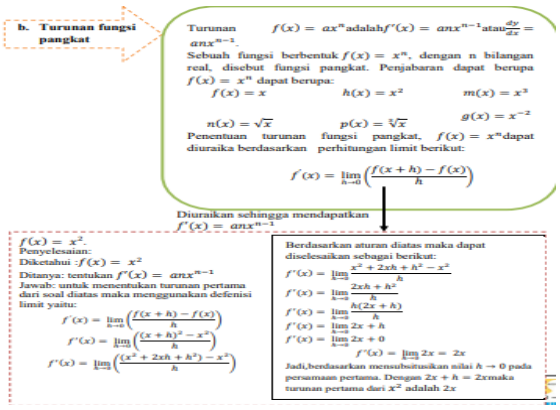


Figure 4. Derivative of the Power Function

Based on pictures 1, 2, 3, and 4, the validator can provide several statements regarding the handout media so that each settlement process can be carried out according to the correct limit calculation. According to (Nurayati, 2020), validation is carried out with the aim of obtaining suggestions, input and opinions to evaluate the handout being developed. Next, revisions are made based on the suggestions given by the validator to obtain a valid handout. In this validation stage, researchers tested the validity of the handout (Utami, 2021)

2. Analyze the practicality of learning tools

A practical analysis was carried out to determine the quality of the learning tools developed based on the results of the student response questionnaire after using the learning implementation handout media. The following are the results obtained.

a) Student Response Data

Student response data was obtained from the results of filling out a questionnaire regarding positive student responses to the device developed using Handout media. The criteria for the percentage of student responses to each aspect of the data analysis results are summarized as follows.

Table 5. Practicality test results

No	Student Name	Score	Percentage	Average
1.	AA	63	75	
2.	AS	73	87	
3.	DMN	69	82	
4.	FAVK	64	76	
5.	GS	69	82	
6.	GEN	63	75	
7.	IS	63	75	
8.	MAD	83	99	83,4921
9.	MONT	79	94	
10.	OYU	73	87	
11.	RVS	74	88	
12.	SANK	70	83	
13.	YEB	72	86	
14.	STM	66	79	
15.	JWM	71	85	

Based on the results of observations in table 5, the total average of student responses to all percentages obtained was very good or met the specified criteria. In this case, the percentage of student responses to the questionnaire was 83.4921. In accordance with the previously determined categories, the results of this analysis show that students' responses to learning using Handout media are very positive (Solihah, 2015., Pertiwi, 2022).

3. Test analysis of student problem-solving ability.

Assessment of the effectiveness of learning tools is carried out through analysis of students' problem-solving ability tests. The form of the questions given is a description with a total of 5 questions. In summary, the results of the analysis of students' problem-solving ability tests are seen in table 6.

Table 6 Test Results for Students' Problem-Solving Ability

No	Student name	Score student	%
1.	AA	33	66%
2.	AS	40	80%
3.	DMN	41	82%
4.	FAVK	30	60%
5.	GS	42	84%
6.	GEN	45	90%
7.	IS	44	88%
8.	MAD	45	90%
9.	MONT	40	80%
10.	OYU	44	88%
11.	RVS	41	82%
12.	SANK	44	88%
13.	YEB	44	88%
14.	STM	46	92%
15.	JWM	29	58%
Classical completion percentage			81%

Based on Table 6, it can be explained that the average test results for students' problem-solving abilities have increased because there are 12 students who meet the criteria for completeness in solving questions. Meanwhile, 3 students did not meet the completeness criteria. Therefore, the average student problem-solving ability test results reached 81%. Thus, the handout media developed is effective in facilitating students' ability to solve problems derived from algebraic functions. This handout media is effective because the subject matter can be developed in detail, and the problem descriptions and solutions are adjusted to the problem-solving indicators according to Polya (1957), namely understanding the problem, devising a plan, carry out the plan, and looking back.

4. CONCLUSION

Based on the results and discussion above, it can be concluded that the development of the Handout device is in very valid criteria, with the average assessment results given by the validator being 89%, meaning that the handout can be used, the Handout media is in the very practical (very valid) criteria for use. The practical aspect of learning handouts is obtained from the results of analysis of student response questionnaires and the implementation of learning. Results of analysis of student response questionnaires obtained an average score of 83.4921 which is included in the very good category. Based on the results of the analysis of the implementation of learning activities, it shows that the percentage of implementation has very practical criteria with a percentage of 81%. The results of developing this Handout media meet the effective requirements as shown by classical completeness of 81% and responses given by students of 83.4921%. Students who provide assessments are students with different abilities, so the results obtained are sufficient to reach the abilities of class XI students who use learning with Handout media in the very effective category. Thus, the learning handout media in the form of handouts developed on material derived from algebraic functions meets the criteria of being very valid and effective.

It is recommended that mathematics teachers use the handout media developed as an alternative reference in learning algebraic function derivative material. For further research, to use this handout media in other types of research to find out the effectiveness of this handout media in various experiments in other classes.

REFERENCES

Anita, Y., Thahir, A., Komaruddin, Suherman, & Rahmawati, N. D. (2021). Buku Saku Digital Berbasis STEM: Pengembangan Media Pembelajaran terhadap Kemampuan Pemecahan Masalah. *Mosharafa: Jurnal Pendidikan Matematika*. 10(3), 401–412. https://doi.org/10.31980/mosharafa.v10i3.672

Delyana, H. (2015). Peningkatan Kemampuan Pemecahan Masalah Matematika Siswa Kelas VII Melalui Penerapan Pendekatan Open Ended. *LEMMA: Letters of Mathematics Education*, 2(1), 26-34. https://doi.org/10.22202/jl.2015.v2i1.523.

Febrianto, R. (2018). Pengembangan Handout Mata Kuliah Perkembangan Peserta Didik untuk Mahasiswa Program Studi Pendidikan Bahasa Indonesia. *Education Journal: Journal Educational Research and Development*, *2*(2), 64-74. Retrieved from https://jurnal.unipar.ac.id/index.php/ej/article/view/122.

Fitriani, N., Hidayah, I. S., & Nurfauziah, P. (2021). Live Worksheet Realistic Mathematics Education Berbantuan Geogebra: Meningkatkan Abstraksi Matematis Siswa SMP pada Materi Segiempat.

JNPM (Jurnal Nasional Pendidikan Matematika), 3 (1), 37-50. https://doi.org/10.33603/jnpm.v5i1.4526.

Solihah, F. (2015). Penggunaan Bahan Ajar Berbasis Pembelajaran Penemuan Terbimbing Untuk Meningkatkan Kemampuan Pemecahan Masalah Matematis Siswa Sma Pada Materi Limit Fungsi. [*Skripsi*]. https://repository.uinjkt.ac.id/dspace/handle/123456789/34166.

Indriani, L., & Maryati, I. (2021). Kemampuan Pemecahan Masalah Matematis Siswa SMP pada Materi Segiempat dan Segitiga di Kampung Sukagalih. *Plusminus: Jurnal Pendidikan Matematika*, *1*(3), 541-552. https://doi.org/10.31980/plusminus.v1i3.962.

Kasri, K. (2018). Peningkatan Prestasi Belajar Matematika melalui Media Puzzle Siswa Kelas I SD. *Jurnal Pendidikan: Riset Dan Konseptual*, *2*(3), 320-325. https://doi.org/10.28926/riset_konseptual.v2i3.69.

Nurayati. (2020). Pengembangan Media Pembelajaran Handout Berbasis Gambar Pada Pembelajaran Matematika Kelas Xii Mas Tahfizhil Qur'an Islamic Islamic Centre Tahun Ajaran 2020/2021. [*Skripsi*]. http://repository.uinsu.ac.id/id/eprint/13712.

Pertiwi, A. P. (2022). Pengembangan Bahan Ajar Model Creative Problem-Solving (CPS) Untuk Memfasilitasi Kemampuan Berpikir Divergen Siswa Pada Materi Turunan Kelas XI SMA/MA. [*Skripsi*]. https://repository.uinjkt.ac.id/dspace/handle/123456789/63427.

Plomp, T. (1997). Educational & Training Systems Design. University of Twente, Faculty of Educational Science and Technology, Enschede, The Netherlands.

Polya, G. (1957). How To Solve It: A New Aspect of Mathematical Method (Second). https://doi.org/10.2307/j.ctvc773pk.

Prihandika, Y. A., Hidayah, I., Susilo, B. E., & Dewi, N. R. (2023, June). Analisis Kesalahan Siswa dalam Menyelesaikan Soal Turunan Fungsi Aljabar. *In Prosiding Seminar Nasional Pascasarjana* (Vol. 6, No. 1, pp. 961-966).

Rozalia, A., Kasrina, K. & Ansori, I. (2018). Pengembangan handout biologi materi keanekaragaman hayati untuk SMA kelas X. *Diklabio: Jurnal Pendidikan dan Pembelajaran Biologi*, *2*(2), 44-51. https://doi.org/10.33369/diklabio.2.2.44-51.

Sampini, S., Mustaji, M., & Harwanto, H. (2021). Problem based learning dan Problem-solving Berpengaruh Terhadap Kemampuan Pemecahan Masalah Matematika. *Mimbar Ilmu*, 26(1), 79–87. https://doi.org/10.23887/mi.v26i1.31501.

Sholikhah, Z., Kartana, T. J., & Utami, W. B. (2018). Efektifitas Model Pembelajaran OpenEnded Terhadap Prestasi Belajar Matematika Ditinjau Dari Kreativitas Siswa. *JES-MAT (Jurnal Edukasi Dan Sains Matematika)*, 4(1), 35. https://doi.org/10.25134/jes-mat.v4i1.908.

Silalahi, F. C. G., Kartini, K., & Hutapea, N. M. (2021). Pengembangan Perangkat Pembelajaran Matematika Berbasis Model Problem Based Learning untuk Memfasilitasi Kemampuan Pemecahan Masalah Matematis Peserta Didik Kelas VIII SMP. *Jurnal Cendekia: Jurnal Pendidikan Matematika*, 5(1), 113–124. https://doi.org/10.31004/cendekia.v5i1.366.

Siregar, M. S., Siregar, E. Y., & Elindra, R. (2021). Analisis Kemampuan Pemecahan Masalah Matematis di Pesantren Nurul Falah Panompuan. *Jurnal MathEdu (Mathematic Education Journal)*, 4(1), 39–44.

Son, A. L., & Fatimah, S. (2020). Students' Mathematical Problem-Solving Ability Based on Teaching Models Intervention and Cognitive Style. *Journal on Mathematics Education*, 11(2), 209-222.

Sugandi, A. I., Sofyan, D., & Maesaroh, S. (2021). Pengembangan Perangkat Pembelajaran Menggunakan Deduktif Induktif Berbantuan Geogebra dalam Meningkatkan Kemampuan Berpikir Kreatif Siswa pada Masa Pandemi. *Jurnal Pembeajaran Matematika Inovatif*, 4(1), 149–160. https://doi.org/10.22460/jpmi.v4i1.149-160.

Utami. R (2021). Pengembangan Modul Ajar Matematika Dengan Model Problem Based Learning Beroreantasi Kemampuam Pemecahan Masalah Matematis Pada Materi Pokok Interal Kelas XI SMA. [*Tesis*]. http://repository.uir.ac.id/id/eprint/11635.

Yustianingsih, R., Syarifuddin, H., & Yerizon, Y. (2017). Pengembangan Perangkat Pembelajaran Matematika Berbasis Problem Based Learning (PBL) untuk Meningkatkan Kemampuan Pemecahan Masalah Peserta Didik Kelas VIII. *JNPM (Jurnal Nasional Pendidikan Matematika)*, 1(2), 258-274. http://dx.doi.org/10.33603/jnpm.v1i2.563.

Zulfiah, A. (2017). Pengembangan Perangkat Pembelajaran Kooperatif Tipe STAD Dengan Metode Scramble Pada Materi Sistem Koordinat. *Jurnal Penelitian Pendidikan*, *34*(2), 105-112. https://doi.org/10.15294/jpp.v34i2.5887.