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Development of Mathematical Modelling Teaching Materials on Mathematics Perception of Junior High School Students

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Abstract

21st-century mathematics learning emphasizes students to think critically, communicate, collaborate, and connect mathematics with the real world. This is in line with mathematical modeling which focuses on learning mathematics using real-world phenomena in the process of solving problems that require understanding and interaction. This study aims to produce mathematics teaching materials based on mathematical modeling in the context of Indonesian forest conservation that has criteria for validity, practicality, and a potential effect on students' mathematical perceptions. The type of research used is design research with development studies. Data collection techniques used questionnaires, interviews, and documentation. Teaching materials were declared valid based on expert review questionnaire assessment and student assessment at the one-to-one evaluation stage. The total questionnaire score was 4.59 with a very valid category. Teaching materials are declared practical based on students' comments at the small group stage and analysis of teaching material completion documents at the field test stage. Furthermore, this study uses the principles of developing mathematical modeling problems according to Gailbraith which can produce mathematical modeling teaching materials that have a potential effect on students' mathematical perceptions, with a questionnaire score of 63% in the very good category.

Keywords: *Indonesian Forest Conservation Context; Mathematical Modelling; Teaching Materials; Students' Mathematics Perception.*

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Abstrak

Pembelajaran matematika abad-21 menekankan peserta didik untuk berpikir kritis, berkomunikasi, berkolaborasi serta menghubungkan ilmu matematika dengan dunia nyata. Hal tersebut sejalan dengan pemodelan matematika yang memfokuskan pembelajaran matematika menggunakan fenomena dunia nyata dalam proses penyelesaian masalah yang membutuhkan pemahaman serta interaksi. Penelitian ini bertujuan untuk menghasilkan bahan ajar matematika berbasis pemodelan matematika konteks konservasi hutan Indonesia yang memiliki kriteria kevalidan, kepraktisan serta memiliki efek potensial terhadap persepsi matematika peserta didik. Jenis penelitian yang digunakan adalah penelitian design research dengan tipe development studies. Teknik pengumpulan data menggunakan angket, wawancara dan dokumentasi. Bahan ajar dinyatakan valid berdasarkan penilaian angket expert review dan penilaian peserta didik pada tahap one to one evaluation. Total skor angket sebesar 4,59 dengan kategori sangat valid. Bahan ajar dinyatakan praktis berdasarkan komentar peserta didik pada tahap small group dan analisis dokumen penyelesaian bahan ajar pada tahap field test. Selanjutnya, penelitian ini menggunakan prinsip pengembangan soal pemodelan matematika menurut Gailbraith yang dapat menghasilkan bahan ajar pemodelan matematika yang memiliki efek potensial terhadap persepsi matematika peserta didik, dengan skor angket persepsi sebesar 63% berkategori sangat baik.

INTRODUCTION

One of the goals of learning mathematics today is that students can solve problems that require the ability to understand problems, design mathematical models, solve problems, and interpret solutions to be resolved (MoEC, 2022). This goal can be represented by mathematical modeling that can support the mathematics learning process in the classroom (Blum & Ferri, 2009; Burkhardt, 2018; Chan, 2019; Lu et al., 2021). With mathematical modeling, students can be motivated to develop a mindset in solving real-world problems to prepare studentsforn the future (Blum & Niss, 1991; Kunwar, 2021; Niss & Blum, 2020).

However, in reality, educators don't know the importance of mathematical modeling so students are not required to think independently in solving problems (Bahir, R. A., & Mampouw, 2020; Simalango, M. M., Darmawijoyo, & Aisyah, 2018). In line with that, the PISA test which uses the same framework as the mathematical modeling framework shows that Indonesia's score in 2018 is still below the average of OECD countries, where only 2.3% of students reached level 5 mathematics (OECD, 2019). In research (Pranitasari, D., & Ratu, 2020), students still have difficulty in solving PISA level 4, 5, and 6 questions that involve reasoning, interpretation, and argumentation.

Nowadays, Mathematics learning is still trapped in the orientation of understanding material and numeracy skills so it has not been able to develop skills in thinking (Fadillah, F., & Munandar, 2021; Surmayanta, & Wibawa, 2020). The research of (Utari et al., 2019) that mathematics is still a difficult and boring lesson so it makes low math learning outcomes. This is supported in bye research of (Najic & Winarso, 2016) which says that students' perceptions of mathematics are related to the methods used. Therefore, a pleasant learning process will lead to a good perception of learning mathematics and influence good math learning outcomes.

To foster good perceptions of mathematics learning, the problems given must be close to students (Chamila et al., 2016; Lisnani et al., 2020; Putra et al., 2016). Therefore, using a real context can make math learning more effective and can reduce students' negative perceptions of mathematics (Boaler, 1993). The context used in this study is Indonesian forest conservation, where forests are one of the national problems in Indonesia (MoEF, 2020; Wijayanti, 2007).

Based on these problems, teaching

materials with mathematical modeling stages are used to help students work independently in solving problems (Saputri & Zulkardi, 2020). The principles in mathematical modeling can train students to construct knowledge to solve real problems (Blum, W., Gailbraith, P., Henn, H.-W., & Niss, 2007; Gailbraith, P., & Holton, 2018). Furthermore, with mathematical modeling learners can make a positive contribution to the process of learning mathematics in real life (Özdemir & Üzel, 2012). Thus, the purpose of this study is to develop junior high school mathematics teaching materials based on mathematical modeling using the context of Indonesian forests that are valid, practical, and have a potential effect on students' mathematical perceptions.

METHOD

This research uses a type of design research with development studies, which consists of two stages, namely the preliminary research stage and the prototyping stage (Akker, J. V., Gravemeijer, K., McKenney, S., & Nieveen, 2006). In the first stage, researchers analyzed the existing context and research problems adjusted to the literature review and theoretical development of design analysis. In

Figure 1. Flow of Formative Evaluation (Tessmer, 1993)

the second stage, we used the formative evaluation stage (Tessmer, 1993) which consists of self-evaluation, expert review, one-to-one evaluation, small group, and field test. The flow of formative evaluation used can be seen in Figure 1.

At the expert review stage, the research subjects consisted of material, product, and language experts. At the one-to-one evaluation stage, the research subjects consisted of 3 students. The small group stage consisted of 9 students and ate field test, stage consisted of 30 nintninth-gradedents at Palembang Junior High School 1. The selection of learners as research subjects was wereried out based on learner abilities, student interests, and student personalities. student interests can show proper motivation to learn and review instructions during evaluation, as well as personality and self-confidence to express criticism during evaluation. So, the selection of learners was based on these three things with high, medium, and low criteria selected by their mathematics teachers. In the small group and field test stages, students must be balanced in each group.

The implementation of one-to-one evaluation, and small groups is carried out for 45 minutes. Where learners complete the teaching materials provided individually at the one-to-one stage and collaborate with their group friends in small groups. Learners can ask the researcher if there are things that make them confused or if they experience difficulties. The researcher manages the evaluation to encourage learner confidence and communication, as the success of the evaluation depends on the learners. In the field test, learning was carried out like a normal class, starting with introductory activities, followed by core activities using mathematical modeling teaching materials and closing activities. The learning process at the field test stage was carried out by the math teacher and the researcher served as an

observer.

The data collection techniques used in this study were questionnaires, and documentation. The questionnaire used is a validation questionnaire, as well as a questionnaire of students' perceptions of mathematics. The validation questionnaire is used to see the validity of teaching materials with assessments made by material experts, product experts, language experts. teaching materials meet valid criteria if the assessment score is categorized as good and based on revisions from expert comments. The score obtained from the expert is summed up and divided by the number of questions given in the questionnaire. The following is the validity category based on the score obtained:

Table 1. Validity Assesment Categories

Average Score (x)	Category
4,20 < x	Very Valid
3,40 < x ≤ 4,20	Valid
2,60 < x ≤ 3,40	Simply
1,80 < x ≤ 2,60	Less
x < 1,80	Very Less

Furthermore, practicality is assessed from the documentation in the form of students' solutions which are analyzed according to the steps of mathematical modeling.

The students' perception questionnaire was used to see the potential effect on students' mathematics perception after the teaching materials were given. After the data were collected, the questionnaire scores were categorized based on Table 2.

Table 2. Questionnaire Scores Categories

Score Range	Criteria
$Mi + 1{,}5SDi \leq \bar{M} \leq Mi + 3{,}0SDi$	Very Good
$Mi + 0SDi \leq \bar{M} \leq Mi + 1{,}5SDi$	Good
$Mi - 1{,}5SDi \leq \bar{M} \leq Mi + 0SDi$	Enough
$Mi - 3SDi \leq \bar{M} \leq Mi - 1{,}5SDi$	Less

Description: Mi = Ideal mean | SDi = Ideal standard deviation

The maximum score is 15 and the minimum score is 3, where there are 3 questions on each math perception indicator.

RESULTS AND DISCUSSION

Results

The first stage is preliminary research stage, the researcher conducted an analysis in the form of problem analysis and context analysis.

Preliminary Research

At this stage, researchers conducted an analysis in the form of problem analysis and context analysis by conducting interviews with the deputy head of curriculum is also a mathematics teacher.

One of the real contexts close to students is the problem of Indonesian forest conservation, it is necessary for students to understand the importance of reforestation and deforestation activities to protect our environment. In line with this, mathematical modeling is a suitable tool used to solve the Indonesian forest problem.

Based on the results of the previous analysis, in the process of learning junior high school mathematics, a facility is needed to make a positive contribution to learning mathematics and reduce negative perceptions for students towards learning mathematics so that the mathematics learning process becomes more effective. Therefore, mathematics teaching materials were developed based on the principles of developing mathematical modeling according to (Blum, W., Gailbraith, P., Henn, H.-W., & Niss, 2007) as follows:

Table 3. Principle of Developing Mathematical Modelling

Problem Design
Problems are developed about real-world
Problems consist of questions that lead learners in solving the problem, such as information that must be known before solving the problem. What they need to do to solve the given problem.
There is a question that asks learners to come up with assumptions and mathematical formulations.
After formulating, learners are expected to interpret the solution they get to the effect that planting trees and reducing deforestation has on the environment.
The problems developed are didactical and contain systematic problems. The problems developed contain steps so that students can solve the problems themselves.

After developing the problem, the stages of solving are based on the stages of mathematical modeling which consist of understanding the task, searching mathematics, using mathematics, and explaining the results (Niss & Blum, 2020).

Prototyping Stage

The prototyping stage in this study uses the formative evaluation stage (Tessmer, 1993). The following results of the prototyping stage are explained as follows:

Self Evaluation

In the self-evaluation, the researcher checks to see obvious errors in the product. Where there are several changes, namely: 1) Eliminating the title of the mathematical modeling stage so that students are not confused about the meaning of the sentence. 2) Changing the word "assumption" to "suppose". 3) The last change lies in changing the solution used, where the calculation of the reforestation area up to 2030 is completed first and then continued with the calculation of the remaining deforested area in 2030. After making revisions, the prototype I was obtained, and will be tested at the one-to-one evaluation and expert review stages to see the validity of teaching materials based on mathematical modeling.

Expert Review

The expert review stage is an evaluation in terms of content accuracy as well as technical quality. Experts who evaluate teaching materials consist of content experts, and instructional design experts.

The followings are the comments and suggestions given by the experts on the prototype I along with the follow-up actions taken:

Table 4. Comments Expert

Comments and Suggestions	Revised
The learning objectives are quite limited, readjust what you want to achieve with the completion of the teaching material.	The learning objectives were revised and adjusted again to the teaching materials and the stages of mathematical modeling used.
Question 1–4 which includes *understanding tasks* on mathematical modeling is more specified with questions that make students better understand the problems given.	The question was revised to only 1 question that represents the beginning of students' understanding of completing the teaching materials in the context of Indonesian forest conservation.
Add complexity to the problem through information on deforestation activities that have increased a% or are constant each year.	Added a question to calculate the area of Indonesia's forests by adding complexity to the problem through information on deforestation activities that have increased by a% or are constant each year.
The context used is very interesting for mathematical modeling, but the problems should be made more *open-ended* to get learners used to being a "modeler".	Based on these comments, the questions were revised to become *open-ended* problems.

Furthermore, the expert also gave a validity score which will be presented in Table 5.

Table 5. Teaching Material Validation Result

Aspects	Average score	Quality
Content	4,8125	Very Valid
Construct	4,4	Very Valid
Language	4,56	Very Valid
Overall	4,59	Very Valid

One-to-One Evaluation

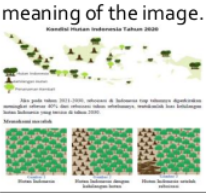
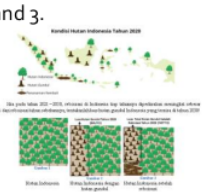
From the results obtained at the expert review stage, researchers also conducted a one-to-one evaluation. One-to-one evaluation involved one-by-one student and a researcher. Students assessed the intrinsic quality through the criteria of clarity, ease of use, sequencing, and completeness. The importance of one-to-one is to provide information from the learner's or user's point of view, where the researcher can maximize the information because they talk directly with students.

At the one-to-one evaluation stage, students solved the problems along with providing comments on the teaching materials provided. During this time, the researcher records the information and reactions given by the students. Since one-to-one relies heavily on student comments in reviewing instructions, information is usually obtained spontaneously. This can also be supported by asking questions such as why students are confused or having difficulty and if students find something interesting.

The results of the one-to-one evaluation found that one of the students had difficulty understanding the sentence of question number 5 "Based on understanding 1, calculate the area of reforestation of Indonesia's forests in 2021-2030", where students have not been able to complete the calculation of the area of reforestation of Indonesia's forests from 2021-2030. The sentence made him focus on the year instead of the nith year reforestation area. Furthermore, researchers provide interventions so that students can solve them and make revisions in the future on the question.

Then, one of the students also commented that the images used must contain consistent images so that the images given have a connection with each other. The following are the results of revisions that have been made at the one-to-one evaluation stage:

Table 6. The result of One-to-One Stage

Before Revision	After Revision
The image of the condition of Indonesia's forests in 2020 in the caption Indonesian forests and replanting is not the same as images 1, 2, and 3 which can lead to misunderstanding of the meaning of the image. 	The picture was revised by making the Indonesian forest picture and the replanting picture the same as pictures 1, 2, and 3. 

Teaching materials can be said to be valid if they are by the objectives of formative evaluation, namely acceptance of the product and the strength of the product from the aspects of relevant content, and consistent constructs (Akker, J. V., Gravemeijer, K., McKenney, S., & Nieveen, 2006). In this study, the validity of teaching materials can be seen from expert comments, student comments, and validity scores in Table 2. Where, the content is the independent curriculum, as well as learning objectives and the needs of students. In terms of construct, it can be seen the suitability of teaching materials with the principles and steps of mathematical modeling with the level of ninth-grade studninth-gradealidity score

in Table 2 shows very valid criteria. This means that the teaching materials developed are by the facts, this relates to the quality of the construct and content of the teaching materials.

Furthermore, the results of revisions at the expert review stage and the one-to-one evaluation stage and production prototype II will be tested at the small group stage.

Small Group

As opposed to one-to-one, small groups focus on student performance to confirm instruction within the group. Thus, the researcher is only an observer and intervenes only when necessary. At this stage, the researcher will identify the clarity of the instructions and the effectiveness of the teaching materials. Furthermore, evaluation in small groups can improve the implementability or the degree to which the instruction can be used appropriately in the environment. It can also provide information about the ease of use and attractiveness of instructions for teachers. This is commonly referred to as practical. The results obtained in the small group stage trial and the revisions made are as follows.

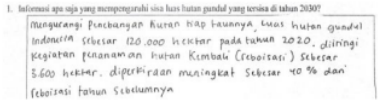
Table 7. The Result of Small Group Stage

Before Revision	After Revision
The sentence "What information must be known to determine the area deforested in 2030?", are understand but some answers are more extensive than expected.	Revise the sentence of question 1 to read "What information affects the remaining area of deforestation in 2030?" to be more specific.
Revision to Definition 1 where there is *referring* to a specific year so that according to MB, MS, FK, and FA the sentence can be clarified again.	Revise the sentence in Definition 1 to make it clearer and easier to understand.
Question 2, according to MB and FK, contained the same meaning as question 3.	Adding the phrase "every year" so that learners understand the question that the expected solution is the calculation every year.
In the sentence counting declining deforestation a% clarified, are learners freed to determine the a that?	To make the sentence in the question clearer, it was revised into 2 questions, first students are devoted to choosing how much the decline in deforestation should be determined, and in the next question students are asked to complete the calculation.
The last question about the earth's temperature did not have a clear impact on forest conditions.	Replace the impact of forest conditions on learners' environment.

Based on the revision results at the small group stage, the teaching materials have met the practical criteria, namely, the clarity of instructions that have been revised from before and the implementation power of teaching materials is suitable for junior high school students to produce prototype III which will be tested at the field test stage.

Field Test

Field tests are evaluations to improve instruction and assess the effectiveness of instruction. Field tests are declared not to require further revision when students who still answer incorrectly are less than 30% of the total number of students. Here is one of the group answers based on the mathematical modeling stage.


1. Informasi apa saja yang mempengaruhi sisa luas hutan gundul yang tersisa di tahun 2030?
Mengurangi Pencbangan Kuran Nap Tahunnya, Luas hutan gundul Indonesia Sebesar 120.000 hektar pada tahun 2020, diiringi kegiatan penanaman hutan Kembali (reboisasi) Sebesar 3.600 hektar, diperkirakan meningkat Sebesar 40 % dari reboisasi tahun sebelumnya

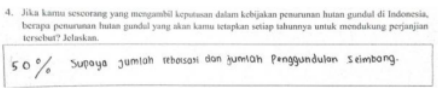
Translate: what information affects the area of remaining forest in 2030? Reduce deforestation each year. Indonesia's deforested area was 120,000 hectares in 2020 and was accompanied by a reforestation of 3600 which is estimated to increase by 40% from the previous year's reforestation.

Figure 2. Understanding Task Group 1

Figure 2 shows that group 1 and group 5 can understand the problems given about the condition of Indonesia's forests. All learners in their groups have fulfilled the *understanding task* stage contained in the teaching materials based on mathematical modeling. Furthermore, at the stages of *searching mathematics* and *using mathematics* in problem number 2, students have also been able to solve it, as seen in Figure 3 group 5 can determine the area of reforestation for each year from 2020 to 2030.

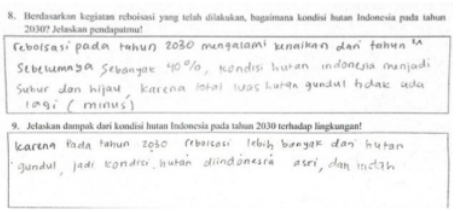
Figure 3 Group 5 Searching Mathematics and Using Mathematics Answer (see Appendix for clearer fig.)

At the *searching mathematics* stage, learners can see the data or information they need next as they make assumptions to solve the next problem. This can be seen in Figure 4, where there is one of the answers of students in their group made assumptions about the decline in deforested forests in Indonesia.



Translate:50% so that the amount of reforestation and the amount of deforestation are balanced
Figure 4. Group 5 Searching Mathematics Answer

The last stage in mathematical modeling according to (Niss & Blum, 2020) is the *explaining result stage*, where at this stage students interpret the results of the calculation of the remaining area of Indonesian forests in 2030 that they get, and make conclusions about the impact of reforestation and deforestation activities on the environment (Figure 5). The following are the learners' answers at the *explaining result* stage.



Translate: 8. Based on the reforestation that has been carried out, what will be the condition of Indonesia's forests in 2030?
Reforestation in 2030 has increased from the previous year by 40%, the condition of Indonesia's forests will be fertile and green because there are no more bare forests.
9. Describe the impact of Indonesia's forest condition in 2030 on the environment!
Because in 2030 reforestation is more than deforestation. So, the condition of Indonesia's forests will be beautiful.
Figure 5. Group 3 Explaining Result

From the results of students' solutions, it is found that most students can solve the problems given correctly and can fulfill the stages of mathematical modeling given. During the learning process, the teacher had no difficulty in implementing the learning process with teaching materials. Students understood the instructions given by the teacher, students could understand the material presented and students were active in their groups and actively expressed their opinions during the learning process. This also supports the practical criteria discussed at the small group stage.

Next is the administration of a mathematics perception questionnaire to see how the potential effect on students' mathematics perceptions after the teaching materials have been developed. The

categories that will be seen in the perception questionnaire consist of interest, general utility, and need for high achievement (Luttrell et al., 2010). The following are the results of the students' mathematics perception questionnaire:

Table 8. The result of Student' Perception

Indicator	f	Percentage	Category
Interest	15	50%	Very good
	8	30%	Good
	6	20%	Simply
	0	0%	Less
General Utility	15	50%	Very good
	13	43%	Good
	2	7%	Simply
	0	0%	Less
Need for High Achievement	27	90%	Very good
	3	10%	Good
	0	0%	Simply
	0	0%	Less
Overall	57	63%	Very good
	24	28%	Good
	8	9%	Simply
	0	0%	Less

Based on the questionnaire results, the overall perception of students towards mathematics is very good after the learning process with teaching materials based on mathematical modeling in the context of Indonesian forest conservation. As seen in the table above, in the category of need for high achievement, the category is very good at 90%, this means that the student's assessment of the importance of learning mathematics is very good.

Discussion

In previous research (Riyanto, 2021; Sari & Darmawijoyo, 2019; Yusherlly, H & Darmawijoyo, 2020), there were developed student worksheet-based mathematical modeling with a financial context, a health context, and a parking fee context. This research develops mathematical modeling teaching materials within the context of Indonesian forest conservation which has valid, practical criteria and potential effects on students' mathematical perceptions.

The validity assessment is based on the validation questionnaire assessment by an expert review and student assessment at the one-to-one validation stage. The validity questionnaire score is 4.59 with a very good category (see Table 2), where good development must be by the construction used, in this case by the stages of mathematical (Niss & Blum, 2020). Furthermore, the need for a good assessment of the content of the teaching materials (Agustina & Farida, 2021), an assessment of the completeness of the teaching materials, the suitability of the learning objectives to be achieved with the curriculum, and the novelty of the content used.

Moreover, the assessment of students at the one-to-one evaluation stage consists of an assessment of the intrinsic quality in the form of clarity of teaching materials, ease of use, and completeness of teaching materials (Tessmer, 1993). In previous research (Yusherlly, H & Darmawijoyo, 2020), students completed teaching materials and commented on understanding the purpose of each question and whether there were sentences that seemed confusing. Furthermore, students assessed how the images in the teaching materials were, and whether the use of the context of everyday life in the form of the context of Indonesian forest conservation could attract them to the mathematics learning process. From the results of these assessments and revisions made, teaching materials have been said to be valid and produce prototype II which will be tested at the small group stage.

Practical assessment is based on students' comments at the small group stage and analysis of teaching material completion documents at the field test

stage (Sari & Darmawijoyo, 2019). At the small group stage, the information to be obtained is the aspect of clarity of instructions and effectiveness of use. Furthermore, the field test stage looks at information about how the instructions are received by students, as well as the achievement of the expected learning objectives (Tessmer 1997). This can be seen in the answers of students who can solve problems with the stages of mathematical modeling well. Problems that are compiled from simple questions and leading students through the stages of mathematical modeling in solving them can make students solve problems well (Khusna & Ulfah, 2021; Saputri & Zulkardi, 2020). This is in line with this research, where at the field test stage students can solve the problems given appropriately, and actively in their groups. This can train students in constructing knowledge in solving problems by the principles of mathematical modeling. These results indicate that the teaching materials developed have met the practical criteria.

After the learning process at the field test stage has been completed, students are given a math perception questionnaire to see the potential effects after the teaching material is given. Perception is an impression through the senses received by the senses that are integrated into the individual(Riswandha & Sumardi, 20020). A good perception of mathematics for students is one of the factors in successful learning of mathematics (Boaler, 1993). The questionnaire score obtained in the excellent category was 63%, the good category was 28%, and the sufficient category was 9% (See Table 3). The interest indicator scored 50% in the excellent category and 30% in the good category, meaning that the teaching materials developed were able to encourage students' motivation to learn mathematics (Luttrell et al., 2010). By helping students to be interested in learning mathematics, it can make students aware of the importance of mathematics in everyday life which influences students' desire to get good achievements in learning mathematics.

Limitation

Students' perception of mathematics is limited by only using indicators that contain positive points, namely interesting, general utility, and need for high achievement. The personal cost indicator has not been assessed in this study.

Implication

The impact of this research is directly related to the current condition of the problem (environmental problem). That problem can make students appreciate and protect their environment. This research also has an impact on the development of environmentally sound learner attitudes by the current "Merdeka" curriculum. Of course, research on the development of mathematics teaching materials with environmentally sound has never been studied before.

CONCLUSION

The development of teaching materials that have been carried out and adapted to the principles of developing modeling problems can make students interested and motivated in learning mathematics. By giving problems that are directly related to the real world, such as the use of the context of Indonesian forest conservation, which is solved based on mathematical modeling, students understand the benefits of mathematics in everyday life. Where usually students think that learning math is just confusing symbols and not used in everyday life. Therefore,

students are willing to work well in learning mathematics, as seen from the activeness of students in the mathematics learning process who work well together in groups, can present the results of the solutions they work on, and are brave in expressing their opinions in class discussions. These three points are in line with indicators of good student perceptions after providing teaching materials.

REFERENCES

Agustina, R., & Farida, N. (2021). Braille Geometry Teaching Materials for Low Vision Students. *Kreano, Jurnal Matematika Kreatif-Inovatif*, *12*(1), 63–74. https://doi.org/10.15294/kreano.v12i1.26562

Bahir, R. A., & Mampouw, H. L. (2020). Identifikasi Kesalahan Siswa SMA dalam Membuat Pemodelan Matematika dan Penyebabnya. *Jurnal Cendikia: Jurnal Pendidikan Matematika*, *4*(1), 72–81.

Blum, W., Gailbraith, P., Henn, H.-W., & Niss, M. (2007). *Journal of Science Mathematics Education in Southeast Asia*. The 14th ACMI Study. Springer Verlag.

Blum, W., & Ferri, R. B. (2009). Mathematical Modelling: Can it be Taught and Learnt? *Journal of Mathematical Modelling and Application*, *1*(1), 45–58.

Blum, W., & Niss, M. (1991). Applied Mathematical Problem Solving, Modelling, Aplications, and Links to Other Subject - State, Trends, and Issues in Mathematics Instruction. *Educational Studies in Mathematics*, *22*, 37–68.

Boaler, J. (1993). Encouraging The Transfer of "School" Mathematics to The "Real World" Through The Integration of Process and Content, Context and Culture. *Educational Studies in Mathematics*, *25*(4), 341–373.

Burkhardt, H. (2018). Ways to Teach Modelling— a 50 Year Study. *ZDM*, *50*, 61–75.

Chamila, N., Zulkardi, Z., & Darmawijoyo, D. (2016). Pengembangan Soal Matematika Model PISA Menggunakan Konteks Jambi. *Jurnal Penelitian Dan Evaluasi Pendidikan*, *20*(2), 198–2017.

Chan, E. C. (2019). Mathematical modeling as problem solving for children in the Singapore mathematics classrooms. *Journal of Science Mathematics Education in Southeast Asia*, 36–61.

Fadillah, F., & Munandar, D. (2021). Analisis Kemampuan Literasi Matematis Siswa Pada SMPN 2 Kerawang Barat. *Wahana Matematika Dan Sains*, *15*(3), 15–25.

Gailbraith, P., & Holton, D. (2018). *Mathematical Modelling: A Guidebook for Teachers and Teams*. Australian Council for Educational Research (ACER).

Khusna, H., & Ulfah, S. (2021). Kemampuan Pemodelan Matematis dalam Menyelesaikan Soal Matematika Kontekstual. *Mosharafa: Jurnal Pendidikan Matematika*, *10*(1), 153–164. https://doi.org/10.31980/mosharafa.v10i1.857

Kunwar, R. (2021). *A Study on Low Performing Students Perception towards Mathematics : A Case of Secondary Level Community School Students of Nepal*. *5*(1), 125–137. https://doi.org/10.3126/researcher.v5i1.41384

Lisnani, L., Zulkardi, Z., Putri, R., & Somakim, S. (2020). Etnomatematika: Pengenalan Bangun Datar Melalui Konteks Museum Negeri Sumatera Selatan Balaputra Dewa. *Mosharafa*, *9*(3), 359–370.

Lu, X., Kaiser, G., & Kaiser, G. (2021). Can mathematical modelling work as a creativity - demanding activity ? An empirical study in China. *ZDM – Mathematics Education*, *0123456789*. https://doi.org/10.1007/s11858-021-01316-4

Luttrell, V. R., Callen, B. W., Allen, C. S., Wood, M. D., Donald, G., Richard, D. C. S., Luttrell, V. R., Callen, B. W., Deeds, D. G., & Richard, D. C. S. (2010). Educational and Psychological Measurement. *Educational and Psychological Measurement*, *70*(1), 142–160. https://doi.org/10.1177/0013164409344526

MoEC. (2022). *Kurikulum Referensi Penerapan Capaian Pembelajaran SD-SMA Matematika*. Guru.Kemdikbud.Go.Id.

MoEF. (2020). *Kementrian Lingkungan Hidup dan Kehutanan*. PPID.Menlhk.Go.Id.

Najichun, M., & Winarso, W. (2016). Hubungan Persepsi Siswa Tentang Guru Matematika Dengan Hasil Belajar Matematika Siswa. *Jurnal Psikologi Undiip*, *15*(2), 139–146.

Niss, M., & Blum, W. (2020). *The Learning and Teaching of Mathematical Modelling*.

OECD. (2019). *PISA 2018 Result: Combined Executive Summaries*. Https://Www.Oecd.Org/Pisa/Publication/PISA2018_CN__IDN.Pdf.

Özdemir, E., & Üzel, D. (2012). *Student Opinions On Teaching Based On Mathematical*. *55*(Procedia-Social and Behavioral Sciences), 1207–1214. https://doi.org/10.1016/j.sbspro.2012.09.616

Pranitasari, D., & Ratu, N. (2020). nalisis Kesalahan Siswa dalam Menyelesaikan Soal Matematika PISA pada Konten Change and Relationship. *AKSIOMA*, *9*(4), 1235–1248.

Putra, Y. Y., Zulkardi, Z., & Hartono, Y. (2016). Pengembangan Soal Matematika Model PISA Level 4,5,6 Menggunakan Konteks Lampung. *Kreano*, *7*(1), 10–16.

Riswandha, S., & Sumardi, S. (20020). Mathematical Communication, Perception of Mathematics Subjects, and Learning Independence on Student Learning Outcomes. *Jurnal Mercumatika*, *4*, 84–93.

Riyanto, B. (2021). Developing Mathematical Modeling Tasks Using Parking Fee for Learning Mathematics. *Journal of Mathematics and Mathematics Education*, *11*(2), 40–49.

Saputri, N. W., & Zulkardi, Z. (2020). Pengembangan LKPD Pemodelan Matematika Siswa SMP Menggunakan Konteks Ojek Online. *Jurnal Pendidikan Matematika*, 1–14.

Sari, F., & Darmawijoyo, D. (2019). Learning Mathematics Modeling Through Student Worksheet in Senior High School: Using Financial Context. *National Conference on Mathematics Education*, 10–13.

Simalango, M. M., Darmawijoyo, & Aisyah, N. (2018). esulitan Siswa dalam Menyelesaikan Soal-soal PISA pada Konten Change and Relationship Level 4,5, dan 6 di SMP N 1 Indralaya. *Jurnal Pendidikan Matematika*, *12*, 43–58.

Surmayanta, & Wibawa, A. (2020). Rekonstruksi Pembelajaran Matematika di Era Revolusi Industri 4.0. *Indonesian Digital Journal of Mathematics and Education*, *7*(1), 11–25. https://doi.org/https://doi.org/10.53717/idealmathedu.v7i1.135

Tessmer, M. (1993). *Planning and Conducting Formative Evaluations*.

Utari, D. R., Wardana, M. Y. S., & Damayani, A. T. (2019). Analisis Kesulitan Belajar Matematika dalam Menyelesaikan Soal Cerita. *Jurnal Ilmiah Sekolah Dasar*, *3*(4), 534–540.

Wijayanti, T. (2007). Konservasi Hutan Mangrove Sebagai Wisata Pendidikan. *Jurnal Ilmiah Teknik Lingkungan*, 15–25.

Yusherlly, H & Darmawijoyo, D. (2020). Mathematical Modelling Worksheet Using Health Context. *National Conference on Mathematics Education (NaCoME)*.

Appendix

1. Informasi apa saja yang mempengaruhi sisa luas hutan gundul yang tersisa di tahun 2030?

Mengurangi Pencbangan hutan tiap taunnya, Luas hutan gundul Indonesia sebesar 120.000 hektar pada tahun 2020. diiringi kegiatan penanaman hutan Kembali (reboisasi) sebesar 3.600 hektar. diperkiraan meningkat sebesar 40 % dari reboisasi tahun sebelumnya

Figure 2. Understanding Task Group 1

Luas reboisasi tahun 2021
$(\frac{40}{100} \cdot 3.600) + 3.600$
$= 1.440 + 3.600$
$= 5.040$ hektar

Luas reboisasi tahun 2022
$(\frac{40}{100} \cdot 5040) + 5040$
$= 2016 + 5040$
$= 7.056$ hektar

Luas reboisasi tahun 2023
$(\frac{40}{100} \cdot 7056) + 7056$
$= 2.822 + 7056$
$= 9.878$ hektar

Luas reboisasi tahun 2024
$(\frac{40}{100} \cdot 9.878) + 9.878$
$= 3.951 + 9.878$
$= 13.829$ hektar

Luas reboisasi tahun 2025
$(\frac{40}{100} \cdot 13.829) + 13.829$
$= 19.360$ hektar

Luas reboisasi tahun 2026
$(\frac{40}{100} \cdot 19.360) + 19.360$
$= 27.104$ hektar

Luas reboisasi tahun 2027
$(\frac{40}{100} \cdot 27.104) + 27.104$
$= 37.945$ hektar

Luas reboisasi tahun 2028
$(\frac{40}{100} \cdot 37.945) + 37.945$
$= 53.123$ hektar

Luas reboisasi tahun 2029
$(\frac{40}{100} \cdot 53.123) + 53.123$
$= 74.372$ hektar

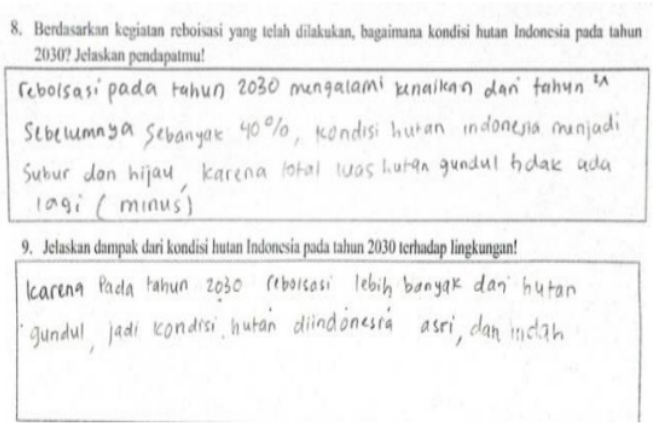
Luas reboisasi tahun 2030
$(\frac{40}{100} \cdot 74.372) + 74.372$
$= 104.120$ hektar

Figure 3. Group 5 Searching Mathematics and Using Mathematics Answer

4. Jika kamu sescorang yang mengambil keputusan dalam kebijakan penurunan hutan gundul di Indonesia, berapa penurunan hutan gundul yang akan kamu tetapkan setiap tahunnya untuk mendukung perjanjian tersebut? Jelaskan.

50 % Supaya jumlah reboisasi dan jumlah Penggundulan seimbang.

Figure 4. Group 5 Searching Mathematics Answer


8. Berdasarkan kegiatan reboisasi yang telah dilakukan, bagaimana kondisi hutan Indonesia pada tahun 2030? Jelaskan pendapatmu!

Reboisasi pada tahun 2030 mengalami kenaikan dari tahun ke sebelumnya sebanyak 40%, kondisi hutan indonesia menjadi subur dan hijau, karena total luas hutan gundul tidak ada lagi (minus)

9. Jelaskan dampak dari kondisi hutan Indonesia pada tahun 2030 terhadap lingkungan!

karena pada tahun 2030 reboisasi lebih banyak dari hutan gundul, jadi kondisi hutan diindonesia asri, dan indah

Figure 5 Group 3 Explaining Result

Table 4. Expert Reviewer Resume result

Expert Reviewer	Content	Construct	Language
Expert 1	4,75	5	4,8
Expert 2	4,75	4,14	4,6
Expert 3	4,75	4,5	4,6
Expert 4	5	4	5
Expert 5	-	-	4,4
Expert 6	-	-	4
Average Score	4,8125	4,4	4,56

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