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DEVELOPMENT OF LEARNING INSTRUMENTS BASED ON THE PROBLEM BASED LEARNING MODEL TO FACILITATE STUDENTS' MATHEMATICAL PROBLEM SOLVING SKILL ON CURVED 3D SHAPES

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ABSTRACT *The aim of this study was to develop educational materials, including syllabi, lesson plans, and worksheets, utilizing a problem-based learning approach to enhance the mathematical problem-solving abilities of ninth-grade junior high school students in dealing with curved side 3D space problems. This research falls under the category of development research (R&D) and employs the 4-D method, which involves defining, designing, developing, and disseminating. The outcome of the study is the creation of valid and practical learning materials, validated by experts with scores of 3.88 for the syllabus, 3.84 for the lesson plans, and 3.77 for the worksheets, meeting the criteria for high validity. Additionally, the practicality scores obtained from small and large group trials were 3.64 and 3.61, respectively, indicating a high level of practicality. In conclusion, the mathematics learning materials developed based on the problem-based learning model for the topic of curved 3D shapes effectively support the enhancement of students' mathematical problem-solving skills at the ninth-grade level, meeting both validity and practicality criteria.*

Keywords: development, 3D space, learning instruments, problem-solving.

INTRODUCTION

Education is intricately linked with science and technology, with mathematics playing a pivotal role in their advancement. According to the appendix of Permendikbud No. 58 of 2014, mathematics serves as the foundational science driving the evolution of modern technology and contributing significantly to various fields while also fostering critical thinking skills. Given the rapid progress in information and communication technology, mastering mathematics from an early age is imperative for future technological innovation and proficiency.

Recognizing the significance of mathematics, it becomes essential to enhance the quality of mathematics education to fulfill its learning objectives. As outlined in the annex of Permendikbud No. 58 of 2014, one of the primary aims of mathematics education at the junior high school level is to cultivate reasoning skills and proficiency in mathematical manipulation, problem analysis, and solution. This encompasses the ability to comprehend problems, construct mathematical models, solve them, and interpret the results, thus addressing real-world challenges. Similarly, the learning objectives outlined in SK BSKAP Permendikbudristek No. 8 of 2022 emphasize problem-solving skills, encompassing problem understanding, model design, solution derivation, and interpretation.

In Wahyuni (2018) research mentioned the proficiency in mathematical problem-solving is an essential skill that students must acquire and represents a fundamental objective within the purview of learning mathematics. According to Isnaini et al., (2016) the skill to solve mathematical problems is of paramount importance for students as it serves as a conduit for understanding, resolving, planning, and devising solutions through non-routine strategies. Novriani & Surya (2017) conceptualizes mathematical problem solving as a process involving the mathematical interpretation of a situation, typically entailing iterative cycles of expressing, testing, and revising mathematical interpretations. Akbar et al., (2017) posits that mathematical problem solving encompasses core processes, including methods, procedures, and strategies, integral to the mathematics curriculum and overarching objectives of mathematics learning, representing the essence of the discipline. The salience of this skill lies in its role as a general teaching goal and a foundational skill in learning mathematics (Sumartini, 2016) . Problem-solving skill not only constitute a goal in learning mathematics but also serve as the primary tool for engaging in mathematical work (NTCM in Apriyani, 2018). NTCM (Talib & Tinamba, 2019) defines problem solving as the process of applying previously acquired knowledge to novel situations. Furthermore, NCTM elucidates the general objectives of teaching problem solving, encompassing the construction of new mathematical knowledge, solving problems within mathematical and other contexts, employing and adjusting various appropriate strategies, and engaging in reflective monitoring of the process of solving mathematical problems (Mustika et al., 2018).

Researchers endeavored to gather insights into the mathematical problem-solving capabilities exhibited by students in Indonesia. The investigation revealed a noteworthy observation: the mathematical problem-solving prowess of these students falls below the global average. This discernment is rooted in an evaluation conducted as part of the Program for International Student Assessment (PISA), an international benchmarking initiative. Apriyani (2018) underscored that the PISA study's questions were designed to assess reasoning, problem-solving, and argumentation skill more prominently than memory and calculation skill. As of 2022, Indonesia held the 69th position among 81 participating countries in the PISA

evaluation, securing a score of 366 in contrast to the international average of 472 (OECD, 2023). These findings underscore the relatively diminished state of mathematical problem-solving skill among Indonesian students.

Mulyati (2016)said the cause of low mathematical problem solving skill is the lack of non-routine problems in the text book, besides that teachers are accustomed to adopting problems contained in the source book. According to Ulvah & Afriansyah, (2016) the low mathematical problem solving skill of students is influenced by students' lack of understanding and interest in mathematics lessons caused by the existence of a passive classroom condition, where students are less involved in learning, as well as some students who think that math is a difficult subject. So that the class tends to be tense, students become reluctant to learn math. In addition, Aryanti et al., (2023) in their research stated that the factors causing the low problem solving skill of students are that students have not been careful in reading and understanding the problem, have not been careful in correcting the solution that has been written, lack of skill in developing a solution strategy, students do not like math lesson, and the application of learning models that are not appropriate.

Karima, Q. (2020) asserted that the problem-solving skill of students at SMPN 20 Pekanbaru remained relatively subpar. Following a test evaluating mathematical problem-solving abilities, specifically focusing on the Two-Variable Linear Equation System, it was identified that students faced challenges in precise identification of known and unknown elements within given problems. Moreover, they exhibited difficulties in transforming problems into mathematical models, and not all students could successfully navigate and solve the problems presented by the teacher. Yustianingsih et al. (2017)corroborated these findings, indicating that students were provided with problems resembling those previously demonstrated by the teacher. However, students, guided by taught strategies, demonstrated a limited inclination to engage in independent problem-solving and critical thinking.

At the secondary level of mathematics education, the material becomes more abstract, particularly in geometry. This increased abstraction poses challenges for students in comprehending and resolving mathematical problems. Dwirahayu, Himawan, and Kustiawati (2018) highlighted the distinctive nature of geometry in mathematics, emphasizing that mastering geometry requires a sustained and continuous learning process. Teaching and learning geometry are intricate tasks, necessitating the exploration of effective learning strategies to enhance students' comprehensive understanding of geometry.

Arifin et al. (2017) in their research suggested that students have difficulty in solving the problem of building a curved 3D shapes given. Student difficulties in the form of difficulties about the concepts and principles related to the problem of building a curved 3D shapes given. Based on this research, it is obtained that the percentage of mastery of the surface area and volume of curved 3D shapes is below 50% and

solving problems in curved 3D shapes obtained a percentage of 0%. This is caused by factors of interest, motivation, teachers, learning habits and readiness, and friends.

According to Akbar (2016), learning practices in schools still experience various problems with the learning instruments used to operate the learning process, one of which is a learning model that does not actively involve students and is not optimal and does not use everyday life situations.

Based on the teaching practice experience carried out at SMP Muhammadiyah 1 Pekanbaru, it was found that the learning instruments used by teachers were not in accordance with Permendikbud Number 22 of 2016. The lesson plans used by teachers still come from handbooks and the internet. According to the explanation of the teacher concerned, the obstacle is the time he has to prepare the lesson plans. In addition, teachers only use handbooks as student learning resources. This is not in accordance with the demands of the 2013 curriculum where students are required to be active so that students become more passive. Based on this experience, when students are given problems during learning, students still have difficulty identifying what is known and what is asked from the problem. This shows that students' problem solving skill in solving everyday life problems are still relatively low. Researchers also conducted interviews with teachers at SMP IT Aufia GIBS Riau. Teachers do not use student activity sheets as teaching materials for students due to time constraints. Teachers only use mathematics textbooks printed by publishers and learning activities are carried out using the lecture method where the teacher first explains the material, gives example problems then students work on practice problems. Based on the teacher's explanation, students' mathematical problem solving skill are still less than expected.

Given the information presented earlier, it underscores the critical necessity of enhancing the quality of mathematics education to actively engage students and foster their proficiency in mathematical problem-solving. Consequently, the imperative arises to develop educational resources, specifically syllabus, lesson plans, and student worksheets, to serve as instructional guides for teachers and to facilitate the learning process.

In accordance with Regulation Permendikbud No. 103 of 2014, the development of educational instruments like syllabus, lesson plans, and worksheets should adhere to a specific pedagogical model to ensure a targeted focus on the intended objectives. Furthermore, Regulation Number 103 of 2014 emphasizes the incorporation of a scientific approach within the 2013 curriculum, allowing for the utilization of diverse learning strategies and models that promote active student participation. A learning model is characterized by its nomenclature, distinctive features, syntactic structure, organizational framework, and cultural context, encompassing methodologies such as project-based learning, problem-based learning, and inquiry/discovery learning.

The practical application of curved 3D shapes in everyday life serves to enhance students' comprehension in a tangible context. Consequently, the problem-based learning (PBL) model emerges as a viable alternative to aid in comprehending curved 3D shapes. According to Fardani et al., (2021), the utilization of the problem-based learning model effectively nurtures students' proficiency in problem-solving, communication, group collaboration, and interpersonal skill. This success is attributed to the PBL model's presentation of authentic problems, stimulating active engagement and learning among students. Additionally, Majid (2014) contends that the implementation of the problem-based learning model involves collaborative teamwork in resolving real-world problems, fostering heightened interaction among peers and augmenting students' adeptness in addressing real-life challenges.

In research of Sumartini (2016) supports the efficacy of the Problem-Based Learning (PBL) model in enhancing students' mathematical problem-solving skill, asserting that students exposed to PBL outperform their counterparts subjected to conventional learning. Furthermore, a study of Jatisunda (2016), focusing on junior high school students and a contextual approach, underscores the superior improvement in problem-solving skill among students engaging in contextual learning compared to those employing conventional methods. This underscores the premise that the adoption of specific learning models or approaches can effectively facilitate and cultivate students' problem-solving abilities.

Researchers are encouraged to devise instructional materials for mathematics education, such as syllabi, lesson plans, and worksheets, employing a problem-based learning (PBL) approach to enhance mathematical problem-solving abilities among 9th-grade SMP/MTs students, specifically focusing on curved 3D shapes. This study centers on analyzing the validation of the developed instructional materials concerning curved 3D shapes. The research question addresses whether the developed learning materials—comprising syllabi, lesson plans, and worksheets based on problem-based learning—are valid and practical for improving the mathematical problem-solving skills of 9th-grade junior high school students in the context of curved 3D shapes. The objective of this study is to create mathematics learning materials in the form of syllabi, lesson plans, and worksheets utilizing problem-based learning approaches that meet validity criteria, aiming to enhance the mathematical problem-solving proficiency of 9th-grade junior high school students regarding curved 3D shapes.

METHOD

The this research is a research and development (R&D), which is research that produces or develops a product. This study adopts 4-D model by Thiagarajan (1974), encompassing the defining, designing, developing, and disseminating stages. However, the current investigation focuses solely on the define, design, and develop stages. In the define stage, an end-start analysis was conducted to pinpoint issues,

complemented by student analysis to scrutinize student characteristics, concept analysis involving the compilation of curved 3D shapes, and task analysis to formulate competency achievement indicators and learning objective specifications. The design stage entails crafting prototypes of learning instruments, involving four steps: establishing test standards, selecting media, choosing formats, and creating initial designs. At the development stage, the instruments that have been made will be validated by three validators. Validation activities aim to obtain data on the validity of the device made and given suggestions for improvement to be revised. After the device is declared valid, then small group trials and large group trials are carried out to determine the practicality of the tool. In the disseminate stage, instruments that are already valid and practical will be disseminated through three stages, namely validation testing, packaging, diffusion and adaptation.

The data acquired in this study comprises quantitative data, which originates from the evaluations conducted by validators of the learning instruments (syllabi, lesson plans, and worksheets), as well as from student response questionnaires. The validation tool utilized in this research consists of validation sheets for the syllabi, lesson plans, and worksheets. Validators evaluate these materials using a Likert scale with four response options: 1 (very unsuitable), 2 (unsuitable), 3 (suitable), and 4 (very suitable). Meanwhile, students complete a questionnaire using a Likert scale with four response options: 1 (very disagree), 2 (disagree), 3 (agree), and 4 (very agree).

The validation outcomes of the learning instruments are analyzed using the average value formula, which is calculated as follows:

$$\bar{M}_v = \frac{\sum_{i=1}^{n} \bar{V}_i}{n}$$

Description:

$\bar{M}_v$: Average assessment results from validators

$\bar{V}_i$: The average of the assessment results of the i-th validator

n : The total of validators

Source : Adaptation of Juniantari (2017)

The calculation of the range involves subtracting the lowest score from the highest score and then dividing the result by the highest score. According to the computation, a range of 0.75 was determined. The criteria for the average validation analysis are outlined in the table below:

Tabel 1. Criteria for Learning Tool Validity

Interval	Category
$3{,}25 \leq \bar{M}_v \leq 4$	Very Valid
$2{,}50 \leq \bar{M}_v < 3{,}25$	Valid
$1{,}75 \leq \bar{M}_v < 2{,}50$	Less Valid
$1{,}00 \leq \bar{M}_v < 1{,}75$	Not Valid

Source : Adaptation of Juniantari (2017)

As indicated in Table 3.5, the learning tool is considered valid when the obtained validity category falls within the valid range, with an average interval of at least 2.50.$\leq \bar{M}_v < 3{,}25$.

Analysis of the practicality of worksheets using student response questionnaire data can be done using the following formula:

$$\bar{T}_v = \frac{\sum_{i=1}^{n} \bar{P}_i}{n}$$

Description:

$\bar{T}_v$: average total practicality

$\bar{P}_i$: average practicality of i-th practitioner

n : The total of respondents

Source: Adaptation of Widoyoko (2014)

The criteria for the student response questionnaire can be seen in table below:

Tabel 2. Criteria for Learning Tool Validity

Interval	Category
$3{,}25 \leq \bar{T}_v \leq 4$	Very Practical
$2{,}50 \leq \bar{T}_v < 3{,}25$	Practical
$1{,}75 \leq \bar{T}_v < 2{,}50$	Less Practical
$1{,}00 \leq \bar{T}_v < 1{,}75$	Not Practical

Source: Modification of Widoyoko (2014)

The developed product is said to fulfill the aspect of good practicality if at least the level of practicality achieved is practical with an average interval of $2{,}50 \leq \bar{T}_v < 3{,}25$.

RESULT AND DISCUSSION

This research undertakes the creation of educational tools in mathematics, including syllabi, lesson plans, and worksheets, utilizing a problem-based learning approach focused on the topic of constructing curved 3D shapes. These tools aim to enhance the mathematical problem-solving abilities of ninth-grade students in junior high schools, meeting both valid and practical standards. The research methodology employed follows the 4-D model, encompassing define, design, development, and dissemination stages, with a specific focus on define, design, and development phases.

Beginning with the define stage, the study involves identifying and articulating initial challenges, requiring solutions to address the identified issues. The impetus for this developmental endeavor arises from the recognized need to improve students' mathematical problem-solving skills, aligning with the objectives of mathematics education outlined in the 2013 curriculum. Observations in educational contexts indicate a relative inadequacy in students' mathematical problem-solving abilities, as evidenced by underwhelming performance in the PISA test., where Indonesia's scores fall below the international average. Additionally, corroborating evidence is found in the findings of other researchers and insights gleaned from interviews with teachers at IT Aufia GIBS Riau Junior High School, indicating that students' problem-solving skill have yet to reach a commendable level.

Additionally, according to interviews with teachers at Muhammadiyah 1 Pekan Baru Junior High School, it was found that teachers solely rely on syllabus and lesson plans sourced from mathematics textbooks published by external publishers. Furthermore worksheets are not incorporated into the instructional process, primarily due to the time constraints faced by teachers, hindering their skill to create or develop syllabus, lesson plans, and student activity sheets.

Subsequently, researchers undertook a student analysis to ascertain the characteristics, capabilities, and progress of students during the learning process. Drawing on Piaget's developmental theory (Ramadhani et al., 2021), it is recognized that students aged 11-18 can engage in formal thought processes, achieving logical reasoning in drawing conclusions, interpreting information, and formulating hypotheses. However, given the variskill in students' abilities, it is imperative that syllabus, lesson plans, and student activity sheets cater to students with diverse skill levels, particularly those with moderate to low abilities.

Following this, concept analysis, task analysis, and the articulation of learning objectives are conducted to devise learning activities, determine appropriate teaching methods, outline the specifics of learning materials, and establish competencies and objectives aligned with curriculum requirements and the needs of the students.

During the design phase, researchers engaged in activities aimed at generating a product design for learning instruments, comprising syllabus, lesson plans, and worksheets. The design of these components is tailored to align with the stages of the problem-based learning model and the scientific approach. Adherence to a pre-established format and compliance with Permendikbud No. 22 of 2016 guide the development of syllabus, lesson plans, and worksheets. The worksheets are crafted to correspond with the stages of the problem-based learning model and the scientific approach, aiming to enhance students' mathematical problem-solving skill in tackling curved 3D shapes related problems. In tandem with designing learning instruments, researchers also formulated validation sheets for syllabus, lesson plans, and worksheets, along with questionnaires gauging student responses.

In the development stage, the designed learning instruments, encompassing syllabus, lesson plans, and worksheets, underwent a validation process facilitated by appointed validators. The data stemming from the syllabus validation indicated that the developed syllabus met the criteria for being deemed highly valid, with the collective average validation score from three validators reaching 3.92. The subsequent section provides a breakdown of the syllabus validation results.

1. The identity and syllabus components achieved an average score of 4.00 with highly valid criteria, signifying that the completeness of the identity and syllabus components adhered to the stipulations outlined in Permendikbud No. 22 of 2016.
2. The KI and KD aspects garnered an average score of 4.00 with highly valid criteria, indicating alignment with Permendikbud No. 37 of 2018.
3. The learning material aspect received an average score of 3.67 with highly valid criteria, underscoring that the presentation of learning material conforms to and supports the attainment of the KD.
4. The IPK aspect attained an average score of 3.50 with highly valid criteria, suggesting that the IPK was suitable and supportive of KD achievement, employing operational verbs amenable to measurement.
5. The learning activities aspect achieved an average score of 3.83 with highly valid criteria, affirming that learning activities are congruent with the stages of the PBL model and the scientific approach.
6. The assessment aspect secured an average score of 4.00 with highly valid criteria, indicating that the techniques and formats employed for assessing knowledge and skill align with GPA standards.
7. The time allocation aspect received an average score of 4.00 with highly valid criteria, signifying that the allocated time is in accordance with the material and learning activities.
8. The learning resources aspect obtained an average score of 3.67 with highly valid criteria, affirming that learning resources align with the prescribed learning materials and cater to student characteristics.

The data derived from the validation of the lesson plans indicates that the crafted lesson plans falls within the highly valid criteria, as evidenced by a collective average validation score of 3.90 from the three validators. The subsequent section provides a breakdown of the validation results for the lesson plans.

1. The identity aspect and components of the lesson plans achieved an average score of 4.00, meeting the criteria for high validity. This signifies that the entirety of the identity and lesson plans components aligns with the stipulations outlined in Permendikbud No. 22 of 2016.
2. The KI aspect received an average score of 4.00 with highly valid criteria, indicating its alignment with Permendikbud No. 37 of 2018.
3. The KD and IPK aspects garnered an average score of 3.91 with highly valid criteria, signifying compliance with Permendikbud No. 37 of 2018. Furthermore, the IPK was deemed appropriate, supporting KD achievement and utilizing measurable operational verbs.
4. The aspect of learning objectives obtained an average score of 3.94 with highly valid criteria, demonstrating that the formulated learning objectives align with the IPK and learning material, incorporating the ABCD (Audience, Behavior, Condition, and Degree) format.
5. The aspect of learning materials achieved an average score of 3.72 with highly valid criteria, indicating that the learning material adequately encompasses facts, concepts, principles, and procedures, aligning appropriately with the learning objectives.
6. Aspects of learning models, approaches, and methods attained an average score of 3.92 with highly valid criteria, confirming that the employed learning models, approaches, and methods are congruent with the learning material and contribute to the achievement of learning objectives.
7. Aspects of media, instruments, and learning resources secured an average score of 3.61 with highly valid criteria, affirming that the media, instruments, and learning resources align with the learning material and support the attainment of learning objectives.
8. The aspect of learning activities received an average score of 3.89 with highly valid criteria, indicating that learning activities encompass appropriate preliminary, core, and closing activities. These activities also incorporate the stages of the PBL model and scientific approach, effectively facilitating problem-solving.
9. The assessment aspect garnered an average score of 3.75 with highly valid criteria, demonstrating the inclusion of knowledge and skill assessments, with assessment instruments aligning with problem-solving indicators.

The results of the worksheets validation indicate that the developed worksheets meets the highly valid criteria, as evidenced by the collective average validation

score of 3.79 from the three validators. The subsequent section provides a detailed breakdown of the worksheets validation results.

1. The worksheets cover's appearance aspect achieved an average score of 4.00 with highly valid criteria, signifying that the cover accurately incorporates the learning material's title, space for student identity, learning objectives, and worksheets work instructions.
2. The learning material aspect received an average score of 3.71 with highly valid criteria, indicating that the material aligns with the learning objectives, supporting information correlates with the presented material, and the material is comprehensive and systematically organized.
3. The quality aspect of learning activities obtained an average score of 3.76 with highly valid criteria, demonstrating that worksheets activities encourage student engagement, aid in knowledge construction, and contribute to achieving learning objectives.
4. The aspect of the suitskill of learning activities on the worksheets with the PBL model and the scientific approach secured an average score of 3.82 with highly valid criteria, signifying that the activity steps on the worksheets align with the PBL model and the scientific approach.
5. The suitskill aspect of the worksheets to facilitate problem-solving garnered an average score of 3.76 with highly valid criteria, indicating that the worksheet's activity steps effectively facilitate student problem-solving.
6. The didactical requirements aspect achieved an average score of 3.74 with highly valid criteria, suggesting that the worksheets can accommodate students with diverse abilities and support collaborative group work.
7. The construction requirements aspect attained an average score of 3.87 with highly valid criteria, indicating that the clarity of sentences and language use in the worksheets aligns with the students' cognitive level.
8. The technical requirements aspect received an average score of 3.67 with highly valid criteria, underscoring that the worksheets's visual appeal, legibility of writing, appropriateness of image size and color, alignment of images with the material, and adequacy of space for student responses meet the prescribed criteria.

Based on the findings of the validation analysis, it can be inferred that the educational materials, including syllabi, lesson plans, and worksheets, designed according to the problem-based learning model for curved 3D shapes, effectively facilitate the mathematical comprehension skills of ninth-grade students in Junior High School.

The trial encompassed both small and large groups, with the former involving six students from Class IX A at Islamic Junior High School Aufia GIBS Riau, selected for their diverse skill levels as recommended by mathematics instructors. Feedback gathered from the students' questionnaire responses regarding the utilization of

worksheets indicated that the developed materials met the criteria for practicality, achieving an overall average score of 3.64. Below are the specifics of the questionnaire results concerning the worksheet usage during the small group trial.

1. The appearance aspect of the worksheets obtained an average score of 3.65 with very practical criteria which indicated that the appearance of the worksheets was attractive, the color composition on the worksheets was harmonious, the images/illustrations on the worksheets were clear and helped students in working on the worksheets and the free space provided was sufficient to complete the activities on the worksheets.
2. The aspect of ease of use of the worksheets obtained an average score of 3.58 with very practical criteria which indicated that the worksheets was presented in order so that it was easy to understand, the activity instructions on the worksheets were easy to understand, the language used in the worksheets was easy to understand, the writing on the worksheets was clear and the terms used in the worksheets were easy for students to understand.
3. The content aspect of the worksheets obtained an average score of 3.70 with very practical criteria which shows that the activities on the worksheets help students understand the material of the curved 3D shapes, learning using the worksheets raises students' curiosity, the problems on the worksheets are often encountered in everyday life and the worksheets trains students in asking questions and expressing opinions.

After the small group trial, the researchers conducted a large group trial in class IXB Islamic Junior High School Aufia GIBS Riau consisting of 25 students. The data from the student response questionnaire on the use of worksheets showed that the worksheets developed was included in the very practical criteria with an average total practicality score of 3.61. The following are the details of the results of the student response questionnaire on the use of worksheets in the large group trial.

1. The appearance aspect of the worksheets obtained an average score of 3.70 with very practical criteria which indicated that the appearance of the worksheets was attractive, the color composition on the worksheets was harmonious, the images/illustrations on the worksheets were clear and helped students in working on the worksheets and the free space provided was sufficient to complete the activities on the worksheets.
2. The aspect of ease of use of the worksheets obtained an average score of 3.55 with very practical criteria which indicated that the worksheets was presented in order so that it was easy to understand, the activity instructions on the worksheets were easy to understand, the language used in the worksheets was easy to understand, the writing on the worksheets was clear and the terms used in the worksheets were easy for students to understand.
3. The content aspect of the worksheets obtained an average score of 3.60 with very practical criteria which shows that the activities on the worksheets help

students understand the material of the curved 3D shapes, learning using the worksheets raises students' curiosity, the problems on the worksheets are often encountered in everyday life and the worksheets trains students in asking questions and expressing opinions.

Based on the outcomes derived from analyzing the student response questionnaire regarding worksheet usage and assessing the worksheets completed by students in both small and large groups, it is determined that the worksheets, structured upon the problem-based learning model focusing on curved 3D shapes, effectively enhance the mathematical problem-solving abilities of ninth-grade students in junior high school.

The study's findings affirm that the mathematics learning tools, employing the problem-based learning model for curved 3D shapes, meet both valid and practical criteria for enhancing the mathematical problem-solving skills of ninth-grade students in junior high school. Silalahi et al., (2021) similarly concluded in their research that learning tools developed based on the problem-based learning model effectively facilitate the mathematical problem-solving abilities of eighth-grade junior high school students, meeting both valid and practical requirements. This indicates that the developed tools are proficient in enhancing mathematical problem-solving skills. During the Disseminate stage, researchers compile the learning tools into book form.

CONCLUSSION AND SUGGESTION

This research in educational development yields mathematics learning materials comprising syllabi, lesson plans, and worksheets structured around a problem-based learning model focused on curved 3D shapes, aimed at enhancing the mathematical problem-solving abilities of ninth-grade junior high school students. The developmental process employed in this study adheres to the 4-D model, encompassing four key stages: define, design, develop, and disseminate. During the define stage, activities include preliminary analysis, student profiling, concept elucidation, task examination, and formulation of learning objectives. In the design stage, efforts are directed towards crafting learning materials and devising validation and practicality assessment tools. The development phase involves the validation of learning materials, along with small and large group trials. Finally, in the disseminate stage, the materials are compiled into book form. Based on the validation results and trial outcomes, it is evident that the problem-based learning model-based learning materials focusing on curved 3D shapes effectively enhance the problem-solving skills of ninth-grade junior high school students, meeting both validity and practicality criteria.

A recommendation stemming from this research is to endorse the utilization of the validated and practical learning materials as an alternative tool for mathematics

instruction in classrooms, offering teachers an effective resource to enhance the learning experience.

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