**Implications of Understanding by Design in Developing Problem-Based Learning Models to Improve Students' Literacy and Numeration on Comparative Materials**

**Usmadi**

Muhammadiyah University West Sumatra/Mathematics Education, Padang, 25172, Indonesia

E-mail: [usmadi3012@gmail.com](mailto:usmadi3012@gmail.com)

ORCID iD : <https://orcid.org/0009-0009-3840-7774>

**Ria Sriwahyuni**

State Junior High School 8 in Padang, Padang, 25172, Indonesia

E-mail:  [riasriwahyuni3@gmail.com](mailto:%20riasriwahyuni3@gmail.com)

**Ergusni**

Muhammadiyah University West Sumatra, Padang/Mathematics Education, 25172, Indonesia

E-mail: ergusni12@gmail.com

ORCID iD : <https://orcid.org/0009-0003-3507-1247>

**Mahyudin Ritonga**

Muhammadiyah University West Sumatra, Padang, 25172, Indonesia

E-mail: [mahyudinritonga@gmail.com](mailto:mahyudinritonga@gmail.com)

ORCID iD : <https://orcid.org/0000-0003-1397-5133>

\*Corresponding Author

**Abstract:** This research aims to develop a Problem-Based Learning model to enhance students' literacy and numeracy skills in value comparison teaching materials. The development process uses the Understanding by Design (UbD) method, following these steps: 1. Identify problems in learning, 2. Determine assessment evidence, 3. Plan learning activities. The results of this development research are: 1. The identified problem for which a solution will be sought is the low literacy and numeracy skills of students in comparative teaching materials, 2. Assessment evidence proving that students have achieved or are working towards the learning objectives, namely Assessment for Learning or assessment during the learning activities, includes: (1) Cognitive assessment through quizzes, which showed that 26 students completed it with a success rate of 90% (90% above the KKTP) and 3 students did not complete it, resulting in a 10% incomplete rate (below the KKTP). (2) Cognitive assessment via LKPD, which showed that 29 students completed it with a 100% success rate, and no students failed to meet the KKTP, which was 75. The positive impacts of implementing this innovative learning model are: a. Students' science process skills and critical thinking abilities have developed well, b. Students are becoming accustomed to communicating and collaborating in groups to solve problems, c. An increase in student literacy and numeracy in learning also encourages improved student learning outcomes, d. The use of the innovative Problem-Based Learning model, which is student-centered, makes students more active and can improve literacy and numeracy skills in learning value comparison. Additionally, the use of TPACK-based learning media, such as videos displayed on PowerPoint slides, makes it easier for students to understand the teaching material, remain enthusiastic during the learning process, and avoid boredom, thereby increasing their literacy and numeracy skills.

**Index Terms**: Problem-Based Learning (PBL), Literacy and Numeracy Skills, Understanding by Design (UbD), Cognitive Assessment, TPACK-based Learning Media.

##### **1. Introduction**

Education emphasizes that the educational process should be carried out consciously and well-planned, utilizing innovative learning models. The application of these models aims to create a learning atmosphere and process that actively engages students in developing their potential. Improving the quality of learning and teaching can be achieved through educators implementing innovative learning models in the classroom. According to Republic of Indonesia Law No. 20 of 2023, the aim of education is to cultivate students who are faithful and devoted to Allah SWT, possess noble character, and are healthy, knowledgeable, capable, creative, independent, and responsible. This underscores the importance of maximizing the role of educators to enhance the quality of education, particularly in terms of learning processes and outcomes. Key elements necessary for improving the quality of learning processes and outcomes in schools include: (1) professional educators, (2) student motivation, (3) curriculum materials, and (4) the quality and type of support available for the learning process in the classroom [7b, 43].

Strong literacy and numeracy skills are another expected ability of students. Numeracy and literacy skills are the ability to use various numbers and symbols related to basic mathematics to solve practical problems in various contexts of daily life. Siti Hajar (2021) states that to increase excellence and competitiveness in facing the challenges of the 21st century, Indonesian society must master six basic literacies, namely: (a) language literacy, (b) numeracy literacy, (c) scientific literacy, (d) digital literacy, (e) financial literacy, and (f) cultural and civic literacy [37]. Literacy is considered the most important skill for students and the younger generation to learn and face future challenges [27a,28,b,30]. By mastering literacy, students develop the ability to interpret and critically analyze the complexities of their environment. Therefore, these six literacies are essential for all students to possess.

Since 2016, the Ministry of Education and Culture has been striving to create a culture of literacy by launching the National Literacy Movement (GLN). This movement promotes national literacy through various activities aimed at improving quality of life, competitiveness, character development, and the skills needed in the 21st century. The National Literacy Movement emphasizes the importance of mastering six basic literacies: language, numeracy, digital, scientific, financial, and cultural and civic literacy. [37]. One of the most important aspects of literacy is numeracy.

Numeracy literacy skills are crucial, but the reality in many schools is that students continue to struggle with these skills. This is evident in several ways: (a) students often have difficulty understanding the problems presented in questions, (b) they lack the strategies to solve the given problems, (c) a significant number of students struggle to answer the questions, and (d) many students score below the Learning Objective Completion Criteria (KKTP).

Given these challenges, developing an appropriate and innovative learning model is essential. Shifting from conventional methods to a problem-based learning (PBL) approach is a promising solution. PBL actively engages students in solving real-world problems, fostering critical thinking and deeper understanding [13]. Through problem-based learning, students actively investigate, explore, and solidify their understanding of concepts as they seek solutions. To achieve this in the mathematics classroom, educators can leverage innovative learning models that mirror the scientific method. Here's how this approach aligns with the scientific method: (1) Student-Centered Learning: Learning activities are designed around student exploration and discovery.; (2) Fostering Critical Thinking: Students are encouraged to think independently, analyze problems, develop solution strategies, and share their ideas freely.; (3) Guided Practice: Educators provide guidance and support to help students develop critical and creative thinking skills as they approach problems.; (4) Collaboration and Communication: Collaborative learning groups are formed, and students are trained to communicate effectively using mathematical tools like graphs, diagrams, and symbols.; (5) Sharing and Reflection: Students present their work to the class, fostering discussion and the discovery of diverse concepts, solution approaches, and underlying mathematical principles [43].

The Problem-Based Learning (PBL) model is well-suited to improve students' numeracy literacy skills. The learning process itself incorporates several numeracy literacy indicators. For instance, when students collaborate in groups to solve problems from worksheets, they engage in Indicator 1: working effectively with models in concrete situations. Additionally, Indicator 3: using skills and reasoning with some knowledge, comes into play as students develop problem-solving strategies. Similarly, Indicator 2: selecting and presenting information, and connecting it to real-world contexts, is addressed during the information gathering stage. Finally, presenting discussion results aligns with Indicator 4: providing explanations based on actions and discussion outcomes. Educators play a critical role in creating a meaningful and supportive learning environment aligned with the chosen model [6]. They can further enhance students' numeracy literacy and attention spans by utilizing engaging learning resources and media. [36]. Research also confirms the effectiveness of the Problem-Based Learning (PBL) model. In this approach, students actively engage in solving real-world problems. Through investigation, exploration, and discovery during problem-solving, students solidify their mathematical concepts and knowledge. This active learning environment has been shown to positively impact mathematical literacy [13, 9].

Numeracy literacy is a subset of mathematical literacy. The term was introduced by the National Council of Teachers of Mathematics (NCTM) as part of their vision for mathematics education, predating its inclusion in the Program for International Student Assessment (PISA). Mathematical literacy encompasses the ability to solve everyday problems using mathematical concepts and skills. Developing numeracy literacy strengthens these overall mathematical abilities [29]. The Ministry of Education and Culture of Indonesia (Kemdikbud) [37] defines numeracy literacy as the knowledge to use various kinds of numbers and symbols related to basic mathematics to solve practical problems in everyday life and analyze information displayed in various forms. Based on this definition, numeracy can be understood as the ability to understand and apply mathematics in everyday contexts.

Numeracy literacy is the ability to develop and apply mathematical knowledge and skills in solving real-life problems. This includes acquiring, interpreting, applying, and communicating numbers and symbols related to basic mathematics, as well as analyzing information presented in various forms (narratives, graphs, tables, charts, etc.) to make informed decisions [21]. A key challenge lies in Indonesian students' ability to connect and apply their mathematical knowledge to solve real-world problems. Additionally, students often struggle with translating mathematical language and symbols, as well as effectively presenting information [36].

Improving the quality of mathematics learning hinges on educators' ability to identify and address various student challenges. These challenges encompass a broad range of areas, including: (1) Supporting students with disabilities and special needs, (2) Building positive relationships with students, (3) Implementing effective classroom management strategies, (4) Providing constructive feedback, (5) Employing diverse teaching methods, (6) Addressing student motivation issues, (7) Integrating HOTS (High Order Thinking Skills) into the curriculum, (8) Fostering numeracy literacy, (9) Identifying and correcting misconceptions, (10) Utilizing technology effectively in lessons, (11) Implementing appropriate assessment strategies, (12) Maintaining positive communication with parents, (13) Integrating innovative learning models, (14) Addressing other related challenges that educators encounter daily [25, 40].

Given the identified challenges, particularly those related to numeracy literacy and value comparison in mathematics, implementing an innovative learning model like Problem-Based Learning (PBL) can be highly beneficial. The Understanding by Design (UbD) framework offers a valuable approach to develop PBL effectively. UbD utilizes a "backward design" process, which starts by defining the desired learning outcomes. These outcomes should be measurable and aligned with specific learning goals and standards. Once the desired outcomes are established, UbD guides the development of assessment strategies to measure student achievement and, finally, the planning of engaging learning experiences [ 25, 40].

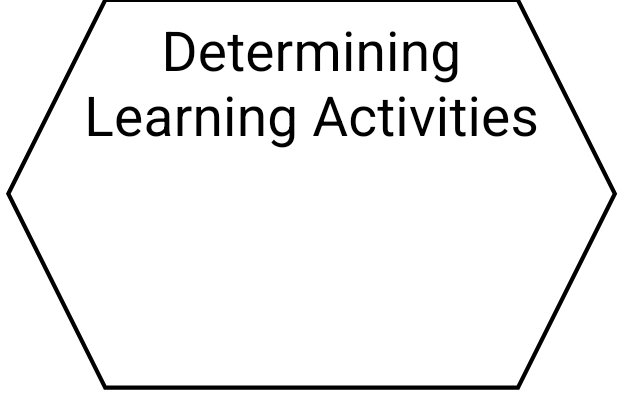
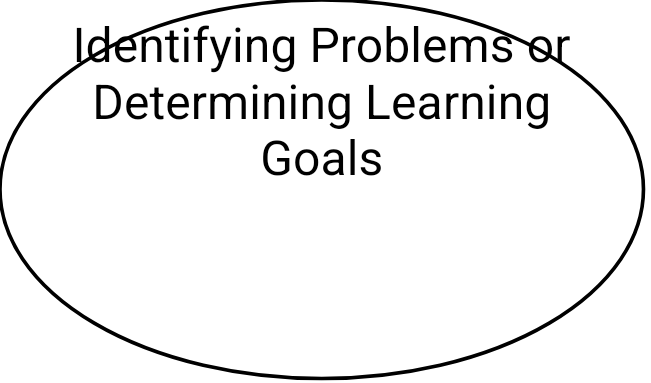
The backward design flow represents an innovative approach to curriculum development and lesson planning [17, 18, 25, 40]. The essence of backward design in learning design lies in starting with learning objectives to ensure activities address student needs [17, 18, 25, 40]. Backward Design is a results-oriented design approach with three key stages: (1) identifying desired learning outcomes, (2) establishing evidence of learning achievement, and (3) designing engaging learning experiences [25, 40].

##### **2. Methodology**

*2.1. Development Methods*

This research utilizes the Understanding by Design (UbD) framework to develop a Problem-Based Learning (PBL) model that specifically targets improving students' numeracy literacy and their ability to compare values. UbD emphasizes prioritizing desired learning outcomes. Following this principle, the UbD process involves first establishing clear learning objectives. Then, educators develop assessments to measure student achievement of those objectives. Finally, engaging learning activities are designed to facilitate student learning [25,40]. The visual representation of the UbD flow is presented in Figure 1 below.





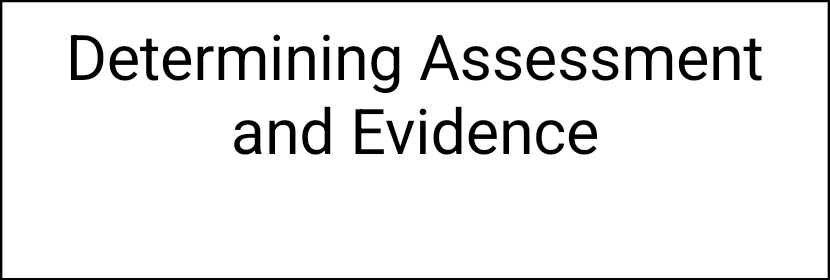




Fig.1. The Understanding by Design (UbD) Development Process

*2.2. Development Steps*

*Stage 1. Determine goals*

Effective learning activities require students to achieve specific learning objectives. These objectives, as defined in the Indonesian education curriculum, outline the knowledge, skills, and attitudes that students are expected to gain, possess, and master during a learning activity. To ensure these objectives are achievable, educators must consider the unique characteristics of their students. This includes understanding their learning needs and current levels of achievement before setting expectations for mastery. Additionally, learning objectives can be tailored to the specific environment of each school.

The specific curriculum used by a school influences how learning objectives are developed. Schools following the 2013 Curriculum base their learning objectives on "Basic Competencies" (KD). These competencies define the knowledge, behavior, skills, and attitudes students are expected to master after completing learning materials for a particular grade level. In contrast, schools implementing the Independent Curriculum use "Learning Achievements" (CP) to establish learning objectives. CPs define the learning competencies students must attain at each developmental stage. These Learning Achievements encompass a set of competencies and the scope of learning materials, presented comprehensively in a narrative form [25, 40].

A key concept of the Understanding by Design (UbD) method is the emphasis on transfer of learning. This means students don't just excel in class; they can apply their knowledge and skills to real-world situations. To cultivate this ability in students, educators must ask probing questions. These questions encourage students to think critically about how to use their understanding to achieve goals.

*Stage 2. Determine the Assessmen****t***

To ensure effective learning and assessment that improve students' knowledge, skills, and attitudes, educators need to plan both systematically. Three key assessment approaches are crucial for measuring student learning outcomes. The first is assessment for learning (AfL). AfL occurs during the learning process itself and aims to enhance both teaching and learning. It provides educators with valuable feedback on student progress, allowing them to monitor learning and identify areas that may require adjustment. Examples of AfL in this research include quizzes, presentations, and assignments.

The second approach is assessment as learning (AaL). Similar to AfL, AaL takes place during the learning process. However, AaL actively involves students in the assessment activities themselves. This includes self-assessment and peer-assessment, where students participate in creating assessment procedures, criteria, and rubrics. By understanding these expectations, students can take ownership of their learning and strive for better outcomes. Both AfL and AaL contribute to formative assessment, which is an ongoing process that aims to improve teaching and learning. The third approach is assessment of learning (AoL). This type of assessment occurs at the end of a learning process to measure student achievement. Examples of AoL include daily tests, mid-semester exams, and final exams. AoL forms part of summative assessment, which is essential for educators to gauge overall student learning.

*Stage 3. Determine Learning Activities*

At this stage, after knowing the learning objectives to be achieved and determining the tools to measure this achievement. Next, what can be done to achieve learning objectives, it is necessary to determine learning activities using an appropriate approach. The learning approach can be interpreted as our perspective on the learning process. Approach Learning should be carried out centered on students. Apart from determining the learning approach, you can also choose the models, strategies, and methods that will be used.

If you have chosen a method that can be done, then the next step is to prepare learning media. Learning media is anything that can be used to help convey information to students and can stimulate thoughts, feelings, attention, and the desire to learn so that it can encourage the learning process. According to to Arsyad, 2015 [ in 42], learning media is anything that can be used to convey information in the teaching and learning process so that it can stimulate students' attention and interest in learning. The choice of learning media can be guided by the grouping of types of learning media. According to Leshin et al. 1992 [in 42], types of learning media, namely (1) human-based media (educators, instructors, tutors, role-playing, group activities, field trips), (2) print-based media (books, guides, exercise books, work aids, and loose sheets), (3) visual-based media (books, charts, graphs, maps, pictures, transparencies, slides), (4) audio-visual based media (video, film, slide tape programs, television), (5 ) computer-based media (computer-assisted teaching, interactive video, hypertext).

*2.3. Development Process and Results*

This research explores the development and implementation of a Problem-Based Learning Model (PBL) designed to enhance students' numeracy literacy and their ability to compare values. The Understanding by Design (UbD) framework guided this development process.

*Development Process*

The development carried out in this research follows the following development path.

*Stage 1. Problem Identification*

This research identified general learning problems that can vary depending on the specific classroom context. These problems were determined based on the researcher's experience, discussions with fellow educators, and consideration of the unique needs and challenges within the sample schools' learning environments. The identified problems include:

1. Positive Discipline: The problem identified is that educators have not used time optimally in the teaching and learning process. An in-depth and comprehensive analysis found that the causes included educators exceeding the time set in the teaching module, students being unable to complete the LKPD within the specified time, and students not being able to maximize presentation time in front of the class.
2. Learning Methods: Educators are not yet optimal in using and implementing differentiated learning approach methods. The cause of this problem, based on an in-depth and comprehensive analysis, is that educators' understanding of differentiated learning methods is still not optimal. Educators have not had the opportunity to learn differentiated learning methods fully, they are still monotonous in implementing these methods, and they are overly focused on following each step of the differentiated learning method precisely. Additionally, students are still not enthusiastic about learning mathematics.
3. Student motivation is a critical issue, particularly in mathematics education. After conducting an in-depth analysis of the causes of low motivation, several factors were identified. These include students’ lack of understanding of the material, exclusion from group discussions, laziness in studying, and reluctance to actively participate in learning. Additionally, some students are shy during presentations and hesitant to ask or respond to questions from their peers.
4. HOTS (High Order Thinking Skills) material; The problem identified is the low ability of students to work on HOTS questions. Based on the results of an in-depth and comprehensive analysis, it was found that the causes of these problems were that students did not understand the existing question problems, students did not understand how to solve HOTS questions, very few students were able to answer HOTS questions, many students got marks. under KKTP, educators have not familiarized students with working on HOTS questions.
5. Literacy; The problems identified are: (a) Students' low listening ability. Based on an in-depth and comprehensive analysis, the cause of this problem is that several students are not optimal in recording the material presented by the teacher and are unable to answer sudden questions posed by the teacher. (b) Students' reading ability is low. The reasons are that students still have a low interest in reading, and educators have not provided or introduced a variety of reading materials to students. (c) Students still do not have intrinsic motivation to obtain information from reading. The cause of this problem is that students read only when instructed by educators and read only to fulfill assignments, even though the expectation is that students should read to increase their knowledge. (d) Low interest in reading by students, both at home and at school. The causes are that students do not want to make summaries of the material provided in the form of teaching materials, are unable to answer educators' questions relating to the material in the teaching materials, and few students can provide opinions about educators' questions related to teaching materials.
6. Numeracy; The problem identified is the low numeracy skills of students in Mathematics lessons. After conducting an in-depth and comprehensive analysis, it was found that the causes were that students did not understand the problems in the questions, students did not know how to solve the given questions, very few students were able to answer the questions correctly, and many students scored below the KKTP.
7. Assessment; The problems identified regarding assessment are: (a) Educators' understanding is not yet optimal in preparing assessments. The causes include that the assessment rubrics created by educators do not comply with the question assessment criteria, the weighting of each question is still inappropriate, and there are too many questions given the available time to complete them. (b) Students' understanding is not yet optimal in completing the assessments provided. The reasons are that students have not been able to complete the questions on the LKPD well, have not been able to complete presentations effectively, have not been able to complete quiz questions within the specified time, many students' assessment results are still below the KKTP, and many students have not yet achieved their learning objectives.

*Stage 2. Exploration of the Cause of the Problem*

In this step, an exploration of the causes of the previously identified problem is carried out. The process involves: (1) Literature Review; Conducting a literature search related to the identified problem, reading articles, journals, books, or other relevant sources of information, and identifying factors causing the problem based on the findings in the literature. (2) Interviews; Conducting interviews with educators, school principals, school supervisors, and colleagues at the school. This involves asking questions to individuals who have experience related to the identified problem, soliciting their experiences, views, and thoughts regarding the causes of the problem, and using the information obtained from interviews as a reference for analyzing the causes of the problem.

Then, interviews were also conducted with experts and other related parties. The activities carried out included searching for experts or other related parties who have expertise or experience in the identified problems, conducting interviews with these experts to gain deeper insight and understanding of the causes of the problems, and asking for their suggestions or recommendations regarding steps that can be taken to overcome them. Additionally, input, direction, and suggestions were sought from them to help analyze the causes of the problem in more depth. After collecting the information from the steps above, you can use the collected data as a basis for analyzing and identifying more specific causes of the problems. The next step is to plan appropriate strategies and actions to overcome the problem.

Based on the steps above, the results obtained from the exploration of the causes of the identified problems, which have been determined as issues for which solutions will be sought, are as follows:

*1. Educators have not been optimal in building collaborative relationships with students in mathematics learning*

The results of exploring the causes of the problem are based on:

1. Literature review: Educators have not been optimal in building collaborative relationships with students in mathematics learning. The learning process is less relevant to the ideal picture, as students tend to prefer learning process designs that are more teacher-centered. Moreover, students do not pay attention during learning sessions and often complain when given assignments [14].
2. The results of observations of mathematics learning show that: (1) In the introductory part, educators do not link students' initial knowledge with previously studied learning material; instead, educators directly convey the topic of the material being studied. (2) In the core learning activities, students only listen to the descriptions and look at the examples given by the teacher. They remain silent when asked to pose questions and also when the teacher asks questions. Students are not encouraged to engage in discussions and only perform tasks they can complete individually without attempting to collaborate with their peers. (3) In closing activities, educators fail to summarize the provided learning material and neglect to evaluate it [8].
3. Interviews with experts and colleagues: After conducting in-depth and comprehensive analyses through interviews with experts and colleagues regarding the root causes of the identified problems, it was found that the main causes were as follows: (1) educators were not optimal in building relationships with students because students did not pay attention to learning; (2) educators have not optimally implemented innovative learning models; (3) there is insufficient implementation time in the mathematics teaching and learning process due to the demands of dense teaching materials; (4) there is a lack of motivation and role models from families; and (5) students are more interested in gadgets.

*2. Low Motivation Of Students In The Mathematics Learning Process*

The results of exploring the causes of the problem are based on:

1. Literature Review; Factors that influence students' learning motivation, according to [5], include: (1) Students' goals and aspirations: The realization of personal goals and aspirations can enhance motivation for learning by fostering a sense of independence and satisfaction. (2) Student abilities: Desire must be accompanied by the will or ability to achieve goals. (3) Student conditions: Physical and spiritual conditions of students influence their motivation to learn. (4) Students' environmental conditions: This includes natural surroundings, peer interactions, and community life. (5) Dynamic elements in learning: Students' feelings, attention, will, memories, and thoughts undergo changes influenced by life experiences. (6) Educators' efforts in teaching students: Educators' dedication to teaching influences students' motivation. (7) Educators' professionalism: Educators interact daily with numerous students, both inside and outside school, demonstrating professionalism in their efforts to teach [26].
2. Interviews with experts and colleagues; Based on the results of interviews with experts, the following data were obtained: (1) Students do not see the relevance or benefits of learning mathematics in their daily lives. (2) Students feel incompetent or lack confidence in mathematics because they perceive it as too difficult to achieve success. (3) Past negative experiences or failures in learning mathematics can cause students to lose motivation. (4) Students have not received adequate support from educators, peers, or parents to maintain their motivation in learning mathematics. (5) Teaching methods are monotonous or too theoretical, lacking creative or interactive elements. (6) Educators do not provide contextual questions related to everyday life in mathematics learning. (7) Students' preconceived notions make them view mathematics as a difficult subject.

*3. Low Prerequisite Abilities of Students In Learning Mathematics*

The results of exploring the causes of the problem are based on:

1. Literature Review; The low prerequisite abilities of students in learning mathematics are caused by (1) Not having the prerequisite knowledge, (2) Not understanding and recognizing basic concepts (3) Not having the ability and accuracy to listen to problems, (4) Not having the ability to listen back to the answers obtained [9, 10].
2. Interviews with experts and colleagues revealed the following: (1) students have not been optimal in understanding the concepts of prerequisite mathematics material in elementary schools, (2) educators in elementary schools have not been optimal in teaching basic mathematical concepts, because they have not studied mathematics in depth, (3) educators have not used media to instill basic mathematical concepts.

*4. Low ability of students in working on HOTS (High Order Thinking Skills) questions*

The results of exploring the causes of the problem are based on:

1. Literature Review; The low level of critical thinking skills is due to: (1) efforts to develop critical thinking skills in schools are rarely carried out. (2) the low critical and creative thinking abilities of students in mathematics can also be seen from the results of students' answers in working on mathematics questions at school which are still not satisfactory (Aisyah in [16]. One of the causes of students' low mastery of mathematics is: (1) educators do not provide sufficient opportunities for students to build their knowledge. (2) mathematics is studied by most students directly in a ready-made (formal) form because mathematics is seen by most educators as a procedural and mechanistic process [16]. (3) several student errors were found in solving HOTS questions in mathematics subjects based on: Newman's theory, namely, errors in reading questions, errors in understanding the problem, transformation errors, process skills errors, and final answer research errors [8]. (4) the factors that cause students to make mistakes in answering questions are (a) students cannot understand the geometric transformation material properly and correctly. (b) students do not understand the concept of the material being taught, (c ) lack of conceptual mastery of the material being taught, (d) discontinuous learning methods, (e) lack of effort put into working on the questions given, (f) students are not careful and hasty in solving the questions given. (g ) the average critical mathematical thinking ability of junior high school students is still low. The average score of critical mathematical thinking ability of junior high school students is only 68 on a scale of 0–100, which falls into the sufficient category (Syahbana, 2012 in [16]. A part from that, from initial research by giving a critical mathematical thinking ability test conducted by researchers at Ar-Rahman Percut [16] Middle School, out of 30 students, only 2 people could answer the questions correctly and completely, while the others were just guessing the answers. One of the psychological factors that contributes to students' success in doing questions well is self-confidence. (h) Students' problem-solving abilities are low due to a lack of understanding of concepts, and conceptual errors are caused by students' lack of reasoning abilities (Ruseffendi [in 16].
2. Interviews with experts and colleagues; As a result of interviews with experts and colleagues, data were obtained: (1) students in elementary schools have not been introduced to HOTS questions, (2) educators in elementary schools have not yet gotten used to giving HOTS questions, (3) educators in secondary schools too not yet accustomed to giving HOTS questions, (4) students do not understand and know how to solve HOTS questions.

*5. Students have a low interest in reading the teaching materials provided by educators*

The results of exploring the causes of the problem are based on:

1. Literature Review; According to [32] the low reading interest in teaching materials provided by educators is (1) students are not yet accustomed to reading, (2) students tend to prefer watching rather than reading books, and (3) students' reading ability is still limited. very limited, (4) students' free time is mostly used to play gadgets for social media rather than reading articles or searching for knowledge on the internet.
2. Expert and peer interviews; The results of interviews with experts and colleagues regarding the problem of low reading interest in teaching materials provided by educators are (1) students are not yet accustomed to reading, (2) educators have not been optimal in making teaching materials that are interesting for students, (3) Reading materials are still lacking to support students' interest in reading, (4) learning support from parents is lacking.

*6. Low student learning outcomes in mathematics learning*

The results of exploring the causes of the problem are based on:

1. Literature Review; Factors causing students' low or lack of understanding of mathematical concepts, one of which is (1) the learning methods used by teachers, for example in learning that is oriented towards traditional approaches which place students in the teaching and learning process as listeners, (2) lack of interest students in taking mathematics lessons, this is due to the belief that mathematics is one of the most difficult and scary subjects compared to other subjects [27b] . Furthermore, Suryosubroto (2009) [in 27b] stated that the success of achieving competency in one subject depends on several aspects, namely: (1) how an educator implements learning. (2) the current tendency of learning is still centered on educators by telling stories or lecturing, (3) students are less actively involved in the learning process, (4) media is rarely used in learning, so learning becomes dry and less meaningful, (5) problems or obstacles related to the learning process can be caused by various components; the ability of educators in teaching (educators), those who are given learning materials (students), the materials taught (teaching materials), the learning process (strategies, methods, teaching techniques), learning facilities and infrastructure, the evaluation system implemented (M Syazali, 2015 [in 27b].
2. Expert and peer interviews; The data obtained is based on interviews with colleagues and education experts, namely: (1) students lack practice related to the mathematics material being taught, (2) students' critical thinking skills are still low, (3) students' absorption of understanding is still low, ( 4) students' ability to ask questions is still lacking, even though they do not understand the material being taught, (5) students do not have clear goals for studying at school.

*7. Educators are not optimal in implementing differentiated learning*

The results of exploring the causes of the problem are based on:

1. Literature Review; Educators are not yet optimal in implementing differentiated learning, this is in line with the research results of [2] that the difficulties experienced by educators during implementing differentiated learning are (1) educators' readiness when planning differentiated learning, (2) educators' abilities are not yet optimal in carry out diagnostic assessments [46]. The next finding is that there are still many educators who do not have experience with freedom of learning, namely (1) the learning carried out is still monotonous, (2) the quality of education is still not optimal (Hariani et al. [in 25a], (3) there are also many educators who have not integrated technology in classroom learning, so that educators' Technological, Pedagogical, Content Knowledge (TPACK) abilities are still low [19,20]. The results of an in-depth and comprehensive analysis of problem-related data show that partner educators feel that they still have difficulties implementing differentiated learning, starting from content differentiation, process differentiation, to product differentiation. One of the educators observed by the PBM Team stated that: (1) he still predominantly carried out product differentiation learning, (2) very rarely applied content and process differentiation learning. (3) the lack of skill of these educators in exploring students' needs which will later be utilized in creating a differentiated learning environment based on content and processes, (4) the lack of skill of educators in applying various technologies [25a].
2. Expert and peer interviews; Based on interviews from experts and colleagues, data was obtained that: (1) Educators do not have sufficient time to explore differentiated learning approaches, (2) students are not yet familiar with differentiated learning approaches, (3) educators are not yet familiar with differentiated learning approaches.

*Stage 3. Determining the Root Cause of the Problem*

After exploring the causes of the problem, the next step is to determine the root cause of the problem that is closest to the context faced by educators in their classrooms. Indicators to determine the root cause of the problem: a. Consult with educators/principals/school supervisors/colleagues and experts/relevant parties. Data findings regarding the causes of problems are (1) share information about the causes of problems that have been identified and explain the specific context faced, (2) ask for their opinions, suggestions, and recommendations in determining the most relevant root causes of problems, (3) analyze and consideration; (a) review the data and information that has been collected during the exploration of the causes of the problem, (b) consider the classroom/school context at hand and evaluate the root causes of the problem that are most relevant to the situation, (c) identify the root causes of the problem that have a significant impact on learning outcomes or challenges faced by educators in daily tasks, determining problems and root causes of problems: (a) select at least 2 (two) problems that best suit the daily tasks of educators. (b) explain the root cause of each selected problem in detail, (c) review the research and analysis, to ensure the root cause is relevant and has the potential to be addressed, (d) make sure to record the information obtained in a worksheet and use it as a guidance in the next steps to find a solution to the problem that has been identified.

Results of Exploration of the causes of the problem: (a) students do not pay attention to learning, (b) educators have not applied innovative learning models optimally, (c) time for implementing the mathematics teaching and learning process is quite insufficient due to the dense demands of the material, ( d) lack of motivation and role models from the family and (e) students are more interested in gadgets. The root causes of the problem are (1) learning is less interesting, due to a lack of planning by educators, (2) the video media used has not been designed by educators themselves, (3) educators' understanding is not yet optimal in implementing innovative learning models, (4) the use of gadgets is not optimal. as a learning medium. Analysis of the root cause of the problem, namely the lack of understanding of educators in implementing integrated innovative learning in TPACK media.

Supporting data (empirical data/reflective data 1): (1) educators have first experience in implementing a differentiated approach, so educators still focus on existing syntax, (2) educators lack understanding of differentiated learning approaches, so in implementation, educators explain teaching material. (3) educators do not pay enough attention or guide students, (4) learning outcomes will influence the differentiation learning approach not being optimal. Then, the results of the exploration of the causes of the problem are (1) students do not see the relevance or benefits of learning mathematics for their daily lives, (2) teaching is monotonous or too theoretical without creative or interactive elements. Meanwhile, the root cause of the problem is (1) educators have not maximized the benefits of the material being studied, (2) learning is less interesting, due to a lack of planning by educators.

Lack of understanding by educators in implementing innovative learning that integrates the use of the material studied. The selected problems that will be resolved based on the results of exploring the causes of the problem are (1) students do not have sufficient prerequisite knowledge, (2) educators in elementary schools are not optimal in teaching basic mathematical concepts, because they do not study mathematics, (3) educators have not used media to instill basic mathematical concepts. Meanwhile, the root causes of the problem are (1) educators in elementary schools have not been optimal in explaining the instillation of prerequisite material concepts, because they are not experts in that field, and (2) the use of learning media has not been optimal. Meanwhile, analysis of the root causes of the problem from supporting data, namely the lack of understanding of educators in implementing innovative learning in cultivating students' prerequisite material concepts.

Other selected problems that will be resolved are (1) educators do not provide sufficient opportunities for students to build their knowledge, (2) students do not understand mathematical concepts optimally, and (3) teachers in secondary schools are also not used to asking questions. HOTS questions, (4) students do not understand and know how to solve HOTS questions. The causes are (a) students are not yet used to reading, (b) students spend more free time playing with gadgets, (c) educators have not maximized their ability to make teaching materials that are interesting to students, (d) reading materials are still insufficient to support students' interest in reading, (e) the learning methods used by educators are not yet innovative, (f) media is rarely used in learning, so learning becomes dry and less meaningful, (g) students lack practice related to the mathematics material being taught, (h) students' critical thinking abilities and absorption capacity are still low. Regarding the readiness of educators when planning differentiated learning, namely (1) educators' abilities are not yet optimal in carrying out diagnostic assessments, (2) educators do not have sufficient time to explore the approach to differentiated learning, (3) educators are not yet familiar with the differentiated learning approach.

*Stage 4. Exploratory Alternative Solutions*

Activities carried out at the alternative solution exploration stage, namely from the problems that have been identified, it is determined which problems are deemed the most urgent related to learning from several problems that have been discovered in the problem identification stage and determined in the previous stage to be resolved. Then analyze in depth the causes of the problem and categories of causes of the problem. In this case, it is a sharpening of the previous stage. Categorize the causes of problems that have previously been identified whether they are closer to materials, methods, or learning media. These three are the aspects that make it most possible for intervention researchers to directly address classroom problems. Two or more different problems that come to the surface during observation may have one or more common causes. Conversely, one problem can have two or more causes.

Based on the process in this research, the problem in learning that is most urgent to find a solution for is the low level of literacy and numeracy in solving students' LKPD questions and quizzes in mathematics learning. The cause of the problem is that educators have not optimally implemented innovative learning models/approaches. Meanwhile, the alternative solution offered is for educators to apply innovative learning models/approaches.

From the solutions offered for solving literacy and numeracy problems, namely, educators applying innovative learning models and/or approaches, it is necessary to conduct a review of related literature:

1. Teaching at the Right Level (TaRL) is a learning approach that refers to the level of achievement or ability of students. TaRL is a form of implementation that follows Ki Hadjar Dewantara's educational philosophy. By paying attention to the achievements, level of ability, and needs of students as a reference for designing learning, educators make every effort for student-centered learning. The aim of teaching using this approach is to strengthen students' numeracy and literacy skills, as well as knowledge of the subjects that are learning outcomes [25]. The advantages of Teaching at the Right Level (TaRL), namely (1) Learning is appropriate to the level of students' abilities, (2) learning becomes more effective, (3) it uses material that is relevant and appropriate for students, while the weaknesses of Teaching at the Right Level (TaRL) are: Right Level (TaRL) is time and cost limited, not suitable for small projects, not suitable for projects that require rapid changes and increased costs in the evaluation phase, as well as difficulty in determining user needs. The mitigation process to reduce the weaknesses of Teaching at the Right Level (TaRL) is (1) Educators ask superiors for help in overcoming them, (2) educators try to deepen this understanding and consult with experts, (3) educators try step by step in implementing the learning process.
2. Problem-Based Learning (PBL) Model; This model is suitable for increasing students' numeracy literacy because the learning process includes indicators of numeracy literacy abilities, where in these PBL steps students discuss with their groups to complete the problem sheet given, this includes indicator 1, namely working effectively with the model in concrete situations and in indicator 3, namely using skills and reasoning with some knowledge. Then the step of collecting information to solve problems includes indicator 2, namely selecting and representing information, and connecting them with real situations. When students present the results of the discussion, it includes indicator 4, where students provide an explanation based on their actions from the results of the discussion [6]. Based on an in-depth and comprehensive analysis, the advantages of the Problem-Based Learning Model are obtained, namely (1) students can think critically, and very effectively to understand lesson content, (2) problem-solving will build and challenge students' abilities, (3) provide satisfaction for find out for yourself. Meanwhile, the disadvantages are (1) not all learning materials can apply the Problem-Based Learning model (2) the time required to complete the learning materials is longer and (3) students who are not used to analyzing a problem, are usually reluctant to do it. Mitigation measures taken to reduce the weaknesses of the Problem-Based Learning Model are (1) educators can choose urgent teaching materials by the learning process of the Problem-Based Learning Model, (2) educators can maximize the use of time and (3) educators can provide motivation to students so that want to analyze existing problems.
3. Powtoon video media; Powtoon video media application is an application that produces online-based animated video offerings. PowToon was produced in January 2012. PowToon can be used offline both in presentation and pdf form [1]. The advantages of Powtoon video media are handwritten animation, cartoons, transition effects, and easy use of the timeline. Analysis of the advantages of media according to the characteristics of the material, namely students will like it, students will be interested and enthusiastic about learning. Meanwhile, the disadvantages are based on the analysis. The weakness of the Powtoon video media is that the discussion of the material contained in the Powtoon animated video is only limited, the duration given for developing layouts in Powtoon is limited to a maximum of three minutes, a supporting application is needed to process the video, so that it becomes a product ready for testing, like Active does. presenter to carry out the editing process. Analyze the weaknesses of the media according to the characteristics of the material, namely it requires time and energy, and requires careful thinking. The mitigation process carried out is that educators will adapt to the material to be studied, educators will use the time provided, educators will provide the necessary equipment.
4. Educators Apply Innovative Learning Media; The innovative learning media used is Student Worksheets (LKPD). LKPD is a type of learning tool that can help students understand the material easily [28a]. LKPD will also be useful for students because it can make the learning interesting, provide opportunities for them to learn independently, and make it easier to learn each competency that must be mastered, especially in mathematics learning activities [1,12]. 3. Powtoon video media; Powtoon video media application is an application that produces online-based animated video offerings. PowToon was produced in January 2012. PowToon can be used offline both in presentation and pdf form [1]. The advantages of Powtoon video media are handwritten animation, cartoons, transition effects, and easy use of the timeline. Analysis of the advantages of media according to the characteristics of the material, namely students will like it, students will be interested and enthusiastic about learning. Meanwhile, the disadvantages are based on the analysis. The weakness of the Powtoon video media is that the discussion of the material contained in the Powtoon animated video is only limited, the duration given for developing layouts in Powtoon is limited to a maximum of three minutes, a supporting application is needed to process the video, so that it becomes a product ready for testing, like Active does. presenter to carry out the editing process. Analyze the weaknesses of the media according to the characteristics of the material, namely it requires time and energy, and requires careful thinking. The mitigation process carried out is that educators will adapt to the material to be studied, educators will use the time provided, educators will provide the necessary equipment.

*4. Educators Apply Innovative Learning Media****;*** The innovative learning media used is Student Worksheets (LKPD). LKPD is a type of learning tool that can help students understand the material easily [28a]. LKPD will also be useful for students because it can make the learning interesting, provide opportunities for them to learn independently, and make it easier to learn each competency that must be mastered, especially in mathematics learning activities [12].

The advantage of implementing LKPD is that it activates students in the learning process, helps develop concepts, trains to discover and develop process skills, and can be used as a guide for educators and students in carrying out the learning and assessment process. The weakness of the LKPD is that the tasks contained in the LKPD are only questions without clear examples, the LKPD is less interesting so students become bored quickly. Meanwhile, the mitigation process to reduce weaknesses is that educators can dig deeper so that the appearance of the LKPD is more structured and more attractive, providing a more interesting mix of colors and images and updated images.

*5. Educators apply innovative learning media in the form of using YouTube****;*** YouTube is used as a tool to dig up information, in the form of learning videos related to teaching materials which are able to provide understanding for students, so that the problems solving process is easier and students do not find it too difficult to solve the problems given. Students can explore information in the form of learning videos related to the material, making it easier to understand learning material that is considered difficult compared to conventional delivery. Because YouTube media is more interesting, so students don't feel bored rather than having to study writing in textbooks [22].

YouTube is an audio visual/digital media that is currently popular and growing very rapidly, where all people can easily access it. YouTube media is a learning media based on information and communication technology that is used to encourage students' creativity to be more active, so that students create designs and find concepts with their own efforts [28b,6]. The advantage of YouTube media is that there is a large variety of content, many content creators themselves. Meanwhile, the weakness of YouTube media is that there is too much of it, so it is difficult to choose content that is suitable and worth watching. Mitigation to overcome weaknesses is that educators try to choose content that is appropriate to learning and cut videos if there is something that is not needed.

*6. Use of the Quizizz application;* To overcome the problem of weak numeracy literacy in Indonesia, various research on literacy has been carried out, such as research conducted by [23] which found that students who have high literacy skills are able and correct in using numbers and symbols in various forms (graphs, tables, charts, diagrams and more) to solve basic math problems. Likewise, [33] concluded that using the Quizizz application can increase the numeracy literacy of elementary school students, and numeracy literacy has an impact on improving children's thinking patterns in solving problems faced in everyday life [31b].

The advantages of Quizizz media are that it is fun, real-time, and effective. Meanwhile, Quizizz's weakness is that it depends on the internet network, it cannot revise answers, depending on the cellphone/laptop device. Mitigation to anticipate weaknesses is that students' cell phones will be connected to the school WiFi, and educators will ask students to share with friends who do not have the power to use the application.

*Stage 5. Determining the Solution*

The problem chosen to be addressed is the low level of literacy and numeracy in solving students' mathematical problems in mathematics learning. The causes of the problem are: (1) students' understanding of the teaching material is not optimal, (2) the teaching material in the LKPD is not well structured, (3) the questions given by educators are not under the students' level of ability, (4) educators have not provided mathematical problem-solving facilities to students. The solution chosen is the application of an innovative learning model, namely using the Problem-Based Learning model in mathematics learning. The reason for using the Problem-Based Learning Model is because it can: (a) organize students to learn, (b) make students actively discuss and divide tasks in searching for data/materials needed to solve mathematical problems, (c) guide individual and group investigations, students actively search for data/materials from various sources needed to solve mathematical problems. (d) develop and present the results of the work, (e) students actively plan and prepare an appropriate report form to show the results of the investigation, (f) the report can be in the form of a written report, video, or other model. (g) students are also actively involved in presentation activities.

The advantages of the Problem-Based Learning Model are: (1) it challenges students' abilities and provides satisfaction in discovering new knowledge so that students are motivated. (2) increase students' motivation and learning activities. (3) assist students in transferring knowledge to understand real-world problems. (4) help students to develop new knowledge and take responsibility for the learning they do. (5) develop students' ability to think critically and develop the ability to adapt to new knowledge. (6) provide opportunities for students to apply the knowledge they have in the real world. (7) develop students' interest in continuing to learn even though formal education has ended. (8) makes it easier for students to master the concepts studied to solve real-world problems.

Meanwhile, the disadvantages of the PBL model are (1) students do not have the intention or do not believe that the problem being studied is difficult to solve, so students will feel reluctant to try it. (2) requires expensive costs and a long time. The mitigation process carried out to reduce the shortcomings of the Problem-Based Learning Model is (1) selecting material and questions, adjusted to the level of ability of students and providing reinforcement and motivation that students are capable of, (2) Educators will provide sufficient costs and maximize time well.

*Stage 6. Action Plan*

Based on the alternative solutions to the problem to be solved, the learning objectives formulated are to improve students' mathematical literacy and numeracy skills in mathematics learning, namely: (1) students can explain the concept of comparison following the literacy of the material being studied correctly (C1). (2) students can solve everyday problems by using appropriate comparisons with the literacy and numeracy of the material studied (C4).

Evidence of assessment that must exist to prove that students have achieved/towards the learning objectives is:

a. Formative Assessment (Assessment for Learning/Assessment during learning activities, namely: (a) Affective Aspect; Attitude assessment is used in the form of an observation sheet on students during Learning activities take place and are stated in the attitude assessment rubric. As for those assessed from the affective aspect, namely Responsibility, Thoroughness, and Discipline. (b) Psychomotor; Skills assessment, namely in the form of students' skills in completing and completing questions on the LKPD.

b. Assessment of learning (Assessment which is carried out at the end of learning/summative assessment). In this study, LKPD and Quiz assessments were used. Learning activities and formative assessments are activities or activities that can gradually help students provide evidence of assessment, achieve learning goals, students' obstacles, and help achieve learning goals. The activities carried out are depicted in the syntax of the Problem Based Learning Model which has been developed as follows.

*3. Preliminary Activities*

*Orientation*

1. Educators start the activity by saying greetings, followed by a joint prayer led by the class leader (Pray to God Almighty with PPT)
2. Educators ask for news and check students' attendance.
3. Educators ask about students' learning readiness, such as, how is Ananda now? Are you ready to learn mathematics today?
4. students are reminded of the class agreement that was made previously, namely:

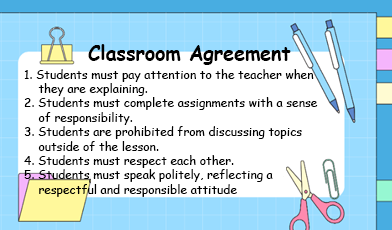


Fig.2. Classroom Agreement Between Teachers and Students

1. Application of Technology in learning (TPACK-Pedagogical, Technology-Knowledge, PPT)

*Apperception*

Students receive information about the learning that will be carried out which is related to the previous material by saying: "What do you do by simplifying 2 comparisons in the form of fractions?" The answers correspond to the lighter questions.

*Motivation*

Educators motivate students. Motivational sentence "By studying value comparisons, you will be able to find solutions to everyday life problems such as business sales of products, services, and sales of electronic equipment". Then the Educator conveys the learning objectives and criteria for achieving learning objectives so that students are directed in the learning process (Application of TPACK-Technology-PPT).

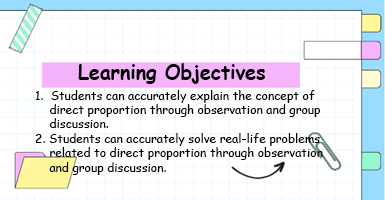


Fig.3. Learning Objectives

Students listen to the flow of learning activities that will be carried out today (Application of TPACK- Technology-PPT).

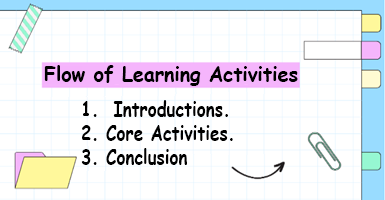


Fig. 4. Flow of Learning Activities

Students listen to the assessment techniques applied at this meeting, namely cognitive, affective, and psychomotor assessments.

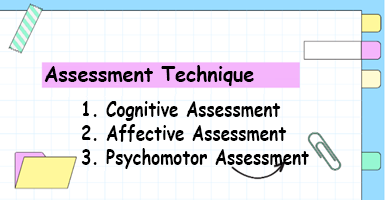


Fig.5. Assessment Technique

Students are informed of today's learning steps

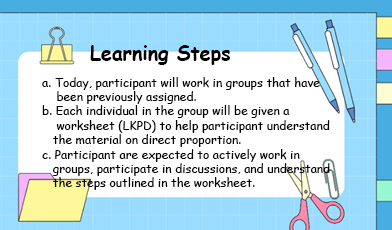


Fig.6. Learning steps

Students are asked to sit in predetermined groups (heterogeneous group division). Then the Educator provides ice-breaking if necessary.

*4. Core Activities*

*Phase 1. Student Orientation towards Problems*

Students pay attention to the case video display about Value Comparisons that can be found around us in the YouTube video show, with the link: https://www.youtube.com/watch?v=lJLu-NtIT1M. (problem-solving indicator: understanding the problem).

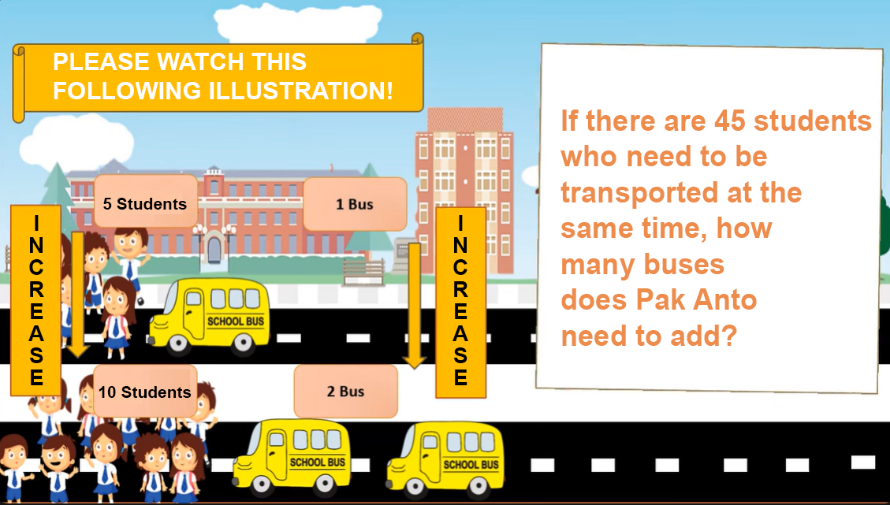


Fig.7. Case video about comparisons of value that can be found around students

Educators ask stimulating questions regarding the problem. Pay attention to the video illustration that you have watched. Try reading and observing the problems displayed in the PPT. (observe); Try reviewing the information you got from this problem. (Literacy); Can you determine what is known and what is asked about the problem; How do you solve this problem?

*Phase 2. Organizing students to learn*

1. Students are divided into medium groups consisting of 4-5 people taking into account the students' diagnostic tests.
2. Students get a Student Worksheet distributed by the Educator to work on for 15 minutes.
3. Students discuss to find equivalent comparisons.
4. Students can read the source books and teaching materials provided as a guide in completing each step in the LKPD.
5. Students are allowed to ask questions related to things they do not understand in the steps given on the LKPD (Communication).

*Phase 3. Guiding Individual and Group Investigations*

1. Students are guided by educators during discussions such as educators approach each group to see group cooperation and provide assistance if students face difficulties.
2. Students through group discussions are expected to be able to explain the concept of value comparisons for the problems given.
3. Students through group discussions are expected to be able to solve daily problems related to the comparison of the value of the problems given (critical thinking -4C),
4. Students and their groups collect all the information for solving problems on the LKPD.
5. Students are asked to explore information through reading books and teaching materials.

*Phase 4. Developing and Presenting Work Results*

1. Students make presentations in public forums (questioning, discussion, opinion, and argumentation activities) about their understanding of the concept of equal comparison.
2. Other students provide constructive input in the form of comments or suggestions to friends who have opinions.
3. Educators give rewards in the form of future star stickers to active groups (Application of motivation: pedagogic-TPACK)
4. Students presenting return to their seats.

*Phase 5. Analyze and evaluate the problem-solving process*

1. Students with the guidance of educators critically re-examine the correctness of the discussion results. (Collaboration-4C).
2. Students with the guidance of educators conclude from the results of group representatives' presentations communicatively. (questioning-scientific), (Communication – 4c).
3. Educators give rewards in the form of Future Star stickers to active groups. (Application of motivation: pedagogy-TPACK).
4. Educator Reinforces equal comparisons.
5. Educators will show a complete/complete way of answering story questions contained in the LKPD and one trigger question to deepen students' understanding as well as preparation for working on Quiz questions using Power Points (Application of TPACK-Technology-PPT).
6. Educators provide ice breakers if necessary.

*Phase 6. Closing Activities*

* 1. Educators motivate students to want to make conclusions from the activities they have carried out (actively have an opinion).
  2. Educators give quiz questions at the end of the lesson, do them directly, and do them individually (actively taking quizzes)
  3. Educators reflect on the activities carried out at today's meeting by asking:
  4. Did you enjoy studying today?
  5. What are the benefits of learning about equivalent comparisons?
  6. Do you find it difficult to learn using differentiated learning?
  7. Students are informed that the next meeting will be a comparison of grades and the mother hopes that student will read at home.
  8. Students listen to the educator's explanation regarding follow-up plans for further learning.
  9. Educators and students end the learning process by reading alhamdulillah and saying greetings (PPK: religious).

*Phase 7. Reflective Results*

The Evaluation Plan contains the design or design of the instrument that will be used to carry out critical observations and evaluation/reflection on the implementation of the action plan (in the form of teaching modules/RPP) that has been developed. The reflection carried out is on the innovative PBL learning model that has been implemented, in the form of:

1. For learning observations, the instrument needed is an observation checklist sheet, while the development plan is in the form of developing a teaching module/RPP (activity and assessment section) with the addition of an implementation/non-implementation column and a notes column. Results of development. The observation sheet can be seen at the following link. <https://drive.google.com/file/d/1c7gb98oa-Y729Cl5VSvsU684UYDCzOv9/view?usp=sharing>
2. Reflection, instrument requirements, namely a reflection sheet containing a list of reflective questions. The development plan is to prepare 5 reflective questions regarding the implementation/non-implementation of the action plan. The results of the development plan can be seen at the following link <https://drive.google.com/file/d/134EPNYBqA8UwtEGAYty380qUeYNcV8w3/view?usp=sharing>
3. The survey, the instrument required, is in the form of a survey sheet containing a list of reflective questions. Development plan, namely preparing 5 reflective questions regarding the implementation/non-implementation of the action plan. The development results can be seen at the following link <https://drive.google.com/file/d/1KEJPWNVvvglNKs10I0dD8lfc0yfkK-tV/view?usp=sharing>

*Research Result*

The results of this research are the syntax of the Innovative Problem-Based learning model and its implications in the learning process in the form of a learning video (can be seen at this link: <https://drive.google.com/file/d/1rM5Q1Sx2KBNxvEDlKy51Vl-f-J9qf5ZQ/view?usp=sharing> ). The results obtained from assessment activities after implementing the innovative PBL learning model that was developed, have had a positive impact on students in the learning process and can increase students' literacy and numeracy on contextual questions. Likewise, it has a positive impact on increasing understanding of value comparison teaching material. From the results of the examination of the LKPD (Students Worksheet) questions, all students have completed the learning objectives and/or obtained a score above the KKTP (Learning Objective Achievement Criteria) which has been agreed upon by the KKG (Educator Working Group) which is 75. These results can be seen based on the results of processed research data as follows.

*a. Cognitive Assessment Quiz****.***

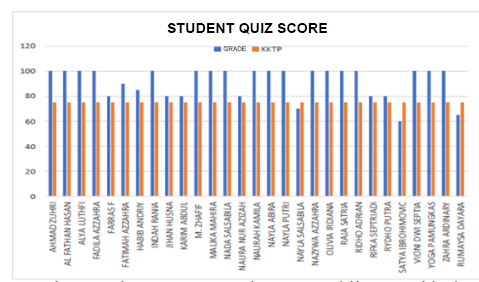


Fig.8. Student Quiz Scores

In examining the quiz questions, 26 students scored above the KKTP and 3 below the KKTP.

*b. Percentage of quiz cognitive assessment*

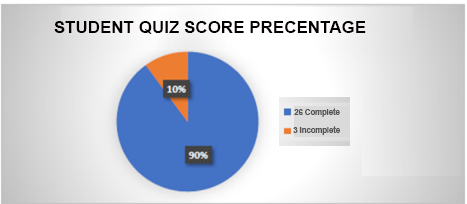


Fig 9. Students Quiz Scores Percentage

In examining the quiz questions, 26 students scored above the KKTP with a completion percentage of 90%, and 3 students below the KKTP with a completion percentage of 10%.

*c. Cognitive Assessment of LKPD*

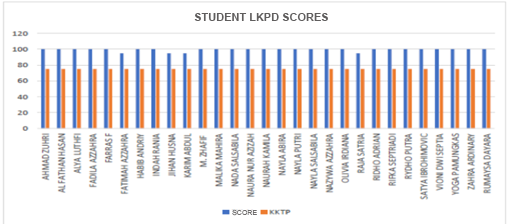


Fig.10. Student LKPD Scores

In the examination of the quiz questions, 29 students scored above the KKTP and none below the KKTP. This means that all students are complete in achieving the learning objectives.

*d. Percentage of LKPD Cognitive Assessment*

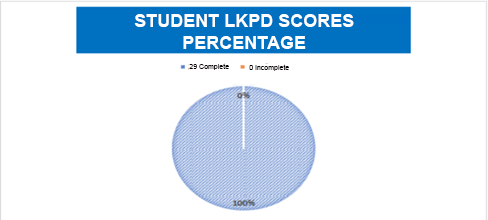


Fig.11. Student LKPD Scores Percentage

In examining the quiz questions, 29 students scored above the KKTP with a completion percentage of 100% and none below the KKTP. This shows that all students have completed the achievement of the learning objectives that have been formulated.

**4. Conclusion**

The process of implementing the Understanding design method in developing the Problem-Based Learning model to solve students' literacy and numeracy problems, follows the steps, namely: Activity 1. The process of developing an innovative learning model is: (1) Identifying problems and/or learning objectives that have been integrated with problems that have been identified, through activities; problem identification, exploration of the cause of the problem and determination of the root cause of the problem. (2) Exploration of alternative solutions, the activity carried out is exploring several alternative solutions to the causes of problems that have been determined, carrying out exploration through literature reviews, and interviews with educators, experts, and school principals. Based on the root cause of the problem, an in-depth and comprehensive analysis of the strengths and weaknesses of each alternative solution is then carried out. (3) Determining solutions, through analyzing activities in depth and comprehensively and/or ensuring relevant solutions from the alternative solutions explored, consulting with fellow educators and education experts. Activity 2. Determine assessment evidence; proof of assessment in the form of Assessment for learning and assessment as learning, through activities; group cognitive assessment based on the results of the LKPD and individual cognitive assessment through quiz questions. Step 3. Determine the innovative learning steps from the problem-based learning model being developed, looking at the impact of the innovative Problem-Based Learning model being developed, namely: in the form of LKPD results and students' quiz results.

The results of the discussion from the LKPD showed that the application of the Problem-Based Learning model provided group and individual completion with a classical completion percentage of 90%, meaning that out of 29 students, 26 completed and 3 did not. Individual completion reaches 100%. This means that all students who take the quiz can solve the quiz questions 100%, meaning that all students are complete in achieving learning objectives that have been integrated with the problems for which solutions will be sought.

##### **Acknowledgment**

The researcher would like to thank the Dean of FKIP UM West Sumatra, the Principal of SMPN 8 Padang City, the teacher council, and all parties who have supported and contributed to the research process up to the process of writing the research report. God willing, Allah Ta'alla will make it a pious deed. Amen.

##### **References**

[1] Astika RY., Anggoro BS., Andriani S., "Development of Mathematics Learning Media Videos with the Help of Powtoon’, *Journal of Mathematics Education Thought and Research (JP3M)*, vol.2, no.2, pp.85-96, 2019.

[1a] Alan, U. F., & Afriansyah, E. A. “Students' Mathematical Understanding Ability Through Auditory Intellectual Repetition and Problem Based Learning Models”. *Journal of Mathematics Education*, vol.11, no.1, pp. 67–78, 2017. <https://doi.org/10.22342/jpm.11.1.3890.67-78>.

[2] A. Sri Wahyuni. Literature Review: “Differentiated Approaches in Science Learning”. *Journal of Mathematics Education*, vol. 12, no. 2, pp. 118–126. 2022. <https://doi.org/10.37630/jpm.v12i2.562>

[3] Atika, N., & MZ, Z. A. “Development of Worksheets Based on The RME Approach To Develop Students' Mathematical Critical Thinking Abilities”. *Suska Journal of Mathematics Education*, vol.2.no.2, pp.103–110. 2016.

[4] B.W. Setya et al, MATHEMATICS, Erlangga, Jakarta, 2022. [https://pendidik.kemdikbud.go.id/assessment/ packets/83](https://pendidik.kemdikbud.go.id/assessment/%20packets/83). <https://www.quipper.com/id/blog/info-pendidik/problem-based-learning/>

[5] Development of Student Worksheets (LKPD) based on Realistic Mathematic Education (RME) on One-Variable Linear Equations and Inequalities Material. *M A T H L I N E Journal of Mathematics and Mathematics Education*. ISSN 2502-5872 (Print). ISSN 2622-3627 (Electronic). Vol. 5 No. 2 , pp. 111-127. DOI: <https://doi.org/10.31943/mathline.v5i2.154>. [file:///C:/Users/Toshiba/Downloads/wiwitdl28,+Liza+Gustin.pdf](about:blank)

[6] Dyah Ambarwati. Meyta Dwi . Kurniasih. The Influence of Problem Based Learning Assisted by YouTube Media on Students' Numeracy Literacy Ability. *Scholar's Journal: Journal of Mathematics Education*. P-ISSN: 2614-3038 Vol. 05, no. 03, pp. 2857-2868.2021. <https://www.j-cup.org/index.php/cendekia/article/view/829/480>

[7a] D Yani, S Muhanal, A Mashfufah . *“Journal of Innovation and Technology*”. 2023. [file:///C:/Users/ASUS/Downloads/31-Article%20Text-168-1-10-20230114.pdf](about:blank).

[7b] Danim, Sudarwan. “Educational Innovation: In Efforts to Increase the Professionalism of Education Personnel. Bandung”: *Pustaka Setia*. 2011.

[8] Ekowati, D. W., Astuti, Y. P., Utami, I. W. P., Mukhlishina, I., & Suwandayani, B. I. “Numeracy Literacy in Muhammadiyah Elementary Schools”. *ELSE (Elementary School Education Journal): Journal of Elementary School Education and Learning*, vol.3, no.1, pp. 93–103. 2019. Retrieved from. <https://doi.org/10.30651/else.v3i1.2541>

[9] Firdaus, F. M., Wahyudin, & Herman, T. “Improving Primary Students Mathematical Literacy Through Problem Based Learning and Direct Instruction”. *Educational Research and Reviews*, vol.12, no. 4, pp. 212–219. 2017. <https://doi.org/10.5897/ERR2016.3072>

[10] Farah Indrawati. “Obstacles in Mathematics Learning. National Scientific Symposium with the theme: (Improving the Quality of Scientific Publications through Research Results and Community Service to the Community)”, pp: 62-69.2019.DOI: 10.30998/simponi.v0i0.293. [https://scholar.google.com/citations? view\_op=view\_citation&hl=id &user=ckZv\_rMAAAAJ&citation\_for\_view=ckZv\_rMAAAAJ:UeHWp8X0CEIC](https://scholar.google.com/citations?%20view_op=view_citation&hl=id%20&user=ckZv_rMAAAAJ&citation_for_view=ckZv_rMAAAAJ:UeHWp8X0CEIC)

[11] Fox, B. E., & Doherty, J. J. “Design To Learn, Learn To Design: Using Backward Design for Information Literacy Instruction”. *Communications in Information Literacy*, vol.5, no.2, pp.144–155. 2011.

[12]Gustin, L., Sari, M., Putri, R., & Putra, A., Development of Student Worksheets (LKPD) Based on Realistic Mathematic Education (RME) on the Material of Linear Equations and Inequalities in One Variable, Mathline: Journal of Mathematics and Mathematics Education, vol.5, no. 2, pp. 111-127. 2020. <https://doi.org/10.31943/mathline.v5i2.154>.

[13] Indah, N., Mania, S., & Nursalam. “Improving Students' Mathematical Literacy Abilities Through Application of the Problem Based Learning Model in Class VII of SMP Negeri 5 Pallangga, Gowa Regency”. MaPan, vol.4, no.2, pp.200–210. 2016. <https://doi.org/10.24252/mapan.2016v4n2a4>.

[14] I Komang Suparsawan, “Collaboration of the Scientific Approach with the STAD learning model to Activate Students”. 2020.

<https://www.google.co.id/books/edition/KOLABORASI_PENDEKATAN_SAINTIFIK_DENGAN_M/8df9DwAAQBAJ?hl=en&gbpv=1&dq=IK+Suparsawan,+SP+SD+-+2020+-+books.google.com&printsec=frontcover>.

[15] Juriah, & Zulfiani. “Application of the Problem Based Learning Model Assisted by Video Media to Improve Student Learning Outcomes on the Concept of Environmental Change and Conservation Efforts”. *Edus Science*, vol.11.no.1, pp. 1–11. 2019. <https://doi.org/10.15408/es.v11i1.6394>.

[16] Kamsinah, “Problems and Solutions for Mathematics Learning at the Madrasah Tsanawiyah Level”. *ULIL ALBAB: Multidisciplinary Scientific Journal*. vol.1, no.9. pp.3214-3231. 2022. Https://Journal-Nusantara. Com/Index.Php/JIM/Article/View/764/616

[17] Korotchenko, T. V., Matveenko, I. A., Strelnikova, A. B., & Phillips, C. “Backward Design Method in Foreign Language Curriculum Development”. *Procedia: Social and Behavioral Sciences*, vol.2 , no.15, pp.213–217. 2015.

[18] Llerena, C. L. A. “The Benefits of Backward Design in The English As a Foreign Language Context”. *IJEE: Indonesian Journal of English Education*, vol.7, no.2, pp.145-158, 2020.

[19] Lukman, H. S., Sutisnawati, A., & Elnawati, E. “Elementary Mathematics Teaching Module Based on the TPACK-21 Perspective”. *AKSIOMA: Journal of the Mathematics Education Study Program,*  vol.11, no. 4, pp. 3225–3236. 2022.

[20] Lukman, H. S., Sutisnawati, A., Setiani, A., & Muhassanah, N. “TPACK-21 Model for Elementary School Teachers in Sukabumi City”. *ELSE (Elementary School Education Journal): Journal of Elementary School Education and Learning*, vol.6, no.2, pp. 398–418, 2022. Retrieved from; http://journal.um-surabaya.ac.id /index.php/pgsd/article/view/12712/5321

[21] Mahmud, M. R., & Pratiwi, I. M. (2019). “Students' Numeracy Literacy in Solving Unstructured Problems”. *KALAMATIKA Journal of Mathematics Education*,vol.4, no. 1, pp. 69–88. [https://doi.org/https: //doi.org/10.22236/KALAMATIKA.vol4no1.2019pp69-88](https://doi.org/https:%20//doi.org/10.22236/KALAMATIKA.vol4no1.2019pp69-88).

[22] Mujianto, H, “Utilization of YouTube as a Teaching Media in Increasing Interest and Motivation for Learning”. *Journal of Communication Thought and Research Results*, vol.5, no. 1, pp. 135–159, 2019. <https://journal.uniga.ac.id/index.php/JK/article/view/588/566>.

[23] Maulidina, A. P., & Hartatik, S. “Profile of Numeracy Ability of Primary School Students with High Ability in Solving Mathematical Problems”. *Journal of Basic Education (JBPD)*, vol. 3, no. 2, pp. 61–66, 2019. Retrieved from. <https://doi.org/10.21067/jbpd.v3i2.3408>

[24] Muhammad Syazali. “The Influence of the Creative Problem Solving Learning Model Assisted by Maple II on Mathematical Problem Solving Ability”. *Al-Jabar: Journal of Mathematics Education*, vol. 6, no. 1, pp. 91 – 98 , 2015. [file:///C:/Users/Toshiba/Downloads/58-101-2-PB.pdf](about:blank). http://www.ejournal. radenintan.ac.id/ index.php/al-jabar/article/view/58/51.

[25a] Meizar. A., Titim Eliawati , Rahmi Ramadhani , “Implementation Of Differentiation Learning Based On Inner Pancasila Student Profiles Improving Teachers' Teaching Skills Junior High School, *JCES (Journal Of Character Education Society*, vol. 6, no. 4, pp. 638-649, 2023. [https://Doi.Org/10.31764/Jces.V6i4.16294](https://doi.org/10.31764/Jces.V6i4.16294).

[25b] PPG DALJAB Reading Material Module, 2023. [https://jurnaldikbud.kemdikbud.go.id/ index.php/ jpnk/article/download/35/](https://jurnaldikbud.kemdikbud.go.id/%20index.php/%20jpnk/article/download/35/).

[26] Naibaho. Dwi Putriana. “Differentiated Learning Strategies Can Improve Students' Understanding of Learning”. *Journal of Creative Student Research (JCSR),* vol.1, no.2, pp.81–91, 2023.

[27a] National Literacy Movement. “Numeracy Literacy Support Material”. Jakarta: Ministry of Education and Culture, Ministry of Education and Culture, Research and Technology. 2019. PPG Reading Materials in Position.2023. <https://www.j-cup.org/index.php/cendekia/article/view/829/480>

[27b] Nabilah, T, Abadi.AP., 'Factors Causing Low Student Learning Outcomes', Proceedings of Sesiomadika 2. 2020.

[27c] Niken Eka Priyani, “Development of Numeracy Literacy Assisted by the Ethnomathematics Puzzle Game Application in Mathematics Learning in Border Schools”. *Journal of Elementary Education Didactics*, vol. 6, no. 1, pp. 267-280 2022. Article Url: [https://ojsdikdas.kemdikbud.go.id/index.php/ didaktika/ article/view/536](https://ojsdikdas.kemdikbud.go.id/index.php/%20didaktika/%20article/view/536), doi: 10.26811/didaktika. v6i1.536.

[28a] Novelia, R. “Application Of An Assisted Mastery Learning Model LKPD To Improve Participants' Mathematics Learning Outcomes Education In Class VIII3 State Middle School 4 Bengkulu City. Research Journal School Mathematics Learning (JP2MS), vol.1, no.1, 2017.

[28b] Nolaputra, A. P., Wardono, & Supriyono. “Analysis of Mathematical Literacy Abilities in PBL Learning with RME Approach Assisted by Schoology for Middle School Students”. *Proceedings of the National Mathematics Seminar*, vol.1, pp. 18–32, 2018. [https://journal.unnes.ac.id/sju/index.php/ prisma/article/view/19672](https://journal.unnes.ac.id/sju/index.php/%20prisma/article/view/19672)

[29] OECD, Program for International Student Assessment (PISA) Results From PISA 2018. *OECD Publishing I–III*, pp.1–10, 2018. <https://doi.org/https://doi.org/10.1787/5f07c754-en>.

[30] Pangesti, F. T. P, “Developing Numeracy Literacy in Mathematics Learning with HOTS Questions”, *Indonesian Digital Journal of Mathematics and Education*, vol.5, no.9, pp. 566–575, 2018. <http://idealmathedu.p4tkmatematika.org>.

[31a] Putu Hesti Mardika Astuti1 et. Al.,” Development of Collaborative Learning Tools in Mathematics Subjects on the Topic of Cubes and Blocks”. *Primary School Scientific Journal*, vol.3, no 3, pp. 269-277, 2019. <https://ejournal.undiksha.ac.id/index.php/JISD/article/view/18331/11524>.

[31b] Priyani, N. E. “Improving Student Learning Outcomes Through Dayak Culture-Based Ethnomathematics Modules with a Joyful Learning Approach. *In Proceedings of the National PTK Competition Article: Innovation*

*Elementary School Learning during the Pandemic*: *Muhammadiyah University of Surakarta*, pp. 274–283, 2021.

[32] Rahim, F., “Reading Teaching in Elementary Schools”. Jakarta: Bumi Literacy. Earth of letters. 2008.

[33] Saefurohman, S., Maryanti, R., Azizah, N. N., al Husaeni, D. F., & Wulandary, V., “Efforts To Increase Numeracy Literacy of Elementary School Students Through Quizizz Learning Media. *ASEAN Journal of Science and Engineering Education*, vol.1, no. 3, pp. 167–174, 2021. Retrieved from; <https://ejournal.upi.edu/index.php/AJSEE/article/view/38570>.

[34] Santika, ID., “Differentiated Learning and the Relevance of Ki Hajar Dewantara's Pedagogical Vision in Realizing Freedom of Learning”, *Journal of Education and Counseling*, vol. 5, no. 1, pp.1707–1715, 2023.

[35] Sri Wahyuni Naibaho et al., “Analysis of Factors Causing Low Learning Motivation of MTs Students Negeri 1 Central Tapanuli During the Covid-19 Pandemic. *JOURNAL MathEdu (Mathematic Education Journal),*vol.4, no. 2, pp.304-312, 2021. [https://www.journal.ipts.ac.id/ index.php/ MathEdu/article/view/2596/1769](https://www.journal.ipts.ac.id/%20index.php/%20MathEdu/article/view/2596/1769).

[36] Tasyanti, T., Wardono, & Rochmad. “Analysis of Mathematical Literacy Abilities Based on Students' Emotional Intelligence Through the Group Investigation Type Cooperative Learning Model”, *PRISMA, Proceedings of the National Seminar on Mathematics*, vol. 1, pp.334–346, 2018. [https://journal.unnes.ac.id/sju/ index.php/ prisma/ article/view/19611](https://journal.unnes.ac.id/sju/%20index.php/%20prisma/%20article/view/19611)

[37]Kemendikbud, “GLN TEAM Ministry of Education and Culture”, *National Literacy Movement. Jakarta : Ministry of Education and Culture*, 2017a. <https://gln.kemdikbud.go.id/glnsite/category/literasi-numerasi>

[38] Kemendikbud, “GLN TEAM Ministry of Education and Culture”, *Numeracy Literacy Support Material. Jakarta : Ministry of Education and Culture*. 2017b. <https://gln.kemdikbud.go.id/glnsite/category/literasi-numerasi>

[39] Tohari, H., Mustaji, Nf., & Bachri, B. S., “The Effect of Using YouTube on Learning Motivation and Student Learning Outcomes. “*Kwangsan Journal of Educational Technology,* vol.7, no. 1, pp.1–13, 2019. [https://doi.org/10.31800/jtp.kw.v7n1.p1—13](https://doi.org/10.31800/jtp.kw.v7n1.p1%E2%80%9413).

[40] Usmadi, “Development of Learning Tools’. PPG Lecture PPT, 2024. [https://docs.google.com/presentation/d/ 1x9BR9zRKDSTDLSTdu\_Evqg6HrDLLFHLb/edit?usp=sharing&ouid=118257212089061313665&rtpof=true&sd=true](https://docs.google.com/presentation/d/%201x9BR9zRKDSTDLSTdu_Evqg6HrDLLFHLb/edit?usp=sharing&ouid=118257212089061313665&rtpof=true&sd=true).

[41] Usmadi, “Effective Teacher. PPG Lecture PPT, 2023. [https://docs.google.com/presentation/d/ 1V5Jyzi1o6OeAERSrCViXUg6dfJcEXk0B/edit?usp=sharing&ouid=118257212089061313665&rtpof=true&sd=true](https://docs.google.com/presentation/d/%201V5Jyzi1o6OeAERSrCViXUg6dfJcEXk0B/edit?usp=sharing&ouid=118257212089061313665&rtpof=true&sd=true).

[42] Usmadi, “PPG Learning Models 2023” *PPG Lecture PPT*, 2023. PPG Lecture PPT. [https://drive.google.com/ file/d/1pHmt5D-vQEn-\_U5bN3B4hYwIV1ZFiiH2/view?usp=sharing](https://drive.google.com/%20file/d/1pHmt5D-vQEn-_U5bN3B4hYwIV1ZFiiH2/view?usp=sharing)

[43] Usmadi, “ARCSI Learning Model with a Scientific Approach”, *UMSB PRESS*. 2022. ISBN: 978-623-9947-8-2. <https://drive.google.com/file/d/1faC8y-TjzwnItQihpZKnyZWIUAdM-2ic/view?usp=sharing>

[43] Utami, A. D., “Types of Student Errors in Solving Geometry Problems Based on Newman'S Error Analysis (Nea)”. *JIPM (Scientific Journal of Mathematics Education)*, vol.4, no.2, pp. 85, 2016. [https://doi.org/10.25273/ jipm.v4i2.842](https://doi.org/10.25273/%20jipm.v4i2.842)

[45] Widiastuti, E. R., & Kurniasih, M. D., “The Influence of the Problem Based Learning Model Assisted by Cabri 3D V2 Software on Students' Numeracy Literacy Ability”, *Scholar's Journal: Journal of Mathematics Education*, vol. 5, no. 2, pp.1687–1699, 2021. <https://doi.org/10.31004/cendekia.v5i2.690>

[46] Yani, D., Muhanal, S., & Mashfufah, A., “Implementation of Diagnostic Assessment to Determine Student Learning Style Profiles in Differentiated Learning in Elementary Schools”, *Journal of Educational Innovation and Technology JURINOTEP*, vol. 1, no. 3, pp. 241–360. 2023.

**Authors’ Profiles**



**Dr. Drs. Usmadi., M.Pd.**, born in Air Tabit, Agam Regency, West Sumatra, December 30, 1964. Completed elementary school in 1979, junior high school in 1981 and high school in 1984. Then continued his education at Hatta University Padang majoring in mathematics education and graduated in 1989. Master's Education at Surabaya State University (UNESA) in the mathematics education study program and graduated in 2002, and continued the education of the Doctoral Program at Padang State University (UNP) in the education science study program, graduated in 2017. First served as a lecturer at Batang Hari Jambi University in 1991, in 1995 moved to the College of Teacher Training and Education (STKIP) Muhammadiyah Sungai Penuh at Jambi. Then in 2005 moved to teach at the Ahlussunnah Teacher Training and Education College (STKIP) in Bukittinggi, then in 2018 again moved to teach at the University of Muhammadiyah West Sumatra (UM West Sumatra) until now.



Ria Sriwahyuni, S.Pd. Gr, born in Padang, West Sumatera Barat, Agustus 26, 1989. Completed elementary school (SD) in 2001, Junior high school (MTsN) in 2004 and junior high school (MAN) in 2007. Then continued his education at Universitas Negeri Padang majoring in Mathematics Education and graduated in 2012. First served as a teacher at state junior high school 33 in Padang in 2013, used to be a tutor in excellent in 2017 then finished in 2019. Second served as a teacher at state junior high school 8 in Padang in 2017 until **now.**



**Ergusni, M.Pd.**, born in Koto Baru Simalanggang, Lima Puluh Regency, West Sumatra City on August 12, 1965. Completed Koto Baru Public Elementary School 1 (SD) in 1979, State Junior High School (SMP) in 1981 and Payakumbuh High School (SMPP) in 1984. Then continued his education at IKIP Padang majoring in physics education and graduated in 1990. Master's education was taken at Surabaya State University (UNESA) in the science education study program and graduated in 2002. First served as a lecturer at STIP Graha Karya Muara Bulian Jambi in 1991, in 1995 moved to the College of Education (STKIP) Muhammadiyah Sungai Penuh Jambi. Then in 2005 moved to teach at the Ahlussunnah Teacher Training and Education College (STKIP) in Bukittinggi, then in 2018 again moved to teach at the University of Muhammadiyah West Sumatra (UM West Sumatra) until now.

**How to cite this paper: A. Usmadi**, B. Ria Sriwahyuni, C. Ergusni, "Paper Title: Implications of Understanding by Design in Developing Problem Based Learning Models To Improve Students' Literacy and Numeration on Comparative Materials ", International Journal of Modern Education and Computer Science (IJMECS), Vol.11, No.6, pp. 1-4, 2024.DOI: 10.5815/ijmecs.2024.06.01