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PRELIMINARY RESEARCH: DEVELOPMENT OF DIGITAL STUDENT WORKSHEETS BASED ON INDONESIAN REALISTIC MATHEMATICS EDUCATION TO IMPROVE DEAF STUDENTS' UNDERSTANDING OF MATHEMATICAL CONCEPTS

Mariana Sanita Boru[1*], Lukita Ambarwati[2], Flavia Aurelia Hidajat[3]
[1,2,3]Mathematics Education Masters Study Program, Universitas Negeri Jakarta, Jakarta Province, Indonesia
*Correspondence: marianaboru9@gmail.com

ABSTRACT

Understanding mathematical concepts is an essential basis for thinking in solving mathematical and real world problems. However, students still do not understand mathematical concepts. The low ability to understand mathematical concepts is not only limited to normal students, but is also experienced by students with special needs, namely the deaf. Therefore, mathematics learning must be focused on improving a person's ability to understand concepts. The aim of this research is to develop Student Worksheets (LKPD) using the Indonesian Realistic Mathematics Approach (PMRI) to improve the ability to understand mathematical concepts for deaf students. The method used is research and development with the ADDIE model (Analysis, Design, Development, Implementation and Evaluation). At the analysis and design stage, data is collected through observation, questionnaires, interviews and tests. Next, the data is processed descriptively and quantitatively. Findings from the analysis results show that one of the subjects considered difficult by deaf students is whole numbers. This is caused by teaching materials that do not suit their characteristics. The results of the test for the ability to understand mathematical concepts show that the average score obtained by students is 53.20 and is categorized as low. Only one in six students meets the minimum completion requirement of 65 set by the school. Therefore, this research can be continued by developing PMRI-based digital LKPD to improve the ability to understand mathematical concepts. This is because the PMRI-based digital LKPD includes various stimuli carried out through various media, such as pictures, readings and videos and the contents of the LKPD have been summarized from several sources and presented using an approach that starts from the context of students' daily lives and continues with mathematics learning. formal. Another advantage is that this LKPD can be accessed at any time so it is easier for students to understand it.
Keywords: Concept Understanding, Digital LKPD, PMRI, Deaf

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PRELIMINARY

Understanding mathematical concepts is the basis for mastering other abilities, so this ability is very important for students to have (Kusnandar & Yusuf, 2023). Understanding concepts is an individual's skill in finding, understanding, interpreting, and concluding a concept through events, objects, or activities related to mathematics

(Artayasa et al., 2018). Understanding mathematical concepts is an essential basis for thinking to solve mathematical problems and other real problems (Hadi & Kasum, 2015). Understanding mathematical concepts allows someone to understand new information that can be used to make decisions, solve problems, generalize, reflect, and draw conclusions in mathematics learning (Churchill, 2017).

Concept understanding is demonstrated by someone meeting the indicators of understanding the mathematical concept itself. Indicators of the ability to understand mathematical concepts according to the 2013 Curriculum in (Hendriana et al., 2017) are: 1) repeating concepts that have been studied, 2) classifying objects, 3) identifying the properties of operations or concepts, 4) using concepts logically, 5) provide examples or counterexamples of the concepts being studied, 6) present concepts in shared mathematical representations, 7) connect various concepts in mathematical and non-mathematical fields, 8) develop necessary and/or sufficient conditions for a concept.

According to data in the field, not all students currently have adequate skills in understanding mathematical concepts. Indonesian students still lack understanding of concepts (Khairani & Nugraha, 2022). According to research, students find it difficult to convey the ideas they have learned orally and convey these ideas through mathematical representations (Kartika, 2018). According to Aida et al., (2017) students still find it difficult to use, utilize and determine certain steps or operations. Additionally, they have difficulty implementing concepts.

The low ability to understand concepts is not only limited to normal students, but is also experienced by students with special needs. One of them is deaf. Deaf students are children who have lost their ability to hear from mild (poor hearing) to severe (deaf) (Setyawan, 2019). Hidayat and Suherman (2016) revealed that deaf students' conceptual understanding and mathematical understanding abilities were classified as low. Research by Aini and Suryowati (2022) also revealed that students with special needs do not meet all the criteria for understanding mathematical concepts.

Factors causing low understanding of mathematical concepts come from internal and external factors. Referring to Hasanah et al., (2018), internal factors are caused by cognitive development, in this case the working memory of deaf students is lower than that of normal students. In general, deaf children have normal and average intelligence, but due to limited hearing abilities, the information they receive is low, as a result, the achievements of deaf children are often lower than normal children (Rahmah, 2018). Visual abilities can be used to overcome the hearing limitations of deaf students. Visuals

that contain pictures or real objects are very helpful for children who cannot hear (Swanwick, 2016).

External factors related to the learning process include learning approaches, media and teaching materials used (Diana et al., 2020). Students tend to memorize more than they understand the basic material or the benefits of that material (Jeheman et al., 2019). As a result, when students are asked math questions related to everyday life, they have difficulty solving them. This is in accordance with the results of a needs analysis carried out at SMPLB Negeri 7 Jakarta in the form of giving test questions on the ability to understand the concept of the subject of integers to 6 deaf students in class VII. The students had difficulty solving the questions because they did not understand the daily life problems presented. As a result, they are mistaken and even ignorant in changing the problem presented to mathematical form and the process of solving it.

Based on the previous description, innovation is needed in the learning process so that there is an increase in the ability to understand mathematical concepts. Educators can apply the Indonesian Realistic Mathematics Education Approach (PMRI) because it starts from the students' daily perspective and continues with formal mathematics learning (Nasution & Ahmad, 2018). Azizah (2018) stated that the meaningfulness of concepts is the basis of Realistic Mathematics Education (PMRI). If lessons are meaningful for students, their learning process will be easier to accept. The PMRI approach can be used at every level of education, so it is easy to develop according to circumstances (Fauzi & Waluya, 2018). Learning with PMRI allows the learning process to take place interactively, there is interaction between fellow students and with the teacher (Hadi, 2017).

Hobri (2009) explains that in designing learning with PMRI there are several stages that must be carried out by educators, namely: 1) understanding contextual problems, 2) providing explanations of contextual problems, 3) solving contextual problems, 4) comparing and discussing answers, and 5) concluded (Ningsih, 2014). Therefore, PMRI allows it to be used in learning intended to increase understanding of concepts. The main idea of PMRI learning is that students should be given the opportunity to revitalize mathematical concepts and foundations through the experiences they have in their environment (Rahmadan et al., 2020).

Learning with PMRI can be successful if it starts with careful planning. This planning includes making teaching materials in the form of Student Worksheets (LKPD). LKPD is a teaching material that contains various guides for carrying out learning

activities. It is hoped that students will understand better with LKPD (Istiqomah et al., 2021). LKPD has several advantages compared to other teaching materials. One of them is that the contents of the LKPD have been summarized from various sources and presented in a simpler format so that students understand it more easily (Kosasih, 2020). By using LKPD, students can gain a better understanding of the concepts being taught and increase their activity and creativity during learning activities (Prastowo, 2016).

If it is oriented towards the future learning process then LKPD which are printed teaching materials in the form of sheets of paper will become less relevant because future learning will prioritize the use of digital-based technology which can be accessed via computers, notebooks or smartphones (Lavtania et al., 2021). Therefore, it is necessary to develop digital-based LKPD. Digital-based LKPD is an effort so that students can utilize technology (Witri et al., 2020). Digital LKPD includes various stimuli carried out through various media, such as pictures, reading, and videos, and contains various activities, such as watching learning videos, reading material summaries, and carrying out activity steps (Cahyani et al., 2022).

This is relevant for deaf students because it is based on information obtained through teacher interviews regarding the obstacles of deaf students, namely that the learning process must be drilled or repeated because students often forget what they have learned. This opinion is in accordance with research by Aini and Suryowati (2022) which states that deaf students need help in explaining the meaning of the questions they read and require repetition of the explanation. For this reason, the digital LKPD that will be developed will also be equipped with sign language learning videos.

This is based on the results of the author's observations and teacher interviews during pre-research where in learning activities how to interact with deaf children, namely by using sign language or finger movements. Sign language really helps deaf children in communicating (Gumelar et al., 2018). It is hoped that digital-based LKPD can make the learning process more effective because it can be accessed at any time and is integrated with sign language learning videos that can be accessed repeatedly to answer problems by applying a learning approach that can support the achievement of learning goals.

Remembering that deaf children find it more difficult to accept abstract things than normal children (Ratnaningrum, 2015). For this reason, educators need creativity in presenting material to minimize abstractness. Limited hearing abilities in deaf students can be overcome with their visual abilities. The best mathematical abilities in deaf students are related to visuals (Blatto-Vallee, 2005). Visuals that contain pictures or real objects are

very helpful for children who cannot hear (Swanwick, 2016). Deaf children prefer to visualize problems to build their understanding of a concept (Leton, 2018). Visuals help them connect concrete things with abstract ones (Nikolaraizi et al., 2013). It is hoped that PMRI will be able to facilitate increased understanding of mathematical concepts for deaf students by visualizing abstract objects according to the students' level of thinking and their daily context. Learning methods that integrate daily activities can help students understand abstract mathematical material more easily (Rahmadan et al., 2020).

In research by Wulandari et al., (2019), Supriatna and Lusa (2021) and Gustin et al., (2020) explained that the development of modules and LKPD with PMRI effectively facilitates increasing the ability to understand mathematical concepts. However, the subjects in research by Wulandari et al., (2019), Supriatna and Lusa (2021) and Gustin et al., (2020) only focused on normal or regular students, there is still minimal research on developing teaching materials for deaf students to improve understanding of mathematical concepts. Therefore, the aim of this research is to develop a product in the form of a Student Worksheet (LKPD) based on the Indonesian Realistic Mathematical Approach (PMRI) on integer material which is focused on deaf students, with the hope of facilitating an increase in deaf students' ability to understand concepts.

METHODS

The research and development approach and methods used in this research are the ADDIE development stages which contain five stages: Analysis, Design, Development, Implementation and Evaluation. This research involved all deaf students in class VII at SMPLB N 7 Jakarta, consisting of six people. The analysis stage is carried out through giving questionnaires, class observations, interviews with one of the mathematics teachers named Anita B. Muslimah, S.Pd as well as giving students a test of the ability to understand mathematical concepts which aims to find out the actual situation in the field and the expected conditions. After all the data at this analysis stage is obtained, the data processing process refers to Miles and Huberman which includes the stages of reducing data, displaying data, and drawing conclusions.

In the design stage, the initial product design or initial product design is carried out. The design stage starts from choosing the right media for presenting teaching materials, choosing the format or form of presentation and continues with the initial product design (protoype) along with assessment instruments in the form of media, material and language validation questionnaires. In the development stage, a validation test was carried out by 2

validators each who were experts in the fields of media, materials and language. The assessment data obtained from the validator is analyzed descriptively qualitatively and used as a reference for revising the product, thereby producing a viable product. The results of the assessment of all aspects are measured using a Likert scale.

In the implementation stage, product trials were carried out in small groups and large groups. This trial was carried out to obtain opinions regarding the product being developed. Students are asked to provide responses or opinions regarding the teaching materials developed through student response questionnaires and teacher response questionnaires containing statement items regarding the use of teaching materials during the learning process which have been carried out as evaluations to minimize weaknesses or deficiencies in the products being developed. In the Evaluation Stage, a reassessment is carried out at each stage of activity starting from the analysis, design, development and implementation stages and whether the products that have been made are in accordance with the specifications or not. Apart from that, at this stage it is carried out to obtain an overview of the effectiveness of teaching materials in increasing students' ability to understand concepts before learning using teaching materials and after using teaching materials through test sheets (pre-test and post-test questions). The following is an interpretation table to assess the ability to understand mathematical concepts (Hayati & Marlina, 2021):

Table 1. Interpretation Value of the ability to understand mathematical concepts

Value	Interpretation
85,00-100	Very Good
70,00-84,99	Good
55,00-69,99	Fair
40,00-54,99	Bad
0,00-39,99	Very Bad

RESULT AND DISCUSSION

The research was conducted at SMPLB N 7 Jakarta in June 2023. The first stage carried out was giving questionnaires to six deaf students in class VII with the aim of identifying mathematical problems faced by students, class VII odd semester material which was considered the most difficult, methods/approaches used, media/teaching materials used, as well as additional media/teaching materials needed by students. Filling out the questionnaire was carried out with the help of the teacher who explained the meaning of each question item using sign language. This questionnaire consists of questions that contain alternative answers that students can choose. Apart from that, there

is space for students to write their answers according to their situation if the alternative does not match the answer that will be given. A more complete questionnaire grid is shown in the following table.

Table 2. Student Needs Analysis Questionnaire Grids

Aspect	Indicator
Mathematics	Students' interest in mathematics
	Students' opinions regarding the most difficult material and the reasons
Teaching Materials	Teaching materials used in the learning process
	The relationship between teaching materials and students' understanding of the material being taught
	What types and teaching materials do students want
Digital Teaching Materials	Digital media owned by students
	Use of digital teaching materials
	Students' interest in digital teaching materials in learning
Approaches to Learning Mathematics	Approaches that teachers often use in teaching mathematics
	The relationship between the approach used and students' understanding of the material being taught

Based on a needs analysis in the form of a questionnaire given, it was found that 83% of students considered whole numbers to be a difficult lesson. As many as 33% thought that the difficulties they experienced were caused by teachers teaching too quickly, 83% said that test questions were more difficult than practice questions and they did not understand the material and were afraid to ask the teacher. As many as 67% of students think that the teaching materials used by teachers do not encourage them to be enthusiastic about solving existing problems. The largest percentage of the type of teaching materials desired, namely 83% of students, chose Student Worksheets (LKPD) and learning videos. As many as 67% of students also think that the desired teaching materials must have an attractive design, 50% of students want teaching materials that are easy to understand, can be accessed via cellphone and laptop and have lots of example questions and 83% want explanations of the material with pictures and videos.

The next stage was an interview with one of the teachers who taught mathematics to the deaf class. According to interview findings, it was discovered that the whole number material was considered difficult because it was too abstract for students, contained positive and negative signs which made students confused and the questions given were sometimes in the form of numbers rather than contextual matters. Students often memorize material and formulas so that they do not have clear concepts and are less connected to contextual matters. Students only memorize formulas without understanding their

meaning, so they cannot decipher them when they face different problems (Aliah & Bernard, 2020)

From the results of the next interview, the teacher said that the teaching materials in the form of textbooks provided were sometimes too extensive so the teacher had to simplify the material himself and was not in accordance with the characteristics of deaf students as visual learners or relying on sight. The teacher's hope is that there will be teaching materials that are concise and can facilitate students' needs as visual learners, namely consisting of pictures or videos related to concrete things so that they can facilitate increasing students' ability to understand concepts.

The next stage was a test of understanding mathematical concepts on the subject of integers to obtain information regarding the abilities of SMPLB N 7 Jakarta students in understanding concepts. The test questions were in the form of essay questions for six deaf students in class VII. The indicators used to measure the ability to understand concepts are according to the 2013 Curriculum in (Hendriana et al., 2017) namely: 1) repeating concepts that have been studied, 2) classifying objects, 3) identifying the properties of operations or concepts, 4) using concepts logically, 5) providing examples or counterexamples of the concepts being studied, 6) presenting concepts in shared mathematical representations, 7) connecting various concepts in mathematical and non-mathematical fields, 8) developing necessary and/or sufficient conditions for a draft.

The results of the test for the ability to understand mathematical concepts on the subject of integers show that only one student achieved a score above the minimum school standard, namely 65. The following table shows details of the average scores obtained by students for each indicator of ability to understand mathematical concepts.

Table 3. Recapitulation of Mathematical Concept Understanding Ability Test Results

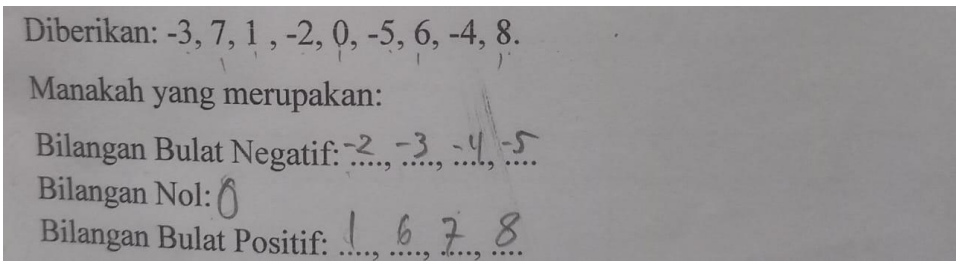
Number	Indicator of ability to understand mathematical concepts	Score/Indicator	Category
1	Repeat concepts that have been learned	55,5	Fair
2	Classifiying objects	94,4	Very Good
3	Identify the properties of an operation or concept	38,8	Very Bad
4	Use concepts logically	54,16	Bad
5	Provide examples or counterexamples of the concepts studied	100	Very Good
6	Presenting concepts in shared mathematical representations	52,7	Bad
7	Connecting various concepts in mathematical and non-mathematical fields	50	Bad
8	Developing necessary and/or sufficient conditions	11,1	Very Bad

Number	Indicator of ability to understand mathematical concepts	Score/Indicator	Category
	for a concept		

Table 3 shows that several indicators are in the fair and very good categories, while some others are in the bad and very bad categories. The following is an explanation of the representation of indicators in the categories very good, fair, bad and very bad.

1. Very Good Category

Indicator 2: Classifiying objects.



English Version

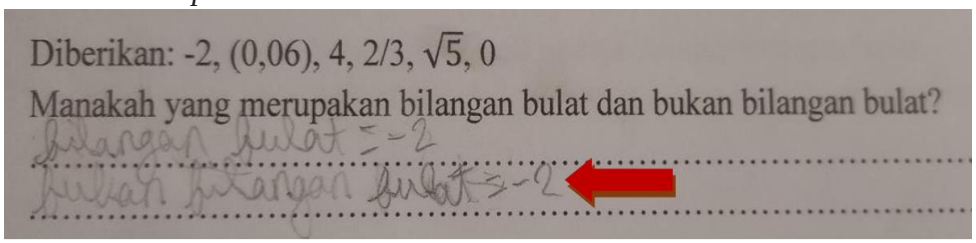
Given: -3, 7, 1, -2, 0, -5, 6, -4, 8
Which one is:
Negative integer: -2, -3, -4, -5
Zero number: 0
Positive integer: 1, 6, 7, 8

Figure 1. Student Answer to Indicator 2

Figure 1 clearly shows that students are able to classify several integers that are presented randomly into the classification of positive integers, zero numbers and negative integers.

2. Fair Category

Indicator 1: Repeat concepts that have been learned.



English Version

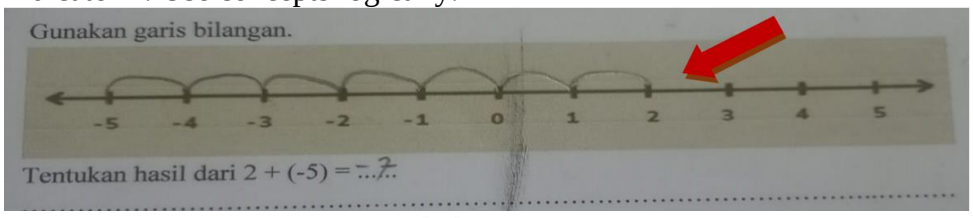
Given: -2, (0.06), 4, 2/3, √5, 0
Which ones are integer and not integer?
integer: -2
not integer: -2

Figure 2. Student Answer to Indicator 1

Figure 2 shows that from the numbers given in the problem, students have not been able to write back completely which ones are whole numbers and which are not whole numbers. Students answered -2 in the non-integer category. The answers given illustrate that students have not been able to restate basic concepts and classify them. There are misconceptions in answering this question. According to Mukhlisa (2021) misconceptions are inaccurate understanding of concepts, incorrect application of concepts, incorrect classification of examples of concept application, different concept meanings, and incorrect hierarchical relationships of concepts.

3. Bad Category

Indicator 4: Use concepts logically.



English Version

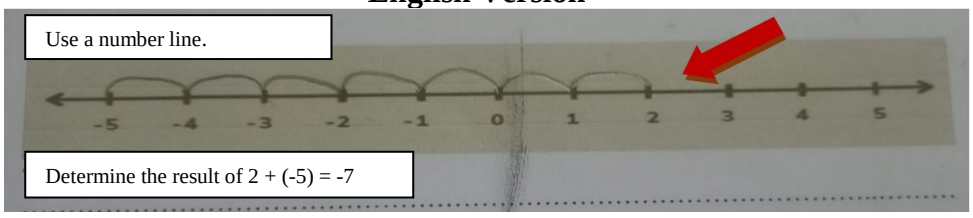
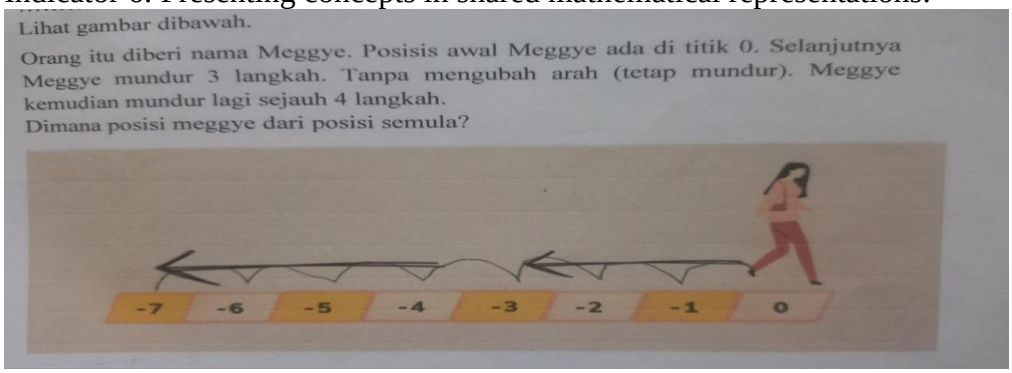


Figure 3. Student Answer to Indicator 4

Figure 3 shows that students have tried to use the given number line to calculate operations on the given integers, but the students made a mistake in

stating the steps on the number line so they did not find the correct results. The answers given show that students are mistaken in applying concepts logically, in this case difficulties in carrying out correct mathematical processes. Students experience difficulty using calculation operations, are less precise in the solution process, cannot find the correct final answer, and make mistakes in drawing conclusions (Rasiman & Asmarani, 2017).

Indicator 6: Presenting concepts in shared mathematical representations.



English Version

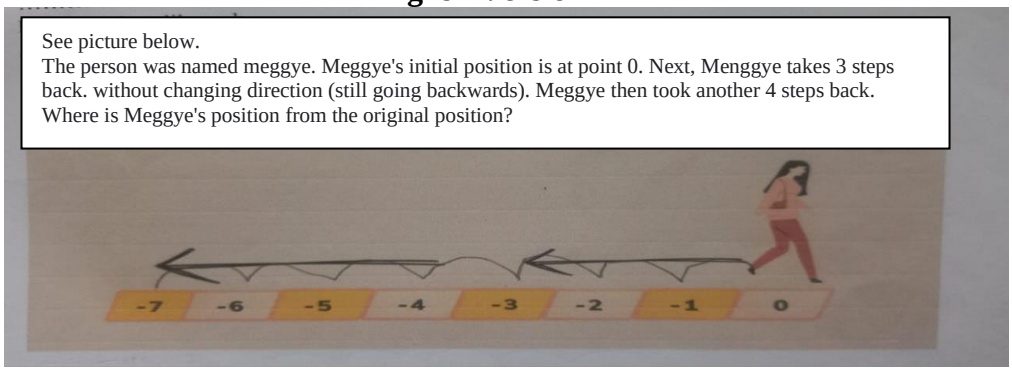
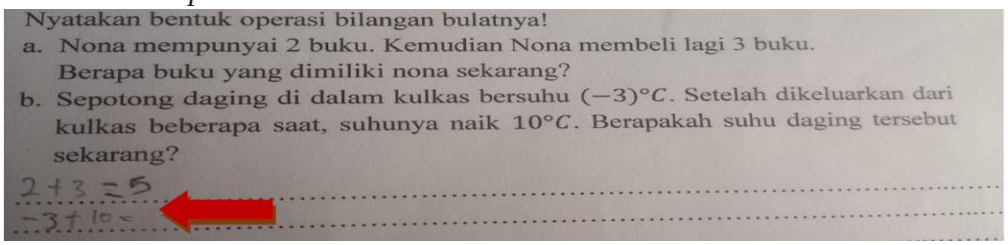


Figure 4. Student Answer to Indicator 6

Figure 4 shows that the questions given are related to the context of everyday life. It can be seen that students have tried to utilize the illustrations given by making steps following the direction of the arrows given but have not been able to change the contextual problem into a mathematical model and determine the results.

4. Very Bad Category

Indicator 3: Identify the properties of an operation or concept.



English Version

State the form of the integer operation!
a. Miss has 2 books. then Miss bought 3 more books. how many books do you have?
b. a piece of meat in the refrigerator at (-3) degrees Celsius. After taking it out of the refrigerator for a while, the temperature rose 10 degrees Celsius. what is the temperature of the meat now?
2+3 =5
-3+10 =

Figure 5. Student Answers S5

Figure 5 shows that for question (a) students were able to state the operational form of integers and answer them correctly. This shows that students have been able to identify the mathematical form of the statement and carry out the positive addition operation of two integers. The same thing for question (b) students are able to identify mathematical shapes. However, in this section students have not yet reached the operational stage of adding positive and negative integers. This is in line with what Santoso and Rodiyana (2019) stated that the general problem is related to integer material, namely number operations with two signs. Deaf children have difficulty understanding negative integers and performing mixed integer operations (Kalisni, 2013).

Based on the representative analysis above, the overall fact is that the ability of deaf students at SMPLB N 7 Jakarta is still low regarding understanding concepts.

The next stage is the design stage, namely designing the creation of a digital Student Worksheet (LKPD) using the Indonesian Realistic Mathematics Education Approach (PMRI) on the subject of integers which can improve the ability to understand mathematical concepts for deaf students. The main stage of design is studying the learning objectives contained in the material. Next, the LKPD is designed according to the learning objectives. The design of the LKPD to be made is as in Figure 6.

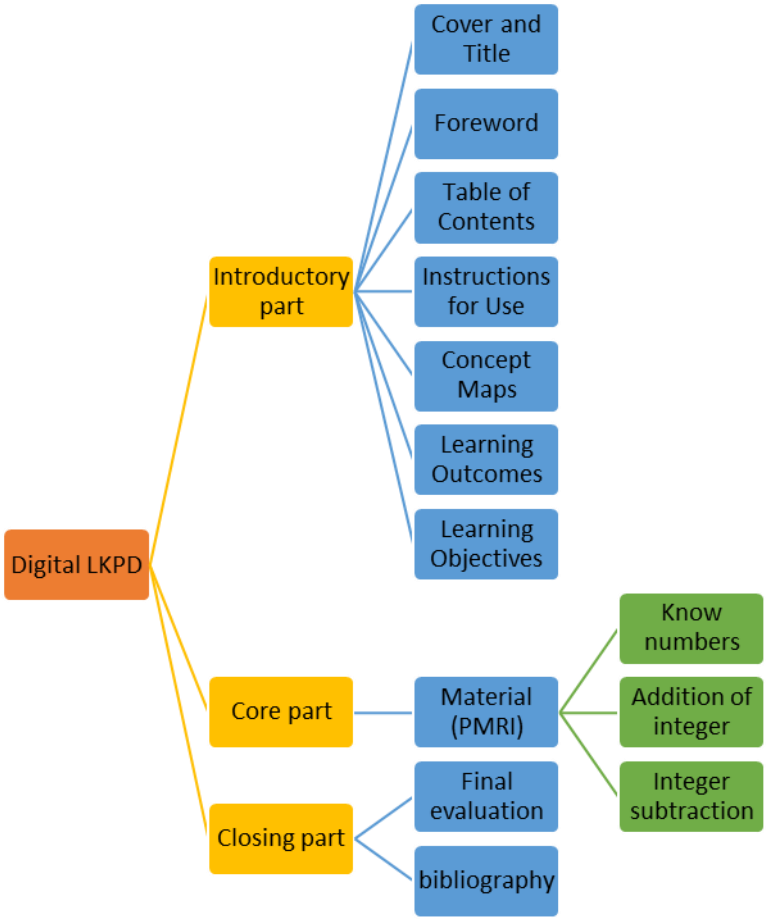


Figure 6. Initial Design of LKPD

Based on the image above, it can be seen that the introductory section contains some of the content presented in the LKPD. The explanation of each content on the LKPD is as follows:

1) Cover and Title

The cover and title sections contain the LKPD title, name of the compiler, class and design of the LKPD cover itself.

English Version

Figure 7. Digital LKPD Cover Design

2) Foreword

The foreword contains a series of words from the author in the form of thanks to all related parties for the completion of the process of making the LKPD. The

foreword page also contains information about the place, month, year and compiler.

3) Table of Contents

The table of contents contains details of the topics presented in the LKPD. Each topic is sorted according to presentation and page number sequence. The table of contents makes it easier for students and teachers to find topics to be studied.

4) Instructions for Use

The instructions contain procedures for using LKPD for both teachers and students.

5) Concept Maps

The concept map contains the big picture that will be studied in the integer material sub-chapter contained in the LKPD. Concept maps are made like flow diagrams to make it easier for students with visual-spatial abilities to see the big picture of the subject matter.

6) Learning Outcomes

This section displays learning outcomes that are synchronized with the curriculum implemented in the school.

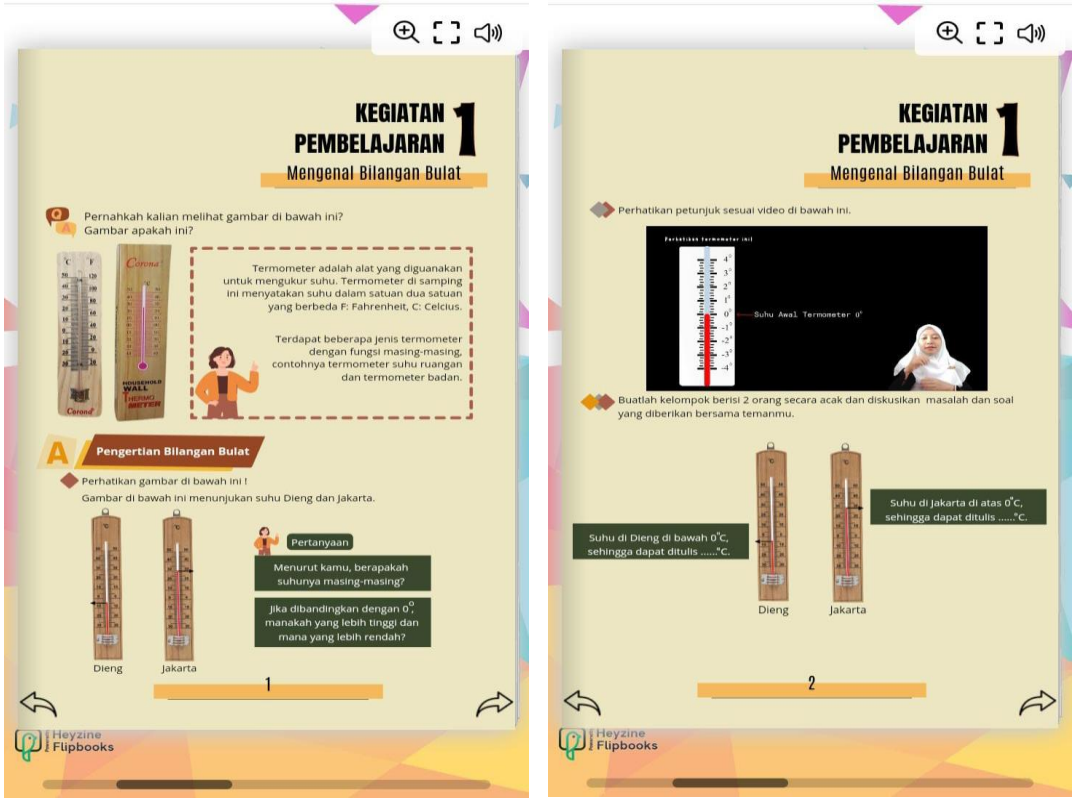
7) Learning Objectives

This section contains the learning objectives to be achieved in the material sub-chapters.

The core part of the LKPD contains material. The explanation of the core parts of the LKPD is as follows:

1) Material

This section contains material on integers which consists of 3 sub-chapters of material, namely: recognizing integers, adding and subtracting integers. This section also contains example questions and discussions, complete with sign language learning videos and practice questions. Each sub-chapter of material is related to PMRI syntax and components.



English Version

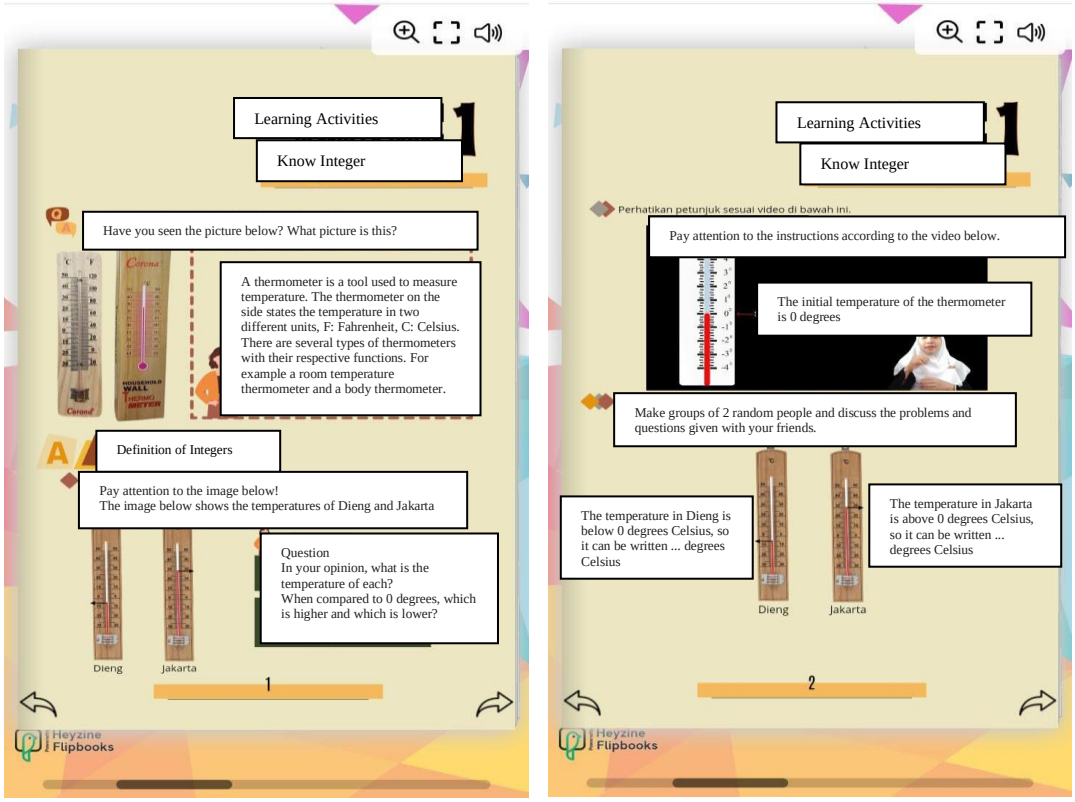


Figure 8. Digital LKPD Content Design

The closing section contains the end of the LKPD and there is a final evaluation of student learning. The following is an explanation of the closing section of the LKPD:

1) Final Evaluation

   This section offers questions related to all LKPD material.

2) Bibliography

   Contains a compilation of references used by the author in compiling the LKPD.

CONCLUSION

This research provides the following conclusions: 1) Students at SMPLB N 7 Jakarta experience difficulties on the subject of integers. This is caused by a lack of teaching materials that suit the characteristics of deaf students and a lack of connection between the material and everyday problems. 2) The results of the test for the ability to understand mathematical concepts show that the average score obtained by students is 53.20. This shows that deaf students' ability to understand mathematical concepts on the subject of integers is still relatively low. Of the six students, only one met the minimum completion criteria of 65 set by the school. Therefore, this research can be continued by developing PMRI-based LKPD to improve the ability to understand mathematical concepts.

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