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Development of Problem Based Learning Model Learning Devices to Teach Tube and Cone Topics

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Abstract: ***This article contains a scientific report on the process and results of developing learning tools to teach Tube and Cone topics at the junior high school level. The learning tools in question consist of a Learning Implementation Plan, Student Worksheets, Learning Media and Learning Outcomes Tests based on the Problem Based learning model. The development process is carried out according to the Kemp model (2011) which consists of 9 stages, namely Identification of Learning Problems, Analysis of Student Characteristics, Task Analysis, Formulating Learning Objectives, Sequencing and Introducing Content, Learning Strategies, Designing Messages, Development of Teaching Materials, and Development of Evaluation Instruments. The decision to get a well-developed learning tool was based on Nieveen's (1999) assessment criteria which included shutter validity, practicality and effectiveness. After passing through the 9 (nine) stages of development and 2 (two) rounds of validation and field trials, the researchers obtained data that was used to measure the achievement of the criteria given by Nieveen. The results of data analysis showed that the learning tools developed met the criteria of being valid, practical and effective, so they could be used to teach the topic of Tubes and Cones to class IX students.***

Keywords: Learning Models, Development Models, Problem Based Learning, Kemp Models, Learning Tools, Valid, Practical and Effective

1. Preliminary

As a result of the COVID-19 pandemic, there has been a change in the way education is organized in Indonesia. One of the prominent changes is the technique of implementing learning using the internet network or known as online learning. With all the challenges that exist, teachers continue to try to provide more meaningful teaching for students, starting from anywhere, whether teaching face-to-face or online learning. The fact that the author encountered was that the learning tools made by the teacher were only administrative completeness due to the demands of the school, so that many plans were not in accordance with the conditions and needs of students.

According to Wibowo (2016), student activity makes learning run according to the learning plan prepared by the teacher, the form of student activity can be in the form of activities on their own or in a group. One of the learning models that are considered in accordance with the demands of the curriculum to study the topic of Tubes and Cones is the Problem-Based Learning (PBL) model Boud, Felleti, and Forgaty (Ngalimum, 2014) state that PBL is a learning approach that involves confronting students with practical problems. In the form of ill-structured or open ended through a stimulus in learning. Meanwhile Ward (Ngalimun, 2014) stated that PBL is a learning model that involves students to solve a problem through the stages of the scientific method so that students can learn knowledge related to the problem and at the same time have the skills to solve problems. According to Handayama (2016), PBL can be interpreted as a series of learning activities that emphasize the process of solving problems faced scientifically. PBL places the problem as the key word of the learning process. This means that without problems there is no learning process. Valiant's (2014) research on the development of an implementation plan for mathematics learning with a Problem Based Learning approach on Curved Side Spatial Building material shows that the developed devices meet valid criteria and practical criteria. Melisa's research (2017) on the development of Realistic mathematics learning tools with a Problem Based Learning model on Linear Program material shows that learning tools are categorized as practical. The learning steps in the classroom that apply the PBL model follow the syntax as proposed by Arends (2007) in **Table-1**.

Table 1: Syntax of Problem Based Learning Model

Stages	Teacher Activities
Phase 1 Student orientation on problems	The teacher explains the learning objectives, describes various important logistical needs, presents a problem and motivates students to engage in problem solving activities.
Phase 2 Organizing students to study	The teacher divides the students into groups. The teacher helps students in defining and organizing learning tasks related to the problem.
Phase 3 Assist with independent and group investigations	The teacher encourages students to get the right information, carry out experiments, and look for explanations and solutions.
Phase 4 Develop and present the work	The teacher assists students in planning and preparing appropriate works, such as reports, videos, and models, and helps them to convey them to others.
Phase 5 Analyze and evaluate the problem solving process	The teacher helps students to reflect on the investigation and the processes used.

(Arends, 2007)

Although there are shortcomings, there are a number of advantages to the Problem Based Learning model (Sanjaya, 2007) which teachers can rely on in creating learning that helps students achieve their competencies.

This development research aims to obtain learning device products based on the PBL model which includes Learning Implementation Plans (RPP), Student Worksheets (LKS),

Learning Media (MP) and Learning Outcomes Tests (THB). One of the appropriate development models for developing learning tools with the Problem Based Learning (PBL) model to teach the Tube and Cone topic is the Kemp model (2011) which consists of 9 (nine) stages of development: (1) Identification of Learning Problems (Instructional Problems). (2) Analysis of Student Characteristics (Learner Characteristics). (3) Task Analysis (Task Analysis). (4) Formulating Learning Objectives (Instructional Objectives). (5) Sequencing and Introducing Learning Materials (Sequencing and Introducing Content). (6) Learning Strategy (Instructional Strategy). (7) Designing the Message. (8) Development of Teaching Materials (Developing Instructional Materials). (9) Development of evaluation instruments (Developing Evaluation Instruments). A good learning device is a learning device that can support learning so that the expected goals in learning are achieved. According to Nieveen (1999), a device is said to be good if it meets product quality aspects which include (1) validity, (2) practicality, and (3) effectiveness. Nieveen (1999) states that a model (in this case a learning device) is of good quality if it meets the criteria of validity, practicality and effectiveness. The validity aspect is related to two things, namely (1) the developed model must be based on solid theoretical rationale (state-of-the-art knowledge) and (2) the components of the developed model must be internally consistent. The practical aspect is related to two things, namely (1) according to the assessment of experts and practitioners, the developed model must be applicable (intended perceived) and (2) operationally in the field, the developed model can be applied (intended operational). Third, the learning model must meet the aspect of effectiveness. The aspect of effectiveness is related to two things, namely (1) according to the assessment of experts and practitioners, the model developed meets the requirements of being effective (intended-experiential) and (2) operationally in the field, the model developed is in accordance with the expected effectiveness (intended-attained).

The topic of Tubes and Cones is a part of the mathematics material for Constructing Curved Sides of Space (BRSL) which is taught at the junior high school/MTS level for even semesters of class IX. The basic competencies that need to be achieved in BRSL learning refer to the 2013 Curriculum, namely: (1) Generalizing the surface area and volume of various curved sides (tubes, cones, and spheres); (2) Solving contextual problems related to the surface area and volume of curved side shapes (tubes, cones, and spheres), as well as the combination of several curved side shapes.

2. Research Procedure

The type of research used is the Research and Development model of Kemp (2011) which consists of 9 (nine) stages and is combined with a process of assessing aspects of validity, practicality and effectiveness according to Nieveen's (1999) criteria as shown in **Figure 1**.

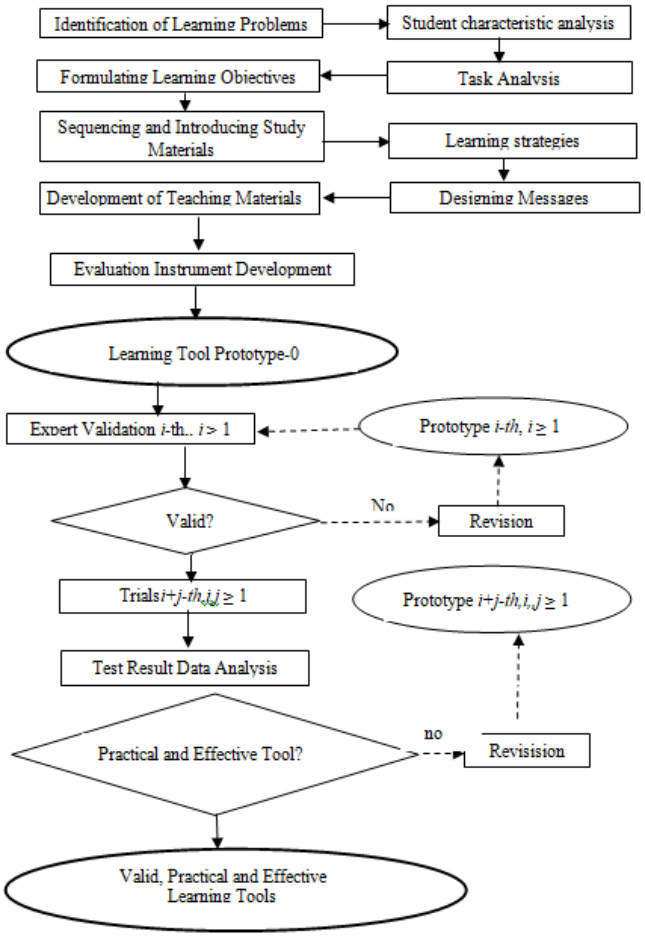

Figure 1: Device development procedure according to Kemp's model and assessment of product development according to Nieveen

The learning tools developed are the Learning Implementation Plan (RPP), Student Worksheet (LKS), Learning Media (MP) and Learning Outcome Test (THB) documents; a learning device based on the Problem Based Learning (PBL) model to teach the topic of Tubes and Cones at the junior high school level. The data on the validity of the learning tools were obtained from the assessments carried out by the validators on each document of the learning tools developed.

Validation data analysis was carried out by calculating the average value given by each validator for each aspect of the validated document assessment. Convert the average score of each aspect into qualitative criteria by referring to the following table.

Table 2: Criteria for Assessment of Validation Results

Criteria Value Validation (Vd)	Qualitative Criteria
Vd = 5	Very Valid
Vd = 4	Valid
Vd = 3	Quite Valid
Vd = 2	Less Valid
Vd = 1	Invalid

Learning tools are said to be valid if every aspect of the assessment of a device document at least has qualitative criteria Quite Valid or obtains mode Vd = 3. Data on practicality and effectiveness are obtained through observations in field test activities and questionnaires to test-

taking students distributed after the use-testing activity developed learning tools.

Table 3: Criteria for Teacher Ability to Manage Learning

Teacher Ability Level (TKG)	Criteria
TKG = 5	Very good
TKG = 4	Well
TKG = 3	Enough
TKG = 2	Not good
TKG = 1	Very Not Good

Data analysis of the practicality of the device was carried out by calculating the average observation score according to each indicator of the teacher's ability to manage learning at each learning meeting. Furthermore, the conversion of the average score into qualitative criteria is carried out by referring to the following table. The teacher's ability to manage learning at least has a good category or has an average TKG = 3 for each observation indicator. If it does not meet these criteria, the device is not yet practical, so it must be revised again. Analysis of learning effectiveness data was carried out by analyzing student learning outcomes data to measure the achievement of learning completeness criteria, and student response data to components and learning processes. A learning is categorized as classical completion if at least 80% of students reach the individual completion criteria and students are categorized as achieving individual completion criteria if students have obtained a minimum score of 75 in accordance with the Minimum Completeness Criteria that have been set by the school. A component and learning process is said to be well responded if the average percentage of responses in each aspect of the response reaches a minimum of 80% of students respond positively. A learning is said to be effective if the criteria for learning completeness and positive response criteria are met.

The subjects of the development trial were students of class IXA and IXB of Leilem Christian Middle School who were enrolled in the even semester of the 2021/2022 academic year. The validation and testing process takes place in cycles until the criteria for validity, practicality and effectiveness are achieved.

3. Results and Discussion

Through all stages of the development of the Kemp model, it is possible to design learning device documents, namely lesson plans, worksheets, learning media and THB which are then named Prototype 0. These prototype 0 documents are then assessed cyclically, both in the validation process and in the field trial process. The validation and testing process was carried out to obtain data on the validity, practicality and effectiveness according to Nieveen's (1999) criteria. This assessment process is cyclical, meaning that if the object of the assessment document is declared to have not met these criteria, then a revision is made according to the correction and asked to be validated again, or a trial is carried out again to assess practical and effective aspects. In the first assessment of the validity aspect, it turned out that the results were not valid and there were notes given by the validator.

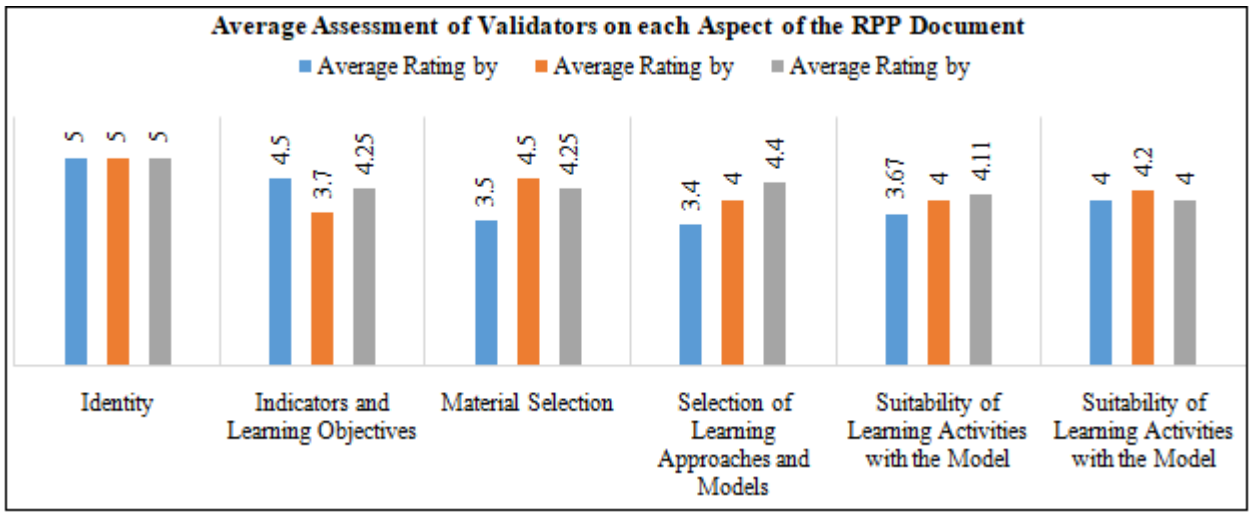

Figure 2: Average Validator Rating for each Aspect Lesson plan

After revision and reassessment, learning tools are obtained with the results of the assessment given by each validator according to the assessment aspects of each document as follows. The Learning Implementation Plan document has 6 (six) main aspects of assessment, namely (1) Identity, (2) Indicators and Learning Objectives, (3) Selection of Materials, (4) Selection of Learning Approaches and Models, (5) Compatibility of Learning Activities with Models and (6) Learning Resources and Assessment of Learning Outcomes. For the 6 aspects of the assessment, validator 1 gives a successive value of 5.00; 4.50; 3.50; 3.40; 3.67; 4.00, validator 2 sets a successive value of 5.00; 3.70; 4.50; 4.00; 4.00; 4.20, validator 3 gives successive values of 5.00; 4.25; 4.25; 4.40; 4.11; 4.00. A clearer presentation of the results of the validator's assessment of each aspect of the assessment of the Learning Implementation Plan document can be seen in **Figure 2**. These data indicate that the character and function of the RPP as stated by Mulyasa (2007) have been fulfilled by the draft RPP. The statement that is considered valid in the second stage ensures that researchers can use the lesson plans to organize tube and cone learning topics. The Student Worksheet Document consists of 5 (five) assessment aspects, namely (1) Format, (2) Content, (3) Language and Writing, (4) Illustration, Layout and Diagrams/Images, (5) Benefits/Usage.

The assessment of the 5 aspects by validator 1 is 4.00; 3.57; 4.20; 4.00; 4.00, the value given by validator 2 is 4.29; 4.00; 4.60; 4.00; 4.50, the value given by validator 3 in a row is 4.57; 4.14; 4.60; 4.25; 5.00. A clearer presentation of the results of the validator's assessment of each aspect of the Student Worksheet document assessment is shown in **Figure 3.**

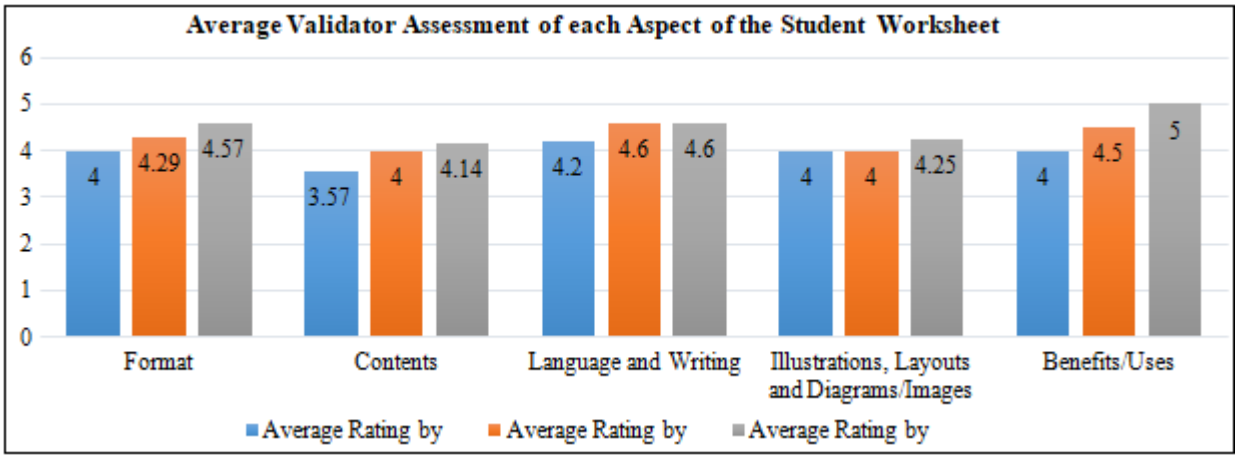

Figure 3: Average Validator Rating for each Aspect Student worksheet

The assessment of the validators showed that the draft LKS prepared by the researcher was in accordance with the General Guidelines for the Development of Teaching Materials (Diknas, 2004) and the main characteristics of an LKS as given by Prastowo (2013). This means that the LKS with validator scores containing these few notes can be used in learning the Tube and Cone topic.

Learning media (Video) consists of 2 (two) assessment aspects, namely Video Content and Video Display. For the 2 aspects of the assessment, validator 1 gives a successive value of 3.90; 3.63, validator 2 gives a value of 4.2: 4.00, validator 3 gives a successive value of 4.2: 4.00. A clearer presentation of the results of the validator's assessment of each aspect of the Learning Media (Video) assessment, can be seen in **Figure 4**

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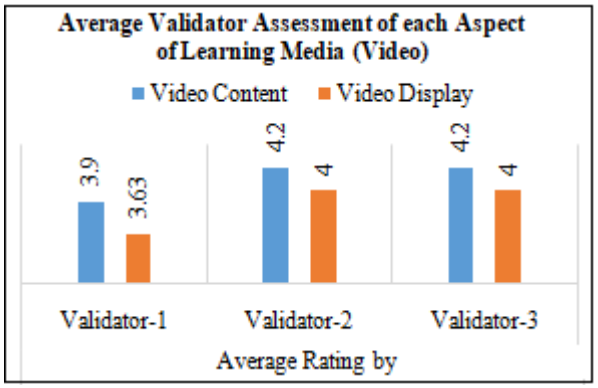
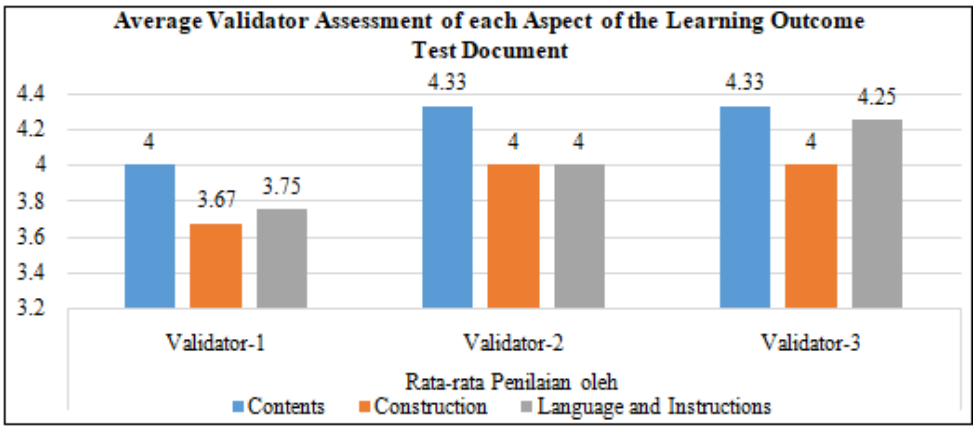


Figure 4: Average Validator Assessment of each Aspect of Learning Media (Video)

These results indicate that the validators agree with the draft of Learning Media in this case the Learning Video compiled by the researcher. This can be seen as the fulfillment of the conditions given by Furoidah (2009) regarding the content that should be included in a learning video. The Learning Outcomes Test Document consists of 3 (three) assessment aspects, namely (1) Content, (2) Construction and (3) Language and Instructions. For the 3 aspects of the assessment, validator 1 gives a successive value of 4.00; 3.67; 3.75, validator 2 gives a value of 4.33: 4.00; 4.00, validator 3 gives a successive value of 4.33; 4.00; 4.25. A clearer presentation of the results of the validator's assessment of each aspect of the assessment of the Learning Outcomes Test document is shown in **Figure 5**. Overall, the results of the assessment show that the revised RPP, LKS, MP and THB documents are now in the valid category.



Graph 5: Average Validator Assessment of each Aspect of the Learning Outcome Test Document

The assessment of the practicality of the device was carried out based on data from observations of the teacher's ability to manage learning in the 2nd trial. There are 4 (four) indicators of the ability of teachers to manage learning, namely (1) Preliminary Activities, (2) Core Activities, (3) Closing Activities and (4) Class Atmosphere. Observations were made in 4 (four) learning meetings. The average observation result of the 4 indicators at the learning meeting guided by RPP-1 is 4.33; 4.50; 4.60; 4.00, at the learning meeting guided by RPP-2 is 4.33; 4.50; 4.60; 4.50, at the learning meeting guided by RPP-3 is 4.67; 4.24; 4.80; 4.50, at the learning meeting guided by RPP-4 the average observation result was 4.67; 4.63; 4.80; 5.00. A clearer presentation of the results of observations on each aspect of the observation on the Teacher's Ability to Manage Learning is shown in **Figure 6**.

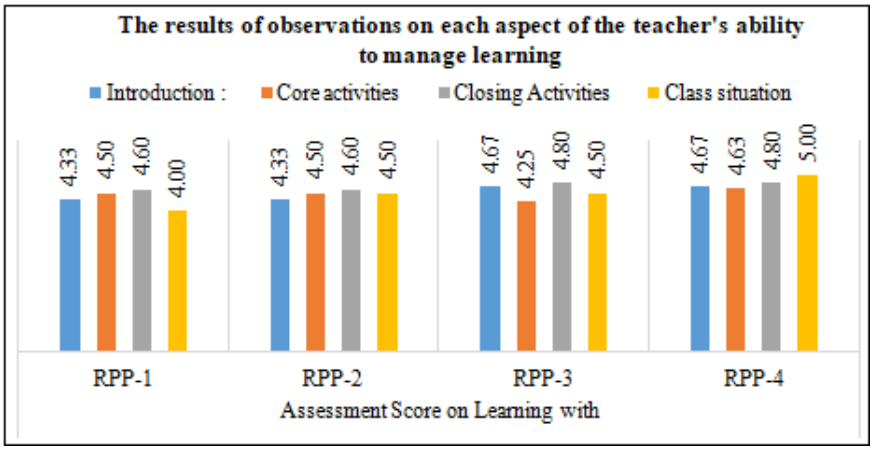


Figure 6: Average Observation Results for each Aspect on Format of Teacher Ability to Manage Learning

If it is included in the criteria for the ability of teachers to manage learning, this data shows that the ability of teachers to manage learning is classified as very good, so it can be stated that the learning tools used in learning are in the practical category.

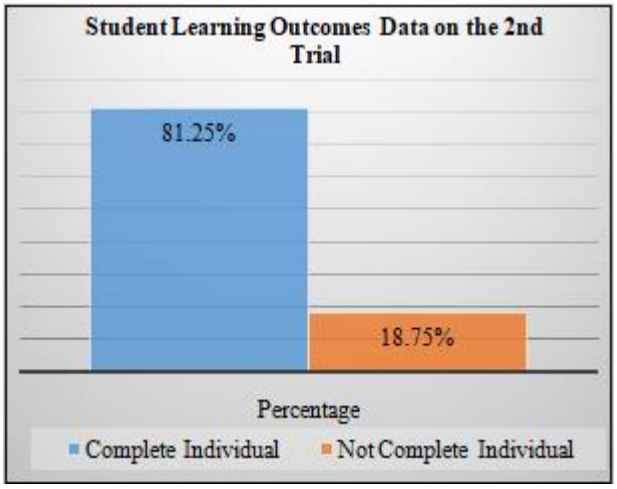


Figure 7: Student Learning Outcomes Data on the 2nd Trial

The assessment of the effectiveness aspect was carried out based on the learning outcomes data and the results of the questionnaire conducted after the 2nd round of trials. Data on student learning outcomes on the topic of Tubes and Cones have reached the criteria for completeness, namely from 32 students there are 26 students or 81.25% which are classified as individual complete criteria (**Figure 7**). Data on student responses to the device and implementation of learning in terms of 5 (five) response aspects, namely (1) students' feelings during learning, there are 84.38% of students responding happily, (2) students' feelings of learning components, there are 85.94% responding happy, (3) students' opinions on the learning component, there were 87.50% new responses, (4) students' opinions on understanding the language used in LKS, learning videos and learning outcomes tests, respectively, there were 87.5%, 87.5%, 84.38% responded clearly, (5) Students' opinions about appearance (writing, illustrations or pictures and the location of pictures), respectively, there were 84.38%, 93.75% and 81.25% students responded interested. A clearer presentation of the results of the validator's assessment of each aspect of the assessment of the Learning Outcomes Test document is shown in **Figure 8**.

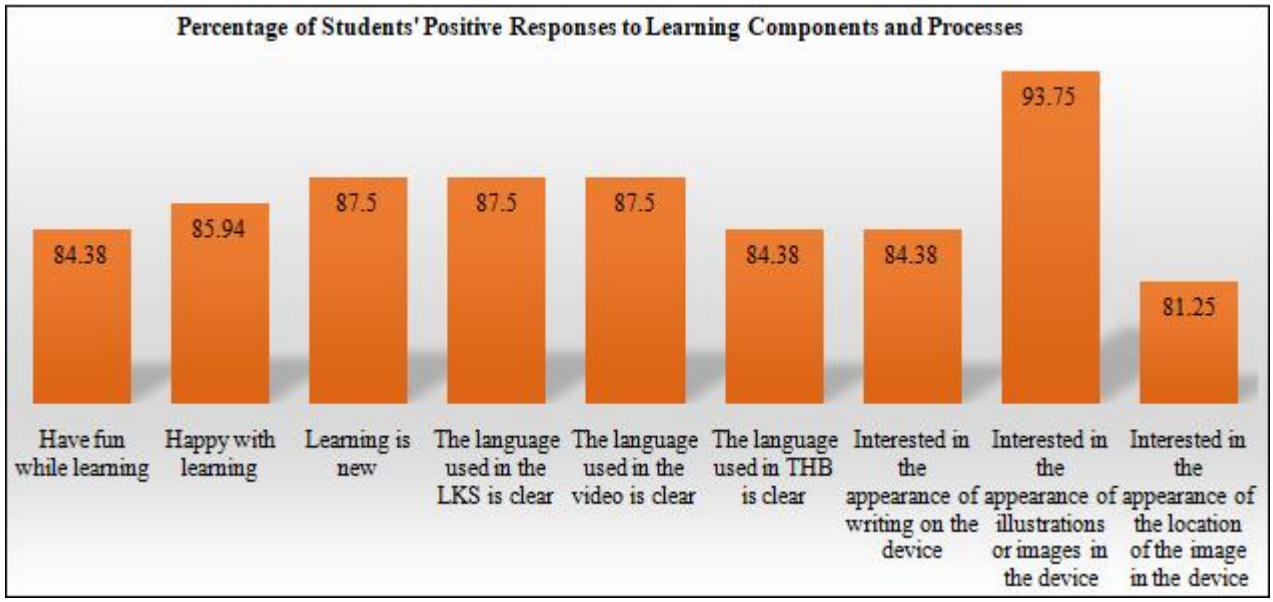


Figure 8: Percentage of Students' Positive Responses to Learning Components and Process

In general, these data state that the learning tools developed are categorized as effective. These results indicate that students experience the learning situation expected from the PBL model, as revealed by Sanjaya (2007) regarding the advantages of the PBL model. It seems that the advantages of the PBL model outweigh the disadvantages.

4. Conclusions and Suggestions

Based on the research objectives and the research process for developing learning tools, the following results were obtained: (1) The process of developing a PBL model of tube and cone learning tools for junior high school students in class IX using the Designing Effective Instruction Model by Jerrold E. Kemp (2011); (2) The results of the development of learning tools are Learning Implementation Plans (RPP), Student Activity Sheets (LKS), Learning Videos (VP) and Learning Outcomes Tests (THB). All learning tools produced are of good quality because they have met the predetermined criteria, namely (a) The learning tools are declared valid based on the validator's assessment, (b) The teacher's ability is stated to be good in carrying out learning for every aspect of each lesson plan implementation, (c) The student's response was declared positive because more than 80% of the students responded positively to the learning tools, (d) The learning outcomes stated that the test questions could be said to be valid and reliable. PBL learning model is said to be effective for teaching Tube and Cone material in class IX SMP because it has met the predetermined criteria, namely: (a) The teacher's ability is stated to be good in carrying out learning for every aspect of each lesson plan implementation, (b) Student responses are declared positive because more than 80% of students respond positively to learning, (c) Complete learning classically is said to be complete because more than 80% of students get a minimum score of 75 according to the Minimum Completeness Criteria that has been set by the school.

Based on the results of the study, it is suggested that: (1) Middle school mathematics teachers for grade IX can use this development learning tool to teach Tube and Cone material, (2) Mathematics teachers can try to implement PBL learning models to teach other materials.

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