



THE DEVELOPMENT OF TEACHING MATERIALS PBL MULTIPLE-REPRESENTATIONS ORIENTED TO IMPROVE CONCEPT MASTERY

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ABSTRACT

Teaching though student center is inadequate only by giving single representation. Therefore, this research sought for improvement of teaching materials problem based (PBL) development which orientates multiple representations. The development was undertaken through Research and Development approach with 3D model (Define, Design, and Develop) and resulted in teaching materials including syllabus, lesson plans, students worksheets, and assessment instruments which included concept mastery test sheets and representations ability. The teaching materials development were tested its validity by experts, the practicality by teaching accomplishment and students' response, and the effectiveness by testing in experiment and control class. Experts' validations showed that the developed materials were valid with the criteria "very good". The implementation of teaching materials was well implemented and obtained positive response from students with good criteria. These results showed that the teaching materials were practical. The effectiveness of teaching materials was shown by classical accomplishment result of experiment class (93,55%) high than control class (87,10%). N-gain concept mastery item C, C2, C3, and C4 were 0,94; 0,44; 0,7; and 0,29.

Key words: teaching materials, PBL, multiple representation, concept mastery

INTRODUCTION

Indonesia's education gets a big challenge to compete with other developing countries linked to the quality of education. This is in accordance with the Kasim submitted (2013) that we wanted to produce a generation that can bring Indonesia into the developed world as predicted many world institutions. Countries that have superior human resources will be more advanced than in the country with many natural resources, but does not have the human resources that are reliable (Sani, 2014: 7). Over time, one of the demands of the quality of education is a demand to develop human resources in order to have a 21st century skill Trilling and Fadel (Abidin, 2014: 9) explains that the main skills a must-have in the context of the 21st century is a skill to learn and innovate.

Physics as the heart of the development of technology has fundamentally changed the human life so much required to innovate. But in fact, found a lot of students are less interested in studying physics and no understanding after studying of physics (Prahani *et al.*,

2014). Judging from the interest of the students towards physics, the physics educators are required to present a meaningful learning in hopes of young people interested in studying of physics.

Meaningful learning is not enough if you only use a single representation to convey all the necessary information, thus multiple representation should be used if the student is expected to pass the most basic level (Sinaga *et al.*, 2013: 7). Students often learn complex science topics using multimedia and hypermedia that include variations of resources including the representation of diagrams, text, equations and animations or video (Whiterspoon *et al.*, 2008: 43). Results of interviews that have been conducted by the Physics teacher in class XI in SMA Tempeh Lumajang there are many teachers who do conventional lectures learning, presentation of the material is less linked with the characteristics of the Adiwiyata school, a little demonstration, then the students do exercises and students' ability to describe the chart or tables are still

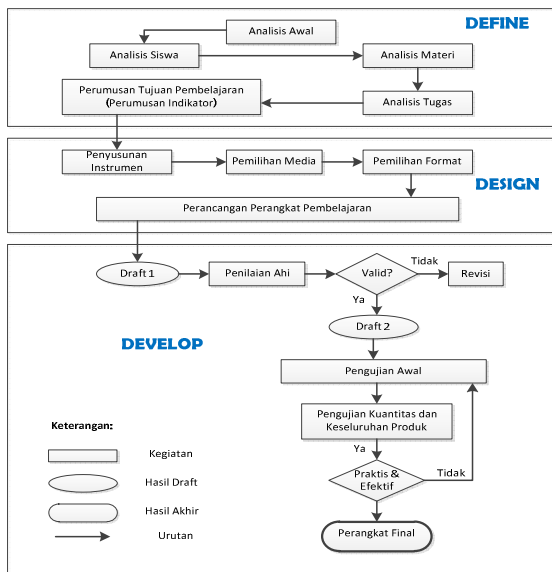
experiencing difficulties. Learning activity that occurs is still dominated by the teacher or monotonous by using books that are drill of matter.

The efforts to facilitate students to obtain meaningful learning one of them with problem-based of learning model. Results Kemdikbud organized teacher training (2013) showed that problem-based learning makes meaningful learning. Students who learn to solve a problem and trying to apply the knowledge or trying to dig up the necessary knowledge. Learning can be more meaningful when learners can be expanded to deal with the situation where the concept is applied. Peaget and Vygotsky (Arends, 2013: 104) reveals that the constructivist concepts developed can help and become the basis for Problem Based Learning. According Mulyasa (2014: 49), teachers are required developing the facilities and learning resources, in addition to be able to make their own learning tools and teaching aids, teachers also must take the initiative to leverage the environment around the school as a learning resource more concrete.

Based on the above research approach with R and D. The purpose of this research is to produce a device-oriented learning PBL multiple representation proven valid, practical and effective in increasing mastery of concepts and the ability of the student representation.

METHODS

The research is to develop learning device by using the approach of Research and Development. 4 - D model of development that is modified from Thiagarajan *et al* (1974) that define, design, develop, and disseminate. Modification of 4D into 3D is presented in Pictures 1.



Testing the effectiveness and practicality of the stages develop by using true experiment research design with pre-test post-test control group design in class XI SMA Tempeh Lumajang. Based on the data of daily tests carried out tests and obtained Barlet XI IPA 2 as an experimental class and XI IPA 3 as the control class.

Data retrieval technique effectiveness and practicality of each using tests to measure mastery of the concepts and capabilities of representation, as well as the feasibility of observation and questionnaires. The qualitative data obtained from observation sheets feasibility study. Analysis of the validity of the learning device by using percentage after getting a description of the expert assessment. Indicators of student response consists of (1) the feeling when the following study, (2) interest in the device used, (3) freshness, (4) ease of understanding, (5) the ease of following study, (6) interest following study, (7) clarity of the teacher's explanation, and (8) the ease of answering the questions. While the indicator of implementation learning is the syntax PBL learning oriented multiple representation consisting of (1) the orientation of the student in question, (2) organize the students, (3) mentoring, (4) develop and present the work as well as (5) to analyze and evaluate the process, and the results of problem solving.

Normality test, homogeneity, and t test to test the hypothesis results of treatment with the aim of seeing any significant difference. Analysis of the students' responses practicality and feasibility study by using descriptions percentage , while the effectiveness of PBL learning - oriented devices multiple representation with shows gain score value of the pre-test and post-test mastery of concepts is packaged in the form of multiple choice questions. Equation gain score using formulations from Hake (2007: 24).

$$(< g >) = \frac{\text{skor posttest} - \text{skor pretest}}{\text{skor maksimal} - \text{skor pretest}}$$

Indicators of the success of the study, namely, (1) the validity of reaching the level of validity valid or very good, (2) effectiveness seen from mastery of concepts students classically \geq KKM (KKM = 75) and percentage complete learned classical reaches 85 % of the number of students and the results of the experimental class better than the control class, (3) practicality obtained from positive students responses

learning of implementation and learning material in the category of good or very good.

RESULT AND EXPLANATION

Research result

Table 1. The Results of Data Recapitulation in Define Phase

No.	Description of activities	Findings
1	Initial Analysis and Curriculum	KTSP has not been linked to characteristics Adiwiyata school, yet student center
2	analysis of Students	As many as 80 % of Lumajang, 20 % from outside Lumajang 5-10 students completed when the daily tests of KKM 75 , students' skills in drawing graphs , tables , diagrams still lacking
3	Materials analysis	Static fluid found many applications in everyday lif, the material in the second semester. Results of the national students' absorption of the competence to understand natural phenomena and regularity in coverage point object mechanics, rigid body, effort, conservation of energy, elasticity, impulse, momentum and the problem of fluid reaches 77.97 %
4	Task analysis	More about the task of working out and manufacture of media
5	Formulation of Learning Objectives	Much emphasis on cognitive shutter

Table 1 shows that have not been arranged by the education unit level curriculum Adiwiyata school characteristics Learning materials and tasks that used not refer to the curriculum by school characteristics Adiwiyata.


(1) Define Phase

Conducted interviews with teachers in SMA Tempeh and literature prior to treatment. Recaps the results of the data obtained from the define phase is presented in Table 1.

(2) Design Phase

At the design stage of the development is done on an existing device. One result of the development of the learning syllabus is presented in Pictures 2.

Kegiatan Pembelajaran	Indikator Pencapaian Kompetensi	Penilaian		Alokasi Waktu	Sumber Belajar
		Teknik	Instrumen		
<ul style="list-style-type: none"> Menganalisis konsep tekanan dan tekanan hidrostatik Menggunakan persamaan tekanan dan tekanan hidrostatik untuk memecahkan suatu masalah Melakukan eksperimen tentang tekanan hidrostatik 	Produk: <ul style="list-style-type: none"> Menformulasikan konsep tekanan (representasi verbal, matematis) Menformulasikan tekanan hidrostatik dalam fluida (representasi verbal, matematis) Menganalisis tekanan dan tekanan hidrostatik yang berkaitan dengan kehidupan sehari-hari. Proses: Melakukan	Tes tulis	Esai	2x45'	<ul style="list-style-type: none"> Buku Fisika kelas XI SMA Erlangga, Buku referensi yang relevan Selang bening Zat cair Gelas ukur Corong Balon penggaris



Kegiatan Pembelajaran	Indikator Pencapaian Kompetensi	Penilaian		Alokasi Waktu	Sumber Belajar
		Teknik/bentuk	Instrumen		
Orientasi masalah <ul style="list-style-type: none"> Menyajikan permasalahan Mengorganisir Siswa untuk bekerjasama <ul style="list-style-type: none"> Melakukan Pembimbingan Kelompok Melakukan eksperimen tentang tekanan hidrostatik Mengembangkan dan meyakinkan hasil karya <ul style="list-style-type: none"> Menganalisis konsep tekanan Proses: Melakukan eksperimen	Produk: <ul style="list-style-type: none"> Memformulasikan konsep tekanan (representasi verbal, matematis) Memformulasikan tekanan hidrostatik dalam fluida (representasi verbal, matematis) Menganalisis tekanan dan tekanan hidrostatik yang berkaitan dengan kehidupan sehari-hari. Proses: Melakukan eksperimen	Tes tulis /esai	1. Berapakah tekanan mutlak yang dialami seekor ikan pada kedalaman 50 m di bawah permukaan danau? (massa jenis air = 1 g/cm^3 , $g = 10 \text{ m/s}^2$, tekanan atmosfer = $1,01 \times 10^5 \text{ N/m}^2$) Representasi gambar: Representasi matematis: Representasi verbal:	2x45'	<ul style="list-style-type: none"> Buku Fisika kelas XI SMA Erlangga, Giancoli Buku referensi yang relevan Selang bening Zat cair Gelas ukur Corong Balon penggaris

Pictures 2. The Results Design of Syllabus Oriented Multiple Representation

Pictures 2 shows the results of the development planning for learning after receiving input from expert assessment. In the column raised learning activities PBL learning oriented syntax multiple representation. Examples instrument mastery of concepts raised as an example.

expert assessment of the learning device is presented in Table 2.

Table 2. Results of Expert Assessment of Learning Tool

No.	Expert	Average of Expert Appraisal		
		Syllabus	LS	SW
1	BSH	4,75	3,44	3,47
2	BSN	5,25	3,68	3,84
3	BTH	4,17	3,80	3,68
4	BYW	4,67	3,56	3,89

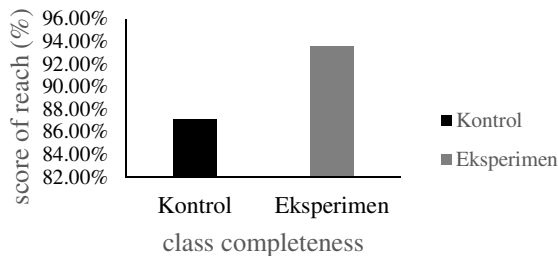
(3) Develop Phase

At this stage of develop assessment by experts of the developed learning materials. Recap the results of

Average	4,71	3,62	3,72
Criteria	Very good	Very good	Very good

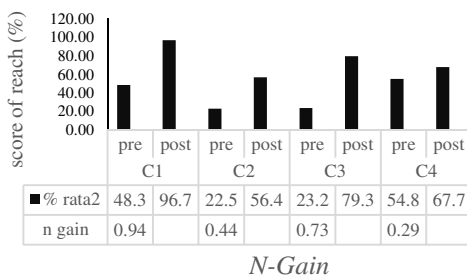
Table 2 shows the results of expert assessment of the syllabus, lesson plans and worksheets were developed with the model PBL multiple representation oriented. Each device developed criteria very well received.

Testing the effectiveness of the learning device by providing test questions mastery of the concepts and capabilities of representation. Results of classical completeness student mastery of concepts presented in Pictures 3.

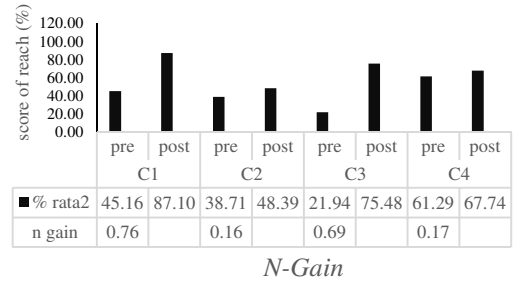


Pictures 3. Percentage of completeness Classical Concepts Mastery

Pictures 3 shows that the mastery of classical completeness concept control class and experimental experience the difference. The experimental class students completed as much as 93.55 %, while the control group only reached 87.10 %. Counting results N-gain mastery of the concept of control and experimental class in terms of cognitive C1 up to C4 is presented in Pictures 4.a and 4.b.

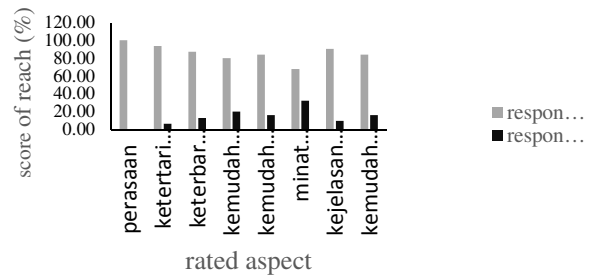


Pictures 4.a Experiment Class



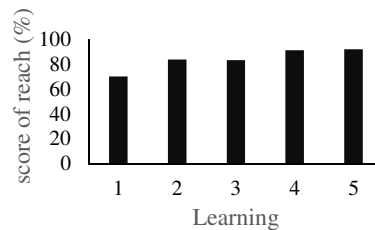
Pictures 4.b Control Class

Pictures 4.a and 4.b show that there are differences in mastery of concepts in each cognitive domain. In the experimental group (Pictures 4.a) mastery of concepts C1 and C2 with N-Gain control as well as in class (Pictures 4.b), but differ on the C2 and C4, N-gain experimental class is higher than the control class. Results of the analysis of the practicality of the learning device seen from the students' responses and feasibility study presented in Pictures 5 and Pictures 6.



Pictures 5. Student Responses of The Learning

Pictures 6 shows the results of the analysis of students' responses to learning. Many students gave a positive response of 10% of the learning that is the aspect of feelings during the course. Lowest achievement in aspects of interest to follow the lessons in the amount of 67.74%.



Pictures 6. Persentation of Implementation Learning

Pictures 7 shows the results of the analysis of feasibility study. At each meeting has increased. But at the third meeting decreased by 0.49%.

Learning tool developed to overcome found problem in the field. Material learning model student-centered school with characterizing Adiwiyata is contextual learning. Ability students who lack the cognitive development of learning-oriented devices multiple representation. Planning for learning the material fluid static created by displaying the syntax PBL is student orientation on the problem, organize in groups, guide students in investigations of individuals or groups, to develop and present the work as well as analyze and evaluate the results of problem solving, as well as the lesson plan and worksheets. Teaching materials were not developed because the existing teaching materials already multiple representation. Student worksheet developed guiding students to find the answers multiple representation concept.

Learning material developed assessment given by experts to gain validity. Validity assessment experts covering feasibility, practicality and effectiveness were then tested to determine the result of the development so it gets a valid criterion. In accordance with the specific characteristics of PBL requires students undertake an investigation authentically seek real solutions of real problems (Arends, 2013: 101) and Akbar says also (2013: 114), that in accordance with cone experience, meaningful learning at the highest stage when the students had to do and get involved.

Results of the analysis of the effectiveness of the learning device of mastery of concepts students. Based on Pictures 2 shows that the C1, C2, C3 is higher than the control class. Differences completeness differ significantly from the comparative tests two averages using the t test, obtained the value t '(t count) and the price of t_{tables} respectively 2.03 and 2.04 which means that there are significant differences between classes use learning device by using a oriented model PBL multiple representation with a class that uses the regular PBL. This invention according to research Fahkrudin *et al* (2013: 53) suggests that the ability to master the concept of experimental class that uses the learning device physics-based health problems is higher than the control class. In accordance with the theory Ausubel meaningful discovery that learning occurs only on the research of a scientific nature (Dahar, 1996: 111).

Results of the analysis show that the normalized gain there is an increase in each cognitive domain showed there was an increase in each C1 up to C4. In the realm of comprehension and analysis, still in the low category

because less explanation deeper and extracting the missing information. This deficiency can be overcome by the provision of additional tasks to be done out of hours learning (homework) apart from the matter of student evaluations. Besides the research results Abdurahman *et al* (2011: 40) suggests that learning with multiple representation able to improve the mastery of concepts. Based on the results of research that developed a device that meets the criteria is valid in accordance with the purpose of research.

Explanations are lacking depth in the closing stages, making students less gain strength in any given material. Purwanto (1997) suggested that one that affects students' mastery of concepts is enviromental input is environmental factors in this case is the teacher and peers. There are significant differences between the control group and the experimental class on the ability of the student representation. The calculations show that $t_{\text{calt}} = 10.629$ is greater than $t_{\text{table}} = 1.697$ means that there are significant differences ability representation of students who use the devices PBL-oriented learning with PBL learning multiple representation usual.

Based on the research results Research and Development approach obtained learning materials by device characteristics multiple representation oriented learning with PBL models, syntax appear in the syllabus, lesson plans and worksheets. In addition, worksheets developed by presenting contextual issues that can train the student representation and packaged in multiple representation learning with instructional videos.

The third device was tested learning content and construct validity by experts, the effectiveness by providing test mastery of concepts and capabilities as well as the representation of the students' responses practicality and feasibility study has proven valid, effective to improve the mastery of concepts and practical implementation. The downside of this study were students not yet accustomed to the lab and do the questions multiple representation. Therefore, the implementation of learning-oriented multiple representation also trained in other subjects.

Practicality learning device seen from a questionnaire completed student, it is known that a 100% positive response to the students' learning happy. Aspects of students' interest towards learning only reached 67.74% gave a positive response. This is because students who are not accustomed to resolving problems with practical and multiple representation trouble and need a lot of time in the settlement. The addition of hours to explain the matter more deeply still needed. This indicates that the learning device for purposes of research has been

reached. Classically increased by 84.09% relatively good achievement. Implementation of learning less than the maximum due to the closing part, the explanation of the lack of teachers so that students lacking in acceptance of the subject matter. At the third meeting of the decline due to the lab do require more analysis. At the stage of analyzing and evaluating the results of problem solving also increased in every meeting, only the third meeting decreased due matter Archimedes law on data analysis at the third meeting quite a lot and requires precision so that any flaws in workmanship. The findings Harsoyo & Sopyan (2014: 5) showed that problem-based learning increases the problem-solving abilities.

CONCLUSION

Based on the research results Research and Development approach obtained learning materials by device characteristics multiple representation oriented learning with PBL models, syntax appear in the syllabus, lesson plans and worksheets. In addition, worksheets developed by presenting contextual issues that can train the student representation and packaged in multiple representation learning with instructional videos. The third device was tested learning content and construct validity by experts, the effectiveness by providing test mastery of concepts and capabilities as well as the representation of the students' responses practicality and feasibility study has proven valid, effective to improve the mastery of the concepts and capabilities of representation as well as practical implementation. The downside of this study were students not yet accustomed to the lab and do the questions multiple representation. Therefore, the implementation of the learning is done in a balanced way between the lectures and practical exercises giving multiple representation outside school hours and also trained in other subjects.

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