The Validity of Realistic Problem Based Learning Model Development of Mathematics Learning in Vocational High School (SMK)

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The Validity of Realistic Problem Based Learning Model Development of Mathematics Learning in Vocational High School (SMK)

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Abstract*—The aims of this research is to determine the validity aspects of Realistic Problem Based Learning Model or abbreviated as Reaalistic PBL Model for students of SMK grade XI semester 1 in Padang. Realistic PBL Model is a learning model developed from Problem Based Learning Model and Realistic Mathematics Education Approach (RME Approach). The development stages of the Realistic Model PBL refer to the Plomp Model consisting of (1) the introductory stage, (2) the prototyping stage which includes planning, evaluation and revision, and (3) the product assessment stage. The validity aspect of Realistic PBL Model is investigated at prototyping stage with 6 test subjects consisting of 4 mathematicians and 1 educational technologist and 1 linguist. The results show that PBL Realistic Model which includes syntax/learning steps, social system, reaction principle, support system and instructional impact and supporting tools, along with learning support tools have fulfilled valid criteria.

***Keywords*—validity, Realistic PBL Model, Vocational High School, SMK**

I. INTRODUCTION

At an ideal level, the learning process should be able to let students to gain learning experiences that can be used to construct their own knowledge. Thus, learning is a construction [1] including in mathematics learning.

In mathematics learning process, there are several components that can affect the achievement of learning objectives. These components include learning steps, the role of teachers and students in learning, the ways teachers respond in learning activities and learning support systems. These components are covered in terms of the learning model. [2] states that "*an instructional model is a step-by-step procedure that leads to specific learning outcomes.*" Thus, the learning model has an important role in learning because it leads to the achievement of learning objectives including in mathematics learning.

In Ministerial Regulation No. 22 of 2006 [3] and No. 22 of 2016 [4] on Content Standards, it is explained that initiating learning by presenting the contextual problems that must be solved by the student should be a habit undertaken by teachers in the school. National Council of Teachers of Mathematics/NCTM [5] also suggests that problem-solving skills are part of the standard process in mathematics learning.

Many studies have shown that mathematics is difficult to understand because there is no variation of the learning model used; the learning approach is not interesting; and done with the classical patterns [6]. These classical patterns cause students to become passive; the teacher acts as a provider of information; and more emphasis on learning memorization from meaningful learning ([7], [8], [9]). These conditions are relatable with the one that was found in the conducted field observations and from the interviews with teachers and students of SMK in Padang conducted in recent years.

In addition, from the field observation, there are also found that some teachers of the Vocational High School (SMK) had difficulties in implementing the National Education Ministerial Regulation no. 22 of 2006 [3] or Permendikbud no. 22 of 2016 [4] which states that problem solving and to start learning mathematics with contextual problems at that time should be a habit done by teachers in SMK.

The difficulties experienced by SMK teachers are caused by the lack of socialization or training on contextual, realistic and PAKEM approaches and the achievement of learning objectives related to concrete mathematical communication in their respective classes. The socialization and the training are still not evenly touching the SMK teachers in 30 provinces in Indonesia [10]. As a result, mathematics learning is done with a model that is not varied or tends to maintain the classical learning patterns of its nature.

Learning with classical patterns often provides less satisfactory conditions and learning outcomes because it does not provide sufficient space for students, as students are more passive by simply hearing explanations from the teacher. As the results, students do not master mathematical concepts and lack the opportunity to do reinvention ([11], and [12]). For example, here are the results of less satisfactory studies found in one of the SMK in Padang as seen in Table I:

TABLE I. MID SEMESTER TEST SCORE OF MECAHNICAL ENGINEERING DEPARTMENT AT SMKN 5 PADANG

No.	Classroom	Percentation(%)	
		Failed	*Passed*
1.	1MI1	59,56%	40,44%
2.	1M2	57,42%	42,58%
3.	1M3	64,45%	35,15%
4.	1M4	65,71%	34,29&

Source: Mathematics teachers of SMKN 5 Padang

The table I above shows that the number of the students who passed the minimum scores is less than 50%. Here, it is considered as necessary to find the right solution. One of the solutions is by using the model and approach of learning that suitable with the characteristics of the problems that have been described previously i.e Problem Based Learning Model (PBL) model and Realistic Mathematics Education (RME).

The PBL model [13], is a learning model in which students work on authentic issues with the intent to develop their own students' knowledge, develop inquiry and high-level thinking skills, develop self-reliance and self-confidence. Problem solving and contextual problems are typical of the PBL Model, and this model also strongly emphasizes the development of teamwork that strongly supports students to improve mathematical communication skills.

Realistic Mathematic Education (RME) approach is an approach devoted exclusively to mathematics learning. This approach also makes problem-solving and contextual problems an important part of learning math. The approach initiated by Freudhenthal (1970)[14] is an approach that emphasizes the mathematical process skills in students, starting with the use of realistic problems that can be imagined by students to deliver students to the process of mathematization. The use of problems easily imagined by students will also avoid anxiety in students when learning math.

The PBL model and the RME Approach have some similarities, e. g. using contextual problems and imaginable, getting students to communicate in the form of discussion, argumentation, and in written form. Based on the above explanation, with evidence of the success of the PBL Model and the advantages of the RME approach, a Learning Model developed is called Realistic Problem Based Learning Model (Realistic PBL). This model is expected to solve mathematical problems in SMK so that research is done to develop Realistic Problem Based Learning Model (Realistic PBL Model) to improve communication skills and mathematical disposition of Vocational High School (SMK) students. This paper will only discuss the validity aspects of the development of Realistic PBL Model.

II. METHODS

A. *Types of the Reserach*

This research is a developmental study that refers to the Plomp Model [15] which consists of (1) preliminary stage, (2) prototyping stage, (3) assessment stage[16].

B. *Time, Place, and Subject of the Research*

The development of Realistic Model PBL was conducted in Padang from August 2016 to November 2017. The subjects of the research involved 6 experts i.e. 4 mathematics education experts, 1 educational technologist and 1 linguist.

C. *Procedure*

Procedures undertaken to determine the validity aspects of the Realistic PBL Model begins with a preliminary stage, by reviewing previous studies and related literature, interviewing some teachers and students of SMK in Padang, and conducting documentary studies on teaching tools owned by the teachers of SMK. Furthermore the results obtained at this preliminary stage will be used to design the developed learning model.

In the prototyping stages, learning model components (syntax, social systems, reaction principles, support systems, and instructional and accompanist impacts), learning support tools, and instruments for assessing the quality of validity and learning models developed is planned. Furthermore the results of learning model planning, learning support tools and instruments are given to the expert to get an assessment of the aspects of validity. Product revisions can be made before and after the quantitative assessment is provided by experts (if required).

D. *Data, Instruments, and Data Collecting Technique*

The data in this research consist of qualitative and quantitative data. The instruments used in collecting data were a rationale appraisal of rational book of Realistic PBL model development and questionnaires for mathematics teachers and student math book with Realistic PBL model. Quantitative data were obtained from the results of the assessment sheet of expertise and by experts, while the qualitative data are in the form of input and advice provided by experts for the perfect product development that will be produced. All instruments used are valid instruments (product moment correlation (r) > 3) and have high reliability and good (Alpha Cronbach value and Index Correlation Coefficient(ICC)> 0.6). Complete instrument test results are seen in Table II.

TABLE II. TEST RESULT OF RESEARCH INSTRUMENTS

Instruments	Validity Result	Reliability (Alpha/ Cronbach)	Average (ICC)
Rational Appraisal of the Realistic PBL Model	4,33	0,665	0,684
Students' Mathematics Book Rating Sheet	4,33	0,611	0,609
Teachers' Mathematics Book Rating Sheet	4,43	0,679	0,657

E. Data Analysis Technique

The Validity of Realistic PBL Model is determined by expert judgment. Scores obtained from the validity assessment sheets were converted into qualitative categorization percentages, with reference to the qualitative categorization according to Arikunto [17] in Table III.

$$P = \frac{\sum_{i=1}^{4} X_i}{\sum_{j=1}^{4} X_j} \times 100\%$$

Index: P=Percentage
$\sum X_i$ =number of score answers by experts
$\sum X_j$ =the number of scores with the highest answer

The learning model is valid if minimal expert judgment on learning model components and learning support tools reaches valid criteria.

TABLE III. THE CRITERIA OF PRODUCT RESEARCH PRODUCT VALIDITY

Score	Persentage	Criteria
5	90%-100%	Very Valid
4	75%-89%	Valid
3	65%-74%	Quite Valid
2	40%-64%	Less Valid
1	0%-39%	Not Valid

Source: [17]

III. RESULTS AND DISCUSSIONS

A. Result

1. Preliminary Stage

Based on the research framework, the preliminary stage of self evaluation is carried out on the things that must be obtained to develop the research product; a) collecting a variety of information including: student conditions, curriculum and learning tools currently in use b) analyzing the information collected c) formulating rational development of Realistic Model PBL d) formulating product design framework. Based on the activities undertaken at this preliminary stage, it was decided to select matrix material in SMK to be developed.

2. Development and Prototyping Stage

The designing process of the developed product is done by prototyping. The developments of PBL Realistic model products are as follows:

a. The First Prototype

The result of the Product Description should accommodate the things required at the introduction stage. In addition, since the model is developed, the requirements / definitions of the learning model must be met. In this prototype, three developed products are produced: a) a realistic PBL model rational book, b) teacher mathematics book for matrix material, and c) student mathematics book matrix material.

1) Expert Review

Expert advice for the first prototype is aimed at the cover of each developed product book (still simple). In the rational book the model is suggested that the steps in the syntax of learning are more detailed and the layout of each is made more orderly. The syntax of prototype I can be seen in Table V.

In the teacher's book, it is advisable to package the learning by building a solid foundation of knowledge firs, so it makes easier to build up the knowledge on it until it reaches the formal mathematical stage (Iceberg-Formal Mathematics). One example that can be seen is in Figure 1.

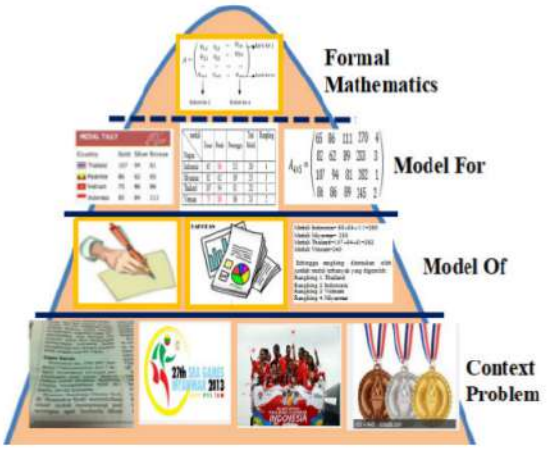

Figure 1. Iceberg to find the concept of the matrix

On the other hand, in the students' book, learning objectives are recommended more operational as well as some of the context of the problem made simpler. Learning objectives written on the students' book related to the formulation of Indicators of competence achievement that must contain operational verbs that reflect actual behavior. An example can be seen in Table IV.

TABLE IV. EXPERT REVIEW ON THE FORMULATION OF INDICATORS OF COMPETENCY ACHIEVEMENT IN MASTER'S MATHEMATICS BOOK WITH REALISTIC PBL MODEL.

Not Reflecting Actual Behavior	
4.1.1	explaining notions and matrix notations
4.1.2	determining the order and matrix elements
4.1.3	recognizing various matrices
4.1.4	determining the transpose matrix
4.1.5	identifying the matrix equations
Reflecting Actual Behavior	
4.1.1	arrange objects in the form of columns and rows (called matrices)
4.1.2	writw many rows and columns (matrix order) of the order of objects
4.1.3	swap rows and columns of a matrix
4.1.4	write the same two matrices

2) Revision

All suggestions and improvements from experts, teachers are accepted by the authors to revise the product except to add an example of problem solving at the beginning of the lesson as it contradicts the principle of developing the PBL realistic model it self, where learning begins with students solving problems.

TABLE V. FIRST PROTOTIPE SYNTAX OF REALISTIC PBL MODEL

No.	Syntax
1	**Phase 1:** Realistic Problem Presentation (presenting, reviewing and understanding the contextual problem).
2	**Phase 2:** Preparation (Organize students to develop problem solving strategies for individuals or groups)
3.	**Phase 3:** Applicating Strategy (Organizing Students Implementing Problem Solving Strategies).
4	**Phase 4:** Presenting the prototype (Communicating troubleshooting results)
5.	**Phase 5**: Follow-up (Teachers give some Realistic feedbacks)
6.	**Phase 6:** Evaluation (Evaluating the learning process and outcomes)

The result of the revised Sintak Realistic PBL Model can be seen in Table VI.

b. Second Prototype

1) Description

The first revised prototype produced a second prototype. The second prototype of all products books has changed with the new book cover. One example can be seen in Figure 2.

Figure 2: Mathematics book cover before and after the revision

In the rational book, the syntax learning model is also created more detail with a strong theoretical rationale; the layout of the rational model book has also been made regularly. Description of activities in the teacher's book has been made more detailed with the purpose of learning more operational. Some of the problems in the context of the problems in teacher books and student books have also been simplified.

TABLE VI. SECOND PROTOTIPE SYNTAX OF REALISTIC PBL MODEL

No.	Syntax
1	**Phase 1:** Realistic Problem Presentation (Reviewing, Presenting realistic issues)
2	**Phase 2:** Understanding and Problem Solving (Teacher gives students an opportunity to understand the problem well, individuals and groups)
3.	**Phase 3:** Assistance (Providing help if needed)
4	**Phase 4:** Presenting the work and Reflecting (Communicating the results of problem solving and reflection)
5.	**Phase 5:** Discovering the knowledge and the Concepts (Teachers and students discover the concepts)
6.	**Phase 6:** Follow-up (Teachers give some Realistic feedbacks)
7.	**Phase 7:** Closing Evaluation (discussing, evaluating processes and outcomes as well as summing up learning)

2) *Expert Review*

In this second prototype, the corrections from the experts are only in some typos, the error in the selection of raw/non-standard words. At this stage the experts provide a quantitative assessment of the validity of the product. The presentation of data summary of validation results on each product can be seen in Table VII, VIII, and IX.

TABLE VII. EXPERT ASSESMENT OF RATIONAL BOOKS OF LEARNING MODEL

No.	Aspect of assessment	Average Rating Score	%	Criteria
1.	Rational Development of Model and Supporting Theory	4,4	88	Valid
2.	Sintak Learning	4,38	87,62	Valid
3.	Social System	4,44	88,75	Valid
4.	Principles of Reaction	4,17	83,33	Valid
5.	Support System	4,3	86	Valid
6.	Impact of Learning and Impact of Companions	4,1	82,08	Valid

In the Table VII, it can be seen that the expert's assessment of all aspects of the rational book of learning model consisting of; rational model development and supporting theory, syntax learning, social systems, support systems and impacts after converted in percentage form lies in the range 80% to 86.67% categorized in valid criteria.

TABLE VIII. EXPERT ASSESMENT OF MATHEMATICS TEACHER'S BOOK WITH REALISTIC PBL MODEL

No.	Aspect of Assessment	Average Rating Score	%	Criteria
1	Learning objectives	4,17	83,33	Valid
2	Teaching Materials	4,25	85	Valid
3	Learning model	4,25	85	Valid
4	Learning Process Activity	4,22	84,44	Valid
5	Assessment Technique	4,33	86,67	Valid
6	LP Components	4,17	83,33	Valid
7	Language	4,17	83,33	Valid
8	Supporters	4,33	86,67	Valid
9	Display	4	80	Valid
10	Benefits	4,33	86,67	Valid

The average expert score of mathematics teacher's book in all aspects is at 4 to 4.33. If the average score is converted to percentage form, it lays in the range 80% to 86.67% whose interpretation of validity criteria included in the valid category.

TABLE IX. EXPERT ASSESMENT OF STUDENT MATHEMATICS BOOKS WITH REALISTIC PBL MODELS

Aspect of Assessment	Average Rating Score	%	Criteria
1. Contents Feasibility			
a. The Suitability of the Material Description with Basic Competence and Standard Competence	4,33	86,67	Valid
b. Accuracy	4,21	84,17	Valid
c. The Suitability of the Material Description with Realistic PBL Model	4,38	87,14	Valid
d.Supporting Material	4,22	84,4	Valid
2. Presenting Aspects			
a. Technique	4,06	81,1	Valid
b. Teaching Presentation	4,33	86,67	Valid
c. Completeness	4,5	90	Very Valid
3. Language Aspects			
a. The Suitability of the language used with students' abilities.	4,42	88,33	Valid
b. Communicativeness	4,17	83,33	Valid
c. Sequences and Ideas	4	80	Valid
4. Graphic Aspects			
a. Buku size	4,17	83,33	Valid
b. Cover design	4,08	81,67	Valid
c. Contents design	4,17	83,33	Valid

The assessment of the experts on the student's mathematics textbook, on all aspects covered by the grading point has met the validity aspect (with valid and highly valid criteria). Specifically for grading the assessment of the average presentation by the expert judgment is within the criterion very valid (90%).

The average validity of all three Realistic PBL Model models can be seen in Figure 3.

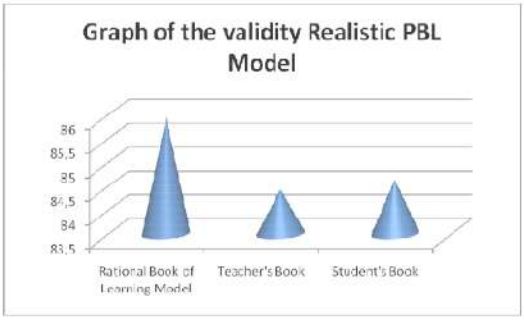

Figure 3: Average Validity of Realistic PBL Model's Product

From the picture, it can be seen that on average, the validity value of rational book model, is slightly higher than the value of the validity of teacher's book and student's math book with Realistic PBL Model and all three lies within valid criteria range.

B. Discussion

[18] argues that validity aspects are clearly recognized after noting the following answers (1) Is the model based on current Knowledge (Content-Validity); and (2) Are the Instructional Material components consistently interactively connected (construct validity). It has been made by six scholars on the Realistic PBL Model, four of them are the learning material experts (subject matter) on mathematics, one of them is the expert of instructional technology, and another one is a linguist. The six scholars recommend three points: 1) Realistic PBL Model Rationale Book, 2) The Mathematics Teachers Book of Realistic PBL Model, 3) the Realistic PBL Model Students' Book are categorized as valid with mean percentage 85,96%, 84,44% 84,63% [17]

In term of contents, the Realistic PBL Model is based on the logical and rational theories demanding the need for the Instructional Model Development. One of them is [19] states that Instruction Model is the guidelines for both the Instruction designers and teachers in arranging their learning activities that can be helpful in finding the information, idea, skills, the way of thinking and expressing the idea. The PBL Realistic Model that last in a particular context as suggested by the Indonesian Education Regulations no. 22. 2006 and no. 22.2016.

The problems characteristics/math test items given in this model is dealt with realistic, contextual, and the familiar illustration for the students. The reason of giving unique math items because mathematics: is useful and applicable for daily live, simple, clear communication media to present the information ([20], [21],[22]). Starting the mathematic class with the contextual dan realistic give a strong foundation for the students to start a math lesson.

Realistic PBL's model has built on a strong and unraveled theory in detail, including social constructivism theory which states that knowledge is constructed and constructed jointly/mutually by the students [23]. Learning mathematics through Realistic PBL Model has been done by putting the students into some groups; it let the students to have the involvement among them, evaluate and improve their mutual understanding in finding the problem solving [24]. In this way, experience in a social context provides an important mechanism for the development of students' thinking [23].

The six experts' assessment on aspects of construct validity, the Realistic PBL Model was based on state of the art knowledge and internal consistency between the components of the model. The complete components of the model include; syntax, social system, reaction principle, support system, direct impact and indirect impact [25]. The Realistic PBL Model Syntax consists of 7 stages: 1) presenting the realistic problems 2) understanding and solving the problem, 3) Assistance 4) presenting the work and reflection 5) discovering the knowledge and concepts 6) follow-up, and 7) evaluating and closing. Expert judgment on learning syntax was also included in valid criteria, meaning that the syntax can be used in learning.

The implementation of the Realistic PBL model syntax was supported by a supporting system component; 1) teacher's math book (contains instructions on learning objectives, teaching materials, learning process activities, assessment techniques, the components of lesson plan, language, supports, appearance and book advantages, 2) student math books (containing accurate material, related with standards competences & basic competencies, presentation of good and complete materials, the appropriate language aspects which suitable the students prograss, and fulfill the aspects of graphics) and 3) Supporting learning environment that in dealt with learning through Realistic PBL Model.

The components of social system in the Realistic PBL Model requires an increase in the proximity of the teacher and the students in the *teacher-assisted instruction process*, the reduced role of the teacher as a knowledge transmitter, effective social interaction and the teacher as a student companion in learning. As realistic PBL model reaction component lead teachers becoming a facilitators who guide, motivate, accommodate the students' differences, monitoring the student activities in running the learning process, and assessment both the students' learning processes and outcomes. It is expected that the implementation of the Realistic PBL Model in mathematics learning have a direct impact on improvement; 1) math ability for vocational students 2) thinking skills (both low and high level) and 3) meaningful knowledge skills. The indirect impact of the Realistic PBL Model emerge is increase; 1) the student learning independency (self regulated learning), 2) ability in expressing the opinions, 3) have a goo tolerance to uncertainty and non-routine problems, and 4) scientific process skills.

The description of the Realistic PBL Model Components shows the existence of internal consistency among the components. It means: (1) the Realistic PBL model component does not have conflict with other components (2) the Realistic PBL model syntax influences the achievement of the model objective achievement (3) social principles, reaction principles, and support systems help the implementation of PBL Realistic Model syntax [18].

The assessment of the six experts shows the validity of Realistic PBL Model both in content and constructs. The results of this study are in line with the results of the validity study related with the development of learning models conducted by [26], [27], [28]. In conclusion, accoording to the six experts, the Realistic PBL model can be used to overcome learning constraints in the vocational schools. Based on the validity of the Realistic PBL Model that has been obtained, then it can be further tested for practicality through formative evaluation; one-to-one, small group evaluation and field test [30]

IV. Conclusion

From the results of the data analysis of validation results by 4 mathematic education experts, 1 educational technologist and 1 linguist obtained that Realistic PBL Model Development has valid criteria, which is reflected on the three products of the development research produced; rational book models, teacher mathematics books and student math books. It is based on an assessment of a logical theoretical rationale, a strong theoretical foundation and components in research products that are consistently interrelated and already referring to the principles of the RME approach and the PBL Model. Thus, Realistic PBL Model can be used to overcome obstacles in learning mathematics, especially in SMK.

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