ME - 13

THE DEVELOMPENT OF TECHNOLOGY APPLICATION BASED MATHEMATICS LEARNING TOOLS ON REAL NUMBERS OPERATIONS AT THE VOCATIONAL SCHOOL OF TECHNOLOGY AND ENGINEERING

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Abstract

This paper is a research report on the development of technology application based Mathematics learning tools at the study program of technology and engineering in a vocational school. The needs to improve the relevance between the results of vocational training in school and demands of public and industry are included as one of the policies of National Education year 2010-2014. The policy determined that education program in school should relevance to the needs of business and industry. That is why; Vocational School (SMK) must be able to produce graduates that have skills and competencies needed by the field of business and industry and internationally recognized standard. SMK is now demanded to play its active roles to develop link and match between school and industry.
The learning tools developed in this research project was technology application based Mathematics learning tools that include (1) Syllabus, (2) Lesson Plan, (3) Students' Textbook, (4) Students' Worksheet, and (5) Instrument of evaluation. The model used in this project was Four-D Model which included three steps as follows: (1) making definition, (2) planning, and (3) development. The result of validation study for this mathematics learning tools was 3.67 (Very Good).

Keywrods: Technology Application, Mathematics Learning Tools, Vocational School

INTRODUCTION

The needs to improve the relevance between the results of vocational training in school and demands of public and industry are included as one of the policies of National Education year 2010-2014. The policy determined that education program in school should relevance to the needs of business and industry. That is why; Vocational School (SMK) must be able to produce graduates that have skills and competencies needed by the field of business and industry and internationally recognized standard. SMK is now demanded to play its active roles to develop link and match between school and industry.

The Ministry of National Education noted that the quality of skilled workforce graduated from SMK was not yet relevance to the demands of industry. It can be seen in our daily life where SMK Graduates could not yet be able to interact with its community. This is due to the fact that our daily life is not match and integrated with learning materials in school. Learning process in school's classroom does not facilitate and apply technology that is used in our daily life. Therefore, it is as if the materials learn in school are separated from current phenomenon in community. Students could not be able to understand why knowledge could give benefits in their daily life. In addition, the lack of contextual textbooks is also another factor contributing to these conditions. The textbook do not facilitate students of SMK to connect what they learn in school and what they find in community.

Theoretical Foundation

1. Mathematics Teaching at SMK

Mathematics teaching in school refers to the three main functions of mathematics: a tool, a mindset, and knowledge. Mathematics learning process focused on the structures of the mathematics system. Abstract ideas in mathematics are developed by its topics in hierarchical ways and deductive reasoning. Therefore, mathematics concepts must be firstly understood before manipulating those topics. Mathematics learning involve the process of thinking where people are said to be thinking if they conduct mental activities; and this is what people need to do when learning mathematics.

The scope of mathematics include 1) operation of numbers, 2) equations, inequalities, and matrix, 3) trigonometry, 4) series and sequencies, 5) two dimension geometry, 6) vector, 7) statistics, and 8) calculus.

2. Technology Application based Mathematics Learning

Substantially technology has become an integral part of human life since thousand years ago. Along with the development of human civilization, technology changes all the time and it is getting complex and sophisticated. Technology is a human being creation that is developed in order to overcome problems and human limitation (Syukur, 2004). All kinds of technology are system created to fulfill specific objectives with the essence to help human being to reduce their burden, improve their productivity, and use resources efficiently.

Ranchman as quoted by Sukestiyano (2009b: 1) define the application of science in daily life or in other disciplines could give benefits in form of technology application. Learning materials of math and science are connected to the real application in daily life or to other disciplines. For examples, the materials of series and sequences are connected to the cell separation in biology or radioactive shedding; central tendency of statistics is connected to the report of classroom improvement or to the report about crime rate, etc.

Through the principles of learning to do, learning to be, and learning together, mathematics learning must rely on the thought that students must learn and it is supposed to be comprehensive and integrated. According to Zuakrdi (in Cahyono, 2009: 25), mathematics learning should direct its orientation to two Freudenthal Perspectives as follows:

1) Mathematics as human activity; students should be given opportunities to learn to do activities in all topics in math, and
2) Mathematics must be connected to reality; it should close to students' situation and condition in their daily life.

Moreover, Cahyono (2009) said that learning strategies should refer to the needs of current technology. It means that all materials should be developed in KTSP Curriculum and connected to the context and technology. The question that need to answer is "is there any benefit of the materials given to students' future?". In studying the materials of real number operation that is connected to automotive technology, students study it through the process of fuel component system, manual transmission, and other components.

3. Mathematics Application in Automotive Technology

Mathematics is part of sciences that applies symbols and topics to figure out a concept. Concept development in mathematics should not be limited to the current topics, but also connected to other relevant topics in other disciplines in integrated ways.

As one of the branches of technology, curriculum of SMK majoring in automotive technology is well-developed in order to cover basic mathematics, physics, and chemistry. Mathematics as a basic science should become to foundation for technology of automotive. Therefore, the relevance of math materials and automotive technology should become the basic of curriculum development of SMK majoring in Technology and Engineering.

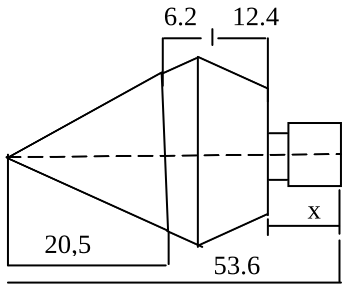
In learning automotive competencies, there are so many counting such as the one used to find out the capacity of machine, cylinder volume, compress comparison, piston acceleration, torsion or torque, correlation between machine and acceleration of the motorcycle in every transmission position, force power of rear tire, and etc. Therefore, in general, mathematics could form students' honesty if they are directed in right ways.

In order to support the success of automotive technology, math learning should be coordinated with automotive learning. It is very important to teach mathematics materials that could become the foundation of problem analysis in automotive technology.

In math problems, this process is called as Applied Routine (R-T) as it is stated by Hudojo (2005: 69) that RT is a routine problem that has thing to do with real life situation in which its completion procedures are very basic and had been previously taught by teachers. In accordance with standard competence and basic competence of automotive and mathematics in the curriculum, the application of mathematics in automotive technology could be described in the following Table 1.

Table 1
The Application of Real Number Operations in Fuel System and Transmission of a Motorcycle

MATERIAL OF REAL NUMBER OPERATIONS	STANDARD OF COMPETENCE	BASIC COMPETENCE	CASE SAMPLES
1. Operation on integers	Motorcycle lamp electric circuits	Current block in the series circuits	Counting total block in a circuit series consists of 3 blocks with 2 Ω, 4 Ω,6 Ω consecutively by adding all blocks as follows: R total = R1 + R2 + R3 = 2 Ω + 4 Ω +6 Ω = 12 Ω

MATERIAL OF REAL NUMBER OPERATIONS	STANDARD OF COMPETENCE	BASIC COMPETENCE	CASE SAMPLES
2. Operation of fractions	Machine components	Tire gear components	Counting the length of unknown sides on tire gear as indicated in the picture:  X = 53,6 – (20,5 + 6,2 + 12,4) = 14,5
3. Number conversions	Fuel chamber	Comparison of compression in piston chamber fuel	The brochure of Suzuki Smash provides its cylindrical capacity in 53.5 mm with piston in 48.8 mm. Then the volume is cylinder multiplied by piston Vsteps = $\frac{\pi}{D} \cdot D^2 \cdot S$ = 109744,96 m = 109,7 cm^3 = 110 cc
4. Direct proportion and converse value	Machine fuel chamber	Direct proportion in machine fuel chamber of piston	If compression proportion is stated as a comparison of cylinder volume with its compression, then the comparison of compression is correlated to volume piston. For example, the comparison of compression of touring motorcycle in 8:1 and 9:1, it means that as long as the compression move consisted in higher piston could be compressed into 8 times of the end volume.
5. Percentage	Air compression	Proportion of piston compression	Counting the power of a motorcycle with its compressor capacity is 85% of piston compression. The proportion then will be like this: 1 : 4, ambient

MATERIAL OF REAL NUMBER OPERATIONS	STANDARD OF COMPETENCE	BASIC COMPETENCE	CASE SAMPLES
			temperature in 30^0 C, mass flow rate in 3,5 kg/dt, constant number of air R = 28,29 kg.m/kg^{0}K.
6. Direct proportion and converse value	Manual transmission system	Manual transmission system of tire gear	Counting the number of tire gears if the known comparison is 12:17. Then the number of gears B (Z_B) = 85 then the number of gears A (Z_A) can be counted by using the following comparison: $Z_A : Z_B = 12 : 17$ $Z_A : 85 = 12 : 17$ $17Z_A = 12 \times 85$ $= \frac{12{,}85}{17}$ $= 60$

This table is based on standard of competency and basic competence

RESEARCH METHOD

The development model used in this project was a modified model of Thiagarajan (in Trianto, 2007: 65) which consists of three steps as follows: 1) making definition, 2) planning, and 3) development.

In order to analyze the data gathered from *validator*, average analysis used in this steps was intended to count average number of every aspects in every tools. Learning tools were classified as good if they fell into the category of Fair, Good, and Very Good.

The results of validation evaluation from experts for each tool were analyzed based on averaged scores. Average scores of aspects were determined based on average scores of each evaluation aspects. The following table describes average scores of validity of the tools.

Table 2
Scores Criterion Determining the Validity Level of the Tools

Interval	Criterions
$1{,}00 \leq Va < 2{,}00$	Not Valid
$2{,}00 \leq Va < 3{,}00$	Less Valid
$3{,}00 \leq Va < 4{,}00$	Fairly Valid
$4{,}00 \leq Va < 5{,}00$	Valid
$Va = 5{,}00$	Very Valid

The criteria of learning tools can be classified as good validity level if the minimum validity could be reached. If the validity could not reach the minimum validity level, then a revision was conducted by inserting corrections and comments from experts so the ideal learning tools could be reaches both for its construct and contents.

In order to test the validity of learning results test instruments, the test items were tried-out in classroom. Then, its validity, reliability, differentiate standard, and difficulty index were calculated.

RESULT AND DISCUSSION

1. The description of the results in Development/Construction Step

From the results of validation of every tool of learning, it could be found average scores of validation in 3.67. The description of validation of the preliminary draft the technology-based learning tools are shown in the following table 3.

Table 3
Evaluation Results of Validity of the Preliminary Draft of the Learning Tools

NO	ASPECTS	SCORE FROM VALIDATOR					AVERAGE	CATEGORIES OF VALIDATION RESULTS
		I	II	III	IV	V		
1	Syllabus	3,80	3,40	3,75	3,60	3,90	3,69	Very Good
2	Lesson Plan	3,80	3,40	3,40	3,60	3,75	3,59	Very Good
3	Students' Textbook	3,90	3,50	3,90	3,65	3,90	3,77	Very Good
4	Students' worksheet (LKS)	3,86	3,71	3,29	3,43	3,29	3,51	Very Good

The results of tryout of the learning results evaluation instrument are shown in the folliwing table 4.

Table 4
The Tryout Results of the Instrument for Evaluating Learning Results

Items	Validiy		Level of difficulty		Differentiate standard		Reliability	
	Item validity scores (r_{xy})	Criteria of item validity	Level of Difficulty	Classification of level of difficulty	Scores of differentiate standard (D)	Classification of differentiate standard	Reliability scores	Classification
1	0,73	High	0,81	Easy	0,27	Fair	0,84	Very High
2	0,86	Very High	0,81	Easy	0,30	Fair		
3	0,88	Very High	0,70	Moderate	0,35	Fair		
4	0,89	Very High	0,75	Easy	0,30	Fair		

5	0,87	Very High	0,40	Moderate	0,24	Fair		
6	0,88	Very High	0,51	Moderate	0,59	Good		
7	0,86	Very High	0,70	Moderate	0,42	Good		
8	0,67	High	0,50	Moderate	0,55	Good		
9	0,84	High	0,61	Moderate	0,75	Very Good		
10	0,68	High	0,74	Easy	0,45	Good		

2. Discussion on Tools Development Results

Technology based mathematics learning tools are tools that was created through the development process and been able to fulfill the minimum validity of construct that was previously determined by experts. It was not only the validity of the end product, but also the creation process that gone through development procedures. The tools used in this project had been previously developed through research and development and validated by experts and gone through many revisions.

CONCLUSION AND SUGGESTION

The followings are some conclusions and suggestion this research could offer:

1. This research and development project using modified Four-D model had successfully produced a prototype of learning tools for teaching technology based mathematics in real number operation in Grade X of Vocational School majoring in Technology and Engineering. The developed mathematics learning tools is a technology based mathematics learning tools in which its design consists of real-life problems in real number operation. Through the validation process of experts and peer review, it can be produced a valid technology-based mathematics learning tools for real number operations in Grade X of Vocational School majoring in Technology and Engineering.
2. The followings are the suggestions of this research: a) teachers need to focus on studying of more specific technology application, and b) teachers need to be able to develop problems that can lead students to develop their mathematics application skills and apply it in real-life situation.

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