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Luther's Model Implementation on Multimedia Development for Building Construction Subject in Vocational High School (SMK)

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***Abstract*—The use of computers in education is the first step towards realizing a technological society. Educational institutions need to optimize the potentials of information and communication technology. Integration of technological aspects into the learning is an effort to grow and to bring up interest & positive attitudes towards technical development. is one of the implementation steps of Technology Pedagogy content Knowledge (TPCK) framework. This research aims at (1) producing a multimedia for Building Construction subject on Vocational High School in the field of Building Modelling and Information Design, (2) knowing the quality of multimedia Building Construction subject in Vocational High School, in the field of Building Modelling and Information Design. This activity comprises research & development. Multimedia validation is carried out by content & media experts. Luther's model namely multimedia development Life Cycle (MDLC) is applied in the multimedia development of Building Construction subject in the field of Building Modelling and Information Design. The models are developed through 6 stages which are concept making, designing, material collecting, assembling, model testing, and model distributing. Researchers have successfully developed a multimedia in Building Construction subject on Vocational High School in field of Building Modelling and Information Design using Multimedia Development Life Cycle (MDLC) model. The results of expert validation indicate that the learning media developed is feasible to use. The next activity will be to carry out a limited trial on the students of Vocational High school in the field of Building Modelling & Information Design.**

Keywords—multimedia; building contruction; Technology Pedagogy Content Knowledge (TPCK); Higher Order Thinking Skills (HOTS)

I. INTRODUCTION

A. Technology Pedagogy Content Knowledge (TPCK)

Curriculum in 2013 requires the learning process to be held interactively, imperatively, fun, challenging, motivating students to actively participate, and provide sufficient space for initiative, creativity, and independence in accordance with the talents, interests, and physical and psychological development of students.

For this reason, each education unit conducts learning planning, implementing the learning process and evaluating the learning process to improve the efficiency and effectiveness of the achievement of graduate competencies.

The use of computers in education is the first step towards realizing a technology society. Educational institutions need to utilize the potential of information and communication technology (ICT) optimally. With the rapid development in the fields of telecommunications technology, multimedia, and information, listening to lectures, recording on paper is certainly outdated. The incorporation of aspects of technology in learning is one of the efforts to foster and foster interest and a positive attitude towards technological development.

An integrated understanding of ICT is the most important than just understanding ICT as a learning aid. The growth paradigm is that technology can support inquiry learning, collaboration and repositioning in carrying out the learning process [1]. There are various models of ICT integration framework in learning, one of them is the framework of Technology Pedagogy Content Knowledge (TPCK).

The development of the framework according to Mishra and Kohler is based on three important knowledge components that must be possessed as educators namely mastering the material in the field of study in accordance with the qualifications and competencies contained in the curriculum, pedagogy, and technology [2].

The concept of integration in TPCK is the involvement of various material and pedagogical components that can support teachers in implementing technology-based learning. Sutrisno states that in TPCK, ICTs will interact with pedagogy and can improve higher order thinking skills (HOTS) [1]. Based on this exposure it is very important to formulate the TPCK framework through comprehensive research activities in vocational schools in an effort to increase the concept of high-level thinking and thinking.

B. Higher Order Thinking Skills (HOTS) issues

Learning at Vocational High School (SMK) that occurs at this time is teacher-centered learning, using the lecture and assignment methods. To further enhance the learning process and the level of students' understanding of subject matter and the development of higher order thinking skills (HOTS), learning innovation is needed.

Variety of learning experiences according to Peter Shen (Ministry of National Education, 2004) reveals that verbal learning or speaking with words (lectures) is a low learning experience. To improve the experience of students, teachers need to enter information into learning using certain learning media, which is learning about nothing.

Technology began to be applied in education because of the view that science was believed to improve the quality of human life. Munir suggested that the development of ICT in education required a comprehensive strategy. In the current ICT era the learning paradigm has shifted from traditional learning to technology-based learning [3].

Integrating technology in learning is a challenge for teachers. Productive integration model if the instructor can connect and compile optimally from the three main components namely subject matter, pedagogy and technology. For this reason, the technology component should be able to be used proportionally and effectively to construct, improve the ability to think and solve problems so that students will be more active in the learning process. One model of integration is the framework of Technology Pedagogy Content Knowledge (TPCK) [1].

The learning process can work well if students are invited to take advantage of all the sensory tools. The more sense devices used to receive and process information, the more likely the information is understood and understood and can be maintained in memory. Direct experience will give the most complete and meaningful impression of information and ideas contained in that experience, therefore it involves vision, hearing, feeling, smell, and touch. This is known as learning by doing or learning to do [4].

The demand for ICT-based learning is the ability of higher order thinking skills (HOTS). HOTS include critical, logical, reflective, metacognitive and creative thinking. ICT in learning can be used as a tool to engage students in thinking. Hapson, M.H. et.al states that the use of ICT is closely related to the components of analysis, synthesis and evaluation in Bloom's taxonomy [1].

II. METHOD

A. Research and Development

The research method used in this study is Research and Development. Sukmadinata argues that research and development is a process or steps to develop a new product or refine an existing product, which can be accounted for [5]. The product in this study is referred to a learning tool for Vocational Secondary Schools (SMK) based on the Technology Pedagogy and Content Knowledge (TPCK) framework. Specifically, teaching materials (modules), student worksheets (LKS), ICT-based learning media will be produced.

The development procedure will be implemented adopting the stages developed by Thiagarajan known as the Four-D Model, namely define, design, developed, and disseminate or in Indonesian it translates to 4P-model which is defining, designing, developing, and disseminating [6]. This research activity is carried out in 2 (two) years as shown below:

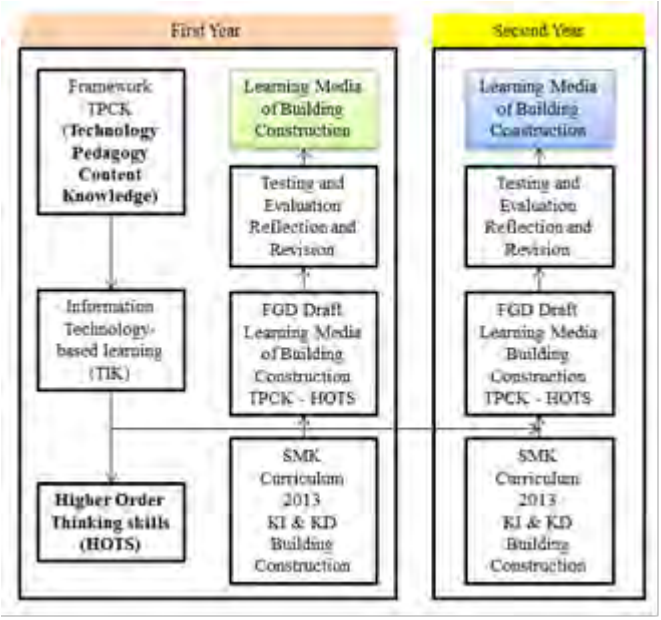

Fig. 1. Stages and activities of research implementation.

B. Research Steps

A comprehensive description of all product development activities for the first year listed in Table below:

TABLE I. OVERVIEW OF THE RESEARCH PROCESS

Steps	Types of Methods	Research Steps	Output
Defi-ne	Descrip-tive	Analysis of learning problems in Building Construction in Vocational High Schools (SMK)	Analysis of learning problems in Building Construction in Vocational High Schools (SMK)
De-sign	Develop-ment study	Draft the Building Construction Learning Tools based on the TPCK framework	Building Construction Learning Tool draft framework based TPCK
	Evalua-tive	Evaluation of draft Building Construction Learning Tools based on the TPCK framework by Experts through FGD	Description of the results of the evaluation of the draft Building Construction Learning Tools based on the TPCK framework by Experts.
	Develop-ment study	Draft revision of Building Construction Learning Tools based on the TPCK framework	Building Construction Learning Tools based on the TPCK framework of trial materials

Table 1. cont.

De-velop	Experi-ment	Trial of Building Construction Learning Tools based on the TPCK framework	Description of implementation, advantages and disadvantages of Building Construction Learning tools based on the TPCK framework
	Evalua-tive	The Application Effectiveness Analysis of the Building Construction Learning Devices based on the TPCK framework in enhancing mastery of concepts and HOTS	Description of understanding the concept of Building Construction and Higher Order Thinking Skills of Vocational students
	Developm ent study	Improvement / Revision of Building Construction Learning Devices based on the TPCK framework based on the results of trials	Building Construction Learning Tools based on the TPCK framework
Disse mi-nate	descriptive	Disseminating research results through scientific publications in journals or seminars	Research results are widely published

III. Result and Discussion

A. Basic Construction Competencies

The curriculum objectives cover four aspects of competence, namely (1) aspects of the competence of spiritual attitudes, (2) social attitudes, (3) knowledge, and (4) skills. These competency aspects are achieved through curricular, co-curricular and extracurricular learning processes. Core Competencies in Modelling Design and Information Design Competence Competencies (DPIB) are listed in Table 2.

TABLE II. Core Competencies of KK DPIB

Core Competence 3 (Knowledge)	Core Competencies 4 (Skills)
Understand, implement, analyze, and evaluate about factual knowledge, conceptual, basic operational, and metacognitive according to Field and scope of Simulation and Digital, and Basic Communication Technology and Engineering at the technical, specific level detail, and complex, regarding with science, technology, art, culture, and humanities in context self-potential development as part of the family, school, world of work, citizens national, regional, and international.	Carry out specific tasks using tools, information, and work procedures that are commonly carried out and solve problems accordingly with the scope of Digital Simulation and Communication, and the Base of Technology and Engineering.
	Showing performance under guidance with quality and quantity measured in accordance with work competency standards.

Table 2. cont.

	Demonstrate the skills of reasoning, processing, and presenting effectively, creatively, productively, critical, independent, collaborative, communicative, and solutive in the abstract realm related to the development of what he learned at school, and able to carry out specific tasks under supervision directly.
	Demonstrate the skills of perception, readiness, imitation, accustomed, advanced motion, making natural movements in the concrete domain related to development of what he learned at school, and being able to carry out specific tasks under direct supervision.

Source: PSMK, 2017

Basic Competencies of Basic Lessons for Construction Design Modelling and Building Information Competence Skills (DPIB) are listed in Table 3.

TABLE III. Basic Competencies of Basic Construction Lessons

Basic competencies 3 (Knowledge)		Basic competencies 4 (Skill)	
3.1	Applying Occupational Safety and Health and Environment (K3LH) to building Construction	4.1	Practice the K3LH on building work
3.2	Understanding the types of building construction (buildings, roads, bridge, and irrigation)	4.2	Presenting types of construction / buildings (buildings, roads, bridge, and irrigation)
3.3	Understanding the specifications and characteristics of wood	4.3	Presenting the specifications And wood characteristics.
3.4	Understanding the specifications and characteristics of concrete.	4.4	Presenting the specifications and concrete characteristics.
3.5	Understanding the specifications and characteristics of steel.	4.5	Presenting the specifications and characteristics of steel.
3.6	Implementing the procedures concrete construction work	4.6	Practice the concrete construction work
3.7	Implementing the procedures steel construction work	4.7	Practice the steel construction work
3.8	Implementing the procedures wood construction work	4.8	Practice the wood construction work
3.9	Implementing the procedures land construction work	4.9	Practice the land construction work
3.10	Implementing the procedures stone construction work	4.10	Practice the construction work
3.11	Understanding the types of tools heavy on work construction	4.11	Present types of heavy equipment in construction work
3.12	Analyzing the usage material and tools for construction work	4.12	Plan the use of materials and tools for construction work
3.13	Evaluating the Construction work	4.13	Make improvements to the results of construction work

Source: PSMK, 2017

B. Roof Construction Teaching Materials

In this study the roof construction teaching material developed was the Structure and Construction of Wooden Horse Roofs. A summary of the teaching materials is described in the following Figure:

Fig. 2. Roof construction teaching materials.

C. Results of Assessment of Teaching Materials

The assessment of the quality of teaching materials developed involves 3 experts selected from the lecturers of the Department of Architecture Engineering of the Indonesian Education University FPTK. The selected assessors through a careful consideration process according to the following aspects: a) the appropriateness of the educational experience, b) the suitability of educational background, c) the quantity of work experience, and d) the quality of mastery of the material.

Assessment of the quality of teaching materials includes aspects of the feasibility of the content and feasibility of the system and language referring to the eligibility criteria of teaching materials developed by the National Education Standards Institution [7]. Aspect feasibility of content includes four indicators: a) suitability of material with KD b) accuracy of material, c) up-to-date material, and d) encouraging curiosity of students. While the feasibility aspects of the system and language are composed of three indicators: a) the effectiveness and ease of the system used, b) the appropriateness and accuracy of the language used, and c) aesthetics and appearance. To clarify the assessment indicators, it will be shown in Table 4 & Table 5:

TABLE IV. INDICATOR OF ASSESSMENT OF TEACHING MATERIALS ASPECTS OF FEASIBILITY CONTENT

Assessment Indicator	Assessment Item
Suitability of material with KD, learning fitness, and High Order Thinking Skills	Suitability of material with KI / KD
	Suitability of the material scope with KI / KD
	Suitability of the material with the learning stages
	The ability of teaching materials in training High Order Thinking Skills
Accuracy of material	Accuracy of concepts and definitions
	Accuracy of data and facts
	Accuracy of examples and cases
	Accuracy of drawings, diagrams and illustrations
	Video accuracy
	Accuracy of animation and simulation
	The accuracy of the terms used
	Accuracy of notations, symbols and icons
Material updates	Material suitability with the development of construction science
	Suitability of images, diagrams and illustrations used
	Using case examples in the field
Encourage curiosity	Encourage student curiosity
	Motivate learning for students

TABLE V. INSTRUMENT FOR ASSESSMENT OF TEACHING MATERIALS SYSTEM AND LANGUAGE ASPECTS

Assessment Indicator	Assessment Item
Ease of the system used	Ease of using learning media
	Does not require high computer specifications
	Easy to install on various existing computer devices
Feasibility and accuracy of the language used	The suitability of the language used with the user's age level
	Accuracy of language in giving instructions to users
	Does not contain negative elements

Table 5. cont.

Aesthetics and appearance	Accuracy in the selection of background colors in the display design
	Accuracy in the selection of type, size and color of letters
	Readability of writing
	Image clarity

Assessment of the quality of feasibility aspects of teaching materials using numbers, namely 4 for SB (Very Good), 3 for B (Good), 2 for K (less), and 1 for SK (Very Less) so that the maximum value that can be achieved is 4 x the amount question. The recapitulation of the results of the assessment of teaching materials by lecturers on the feasibility aspects of the content is shown in Table 6 and the media and language aspects are shown in Table 7.

TABLE VI. RECAPITULATION OF ASSESSMENT OF TEACHING MATERIALS BY EXPERT LECTURERS ON THE ASPECT OF FEASIBILITY OF CONTENTS

No	Evaluator	Assessment Score				Total	Percentage
		1	*2*	*3*	*4*		
1	Expert Lecturer 1	0	0	14	3	54	79,41
2	Expert Lecturer 2	0	0	13	4	55	80,88
3	Expert Lecturer 3	0	0	10	7	58	85,29
Average							81,85
category							Very good

TABLE VII. RECAPITULATION OF ASSESSMENT OF TEACHING MATERIALS BY EXPERT LECTURERS ON SYSTEM AND LANGUAGE ASPECTS

No	Evaluator	Assessment Score				Total	Percentage
		1	*2*	*3*	*4*		
1	Expert Lecturer 1	0	0	7	3	33	82.50
2	Expert Lecturer 2	0	0	3	7	37	92.50
3	Expert Lecturer 3	0	0	3	7	37	92.50
Average							89,17
category							Very good

The result assessment of the quality of teaching materials develop a teaching material of Building Roof Construction that fulfils the requirements of feasibility aspect and applied in the teaching process for vocational students. This process aims to optimize the potentials of information and communication technology and implementation steps of Technology Pedagogy content Knowledge (TPCK) framework.

IV. CONCLUSION

Luther's model namely multimedia development Life Cycle (MDLC) is applied in the multimedia development of Building Construction subject in the field of Building Modelling and Information Design. The models are developed through 6 stages which are concept making, designing, material collecting, assembling, model testing, and model distributing.

Researchers have successfully developed a multimedia in Building Construction subject on Vocational High School in field of Building Modelling and Information Design using Multimedia Development Life Cycle (MDLC) model. The results of expert validation indicate that the learning media developed is feasible to use. The next activity will be to carry out a limited trial on the students of Vocational High school in the field of Building Modelling & Information Design.

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