THE DEVELOPMENT OF E-MODULE OF DESCRIBING STEEL BUILDING MATERIAL SUBJECTS BASED ON CRITICAL THINKING FOR VOCATIONAL HIGH SCHOOL STUDENTS

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Abstract

This study is development research containing two important phases, i.e. preliminary study stage (preparation / analysis and design) and the formative stage of the study (evaluation and revision). This study produced the instructional material in the form of module that is made by using computer-assisted. The material aims to describe basic competence of steel building material based on critical thinking. The subjects were tenth-grade of building engineering students, year 2012/2013. Data collecting methods are walkthrough, observation, questionnaire, and assesment test. The qualitative analysis of students' learning activities found that this study has produced valid and practical e-module and it has a potential effect. A valid product is reflected in terms of content and construction. The practicality of the product is known when the e-module can applied easily in learning activities. The potential effect of the product is known if the e-module has a potential effect for students' critical thinking skills based on learning. Students can use the e-module, which is developed based on the critical thinking skills approach in this study, as an alternative instructional matter for basic competence of describing steel building material. It can be used by teachers to teach the topic of describing steel building material as broadcast media.

Keywords: development research, computer-assisted module, steel building material, critical thinking

1. INTRODUCTION

The discussion about the subjects matter of vocational study of understanding building materials has been carried out. It measures students' knowledge and understanding to the scientific foundation in addition to analyze, reasoning power and problem resolution (BSNP, 2012). There is no single definition of the concept of understanding building materials. According to Jakarta School of Indonesia Website, understanding building materials is an effort that underlies the development and planning activities of the construction.

The research literature indicates that students have difficulty in understandingdescribingsteelbuilding material basiccompetence. Thematerials in theevailable module isrelativelylittle and lesstosupportstudents' understanding. Forexample, manystudents are verycurioustoknowaboutthesteelprofiles and theutilization of steelbuildingmaterials in buildingconstruction, alsotheexercise and thetaskweren'tavailable in the module. Furthermore, theywillnevergetthe real picture of

steelbuildingmaterials and theywilllackunderstandingabouthowthe concept of steelbuildingmaterialsisrepresented and used in buildingconstruction.
This study deals with a problem regarding the learning by using the e-module in vocational high school. We hypothesized that critical thinking approach in steel building materials subjects and computer assisted module could be used as a means to support students' understanding of describing steel building material subjects.

The aim of this study is to produce the instructional material in the form of module that is made by using computer-assisted with the material of describing steel building material subject which is developed based on critical thinking skills approach for being valid, practical, and having potential effects to students' critical thinking skill. The main research question is: how to develop the e-module of describing steel building material subjects based on critical thinking for being valid, practical, and having potential effects to students' critical thinking skill?

2. THEORITICAL FRAMEWORK

Learning by Using The Module in Vocational Study
Describing steel building materials is the basic subject in competency of standard understanding building materials. It's vocational learning that measure students' knowledge and understanding to the building materials.

Instructional material is one of the instruments to improve the quality of learning. They help teachers in terms of functions simplify to teach the topic of the material subjects to the students. The forms of it are printed and unprinted ones. Printed intructional material is a variety of printed material such as modules, handouts, worksheets, books, brochures, leaflets, wallchart. Unprinted one is a variety of information as instructional materials stored in various forms of audio programme, visual, audio-visual, and multimedia such as displays, models, video/film, and computer-assisted materials (Depdiknas, 2007).

The module is systematically compiled instructional materials based on specific and interesting curriculum, in order to help students to master specific instructional objectives. The objectives of learning should be clearly defined and measurable included in ABCD (Audience, Behaviour, Condition, and Degree) criteria.

Learning by using a module is partially or entirely learning based on modules. In this type of learning applied multi-media and multi-method. In learning by using the module, the teacher acts as a manager, supervisor, facilitator and driver of students' learning activities. In the meantime, students develop an understanding of their own role based on learning tasks that have been designed.

The advantages of learning modules are mastery, having purpose, having feedback, motivating, creating collaboration between teachers and students, overcoming the differences in speed of learning, providing remedial teaching opportunity.
Microsoft powerpoint presentation program can be used in classical learning with quite a lot of group. It's able to combine text, video, animation, images, graphics, and sound into one unified presentation.

There're three pattern of learning implementations by using electronic modules in vocational learning: 1) as broadcast media, 2) as supporting media practices, and 3) as an individualize and interactive instructional media (Munadi at al., 2011).

According to the explanation above, it can be concluded that even people of vocational study in the past were using the e-module in learning the vocational basic subjects to improve the quality of learning.

Critical Thinking
According to Torff (2006), critical thinking is a set of cognitive skills and strategies that increase the likelihood of the desired outcome.For Tsui (2002), critical thinking is an ability to identify issues and assumptions, recognize important relationships, make correct inferences, evaluate evidence or authority and deduce conclusions.Students often have to reproduce information and to memorise, at the moment that deeper learning, which creates critical thinkers, requires analysis of data, evaluation, testing of hypotheses, problem solving, planning and reflecting.The visual nature of many educational technologies, the simulations and the animations contribute to in depth conceptual understanding, as they facilitate the creation of cognitive representations of difficult or unfamiliar to the learners notions and concepts (Passey at al., 2004; Livingston &Condie, 2003).

The computer-based learning and teaching methods, which should permit the sensory-motor, the visual and symbolic representation of knowledge (Brunner, 1996), will be supported and reinforced.

The skills registered as a foundation for critical thinking are recognizing problems, finding ways that can be used to address these problems, collecting and collating the necessary information, recognizing assumptions and values that are not declared, understanding and using the language that is precise, clear, and distinctive, analyzing data, assessing the facts and evaluate statements, recognizing the existence of a logical relationship between the problems, determining the conclusions and the necessary similarities, examining the similarities and the conclusions that a person take, rearranging the patterns of one's beliefs based on wider experience, and making a proper assessment about things and certain qualities in everyday life (Glaser, 1941).

3. METHODS

3.1 Participants

The participants were 38 tenth-grade students of vocational school in Lubuklinggau, Indonesia. Three students participated in one to one evaluation and ten students participated in small group evaluation. Both of them were from the same class. The other 25 students participated in field test evaluation. The group of three students and ten students, and also 25 students were both from the same school, but from different classes.

3.2 Research Design

This study is development research (Van Den Akker, 1999) containing two important phases, i.e. preliminary study stage and the formative stage of the study. Preliminary stage through context and problem analysis along with the development of a conceptual framework based on literature review (Nieveen at al., 2006). A prototype is a preliminary version of the whole or a part of an intervention before full commitment is

made to construct and implement the final product. Prototypes may be used in two ways (cf. Smith, 1991). On the one hand, a prototype may be continually refined (based on formative evaluation results and reflections of developers on the prototype) and evolve towards a final deliverable. This refining approach can be referred to with the term *evolutionary* prototyping. On the other hand, developers can design *throw-away* prototypes, such as scenarios or paper-based mock-ups (Nieveen, 1999). A scenario is a narrative description of typical and critical situations that prospective users participate in. Scenarios may be used to make the tentative design specifications more concrete. This makes it easier to communicate the potentials of a system with the target group. A paper-based mock-up comprises a pile of papers representing all screens which may appear during the use of the intervention. This kind of prototype is often used in software development projects. Users may 'walkthrough' the screens to get an idea of the intentions of the software application. Paper-based prototypes focus the attention of the user more on content and overall structure than on appearance. After being evaluated, a throw-away prototype will be discarded and its evaluation results are taken into account in the next prototype. This process will continue until all uncertainties are covered and the final product or intervention can be delivered.

Then, formative stage of this study was formative evaluation in development research taken from Tessmer (1993). According to Tessmer (1993), it starts from more informal in the early stages of a project (self-evaluation, one-to-one evaluation, expert review) to small group evaluation aimed at testing the practicality and effectiveness, to a full field test (if applicable). The layers of formative evaluation by Tessmer (1993) also illustrates that many possible methods of formative evaluation can be chosen, such as: expert review and/or focus groups (important to consider 'experts in what'), self-evaluation or screening (using check list of important characteristics or design specifications), one-to-one evaluation or walkthrough (with representative of target audience), small group or micro-evaluation, field test or try-out (Nieveen, 2010).

Based on prior work Nieveen (1999, see Nieveen chapter 5 (2010)) proposes four generic criteria for high quality interventions. She explains these criteria as follows: The components of the intervention should be based on state-of-the-art knowledge (*content validity*) and all components should be consistently linked to each other (*construct validity*). If the intervention meets these requirements it is considered to be valid. Another characteristic of high-quality interventions is that end-users (for instance the teachers and learners) consider the intervention to be usable and that it is easy for them to use the materials in a way that is largely compatible with the developers' intentions. If these conditions are met, we call these interventions *practical*. A third characteristic of high quality interventions is that they result in the desired outcomes, i.e. that the intervention is *effective*.

Figure 1 shows the development steps conducted (Zulkardi, 2002).

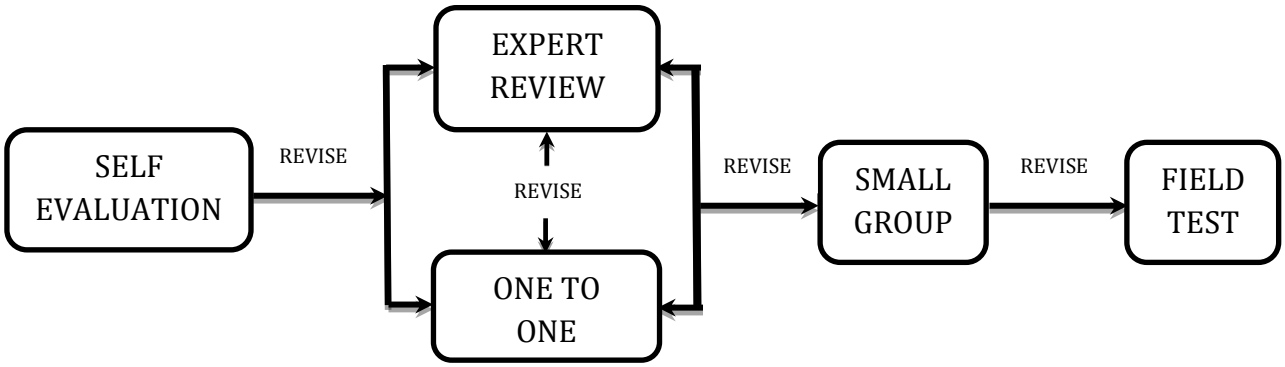


Figure 1. Flowchart of The Development Steps of E-Module

This study involved different types of methods to collect the data such as walkthrough, observations (observation sheets, videotapes and audiotapes recording), questionnaire, and assessment test. Walkthrough was conducted with three experts and three students in expert review and one to one phase. The data from walkthrough collected in validation sheets (for experts only) and in audiotapes. During the learning by using the e-module in the next phase of this study, small group of students was video-taped and the whole-classroom discussions in the field test were also video-taped. After the learning by using the e-module, we collected the observation data of learning process in order to know the potential effects of the e-module to students' critical thinking skill and results on an assessment test at the end of learning process. These data were analyzed to get the insight of the learning process of the students and to investigate to what we had reached the intended content-specific goals.

4. Result and Discussion

First, wepresenttheresult of thepreliminarystage of thisstudy. Weconducted a preparation / analysis and designinginstructionalmaterials. Forpreparation, weanalyzedsomethingrelatedtodeveloptheproductsuch as needsanalysis and students' characteristic, analyzethebuildingmaterialsreferencesthatisusedbystudentsforlearning, discussionswiththefellowteachersabouttherelatedmaterialssubject, analyzethematerials of therelatedsubject. In designing, wedesignedthepaperbased and thecomputerbasedfortheproduct.

Second, weconductedthedevelopmentsteps as follows.

4.1 SelfEvaluation

Selfevaluationisanevaluation of thedevelopers. Wewerecheckingtheproductbyourselvestoknowabout "isthereanyerrors in grammar?", typing, howthelanguageeasytounderstand, suitability in formatting and layout, thecontrast in coloring, and others as needed. Whenit has beenthroughtheselfevaluation, theproductiscalledprototype 1.

4.2 ExpertReview and OnetoOne

Expertreviewinvolvesanexpertreviewing a rough versión of the e-module orprototype 1 to determine itsstrengths and weaknesses. Theprototype 1 isevaluated in terms of intrinsicmeritssuch as contentaccuracyortechnicalquality. 3 (three) expertsreviewedtheprototype 1 togetherwiththedeveloper/designer in

facetofacesettingbyusingwalkthrough. Thereviewswerealsowritten in validationsheets. Some of themajortypesof informationobtainedfromexperts are: a) theinformationthat relate tothesubstances/materials (content): completeness, accuracy, thenecessity, thedepth of materials, and others; b) theinstructionalaboutthelearningdesign: conformitywiththecharacteristics of students, conformitybetweentheobjectives, thematerials, evaluation/test, theaccuracy of media selection, theattractivenessforstudents, and others; c) theinformationabouttheimplementation: ease of use, compatabilitywiththe actual learningenvironment, compatibilitywithenvironmentorother media, and others; d) informationabouttechnicalquality: thequality of audio, image, video, animation, lay out, color, soundeffects, and others. Some of experts' comments and suggests as follows.

Table 1. Experts' Comments and Suggests

Expert	Comment and Suggest
Content Material	severalinformationaboutprofiles and thecodes of steelbuildingmaterialsweremissing
Module Design and CriticalThinkingApproach	severalinformationneededto complete thematerials; thecriticalthinkingapproach in materialsstillless
Media	somenavigabilitybetweenslideswasmissing

Basedontheexperts' comments and suggests (table 1), wemake a fewobviousrevisionsbeforewesubmittedtheprototype 1 tostudents in onetoone.

Onetooneevaluation has done concurrentwithexpertreview. Weexplainedthepurpose of theevaluationtostudentssuch as toletthemknewthematerialswould be failiftheydidnotunderstandsomething. In onetoone, wediscussedtostudentsabouttheirreactionstoprototype 1, probedthestudents' comments, proposedthechangesoralternativestothestudents, and askedfor revisión suggestions. Samples of onetoonequestions are 'didyoufeelchalleged? didyoufeelbored? ifyoucouldchangeonething, whatwouldit be? do theexamples relate toyourownexperiences? whatdoestheschemetellyou? wouldlearningthishelpyou do yourjobbetter? whatwas new thatyoulearned? can youeasilyseethescreen? couldyouhereeverything?, etc. Basedonstudents' comments and suggests, prototype 1 wasrevised. Then, itiscalled as prototype 2.

4.3 Small Group

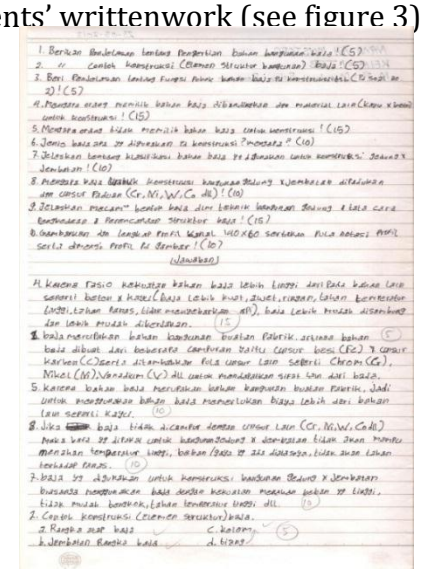
Small groupevaluationsfocusonstudent performance data toconfirmpreviousrevisions and generate new ones. Prototype 2 isadministered in anenvironment similar tothat in whichitwill be used in the 'real world' and in a realisticmanner. Thedeveloperwaspresent as anobservertogatherevaluation data. Thedevelopernotedhowtheprototype 2 wasusedbystudents. Studentsdidthepretests and posttests as part of theevaluation. Thestudentsusedtheprototype 2 withouttoomuchevaluatorinterference, to determine its actual implementability. Figure 2 wasstudents' activities in smallgroup.

Figure 2. Students' activities

Samples of smallgroupquestions are 'do youwantto use it? do youfindthe e-module interesting? doesthe e-module makeyouwanttolearn more aboutsteelbuildingmaterials? whatelements are boring?, etc'. Afterwegatheredtheinformationaboutthe performance and ease of administrationinstead of error debugging and intrinsicqualities, thenwereviewedthe data and makedrevisions. Prototype 2 isevaluatedbystudents in smallgroup in orderto determine thepracticality of thedevelopedproduct. Thenbasedonstudents' opinions in smallgroup, prototype 2 revised so producedprototype 3.

4.4 **Field Test**

Prototype 3 used in thefield test to determine thepotentialeffects of theproduct. Field test indicatethefit and acceptance of theproduct in itsintendedenvironments. In field test, weobservedhowtheproductisused and askedaboutpotentialproblems in itssustained use. Toidentify performance errors, weusedassesment test as one of students' writtenwork (see figure 3).



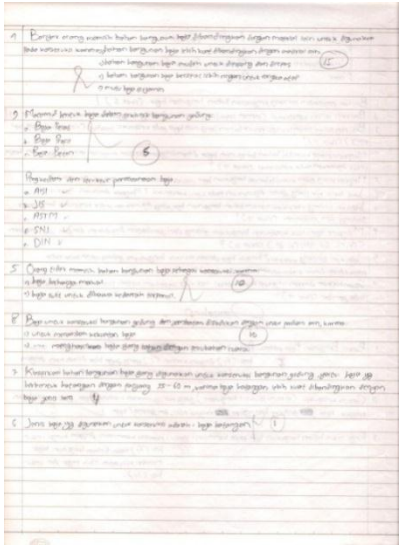


Figure 3. Students' written work

Students gave the solution for their test after they used the prototype 3 in learning. We got something different about students' written work after they used prototype 3 in learning. They gave the solution for their test by themselves.

5. Conclusion and Limitation

From the development steps, we analyzed and discussed that the instructional material in the form of e-module developed in this study could be categorized valid, practical, and has a potential effect. Valid revealed in the revised based on the results of the validation by several experts in terms of content and construct. Practical appeared on the observation of the learning activity followed by small group of students, during the learning takes place when students are using the e-module is known that the achievement of a state in which the students are easy to operate e-module and materials also can be understood as well as the tasks / questions can be done well by all students. Then, the field test learning process in this study produced the potential effect of e-module to students' critical thinking skills. At the end of the learning phase of the field test, the results are 84% of the students belong to the students with a good understanding, and 4 students (16%) belong to the students due to the lack of understanding because of they didn't follow an optimal learning. The mean results obtained student learning by using this instructional material is equal to 6.66 and the mean effect of the use of instructional material in learning of understanding building material is at 3.88 (quite well category), learners impression at this phase that the describing steel building materials e-module based on critical thinking is good enough to use in learning.

Although this study was conducted in only one classroom, the instructional materials of this limited study can be used by the students as an alternative instructional matters on learning ones of describing steel building material basic competence in tenth-grade of drawing building engineering skill competence; The instructional idea in learning activities that train critical thinking skills can be applied in other learning. Other researchers or teachers can use the instructional material as broadcast media to teach the topic of steel building materials and it's important to use a variety of methods to develop students' critical thinking skills in order to achieve an understanding of the material presented and more research needs to be done on the implementation of the e-learning modules using materials of describing steel building materials based on critical thinking in different schools; it's hope that for further researchers can develop more the use of other indicators of critical thinking to make the materials are easy to learn; the instructional material can be used more easily with a computer and other media in accordance with the availability of learning facilities in the future.

REFERENCES

Brunner, J. (1996). The culture of education. Cambridge, MA: Harvard University Press.

BSNP. (2012). Guidelines for the Implementation of a national exam for skill competency of vocational school 2011/2012. Jakarta: Ministry of Education and Culture.

Depdiknas. (2007). Socialization and training KTSP of vocational school. Jakarta: Depdiknas.

Fletcher, S. (1991). Designing competence-based training. London: Kogan Page.

Glaser, E. (1941). An experiment in the development of critical thinking. *Advance School of Education at Teacher's College.* Columbia University.

Livingstone, K., &Condie, R. (2003). Evaluation of SCHOLAR Programme Final Report for The Scottish Executive Education Departement. Edinburg: Scottish Executive.

Munadi, S., Sunarto, S., &Wagiran. (2011). The development of the constructivist contextual module by computer-aided design in machining subject at *staff.uny.ac.id/.../...*pdf

Passey, D., Rogers, C., Machell, J. &Mchugh, G. (2004). The motivational effect of ICT on pupils. England: DfES/University of Lancaster.

Tessmer. (1993). Planning and conducting formative evaluation: Improving the quality of education and training. London: Kogan Page.

Torff, B. (2006). Expert teachers' beliefs about use of critical thinking activities with high and low-advantage learners. *Teacher Education Quarterly,* 33(2), 37-52. (Online) Available: http://www.teqjournal.org/backvols/2006/33_2/11torff.pdf (October 09, 2009)

Tsui, L., (2002). Fostering critical thinking through effective pedagogy: Evidence from four institutional case studies. *The Journal of Education*, 73(6), 740-763.

doi: 10.1353/jhe.2002.0056, http://dx.doi.org/10.1353/jhe.2002.0056

Van den Akker, J., Branch, R., Gustafson, K., Nieveen, N., &Plomp, Tj. (Eds). (1999). Design approaches and tools in education and training. Dordrecht/Boston/London: Kluwer Academic Publishers.

Van den Akker, J., Gravemeijer, K., McKenney, S., &Nieveen, N. (Eds.). (2006). Educational Design Research. London: Routledge.

Van den Akker, J., Bannan, B., Kelly, A E., Nieveen, N., Plomp, Tj. (Eds). (2010). An introduction to educational design research. *Proceedings of the seminar conducted at the east China Normal University, Shanghai (PR China), November 26-27, 2007.* Enschede. www.slo.nl/organisatie/international/publications.

Zulkardi, Z. (2002). Developing a Learning Environment on Realistic Mathematics Education for Indonesian Students Teachers. Enschede: Doctoral Dissertation, University of Twente.