
Innovation in Teaching and Learning of Surveying and Mapping Course Based on Information and Technology (IT)

Sukatiman^a, Ida Nugroho^a

Sebelas Maret University, Jl. Ir. Sutami, Surakarta Central Java, Indonesia

Corresponding e-mail : sukatiman@fkip.uns.ac.id

Abstract: Learning based on Information and Technology in Surveying and Mapping (SM) course is urgently application on vocational education in Indonesian in order to graduate can compete to global markets especially deal with ASEAN Economic Community (AEC) 2015. This paper used action research method with 60 samples students in class SM, while data collected was qualitative descriptive to understand student's achievement. To ensure that teaching aids based on IT whether has strong impacted during learning practice, the students gift feedback it was conducted by questionnaires. Learning strategy was performed in three phased, 1) learning preparation in teaching aids (used of module, TS teodholite equipment, and GPS handheld apparatus) , 2) learning practice conducted by Problem Based Learning (PBL), and 3) evaluation used authentic assessment. The result of the research were 1) 97% students passed and just 3% still needs treatment, 2) the statistic computation use double linear regression showed 3 indicators about normal distribution, correlation, and significantly, and its can be conclusion that teaching aids based on IT has strong impacted to student achievement in learning practice SM course.

Key words: Teaching aids preparation, PBL method, and authentic assessment

1. INTRODUCTION

Indonesia has applied a new curriculum in compulsory education (elementary, secondary and high schools), responsible to the ministry elementary and middle education. The new curriculum namely 2013 curriculum is altering of single level educational curriculum has been utilized for 7 years. The new curriculum uses personality approach by adjusting holistic and humanistic teaching as well as learning to strength of personal characters. The implementation of 2013 school curriculum is not only to answer industrial and business needs workforce, but also to answer international competition especially in facing ASEAN Economic Community (AEC) 2015 that followed by 10 ASEAN countries. ASEAN Economic Community 2015 is general agreement in south Asia community have purposed to make single market and production base comprise five core elements: (i) free flow of goods; (ii) free flow of service; (iii) free flow of investment; (iv) free flow of capital; and (v) free flow of skilled labors. (ASEAN economic community blueprint, 2008).

In facing AEC 2015, the implementation of 2013 curriculum based on middle period Indonesia development 2014 in education sector

that concern about learning methods and curriculum arranges. 2013 Curriculum refers to the President Instruction no.11/ 2010 about acceleration of national development emphasized curriculum update and active learning relies on national civilization to build competitiveness of national character building. UNESCO (2001) recommended toward the local authorities to develop and to expand technical and vocational education by giving high priority, and sufficient financial, evaluating short and long term, and establishing national board responsible for coordinating. Shifting the emphasis to develop capabilities there for assumed to improve the link between education and the labor market (Mulder, 2004). Corresponding by application of Indonesia 2013 new curriculum based on scientific approach (observation, question, process, communication, conclusion, and creativity), teaching and learning will be appropriate using of exploratory or discovery learning.

Higher education as the one element of education board in Indonesia should support in making government programmed success. It mean that application of 2013 schools curriculum should inspire the campuses to make adapt and to application in learning process. If

higher education is to maintain a balance between theory and practice, the professional skills, contemporary experiences, and "real-world" focus on part-time academic staff needs to be identified and subsequently applied in concert with the ability to effectively teach (Watters & Weeks, 1999). Brown (2000) found that these industry-based teachers have the technical skills required in the workplace of their particular discipline, but many lack in the instructional background and teacher experience that enable them to manage the classroom and inspire learning. (Cross & Angelo, 1989) "The quality of education depends largely on what happens when teachers meet students in the classroom". H.S. Barrows, 1982 stated that "A learning method based on the principle of using problems as a starting point for the acquisition and integration of new knowledge."

The Indonesia campuses which have vocational program study as a provider of vocational teachers, should be responsible for producing good teachers who can work appropriate with education fields. To reach this aim, ICT will be the key success in process learning. Van Damme (2001); Tearle (2003) stated, associated with requirement of updated learning is needed to develop an ICT culture, which is an important part of the process in integrating ICT into a school's learning and teaching programmed. The opportunities to develop these (ICT) skills in schools are often restricted by the lack of good ICT provision. (Ofsted 2002, 4). ICT makes a significant contribution in teaching and learning across all subjects and ages, inside and outside the curriculum. (DfES 2003, 7)

The range of courses offered by colleges and universities and employer expectations of graduates has also changed with higher education being asked to produce a more flexible and higher qualified workforce to respond to changes in society (Watters & Weeks, 1999). Sukatiman (2014), in application cooperative model based on teaching aids in practical Surveying and Mapping found that students achievement raised from 73.3% to 100% passed in second cycles.

1.1. Application 2013 Curriculum on Vocational Education

Some reasons implementing 2013 curriculum according to Sholeh Hidayat (2013) were: a) learning process change from teacher give information to the students have to find out (student to tell to student to know) , b) trend in many countries add of learning duration. Learning method showed above have been application in vocational education such as, Polytechnics, vocational schools, and vocational teacher and educations, Even though not specifically yet, so that to perform of 2013 curriculum just a few of adjusted to adapt. An important reason, the popularity of competence concept is the expectation held by many stake holders in the vocational Education and Training (VET) field that the gap between the labor market and education can (and will) be reduced through competence-based education.

A professional lecture is not only transferring and memorizing science, but also dare to do and to bring up innovation, the creativity and to perform alternative solution. The essence of learning is involvement all aspect of human personality such as mind, emotion, and gesture in learning activity to support success of teaching and learning and to get impact of the activity. Progress learning is important to keep the graduates in facing the competitiveness in workplace. Mulyasa (2002) showed that besides have creative atmosphere, teacher should uses academic approach as, a) self-esteem approach, b) creative approach, c) value clarification and moral development approach, d) multiple talent approach, f) pictorial riddle approach, g) synectic approach.

1.2. Goal Problem Based Learning (PBL)

PBL method is learning process by emphasize the student with real problems, Tan (2003). Further, PBL is progressive active learning and approaching of learning focus on unstructured problem that using as initial point in learning process. PBL in education is more about the ability to be flexible in the use of one knowledge base (Chung and Chow, 2004). Breton (1999) found that students were also able

to relate theory to practice and develop greater ability to remember and reuse what they had learnt.

PBL methods are curriculum and process. In its curriculum are planned problems which require students to get interesting knowledge, they will conjure in solving the problems, and have strategy themselves also they will participated in their team. (Barrows, H.W and Kelson, 1993).

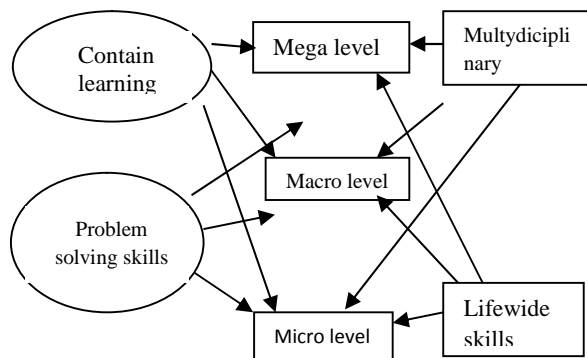


Figure 1: Infusing PBL approaches into the curriculum (Source: Tan, O.S (2003) Problem based Learning innovation: using problem to power learning in the 21st century. Singapore: Thomson Learning)

Figure 1 above showed that PBL can be implemented in various levels, if you have position to influence the major changes in your institution, such as course curriculum, assessment and design of entire learning environment, then you are in mega level. But it is not easy to challenge, because need great deal of planning, expertise and good resources to be success. Macro level is difficult to implement in the traditional curricula, caused by restricted resource. Commonly, through the certain course and it modules adopt a PBL approaches. The inflexibility curriculum is the lack that will limit the ways in implementing of PBL. The lecture will begin in this micro level by using PBL in project work or in certain subject. Overly use PBL is not good, because will spend many time. It takes few course or module which have generic problem solving, collaborative learning and communication are emphasized through PBL approaches.

Problem based learning is learning method by facing students with real problems (Glazer, 2001). Master key of PBL learning is offering of floating problem, and the student is required to discover the answer.

Howard Barrows and Kelson (2003) stated that problem based learning is curriculum and learning process. In it curriculum was planned the problems that required for the student to get important science, makes them mastering to solve the problem, and having the learning strategic to themselves and participate in team. PBL process uses systematic approaches to solve the problems or to face the live challenge were need in daily live. PBL methods have characteristics, that are : 1) learning process starts by having unstructured problems in relation with real problems; 2) the problems changed correspond with aim of learning; 3) the students solve the problems with authentic observation; 4) by collaborative learning they work together to seek the solutions; 5) lecture has function as a tutor and a facilitator; 6) the student responsible to get new knowledge not only from the lecture but also should increase of the science entire learning source; 7) the student presentation of finding product learning in front of class.

1.3. Survey and Mapping Course

Survey and Mapping course has aimed to the student can map site plan in construction works and civil works such as high risk construction, railroad, highway, and river. In this learning, the students mastering basic competences are:

- 1) To define of control point on site either closed polygon or opened polygon system.
- 2) To make existing of landscape and roadways maps, railroads, and channels.
- 3) To draw contour area to plan cut and fill
- 4) To actualize existing drawing on the map product that fulfill in construction plan.

1.4. Teaching aids.

Ogwa (2002), instructional aid mean all the materials or teaching aids or material resources which the factor utilities for the purpose of making teaching and learning more effective and meaningful to the student.

Recently surveying and mapping sector needs equipment such as GPS, Teodholite and supporting tools. Sukatiman (2014), recommended that teaching aids was prepared by a) calibration of teodholite equipment continually to get precision and accurate data, b) rise up teaching aids by using measuring pole in millimeter. Equipment will always update time to time in industrial fields, therefore it's necessary for Indonesian government as an authorities of centre development to upgrade new equipment in vocational schools. Furthermore, the schools or campuses should active to make interrelation with supplier or consultant accustomed to new equipment.

1.5. Module

Module is one learning material as a printout which usually used for learning process in higher education or for learning process in long distance (not face to face). Some utilizing of module are : 1) module is a facilitate of learning that contains of material, method, scope of learning and it is planned by systematic and interested to the student, 2) module is planned related to the learning needs, such as specific topics, it is arranged on self contains, self-instructional and it's utilized base on self alone. Module gives single opportunity for the student to practice, make a resume, and make self-assessment and it accommodate the student to follow up of complication.

2. RESEARCH METHODOLOGY

This research place is in Sebelas Maret University Surakarta Indonesia, especially at building construction education (vocational education). To analyze data, researcher combined qualitative and quantitative methods. Population and samples were the students that followed learning process of Surveying and Mapping practice. There were 60 students that divided in to 10 groups. Research conducted for 16 weeks while the learning process. The Survey and mapping course contains of 2 hours theory and 4 hours practice. The theoretic process was conducted by discussions. Initially learning process focused on using of up-to-date teaching aids (TS theodolite, and handheld GPS type Montana 650). This learning process must be

done to avoid the equipment damaged by the students. Therefore during learning practice the students were assisted by mentors who mastering in surveying and mapping. Application learning process on practice Surveying and Mapping (SM) support to 2013 curriculum and it used of PBL method. The indicator success for students achievement were 90 % passed by score 80.

3. RESULT AND DISCUSSION

The Results and discussion explain research steps and treats in learning process to get learning outcomes. The novelty during learning process in using of teaching aids based on up-to-date IT is posed in reasonable and argumentative. Result and discussion sections also separated into subsections with short, and informative.

3.1. The Students Pretest Achievement

Before learning practice with PBL is used, it is given theory by utilizing module. The module contains of the topics that concern how to survey and map in the real field, but the students does not to practice yet. Pretest is aimed to understand initially student performance in Surveying and Mapping (SM) course. There were 20 objective tests given to the student and the result is shown in diagram below.

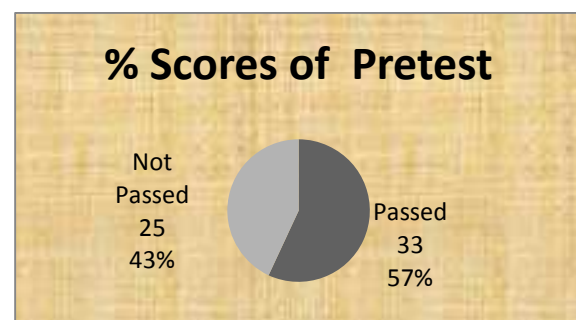


Figure 2. Diagram of Student Score PreTest

The diagram above showed the students achievement of pretest score. It can be explained that 33 students (57%) were passed based on research indicator and 25 students (48%) students were not passed. It could be notice that learning process was not progressed as planned.

Therefore the lecture needs to repair of learning process.

3.2. Students' Scores Achievement

After doing learning process and giving treatment (small group with PBL method in practice), the students are given score by posttest to understand whether PBL is success to application. The posttests contains of subjective test. Besides, summative assessment of students score is taken from 1) posttest, 2) students portfolio, 3) practice performance, and 4) response. (All of the data save by researcher but didn't be posed in this paper). Student's scores on authentic assessment shown in chart below:

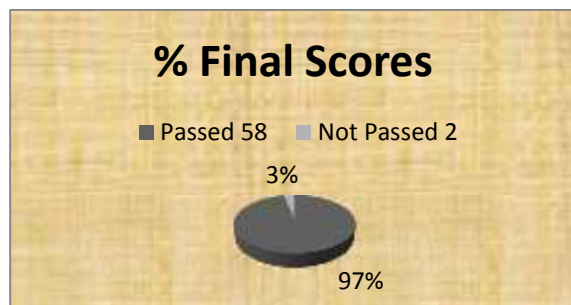


Figure 3. Diagram of Students Final Scores

By showing Pretest scores and authentic assessment scores, researcher acquired of data that learning process by implementing up-to-date teaching aids based on IT has risen to the student achievement. The increasing of students achievement were $58 - 33 \times 100 \% = 43 \%$.

3.3. Students Feedback

To understand whether teaching aids (TS, GPS, and Module) have affected in success of learning processed, it were given the questionnaires as the student's feedback. The questionnaires comprised of 20 objective tests that the students perceived in mastering of teaching aids. The questionnaires can be shown as below:

Tabel 1 : Research Questionnaires in Using The Teaching Aids In Surveying And Mapping Learning Subject

No	Question	Choose answer				
		SA	A	NS	Da	SDa
I	The Use of Module					

1	During learning process, use of module make me easier to adsorb of subject matter that lecturer convey					
2	By using the module as one of teaching aids, I am still difficult to understand of the subject matter					
3	Actually, The Module has the function to clarify message that the stated by the lecturer					
4	The learning process becomes not effective by using of module					
5	The module makes me prepare what is the next subject matter					
6	The module doesn't makes me more serious in following learning process					
7	Using the module, learning process becomes more interactive					
8	Using the module, makes me have more passion to learn it byself.					
9	Module can motivate me to learn new topic that not given by lecturer yet.					
10	With module I can choose the time to learn					
11	The using of module can give the student active to give response					
II	The use of GPS during practice					
12	Using of GPS equipment makes me perceive learning process based on update IT					

13	Use of GPS equipment makes me get global outlook					
14	By using GPS I have motivation in learning the subject matter.					
15	The use of GPS doesn't make the learning process more comfortable					
III	The use of TS Teodholite during practice					
16	TS teodholite is up-to-dated equipment that not easy to use and doesn't like the real learning					
17	During process learning, the use of TS equipment, makes me easy to absorb the subject that convey by lecturer					
18	TS teodholite doesn't make the learning process more interactive					
19	TS equipment makes me more serious to follow learning process					
20	By using TS implementation on the job more effective and efficient					

Declaration:

Score:

SA = Strongly Agree 5

A = Agree 4

NS = Not sure 3

Da = Disagree 2

SDa = Strongly Disagree 1

Note: The result of questionnaires saved by researcher, and it didn't be inserted in this paper

The data show above, its contain 3 independent variables, that is the used of module, application of GPS, and used of Total Station (TS), therefore the researcher used analysis of variable (ANOVA) by application

computer program SPSS 16.0 for windows. The result of statistic can be shown below:

3.3.1. Analysis of Double Regression

Coefficients^a

Model	Unstandardized Coefficients		Standardized Coefficients	t	Sig.	Collinearity Statistics	
	B	Std. Error				Tolerance	VIF
1 (Constant)	7.732	8.237		.939	.352		
Used of module (X1)	1.410	.180	.732	7.838	.000	.751	1.332
Application of TS (X2)	.264	.289	.084	.913	.365	.771	1.297
Application of GPS (X3)	.240	.308	.068	.779	.439	.872	1.147

a. Dependent Variable: Students scores (Y)

From the table above can be seen that double regression equation with 3 independent variables are:

$$Y = 7.732 + 1.410X_1 + 0.264X_2 + 0.240X_3$$

3.3.2. Analysis of Determination Coefficient

Model Summary^b

Model	R	R ²	Adjusted R ²	Std. Error of the Estimate	Durbin-Watson
1	.800 ^a	.639	.620	3.50832	1.526

a. Predictors: (Constant), Application of GPS (X3), Application of TS (X2), Used of module (X1)

R² is used to define the effect of simultaneously independent variables to the dependent variable (student's scores). The output of R² is 0.639. It means that the effect of independent variables is 63.9%, while 36.1% is affected from other factor.

3.3.3. F- test

F test is used to determine the effect of simultaneous independent variables at dependent variable.

Procedures F test is performed below:

3.3.3.1. Define initial hypothesis

$H_0: b_1 = b_2 = b_3 = 0$, its mean that the use of module, application of TS and GPS simultaneous didn't affect to the Students' scores.

$H_a: b_1 \neq b_2 \neq b_3 \neq 0$, its mean that the use of module, application of TS and GPS simultaneous have affected to the Students' scores.

3.3.3.2. Define F measure and F table

F table can be measured by Excel Program with equation $+FINV(0.05, 3, 55)$, where 3 is got from the number of independent variables minus one, 55 is number of respondents minus number of independents ($59-4$). F table = 2.7725. it is compared with F measure as shown in ANOVA table below. F measure = 32.514 > F table = 2.7725, it can be decided that H_0 is rejected, or it means that independent variables gift affect at the student scores.

3.3.3.3. Define significantly.

The significantly use is 0.05. (95% level trust)
The table ANOVA below showed that significantly is $0.000 < 0.05$, it is decided that H_0 rejected.
Conclusion: the use of module, the application TS and GPS simultaneous have affected to the dependent score (students' scores).

3.3.4. t- Test

t- Test is used to understand whether the predictor as a partial (use of module, application of TS and GPS) against the dependent variable (students' scores).

$H_0: b_1 = 0$, it means that use of module doesn't affect to the dependent variable (students' scores)

$H_1: b_1 \neq 0$, it means that use of module has affect to

ANOVA^b

Model	Sum of Squares	df	Mean Square	F	Sig.
Regression	1200.569	3	400.190	32.514	.000 ^a
Residual	676.957	55	12.308		
Total	1877.525	58			

a. Predictors: (Constant), Application of GPS (X3), Application of TS (X2), Used of module (X1)

b. Dependent Variable: Students scores (Y)

the dependent variable (students' scores)

Tables below showed that use of module $t_{\text{measure}} = 7.838 > T_{\text{table}} = 2.000995$.

Tables below showed that application TS $t_{\text{measure}} = 0.913 < T_{\text{table}} = 2.000995$.

Tables below showed that application GPS $t_{\text{measure}} = 0.779 < T_{\text{table}} = 2.000995$.

The three (3) independent variables are showed above only use of module which has $t_{\text{measure}} > t_{\text{table}}$. It mean that use of module has affected to the dependent variable (students' scores), although the two (2) independent variables it didn't affected to the dependent variable

Coefficients^a

Model	Unstandar dized Coefficie nts		Stan dard ized Coef ficients		t	Sig.	Collinearit y Statistics	
	B	Std. Erro r	Beta				Tole ranc e	VIF
1 (Constant)	7.732	8.237			.939	.352		
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a. Dependent Variable: Students scores (Y)

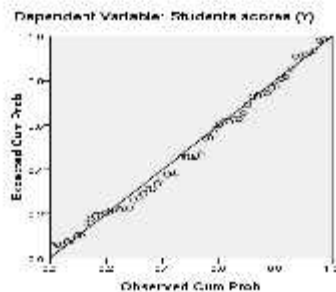
3.3.5. Multi co Linearity-Test

Multi co linearity is situation where there are completes relation between two independent variables or more. Therefore, the good regression model, it isn't problem with co linearity. It is commonly happen, when the tolerance is more than 0.1, and VIF less than 10. With saw the table above, tolerance of all independents variables > 0.1, and all VIF are less than 10. It is conclude that regression model is good.

3.3.6. Regression normal Test Model

From the graphic below can be seen that the data collected around the diagonal line. It means that the data is normal distributed

Normal P P Plot of Regression Standardized Residual



Some statistics computation was done by the researcher but didn't perform in this paper.

4. FINDING

The Novelty in surveying and mapping practice that the students implemented was that they have competence in using Global Positioning System (GPS) apparatus to measure land area. By Measurement area will be easier to plan of surveying equipment, cost estimation and time duration of implementation. GPS apparatus that used in this research was Montana type 650. It was a handheld GPS that has more update data. Furthermore, By application GPS, we get global reference horizontal coordinates (in angle or in distance) and reference vertical height (contour) base on World Geodetics System (WGS 84) as a reference used in Indonesia.

The students should have competence to use of surveying equipment, such as digital theodolite (TS), GPS apparatus, and support equipment. It is caused in projects construction, the surveying equipment is usually used to get accurately data. By application of surveying equipment, the students get guaranty on conducting practical based on technology and global information.

Based on statistic data that contain of students perceived, it was found that TS and GPS still not affected to process learning, therefore its need concern of the assistant and lecturer to increase learning process.

In measurement of polygon, In case the TS theodolite cannot be placed at a polygon point, the surveyor must shoot on that target, the point

shoot from in front and the same point shoot from backward to give accomplished polygon. This step is aimed to get balances of polygon length to avoid mistake of angle and polygon distance.

SNI-196988-2004 and SNI-19-6724-2002 are Indonesian references contain of procedure Accurately and precision in earth project work, by following SNI reference, the lecturer will easy on scoring to student achievement. Accurately measurement in Surveying and Mapping can be performed with measurement of angle and distance. SNI reference is given as followed: By SNI reference showed above, the lecture appraises how the student's competence progress. In addition, update equipment based on IT such as Total Station and GPS will impact accurately measurement.

In processing data, use of measurement form will help the students in understanding step by step of data analytical. Excel program and AutoCAD program, is better used to the student, because it will ensure understanding of processed data measurement.

Range of polygon accuracy	I	II	III	IV
Error of end angle	$2'' \sqrt{n}$	$10'' \sqrt{n}$	$30'' \sqrt{n}$	$60'' \sqrt{n}$
Maximum correction per point.	1''	2''	3''	6''
Accurately of distance	1 : 35000	1 : 10.000	1 : 5.000	1 : 2.000

5. CONCLUSION

After going discussion overall, researcher has conclusion that:

Application of teaching aids in Surveying and mapping based on IT on learning activity has risen of student achievement. Students scored use minimum teaching aid (only module) is 58% passed, while 42 % is not passed. After learning processed using completed teaching aids (module, Total Station, and GPS), scores outcome have increase becomes 97 % passed. It showed that students scored where they didn't used complete teaching aids were weak, and to

improve its, using updated teaching aids is very urgently to use.

Problem based learning (PBL) has relevance to application in 2013 curriculum, it is caused PBL made learning atmospheres more students centered learning and lecturer just role play as facilitator. This is properly according to Breton (1999), who sated that students were also able to relate theory to practice and develop greater ability to remember and reuse what they had learnt. Lecturer as a facilitator in this research is doing by preparing of class learning condition, preparing used of teaching aids (that is module, GPS equipment, and Total Station Theodolite (TS)), based on IT and utilizing of Indonesia National Standard reference (SNI) and planning of authentic assessment comprise of knowledge, affective and skill assessment.

By doing updated learning in vocational skills, it's in line with UNESCO recommendations (2001) in vocational education and training (VET) to give the immense scientific related by globalization, revolution in information and communication technology.

6. ACKNOWLEDGEMENT

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