

THE EFFECTIVENESS OF ICT-ASSISTED PROJECT- BASED LEARNING IN ENHANCING STUDENTS' STATISTICAL COMMUNICATION ABILITY

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ABSTRACT

This study aims to describe the effectiveness of ICT-assisted project-based learning (ICT-assisted PBL) to enhance students' statistical communication ability. This study is quasi experiment, with pretest-posttest control group design. The number of sample are 51 students who were selected in purposive sampling from 102 students. In collecting data, statistical communication ability test, observation, and interview were used. Data obtained was analyzed by using Mann-Whitney U test. The result of this study shows that the application of ICT-assisted PBL is effective that can enhance students' statistic ability; (1) Statistical communication ability achievement and enhancement of students who got ICT- assisted PBL is significantly higher than students who got conventional learning, (2) students' activity is categorized good, and (3) in classical competence, 76,92% of students who achieve individual competence. ICT assisted project based learning can be used to improve student' statical communication ability in introductory statistics learning.

Keywords: statistical communication, Statistical Communication Ability, ICT- assisted Project-Based Learning.

INTRODUCTION

The function of statistics as science plays important role in all aspects of human life, as means to develop way of logical and scientific thinking. Statistics is used in order to collect, arrange, present, analyze and draw a conclusion mathematically. Sudjono (2009) stated that statistics is science which learn and develop principles, method and procedure which are used in order to collect, arrange, present, analyze, and draw conclusion mathematically based on statistic data collection. According to Sudjana (2005), statistics is knowledge which to collect, process or analyze data, and draw conclusion based on data collection and analysis Moore (1992) stated that statistics is the branch of mathematic, and appear as discipline of statistics which has way of thinking characteristic which is more grounded by certain method. Moore (1992) view that statistics as knowledge which provided means to give solution toward phenomena or real life problem.

Statistics plays an important role in various aspects of life that leads to the importance for students in higher education to learn it. According to Sundayana (2012), there are four aspects of statistic learning, namely: basic theoretical knowledge, simple skill, give experience of problem solving which is faced in daily life. Achieving those aspects, students need to understand statistics content. To learn statistics required to organize condition of learning centered on students which lead to students have experience to use statistics as tool to solve the problem that they faced. The process above were intended to form students' ability in communicating concept, procedure and process of statistics.

Statistic is usually used as tools to analysis data to get information which can help someone to draw conclusion and to inform to other people. Statistical communication ability is required to predict the occurrence of a problem based on its characteristic, obtain information and draw conclusion from statistic information. The result of prior study conducted by Lanani (2013) shows that there is 83% of 26 students who have learned statistics introductory in which they are unable to

explain the information into table or diagram and unable to draw conclusion based on the statistic data into table or diagram. This phenomena show that students' statistical communication ability are still low and needed to be enhanced.

Achieving statistical communication ability need interaction process among students with learning sources, such as: peers, lecturers. Students' interaction with information source through active communication formally in learning activity. According to Santyasa & Sukadi (2007), learning is focused on concept and core principle of a science can facilitate students to investigate, solve the problem, and another meaningful tasks such as student center, and produce real product is project based learning (PBL). The use of SPSS software in statistic introductory learning can be functioned as aid for the sake of statistic data analysis, presentation table, graphics and diagram as interpretation based and conclusion drawing toward statistic information.

Based on that explanation, this study implements ICT-assisted project based learning with the aims to find out its effectiveness in enhancing students' statistical communication ability. The result of this study is hoped to enhance statistical knowledge competency and becomes important learning for lecturer toward quality enhancement of statistics introduction learning. This result of study also hoped to become reference for lecturer or teacher in learning model application, the use of ICT media and SPSS software, and also enhancement of students' ability.

LITERATURE REVIEW

Student's Statistical Communication Ability

In understanding statistical communication ability, mathematical communication ability is required. According to Guerreiro (in Izzati, 2012), mathematical communication is an aid in mathematics science transmission in or as basic in building mathematical knowledge. Sumarmo (2013) said that activities which are categorized in mathematical communication; (1) relating to the real object, picture, and diagram into mathematical idea, (2) explaining the idea, situation and mathematical relation in writing or verbally, by real object, picture, graphic or algebra, (3) listening, discussing and writing about mathematics, (4) reading with understanding of mathematical and presenting written forms, (5) formulate conjecture, arranging argument, to determine definition and generalization, and (6) restating mathematical explanation or paragraph in own words.

Based on the explanation above it can be stated students have ability to explain statistical ideas and picture or diagram into statistic model, to understand statistical representation, to generalize statistical concept in written form by using their own words. Those students' ability is indicators to measure students' statistics communication ability in learning statistics.

Despite of the essence in learning, teaching and accessing statistics, the suitability between statistic concept and real life problem, statistic communication ability should be developed in students. This is based on explanation of Parke (2008) that recommendation to creation of mathematics teaching vision which is emphasized in problem solving ability, reasoning and proofing, communication, connection, and representation which is focused on mathematics K-12 (NCTM, 2000), also applied to students of various age in statistics learning.

Statistical communication ability is important prerequisite to help students in statistical thinking, relate one statistical idea to another idea, cast their thinking outcome, both verbally or in writing. The important aspect of statistical communication is ability to communicate concept and statistic result in writing or verbally. According to Rumsey (2002), statistical communication ability is ability of each person in reading, writing, showing, and demonstrating statistic information. Statistic communication means delivering statistic information verbally or in writing by way he/she understand.

Rumsey (Parke, 2008) distinguishes interpretation skill which indicate whether a student understand the concept and communication ability which involve sharing statistical information clearly with the others. Parke (2008) in his study, the students required to write a paper about statistics in task accomplishment, not automatically can enhance student's understanding or enhance student statistical communication skill. Holcomb and Ruffer (in Parke, 2008) explain that introductory statistics course about data in the form of project, in which student working in group to analyze statistic data and perceive series of questions are able to enhance statistical communication of 50% from 100 Ideal maximum score (IMS).

Based on those opinions it can be said that statistical communication skill is important for students to be able to cast their thinking outcome, verbally or in writing in statistic learning. The enhancement of statistical communication ability by enhancing student's understanding toward a concept, habituate student to write technically, develop argument based on data orientation, procedure and statistic process. Statistical communication ability which is intended in this study is student ability in consolidating ideas and understanding statistic information based on statistic rules in writing, from a diagram or table. Indicators of statistical communication ability are student capable to: (1) connect real problem, diagram or table into statistics idea, (2) explaining idea, situation and statistic relation in writing, diagram or table, (3) formulate statistisc statement and make generalization based on statistic data investigation, (4) understand, interpret and judge the idea which is presented in writing, (5) present, process, interpret result observation data, make a guess, and asses statistic information.

ICT-Assisted Project-Based Learning

Thomas (2000) explained that project-based learning (PBL) is learning model which gives opportunity to teachers to manage in class by involving project work. Clegg & Berch (in Wena, 2013) argue that through project work, student's creativity and motivation will be enhanced. Richmond & Striley (in Wena, 2013) asserted that project work is viewed as form of open-ended contextual activity-based learning, and is part of learning process that give strong emphasis in problem solving as a collaborative effort.

PBL is an innovative learning model, use contextual learning, providing opportunity to student to play active role in solving the problem, make decision, research, present, and make report document meaningfully based on problem project which is authentic. Gaer (1998) explained that project-based learning has role to shape learning experiment which is interesting and meaningful to students who are studying in college to enter vocation. Garfield and Change (in Ying Cui, et al, 2010) explain that project learning with authentic problem is alternative approach which can help instructor to find out how good student in thinking and reasoning by statistic ideas.

PBL which is integrated with information and community technology (ICT) aims to provide opportunity to students to learn introductory statistic by using authentic problem project. This is in accord with Munir explanation (2008 & 2011) that integrating ICT in learning can enhance student quality, help in guiding student to obtain authentic statistic information and statistic data processing through special software of statistic. In addition, Isjoni et al (2008) explain that the use of media and ICT source material can help content delivery and attract interest and make teaching not to become boring. Santoso (2003) said that statistic data processing can be done through one of statistic special software, namely: Statistical Product and Service Solution (SPSS). Wijaya (2012) said that as software, SPSS assist statistic data calculation. Its nature as supplement or complementary, software SPSS can be functioned as one of aids in statistic learning. Therefore, introductory statistics learning in this study use project-based learning assisted by ICT (ICT-Assisted PBL).

The Effectiveness of ICT-Assisted PBL

Before explaining about the requirements of effectiveness of ICT-assisted PBL, it is important to explain the meaning of effectiveness itself. Effectiveness comes from the word "effective" which means efficient, succeed or effect (Partanto and Al-Barry, 1994). According to Arikunto (2004), effectiveness is completeness degree of a goal which is predetermined. Novita (2014) explains that the effectiveness of learning is based on four aspects, namely: learning completeness, student activity, student response, and teacher activity in managing learning with student's learning completeness requirement is fulfilled. Mulyasa (2006) reveals that the criteria of learning completeness is viewed from individual completeness aspect and classical completeness. A student is said individual completeness if she/he has absorption ability as least 65% and classical completeness if 85% of students are completed individually. In addition, the result of Nassir study (2013) showed that first, if there is significant difference between learning outcome through PBL (experiment group) and conventional learning (control group), second, project based learning has significant effect on development of student speaking skill.

Based on meaning and requirement of that effectiveness, then the application of ICT-assisted PBL is said effective in enhancing student's statistical communication ability if the minimum of three requisites from four requisites is fulfilled, namely: (1) classical competency if 60% of students with individual competency level minimally is 60% (evaluation of assessment in accord with university academic guidance), (2) the achievement and enhancement of statistical communication ability of students who received ICT-assisted PBL is higher significantly than students of conventional learning, (3) student activity is categorized good, and (4) lecturer (researcher) ability in managing learning is in good qualification.

METHOD OF STUDY

This study is in the form of quasi experiment with pretest-posttest control group design (Sugiyono, 2011). This study uses quantitative method which aims to find out the effectiveness of ICT-assisted PBL in enhancing students' communication ability. To select the sample in this study, the purposive sample is used in this study and the sample of study consists of 51 college students, they were selected from 102 college students who were taking introductory statistic course and the samples consist of 26 students of experiment group and 25 students of control group. This study has two variables, namely: learning model as independent variable, and student's statistical communication ability (SCA) as dependent variable.

The data of this study is obtained directly from learning activity and written test. Data collection is statistical communication ability test consisting of 10 (ten) items in the form of essay test. The instrument is arranged based on indicators that have been validated by expert and try-out. The data is analyzed descriptively and inferentially. Descriptive analysis and interpret student's ability to achievement dealt with and the enhancement students' communication ability. The enhancement of students' statistical communication ability is calculated by using Hake formulation (1999), namely:

$$\text{Normalized Gain } (< g >) = \frac{\text{Score (Posttest)} - \text{Score (Pretest)}}{\text{Score (ideal)} - \text{Score (Pretest)}}$$

The criteria of normalized gain as explained in Table 1.

Table 1.
Criteria of Normalized Gain Index

Normalized Gain Score	Interpretation
$(\langle g \rangle) > 0.7$	High
$0.3 < (\langle g \rangle) \leq 0.7$	Middle
$(\langle g \rangle) \leq 0.3$	Lower

Inferential analysis is to examine the hypothesis by using independent statistic between two samples for Mann-Whitney U test. That test statistic is used after it is known that SCA achievement and enhancement data of students who get ICT-assisted PBL not normally distributed.

HYPOTHESIS OF STUDY

The hypothesis of this study which will be tested to fulfill one of effectiveness requirement of ICT-assisted PBL application, namely achievement and enhancement of statistical communication ability of students who got ICT-assisted PBL is higher significantly than students who got Conventional Learning.

RESULT OF STUDY AND DISCUSSION

Analysis of Student's Statistical Communication Ability Completeness Learning competency is calculated based on the number of students with subject matter mastery level achieve 65% from ideal maximal score (IMS=24). It means, student ability in accomplishing SCA test who achieve minimal 65% is stated that statistical communication ability (learning completed). Identification result of number of students who obtained SCA with minimal 65% or score of 15,6, achieve score of 15,6 (65%) from IMS of 24. Description of student's statistical communication ability presentation (data of appendix 1), the summary is presented in Table 2.

Table 2.
Percentage of Student's Statistical Communication Competence Through ICT-Assisted Project-Based Learning

No	Completeness Interval	Statistical Communication Ability	
		Numbers of Students	Percentage
1	$X \geq 65\%$	20 Students	76.92
2	$X < 65\%$	6 Students	23.08
X = SCA posttest score achieve 15.6 (65%)			

Result of description data in Table 2 shows that there are 20 students or 76.92% achieve statistical communication ability in individually more than 65%, and there are 23.08 students or 23.08% which less than 65%.

The data above shows that the application of ICT-assisted PBL with yield 76.92% of 26 students who achieve statistical communication ability individually less than 65% of classical completeness. Based on interview result, the students' who has statistical communication competency is caused by "the lack of source books and learning infrastructure", "many assignments of another course", "student not get used to learning model" and "low of statistical initial ability". The finding of this study confirm the findings of Parke study (2008) that directing student to write a paper about statistic in task accomplishment, not automatically can enhance student understanding or enhance student's statistical communication skill. Furthermore, Holcomb and Ruffer stated that

introductory statistics learning about statistic data in the form of project, in which students working in group to analyze statistic data and perceive series of question can enhance statistical communication ability of 50% from maximal score of 100 (in Parke, 2008).

Analysis of Student’s Statistical Communication Ability

The description of statistical communication ability (SCA) between students who received ICT-assisted PBL by and Conventional Learning is showed in Table 3.

Table 3. Description of Student’s Statistical Communication Ability

Statistic	Student’s Statistical Communication Ability					
	ICT- Assisted PBL			Conventional Learning		
	Initial	Achievement	Enhancement	Initial	Achievement	Enhancement
Average	1.84	24.35	0.59	1.88	20.96	0.50
DV	1.12	6.08	0.15	0.62	6.01	0.15
CV	60.69	24.96	26.18	62.03	28.67	30.27
Max	4	39	0.97	4	37	0.92
Min	0	17	0.43	0	12	0.26
N	26 student’s			25 student’s		
Explanation: DV=Diviation Standard, CV=Coefficient of Variation, Max=Maximum, Min=Minimum, N=Numbers of Sample Subject, Initial=Pretest Result.						

Based on data in the Table 3, it can be explained that average, maximum and minimum of SCA achievement and enhancement of students who obtain ICT Assisted PBL is higher than students who get CL; (2) variance coefficient of SCA achievement and enhancement of students who obtain ICT-assistedPBL is lower than students who obtain CL. The average of SCA enhancement of students who got ICT-assistedPBL and students who get CL according to Hake’s normalized gain index (1999) is categorized medium. This show that ICT-assisted PBL contribute positively in enhancing student’s statistical communication ability.

From data normality test result of SCA achievement and enhancement of students who receive ICT-assisted PBL, significance value of Shapiro-Wilk less than $\alpha=0.05$ is obtain, so H_0 is rejected (normality test result data of appendix 3). It means that there is one of data normal distributed, homogeneity variance test is not done, and Mann-Whitney U test is used to test those data average difference. Result of statistic test about students’s SCA achievement and enhancement of students between they who received ICT-assisted PBL and who received CL (data of appendix 4). The summary is showed in Table 4 as follow.

Table 4. Test Result of SCA Achievement and Enhancement Average of Students Who Get PBL Assisted By ICT and Students Who Get CL

SCA	Result of Average Difference Testing					
	Difference Average	Test Statistic	Statistic Value	df	Sig.	H_0
Achievement	3.386	Mann-Whitney U	218.000	51	0.021	Rejected
Enhancement	0.089	Mann-WhitneyU	214.000	49	0.018	Rejected
Explanation: H_0 : SCA achievement and enhancement average of student who get PBL and CL is the same. $Sig (1-tailed) = [Sig (2-tailed)]/2$						

The result of data analysis in Table 4 can be explained that all students who received ICT assisted PBL have significant improvement on SCA than the students who received conventional learning. Based on the explanation above can be stated that the contribution ICT assisted PBL is

better than conventional learning to improvement of students' SCA. The improvement of students' SCA who received and conventional learning is medium. This finding confirms the Smit (1998) & Carnell (2008)'s findings that project problem posing in project- based learning enhance students' attitude and perception toward statistic. Moreover, this finding also consistent to the Roschelle et al. (2000) stated that the integration the use of ICT assisted project-based learning can enhance the students' learning ability.

Student Activity and Lecturer Ability in ICT-Assisted PBL

ICT-assisted PBL was applied to the students of experiment group in 10 times of meeting. The result of observation shows that in first meeting, class atmosphere is less dynamic and conducive; students have not been able to accomplish project report in time. This problem was caused by some factors, among others: students are not brave to answer the question directed by lecturer, have not understood the material and stillfeel difficulty to solve the problem related to the project in the form of question on student's worksheet, interaction among students in group discussion has not developed dynamically, students are not familiar the learning scenario yet, and most of the students are not able to use SPSS software, students learned many materials and have many project that should be done in the class.

To overcome that problem, personal approach is used in order that students feel familiar and got used to learn model, try to simplify directed question, limited sub material for each meeting, give motivation to students in order to own and learn source books and hand out given, trying to understand student's worksheet questions, and give freedom to ask the question, and students are given training in using SPSS software about statistic data processing. Training in using SPSS software about statistic data analysis is conducted outside the lecturing hours in schedule. This action encouraged students for being motivated in responding learning activity so that problem can be overcome well in next meeting. Result of observer observation toward student activity in ICT-assisted project-based learning use observation guidance with assessment scale: not enough =1, enough =2, good=3, and very good=4. Average of observation result of that students activity is summarized on Table 5.

Table 5
Student Activity in PBL Assisted by ICT

No	Activity Stage	Aspect Observed	Average	Qualification
1	Introductory	Exploration	3.15	Good
		Presentation	3.15	
2	Core Activity	Assimilation and Organization	3.09	
		Resitation	3.43	
3	Closing	Summary	3.20	
Total			3.20	Good

Based on the data in Table 5, it can be explained that the average of student activity in implementing ICT-assisted PBL achieve 3.20 was good. This shows that students have followed and conducted activity of assisted ICT project-based learning actively.

CONCLUSION AND SUGGESTION

Based on the result and discussion of this study, it can be concluded that ICT-assisted project-based learning is effective in enhancing student's statistical communication ability; (1) SCA

achievement and enhancement of students who received ICT-assisted PBL is significantly higher than students who received conventional learning, (2) student activity in learning achieve 3.20 which is categorized good, and (3) lecturer ability in managing learning achieve 92.60% in good qualification. In contrary, the completeness of student's statistical communication ability classically is yielded through ICT-assisted PBL achieve 76.92% from 26 students who achieve individual competency of 60% of SMI 40.

Based on data exposition, finding and discussion of study, there are some suggestions as follow: (1) ICT-assisted PBL can be used as one alternative of introductory statistic learning approach for lecturer to enhance student's SCA, (2) ICT-assisted PBL is better to be applied to students of semester 5 or 7 in which their regular course had been reduced, (3) in introductory statistic learning, lecturer can present authentic problem project, master investigation process and statistic data presentation, and skillful in using ICT, particularly software SPSS to ease guiding and facilitating students to understand the problem, implement problem solving process, and students who experience learning difficulty, (4) ICT-assisted PBL with authentic problem project also give motivation and awareness to students about the importance of statistics and its implementation in real life and development of another science, (5) The application of ICT assisted PBL should draw attention to availability of learning resource and adequate infrastructure.

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