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# ICT Based-Problem Based Learning on Students' Cognitive Learning Outcomes

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**Abstract:** The purpose of this research is to determine the impact of Problem Based Learning through ICT on students' cognitive achievement. This research using a quasi-experiment design with nonequivalent control group design. Data of pretest and posttest were collected and analyzed by ANACOVA. The result showed that there are differences of cognitive achievement among students in the experimental class and in a conventional class. The average score of student's cognitive achievement in experimental class is 69.032 and in the conventional class is 62.078, which is mean that the achievement of cognitive on students that were taught by PBL through ICT is significantly higher than the students that were taught by conventional learning.

**Key Words:** problem based learning, ICT, cognitive achievement

**Abstrak:** Tujuan penelitian ini adalah untuk mengetahui pengaruh pembelajaran dengan model *problem based learning* berbasis TIK terhadap hasil belajar kognitif siswa. Jenis penelitian yang dilakukan adalah eksperimen semu dengan pola pretes-postes. Hasil analisis data pretes dan postes yang diuji melalui analisis anakova menunjukkan adanya perbedaan hasil belajar kognitif siswa pada kelas eksperimen dan siswa pada kelas konvensional. Rerata terkoreksi hasil belajar kognitif siswa pada kelas eksperimen sebesar 69.032 sedangkan siswa pada kelas konvensional sebesar 62.078. Hal tersebut berarti bahwa pencapaian hasil belajar kognitif siswa dengan model PBL berbasis TIK secara signifikan lebih tinggi dibandingkan kelas konvensional.

**Kata kunci:** *problem based learning*, TIK, hasil belajar kognitif

## INTRODUCTION

The 2013 curriculum requires the implementation of student-centered learning and requires teachers as facilitators in learning activities (Praginda et al., 2013). Problem Based Learning (PBL) is one of the learning models that places teachers as facilitators (O'Brien et al., 2014) and is a student-centered learning approach by presenting problems as triggers of discussion and inquiry activities in learning a material (Wood, 2006). PBL facilitates students to enrich information and build new knowledge that is directly related to real life and the future (Greening, 1998). PBL activities are carried out by dividing students into small groups and the teacher acts as a facilitator in the discussion activities carried out by students in the group (Akinoglu et al., 2006 & Hung et al., 2008).

Walker et al. (2011) stated that the implementation of discussion activities, information seeking and reflection in PBL could be supported by the use of technology. The use of technology in learning can help students to better understand the concept of the material (Barak et al., 2005). Technology provides various sources of information that can be accessed by students in investigative activities to build new knowledge (Donelly, 2005). The use of word-processor and spreadsheet can facilitate students in carrying out information processing and analysis activities (Tan, 2003). In addition, students can carry out reflection activities by utilizing innovative presentation media through power point or multimedia. However, the use of ICT in learning requires teacher skills in designing ICT integration in the learning syntax that will be carried out to obtain maximum benefits (Jeong-So, 2011).



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Learning in general does not involve students to engage in active collaboration, active discussion, active interaction in presenting their work and conducting reflection activities (Vasiliou et al., 2013). The results of observations at SMAN 1 Ponorogo showed that the learning activities that have been carried out in schools are still conventional and the implementation of student-centered learning is merely an activity of giving assignments to students without a clear learning syntax. This affects the cognitive learning outcomes of students seen from the indicators in Bloom's taxonomy.

Based on the existing problems, the solution applied is to conduct ICT-based PBL learning. The use of ICT in PBL is expected to facilitate students in carrying out PBL activities. Students can conduct investigations or information retrieval activities using the internet, conduct discussion activities to process information and conduct analysis using word-processor, students can present their work using innovative power points, and share information using e-mail.

## METHOD

This research was a quasi-experimental study with a pretest-posttest pattern. The sample used in this study were students of XI MIPA 6 and XI MIPA 8, amounting to 64 students. The sample selection was done randomly to the equivalent class of XI MIPA 6 SMAN 1 Ponorogo. The independent variable was learning using the Problem Based Learning model based on ICT and conventional learning, while the dependent variable was the cognitive learning outcomes of students.

The instruments used were a syllabus, Lesson Plan, Student's sheet, observation sheet, implementation of learning syntax, and test questions. The test instrument used to measure students' cognitive learning outcomes in the form of a written test consisting of 24 multiple choice questions and six description questions. Data obtained from pretest and posttest were analyzed using statistical analysis of ANACOVA with the help of statistical software.

## RESULTS

### Implementation of Learning Syntax

The results of the implementation of ICT-based PBL syntax learning was according to from observation sheet of the implementation of learning syntax and linear regression analysis from the results of the pretest and posttest. The consistency of the learning syntax implementation of the results of the pretest-posttest linear regression analysis is presented in Table 1.

These results indicate the parallel level of data (b1, b2) obtained a p-value of 0.062 and the data coincidence level (b1, b2, b3) obtained a p-value of 0.115. The first and second values are greater than 0.05. Thus, it can be seen that the two lines are parallel and coincident. This illustrates that the learning syntax has been implemented consistently.

The results of observations obtained from the observation sheet of the learning syntax implementation of the experimental class and control class showed that the ICT-based PBL syntax in the experimental class was 98.38% and conventional learning in the control class was 95.32%. This shows that learning in both classes is well implemented. Data on the percentage of Lesson Plan implementation in learning are presented in Table 2.

**Table 1. Experimental Class Consistency Test Results**

| Model | | Sum of Squares | df | Mean Square | F | Sig. |
|---|---|---|---|---|---|---|
| 1 | Regression | 19776,260 | 3 | 6592,087 | 115,908 | ,000b |
| | b1,b2 | 205,465557 | 1 | 205,46556 | 3,613 | 0,062 |
| | b1,b2,b3 | 255,17266 | 2 | 127,58633 | 2,243 | 0,115 |
| | Residual | 3412,403 | 60 | 56,873 | | |
| | Total | 23188,663 | 63 | | | |

**Table 2. Lesson Plan Implementation Percentage**

| Learning Model | Lesson Plan Implementation Percentage in Learning | | |
|---|---|---|---|
| | Teacher's Activity (%) | Student's Activity (%) | Avg (%) |
| **ICT-Based PBL** | 99.04 | 97.60 | 98.32 |
| **Conventional** | 95.63 | 95.00 | 95.32 |

**Table 3. Anakova Test Results Effect of Learning Model on Cognitive Learning Outcomes**

| Source | Type III Sum of Squares | df | Mean Square | F | Sig. |
|---|---|---|---|---|---|
| Corrected Model | 5350,799[a] | 2 | 2675,399 | 84,547 | ,000 |
| Intercept | 12514,027 | 1 | 12514,027 | 395,462 | ,000 |
| XKognitif | 3330,971 | 1 | 3330,971 | 105,264 | ,000 |
| Kelas | 710,930 | 1 | 710,930 | 22,466 | ,000 |
| Error | 1930,287 | 61 | 31,644 | | |
| Total | 282318,399 | 64 | | | |
| Corrected Total | 7281,086 | 63 | | | |

a. R Squared = ,735 (Adjusted R Squared = ,726)

**Table 4. Corrected Average Cognitive Learning Outcomes of Experiments and Control Classes**

| Class | Pretest | Posttest | Margin | Increasing | Corrected Average |
|---|---|---|---|---|---|
| Control | 43,97 | 59,69 | 15.72 | 35.75% | 62,078 |
| Experimental | 44,11 | 71,27 | 27.16 | 61.57% | 69,032 |

**Table 5. Average Score of Experimental Class Cognitive Learning Outcomes**

| No | Indicator | Pretest | Category | Posttest | Category | Improvement (%) |
|---|---|---|---|---|---|---|
| 1. | Remembering | 59.98 | M | 87.50 | VH | 46.86 |
| 2. | Understanding | 48.96 | M | 76.04 | H | 55.31 |
| 3. | Applying | 43.73 | M | 64.06 | H | 46.42 |
| 4. | Analyzing | 32.59 | L | 59.38 | M | 82.20 |
| 5. | Evaluating | 40.10 | M | 67.71 | H | 68.85 |
| 6. | Creating | 39.69 | L | 72.93 | H | 83.75 |

Remarks: L: Low M: Moderate H: High VH: Very High

**Table 6. Average Score of Control Class Cognitive Learning Outcomes**

| No. | Indicator | Pretest | Category | Postest | Category | Improvement (%) |
|---|---|---|---|---|---|---|
| 1. | Remembering | 60.42 | H | 84.38 | VH | 39.66 |
| 2. | Understanding | 48.39 | M | 75.50 | H | 56.02 |
| 3. | Applying | 42.97 | M | 68.00 | H | 58.25 |
| 4. | Analyzing | 31.69 | L | 34.37 | L | 8.46 |
| 5. | Evaluating | 40.62 | M | 43.23 | H | 6.43 |
| 6. | Creating | 40.10 | M | 34.90 | L | -12.97 |

## Cognitive Learning Outcomes

The pretest and posttest results were used to test hypotheses using statistical software. The pretest and posttest data were first tested by a pre-requisite test which included the normality test and homogeneity test. The results of the statistical software test show that the pretest and posttest data in the experimental class and the control class are normal and homogeneous, thus it can be continued to do a hypothesis test, by using ANACOVA statistical analysis. The results of the hypothesis test show a significance value of 0,000 and smaller than the alpha value of 0.05. This means that the hypothesis H0 is rejected and Ha is accepted, thus it can be said that there is the influence of ICT-based PBL learning model on students' cognitive learning outcomes. The results of the ANACOVA test summary of the learning model effect on students' cognitive learning outcomes are shown in Table 3.

The mean value corrected in the experimental class was 69,032 and in the control class was 62,078. This shows that students in the experimental class have significantly higher cognitive learning outcomes than students in the control class. the mean corrected values are presented in Table 4 .

Students' cognitive learning outcomes were obtained from the achievement of indicators of cognitive abilities which consist of remembering (C1), understanding (C2), applying (C3), analyzing (C4), evaluating (C5), and creating (C6). Data on the achievement of indicators of the ability of experimental class cognitive learning outcomes are presented in Table 5.

Data regarding cognitive learning outcomes of control class achievement indicators are presented in Table 6.

## DISCUSSION

The results of the ANACOVA test prove that there is an influence of ICT-based PBL learning models on students' cognitive learning outcomes. The mean corrected value of class cognitive learning outcomes of students who were taught with the ICT-based PBL model was higher than the student learning outcomes taught by conventional learning. This shows that the ICT-based PBL model is better to improve students' cognitive learning outcomes. The implementation of ICT-based PBL includes the activities of formulating problems, seeking information, analyzing data, finding solutions to problems and reflecting on and evaluating the results of problem-solving. Mardiana et al. (2016) stated that a series of PBL activities were considered capable of improving students' cognitive learning outcomes.

The implementation of ICT-based PBL was done by integrating ICTs to facilitate activities in PBL. The use of ICT in PBL enables the implementation of PBL easier for students (Dirckinck, 2009). PBL was conducted when students search for information are done by using the internet as a broad source of information. It enables easy access for students to explore and enrich information from a variety of reliable sources, so students do not just use the book as their main source. the amount of information obtained from the internet can make it easier for students to find new knowledge to solve problems. Ritchie et al. (2005) stated that the potential use of ICT in PBL is as a supporting mean of the implementation of problem-solving activities by providing access to information sources from the internet. The implementation of group discussion activities in seeking information teaches students to master cognitive indicators of remembering (C1) and understanding (C2). As stated by De Grave et al. (1984) that students who hold discussions have a stronger memory of the material discussed.

Discussion activities in analyzing and finding problem-solving affect the ability of students in the cognitive realm to apply (C3), analyze (C4), and create (C6). This can be seen from the increasing percentage in the ability of students who are taught by the ICT-based PBL model, namely the ability to apply was 46.42%, analyze was 82.20%, and create was 83.75%. This is in line with the research conducted by Hasanah (2012) which shows an increase in cognitive indicators in students taught with PBL models. De Grave et al. (1984) also stated that the application of PBL was able to influence changes in the initial concepts that students have because of discussion activities that enable information processing to analyze and resolve problems. It is supported by Jonassen's statement (2011), when the discussion process students exchange opinions and conduct arguments that will direct them to process information that has been obtained with information from others, thus strengthening their ability to apply, analyze and build new knowledge.

Students' ability to master evaluating indicators (C5) was obtained by students in reflection and evaluation activities. Information sharing and work results in ICT-based PBL are conducted by presenting in the form of power points. Interesting presentations by presenting images, graphics or videos in power points increases the interest and motivation of students to find out the information presented. Based on research conducted by Kerfoot et al., (2005), it is shown that the use of presentation media that is interesting to use ICT has a positive influence on learning activities. Parks (1999) states that students prefer to have the presentation of images, videos and graphics at power points and that this has a positive impact on learning. This is in line with the results of research that shows an increase in students' cognitive abilities in evaluating information that has been obtained from presentations through power points, which increased by 68.85%.

## CONCLUSION

Based on the results of data analysis and discussion that has been described, it can be concluded that there is an influence of learning with the ICT Based-PBL on students' cognitive learning outcomes. This is indicated by an increase in the cognitive abilities of students who are taught with ICT-based PBL models in remembering, understanding, applying, analyzing, evaluating, and creating higher than students who are taught conventionally.

Based on the results of the research that has been done, it is recommended to utilize ICT in learning and utilize the ICT-based PBL model in Biology learning since it has been proven to have an influence on students' cognitive learning outcomes.

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