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THE APPLICATION OF PROBLEM BASED LEARNING ASSISTED BY BLENDED LEARNING IN ATOMIC SPECTROSCOPY MATERIAL ON COGNITIVE LEARNING OUTCOMES AND STUDENTS' SELF SYSTEM BASED ON MARZANO TAXONOMY

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Abstract:
This study aims to determine differences in cognitive learning outcomes and self-systems based on the marzano taxonomy student's who are taught with a problem based learning model assisted by blended learning on the material of atomic spectroscopy. This study uses cognitive knowledge test instruments that have content validation of 90.17% with very good criteria and Alpha Cronbach reliability coefficient of 0.634 in the high category. The research sample was conducted in two research classes at Malang State University. The results showed a statistically significant difference in students' cognitive knowledge in both research classes (α = 0.050) and the influence of the problem based learning model assisted by blended learning on students' self-systems based on the marzano taxonomy. The results of the study on student cognitive knowledge showed that there were differences in the two research classes and the influence of the learning model on student self-systems. The results of students' cognitive knowledge are supported by student pretest and posttest scores.

Keywords: problem based learning, blended learning, cognitive knowledge, self-system, Marzano taxonomy

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1. Introduction

Science and technology are always developing and progressing, in accordance with the development of the times and human thinking. The sophistication of information and communication technology in the era of globalization has brought significant changes to the development of the world of education. The age development requires education that provides competencies that fit the needs of the community and can compete globally. Students need to be equipped with knowledge, skills, attitudes and value systems to be able to compete fairly against other nations and work with them. The abilities needed in the world of education today are the ability to work together in groups, problem solving skills, the ability to direct themselves, think critically, and be able to communicate effectively and master technology (Kaku, 2011).

The influence of information and communication technology in the world of education is increasingly felt in line with the shift in conventional face-to-face learning patterns towards more open and help with media education. According to Bishop in Rusman, et al (2012), future education will be flexible, open, and can be accessed by anyone who needs regardless of type, age, and educational experience. Then a learning model is needed that can combine learning models with technology, one of which is blended learning.

Blended learning combines various teaching methods and strategies that utilize virtual technology. Supporting media applications are very necessary in the blended learning learning process. One of them is Edmodo application media. In Edmodo application there are several features that can be included including text, graphics, animation, simulation, audio and video, so that it can help teachers and students collaborate, share ideas, communicate and interact with each other (Lahad et al., 2012). Media that can display video is a medium that can reduce difficulties for students to receive learning material. One of them is in understanding chemical material.

Chemistry is a branch of natural science that studies the properties, composition, structure, changes in structure and composition of substances, and the energy that accompanies changes (Licker, 2003). One branch of chemistry is analytical chemistry that analyzes the content of matter or compounds qualitatively and quantitatively (Wonorahardjo, 2013). Analytical methods are divided into two, namely conventional methods and modern methods (instruments). One modern analysis method is to use atomic spectroscopy analysis methods.

Atomic spectroscopy is a quantitative method of elemental analysis that measures based on absorption of light with a certain wavelength by metal atoms in a free state (Skoog et. al., 1982). In understanding the principle of atomic spectroscopy, a good understanding is needed regarding the phenomena of interaction between electromagnetic radiation and a substance which is abstract and difficult for students to imagine, such as the process of absorption, emission, scattering or fluorescence of light. This results in students having to think at a higher level, such as problem solving skills and constructing initial knowledge to discover new knowledge. Therefore, to make it

easier for students to find concepts independently, there is a need to implement constructivism-based learning strategies so as to maximize students' thinking abilities. One alternative strategy needed to improve students' understanding is to construct a broad knowledge of the application of constructivist-based learning strategies. One constructivist based learning is problem based learning (PBL).

PBL is a learning model that presents authentic and meaningful problem situations that can foster curiosity of students to conduct investigations (investigations) and inquiry (Arends, 2012: 396). Students are involved in solving problems through the stages of the scientific method by conducting investigations. The stages of PBL provide opportunities for students to question existing phenomena and actively build understanding of the concept of atomic spectroscopy with more coherent, flexible and systematic. The combination of blended learning with problem based learning has a theoretical foundation. PBL follows the principle of constructivism learning theory that uses a learning approach centered on student learning activities (Hmelo-Silver, 2004) and blended learning must be integrated with constructive learning (Donnelly, 2006). This can be used as a basis for the theoretical mix between blended learning and PBL, evidence that both of them support each other in creating a learning environment so as to improve student achievement and learning outcomes.

Learning outcomes are usually in the form of a score or value obtained after conducting an evaluation which can be said as an assessment of cognitive aspects. Student learning outcomes can also be influenced by several factors including the attractiveness and interest of students in learning a material that is self-regulation such as motivation, metacognition and behavior during the learning process. Based on Marzano's Taxonomy developed by Marzano & Kendall (2007) improvement in learning outcomes can be assessed from the process of learning and thinking of students. Marzano's taxonomy states three mental systems, namely the self-system, the metacognitive system, and the cognitive system. Marzano's taxonomy not only explains how students decide whether to be involved in a new assignment at a time, but also explains how information is processed after a decision has been made. Marzano's taxonomy examines the thinking process of students in understanding a material. Marzano's taxonomy is expected to increase awareness of the process of knowledge and how to compile or use knowledge, and increase one's involvement or someone's commitment to beliefs to be involved in a task.

2. Method

2.1 Research Design

This study aims to determine student learning outcomes based on the Marzano taxonomy after the implementation of the problem based learning model assisted by blended learning and problem based learning models on the material of atomic spectroscopy. The research design used in this study was a quasi-experimental design type pre-posttest group design and descriptive design. The quasi-experimental design

was used to see the effect of the Problem based learning model assisted by blended learning with the problem based learning model on cognitive aspects in the Marzano taxonomy. Descriptive research design was used to describe the effect of Problem based learning models assisted by blended learning on aspects of the self-system in the form of observation during online learning with Edmodo.

2.2 Population and Sample

The study population was students who took the course of Analysis Instrument I academic year 2018/2019 consisting of Offering G and Offering I at the State University of Malang. The sample is taken by convenience sampling (makeshift sampling), which is the selection of samples based on their availability in the population. One class is defined as an experimental class (which is taught by the blended learning model of problem based learning) and one control class (which is taught by the problem based learning model). Determination of the experimental class and control is carried out by lottery.

2.3 Data Collection

The stage carried out in data collection in the study initially prepared treatment instruments and measurement instruments. Treatment instruments consist of learning implementation plans, and student worksheets. The measurement instrument is a matter of testing atomic spectroscopic material. The treatment instrument and measurement instrument were validated by 3 chemistry lecturers at Malang State University. The validity of the items was tested on students who had taken the Instrument I Analysis course specifically on atomic spectroscopy material. After that, determining the 2 classes that will be used for the research are the experimental class (N = 31) and the control class (N = 31). Both classes were conducted pretest to measure students' initial knowledge and each class was introduced to the learning model they would do during the learning process 4 meetings. Then posttest was conducted to measure student cognitive learning outcomes. The self-system is measured through student activities while carrying out discussions on Edmodo in the experimental class.

2.4 Data Analysis

Statistical test analysis was used to determine whether or not there were differences in cognitive learning outcomes between students who were taught with problem based learning models and problem based learning model assisted by blended learning. Statistical test analysis using Independent sample t-Test analysis with the help of SPSS 24 for windows with a significance level α = 0.05 through testing the null hypothesis. Before testing the hypothesis, the analysis prerequisite test is carried out first, namely the test for normality and homogeneity.

Descriptive analysis is used to describe the process of implementing student learning with Problem based learning models and problem based learning model assisted by blended learning. The process of implementation in the experimental class

can be seen from the results of the observation data and the discussion process that took place during online learning through Edmodo.

3. Result

The results of student cognitive knowledge were analyzed from the pretest scores (test scores before learning) and posttest scores (test scores after learning) of atomic spectroscopy material given to the students of the experimental class and the control class. The pretest is intended to measure students' cognitive knowledge before learning atomic spectroscopy material. The recapitulation of students' cognitive knowledge pretest data in the experimental class and control class is presented in Table 1.

Table 1: The Recapitulation Data of Students Cognitive Knowledge Pretest

Class	Number of Students	The Lowest Score	The Highest Score	Average	Deviation Standart
Experiment	31	20	80	51,16	17,68
Control	31	25	80	50,42	14,56

Table 1 shows that the average pretest score of the experimental class students is 51.16 and the control class is 50.42. The difference between the two classes is not too much, which is 0.74.

Before testing hypotheses, pretest data on cognitive knowledge of students must be prerequisite tested first, namely, normality test and homogeneity test using SPSS 24 for Windows. In addition, the pretest data on students' cognitive knowledge must also be tested for similarities on average.

Table 2: The Result of Normality Test of Students Cognitive Knowledge Pretest

Class	Kolmogorov-Smirnov Normality Test		Conclusion
	N	Significancy	
Experimental	31	0,200	Normal
Control	31	0,200	Normal

Table 2 shows that the significance of the experimental class cognitive knowledge pretest data is 0.200 and the control class is 0.200 which is both greater than 0.050, so it is concluded that the cognitive knowledge pretest of the experimental class and control class was normally distributed.

Table 3: The Result of Homogeneity Test of Students Cognitive Knowledge Pretest

Statistic Levene	Significancy	Conclusion
1,180	0,282	Homogeneous

Table 3 shows that the significance of the data on the pretest cognitive knowledge of the two classes is 0.282 which is greater than 0.050, so it is concluded that the cognitive knowledge pretest of the two classes had a homogeneous variant.

Table 4: The Result of Similarity Test on Two Averages of Cognitive Knowledge

Class	N	Significancy	Conclusion
Experimental	31	0,858	Cognitive Knowledge Pretest Data in both experimental and control class are similar
Control	31		

Table 4 shows that the significance of the pretest cognitive knowledge of the two classes is 0.858 which is greater than 0.050, then the data on the pretest cognitive knowledge of the two classes are not different. So, it is concluded that the experimental class and the control class had the same initial cognitive knowledge.

Posttest is intended to measure cognitive knowledge of students after learning atomic spectroscopy material. The recapitulation of cognitive knowledge posttest data of students in the experimental class and control class can be seen in Table 5.

Table 5: The Recapitulation Data of Students Cognitive Knowledge Posttest

Class	Number of Students	The Lowest Score	The Highest Score	Average	Standard deviation
Experimental	31	65	100	85,90	10,71
Control	31	50	100	78,90	13,55

Table 5 shows that the average posttest cognitive knowledge score of experimental class students is 85.90 which is higher than the control class with score 78.90. Based on the average posttest result in the two classes, it shows that the cognitive knowledge of the experimental class students is higher than the control class. The comparison of the average posttest values of cognitive knowledge in the two classes referred to table 5 is presented in Diagram 1.

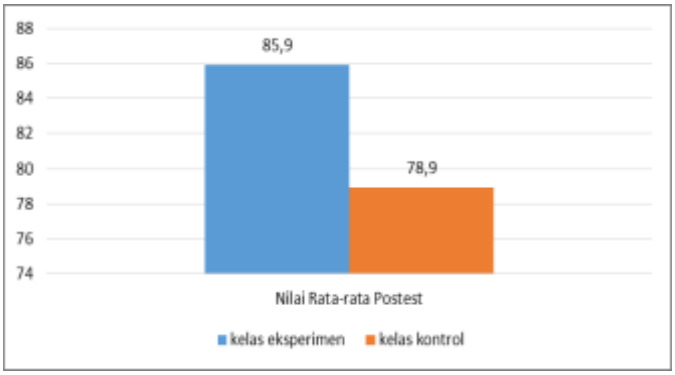

Diagram 1: The Comparison of the Average Posttest Scores of Students' Cognitive Knowledge

To find out more clearly whether the cognitive knowledge of the experimental class and the control class is different or not, so the hypothesis test is conducted. Before testing the hypothesis, the posttest data must also be pre-tested first. The result of the normality test of cognitive knowledge posttest in the experimental class and control class can be seen in Table 6.

Table 6: The Result of Normality Test of Students Cognitive Knowledge Posttest

Class	Kolmogorov-Smirnov Normality Test		Conclusion
	N	Significancy	
Experimental	31	0,160	Normal
Control	31	0,095	Normal

Table 6 shows that the significance of cognitive knowledge posttest data of experimental class is 0.160 and control class is 0.095 which are both greater than 0.050, so it is concluded that cognitive knowledge posttest of experimental class and control class were distributed normally, while the result of homogeneity test of cognitive knowledge posttest in the experimental and control class can be seen in Table 7.

Table 7: The Result of Homogeneity Test of Cognitive Knowledge Posttest

Statistic Levene	Significancy	Conclusion
0,812	0,371	Homogeneous

Table 7 shows that the significance of the cognitive knowledge posttest data in the experimental and control class is 0.812 which is greater than 0.050, so it is concluded that the cognitive knowledge posttest data had a homogeneous variance.

Based on the results of the prerequisite test data and posttest data on atomic spectroscopy material in the experimental class and control class, both classes were normally distributed and had homogeneous variances. Therefore, the appropriate hypothesis test used is the Independent Sample t-Test with a confidence level of 95% (α = 0.050), the learning model as an independent variable, and the posttest score as the dependent variable. The test result conducted by using the SPSS 24 program for windows is shown in Table 8.

Table 8: The Result of Independent Sample t-Test of Cognitive Knowledge

		Levene's Test for Equality of Variances		t-test for Equality of Means						
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
									Lower	Upper
Class	**Equal variances assumed**	0,812	0,371	2,257	60	0,028	7,000	3,101	0,796	13,204
	Equal variances not assumed			2,257	56,967	0,028	7,000	3,101	0,789	13,211

The result of hypothesis testing with the Independent Sample t-Test test has a significance value (0.028) which is smaller than 0.050, then H0 is rejected. Therefore, it can be concluded that the cognitive knowledge of the experimental class taught by the problem based learning model assisted by blended learning is higher than the control class which was taught by the problem based learning model.

4. Discussion and Conclusion

The results of the Independent Sample t-Test have a significance value (0.028) smaller than 0.050, it can be concluded that there are differences in student cognitive learning outcomes taught by the problem based learning model assisted by the blended learning strategy. That is, the problem based learning model assisted by blended learning has a significant impact on students' cognitive learning outcomes on atomic spectroscopy material compared to only applying problem based learning models. The cognitive learning outcomes of the experimental class students were higher than the control class. This is evidenced from the higher average score of the experimental class posttest (85.90) than the control class (78.90), and the experimental class gain score average of 0.71 which is in the high category while the control class is 0 ,57 including the medium category.

Based on the results of the above analysis, the cognitive learning outcomes of students who applied the problem based learning model assisted by blended learning were higher than just applying the problem based learning model, because there was learning with the use of the internet which is often called blended learning.

The learning process assisted by blended learning is not only applied when face-to-face learning is in class, but can also be applied when activities outside of face to face have internet access. Online learning prioritizes interaction between students and students or students with teachers in online discussions conducted by students in small groups or large groups so as to provide opportunities for students to apply concepts that have been obtained with unlimited time in class meetings. According to Sindu (2013) the atmosphere of online learning can educate students more actively in learning; students make designs and search for material with their own efforts.

Blended learning in PBL can help students solve a given problem topic. Students get information not only from the guidebook and explanation of the teacher but can be accessed from various sources using the internet network. So that students in groups are more critical in finding solutions to the right problems. Cognitive understanding refers to a learning environment that allows students to build and confirm the meaning of learning through reflection and discourse in critical inquiry (Garrison, Anderson & Archer, 2001:11).

In a study assisted by blended learning using the Edmodo application there are several features that can be included such as text, graphics, animation, simulation, audio, and video so that it can help students find information, solve problems, and understand atomic spectroscopic material. Based on the first observation shows the

difficulties of students in the instrument analysis material, especially in atomic spectroscopy, namely in understanding the parts and functions of the analysis instrument and understanding the workings of the analysis instruments through images. This can be overcome by providing learning resources in the form of textbooks and internet reading and providing media in the form of animated videos that are included in the Edmodo feature so that it can help students understand the workings of atomic spectroscopic instruments more easily. According to Sanger & Greenbowe (2000) that video and animation can be used to concretize abstract concepts that can improve students' understanding so that their learning outcomes increase.

The self-system based on the Marzano taxonomy is the process by which students identify emotional responses, examine perceptions and self-motivation, test self-benefits, decide whether to continue the current habits or enter to reflect into new activities. The student's self-system is seen from the observation sheet to observe the implementation of the atomic spectroscopy learning process with Edmodo on student activities.

The self-system during the learning process can also be said as self-regulated learning. Self-regulated learning is the ability where students actively participate in their own learning in terms of metacognition, motivation and learning behavior (Zimmerman, 1989). Students who have the ability to self-regulated learning are characterized as active students who efficiently control their learning experience in various ways, including organizing and seeking information to be learned, monitoring the thinking process and seeking help when they do not understand and believe in the abilities and values of their learning.

Students themselves start a learning effort directly to obtain the desired knowledge and expertise, without relying on teachers, parents or other people. Students who have self-regulated learning will tend to have better achievements or understanding. This is reinforced when students have self-regulated learning; they set higher academic goals for themselves, learn more effectively and excel in class (Wolters et al., 2003).

Self-regulated learning is an important factor in online learning or blended learning because students in the online environment need a higher level of interaction and collaboration, more proactivity and self-regulation in the student's personality. Self-regulated learning is an important factor in the success of online learning. Self-regulated learning capabilities are needed by students to be able to adjust and control themselves in the learning process and improve achievement in learning. Students who have high self-regulated learning will prefer activities that support their achievements.

The following is atomic spectroscopy learning which was taught using problem based learning and blended learning in the experimental class. The learning process begins with teachers and students by accessing www.edmodo.com using a personal account. Teachers log in with the choice of I am a teacher, while students log in to the choice of I 'm a student. Students will enter the online class "Off I Instrument Analysis" which the teacher has prepared before. Students in online classes have been divided

into their respective groups and can carry out learning activities, such as reading material, doing assignments, and discussing with other teachers and students.

The online learning activities that teachers can provide through Edmodo vary greatly. The teacher provides discussion material using the Note menu that is made to be shared with students. Teachers can attach learning files or website addresses to be shared with students as learning material. The teacher can make assignments for students to use the Assignment menu. Another activity that is carried out in online learning is that the teacher gives a quiz that can immediately find out the answer using the Quiz menu. Students can also discuss interactively or share information with all members' online learning with teachers and other friends.

Based on the results of the analysis there is an increase in students applying self-regulation activities during learning by involving various self-regulation abilities in aspects of metacognition, motivation, behavior, and learning participation using Edmodo. So that it can be said that students are increasingly active in their learning activities. This shows the compatibility with the relationship theory between the blended learning model and self-regulated learning in creating a learning environment that makes students apply various abilities based on aspects of motivation, metacognition and behavior aspects to achieve learning goals and improve learning achievement.

5. Conclusions and Recommendations

5.1 Conclusions

Based on the results of this study it can be concluded that the application of a blended learning problem based learning model can improve cognitive learning outcomes. The cognitive learning outcomes of students who were taught by using a blended learning model of problem based learning were higher than those in the class that were taught with a problem based learning model.

The application of the problem based learning model assisted by blended learning can affect students' self-systems based on the Marzano taxonomy. This can be seen in each phase of the learning model based on self-regulation activities during learning by involving various self-regulation abilities on aspects of metacognition, motivation, behavior, and learning participation using Edmodo.

5.2 Recommendations

The results showed that the problem based learning model was assisted by blended learning to improve student learning outcomes based on the marzano taxonomy on atomic spectroscopy material. Therefore, blended learning-assisted problem based learning models are recommended to be applied in learning instrument analysis on other material that has the same characteristics as atomic spectroscopic material.

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