Application of Model Problem Based Learning Assisted Blended Learning on Cognitive Knowledge of University Students in Analytical Chemistry Instrument

Varisky Abraham Dumanaw
Universitas Negeri Malang
Surjani Wonorahardjo
Universitas Negeri Malang
Hayuni Retno Widarti
Universitas Negeri Malang

E-mail address: varisky.dumanaw21@gmail.com

Abstract: This study aims to determine differences in cognitive knowledge of students who are taught with a problem based learning aided by blended learning on the material of the uv-vis spectroscopy. This study uses a cognitive knowledge test instrument that has content validation of 87,92% with very good criteria and a Cronbach Alpha reliability coefficient of 0.653 in the high category. The research was conducted at the Universitas Negeri Manado in two classes. The experimental class was taught by the problem based learning model assisted by blended learning and the control class that was taught with a problem based learning model. The results showed a statistically significant difference in students' cognitive knowledge in both study classes (α = 0.050).

Keywords: Blended Learning, Cognitive Knowledge, Problem Based Learning, UV-Vis Spectroscopy

Chemistry is a branch of natural science that studies the nature, composition, structure, changes in the structure and composition of substances, and the energy that accompanies the changes (Licker, 2003). One branch of chemistry is analytical chemistry that analyzes the content of matter or compounds qualitatively and quantitatively (Wonorahardjo, 2013). Qualitative analysis aims to find out what components are contained in a sample of material, but also includes in determining the structure or functional groups and their characteristics. Quantitative analysis aims to determine the relative number of constituent components or material samples. The content of matter or compounds can be analyzed through analytical methods. Analytical methods are divided into two, namely conventional methods and modern methods (instruments). One modern analytical method is the molecular spectroscopy analysis method and subchapters in this material, namely UV-Vis spectroscopy.

UV-Vis spectroscopy at the Department of Chemistry, Manado State University, is taught in Analytical Chemistry. Learning spectroscopic is not only by memorizing the notion of a concept and its application, furthermore, it takes a thought process in understanding it. Therefore, to facilitate students in understanding the concept, it is necessary to apply a constructivist-based learning strategy that is able to make students build their knowledge to solve a problem, one of which is the Problem Based Learning model (PBL).

PBL is built on the principles of constructive, independent contextual, and collaborative. This contextual principle has its foundation on the philosophy of learning constructivism. Constructivism emphasizes that learning does not merely memorize but constructs the knowledge in his mind. PBL is an interactive and innovative learning model that can provide active learning conditions for students when learning by involving students to explore contextual problems related to daily life and solve them through stages of the scientific method (Arends, 2012). PBL is also expected to be a useful and useful learning model for the future in the field of education. Future education will be flexible (open), open, and accessible to anyone, regardless of gender, age, or educational experience (Rusman et al, 2012) . This is in line with the opinion (Rusman et al, 2012) that future education will be more determined by the information network that allows for interaction and collaboration, so that the influence of information and communication technology in the world of education is increasingly felt in line with the shift in learning patterns from conventional face-to-face to a more open and media direction for education. Therefore, we need a learning model that can combine learning with technology, one of which is a blended learning model. The blended learning model is one of the learning methods that meets the rapid development of science and technology criteria, plus also in the PBL learning model problems related to learning can be accessed through online media for that one learning that is suitable to be integrated with PBL is blended learning. Blended learning combines various teaching methods and strategies that utilize virtual technology. Blended learning can be applied not only during the face-to-face learning process, but also when activities outside face-to-face, both in the school environment, at home, and in other places with internet access (Dobrzański & Brom, 2008) The use of learning with blended learning can increase student learning time, simplify and accelerate the communication process between teachers and students (John et al., 2003). Blended learning has other advantages, namely (1) students can control learning activities independently through direct feedback (Strambi & Bauvet, 2003: 81), (2) students have more opportunities to interact, get feedback directly so as to improve learning and performance directly independent (Schraw, 2007: 169), (3) higher learning outcomes compared to conventional learning. Media applications that support are indispensable to the learning process of blended learning. One of them is Edmodo media application.

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 to collaborate with each other, share ideas, communicate and interact. Media that can display video is media that can reduce difficulties for students to receive learning material. Conceptual visualization in the form of pictures, animations, videos and analogies really helps students in understanding chemical material. Based on the Higher Education Curriculum (2015), one of the competencies that must be possessed by students is to be able to apply logical, critical, systematic and innovative thinking in the context of the development or implementation of science and technology and be able to carry out a process of self-evaluation of work groups under its responsibility, and manage the development of work competencies independently.

Competence in education today is the ability to work together in groups, the ability to solve problems, the ability to direct oneself, think critically, master technology and be able to communicate effectively (Kaku, 2011).Menurut Bishop dalam Rusman et. al., (2012), Future education will be flexible, open, and accessible to anyone who needs it regardless of factors of type, age, or educational experience. This is in line with Mason's opinion in Rusman et. al., (2012) that future education will be more determined by information networks that allow for interaction and collaboration. The influence of information and communication technology in the world of education is increasingly felt in line with the shift in learning patterns from conventional face-to-face towards more open and media education. Students need to be equipped with knowledge, skills, attitudes, and self-systems to achieve learning goals in order to improve learning outcomes.

METHOD

The study design was quasi-experimental in two groups (quasi experimental pretest-posttest). The sample selection is done by convenience sampling technique in Manado State University students. Obtained two research classes, namely the experimental class taught with a problem based learning model assisted by blended learning (N = 32) and the control class taught with a problem based learning model (N = 32). Learning outcomes tests are given at the beginning of learning and at the end of learning. The schematic of the research design is presented in table 1.

Table 1. Research Design

Subject	Pretest	Treatment	Posttest
Experiment Class	O_1	X	O_2
Control Class	O_1	-	O_2

Information:
X : learning by using problem based learning models assisted by blended learning
- : learning by using problem based learning models
O_1 : pretest cognitive knowledge
O_2 : posttest cognitive knowledge

The design of this study uses two classes, namely classes taught with problem based learning models assisted by blended learning (experimental classes) and classes taught with problem based learning models (control classes).

RESULTS

The results of students' cognitive knowledge were analyzed using validated and reliable test questions and then given to students of the experimental class and the control class. Cognitive knowledge questions aim to find out the cognitive abilities of students about uv-vis spectroscopy learning in the experimental and control classes. Recapitulation of students' cognitive knowledge pretest data in the experimental class and the control class is presented in table 2. Tables, figures and formulas can be written in one full column, or two columns if necessary. Place pictures and tables on the top or bottom of the text on each page. Tables and images should not be placed between paragraphs.

Table 2. Pretest Data Recapitulation Of Student Cognitive Knowledge

Class	N	Lowest Value	Highest Value	Average	Standard Deviation
Experiment	32	24	77	56,72	14,29
Control	32	30	75	54,31	11,03

Table 2 shows the results of the cognitive knowledge pretest in the experimental class and the control class where the average value in the experimental class was 56.72 and the control class 54.31. The difference between the two classes is not too large at 2.41 which means there is no significant difference in ability between the experimental class and the control class or it can be concluded that the experimental class and the control class have the same initial ability.

Before testing the hypothesis, the student's cognitive knowledge pretest data must be tested in advance, that is, a normality test and a homogeneity test using SPSS 24 for windows. In addition, the student's cognitive knowledge pretest data must also be tested for the similarity of two averages.

Table 3. Data Normality Test Results for Student Cognitive Knowledge Pretest

Class	Normality Test *Kolmogorov-Smirnov*		Conclusion
	N	Significance	
Experiment	32	0,200	Normal
Control	32	0,200	Normal

Table 3 shows that the significance of the cognitive knowledge pretest data of the experimental class (0.200) and the control class (0.200) are both greater than 0.050, so it is concluded that the cognitive knowledge pretest of the experimental class and the control class is normally distributed.

Table 4. Homogeneity Test Results of Student Cognitive Knowledge Pretest Data

Levene Statistik	Significance	Conclusion
1,719	0,195	Homogen

Table 4 shows that the significance of the cognitive knowledge pretest data of both classes (0.195) is greater than 0.050, so it can be concluded that the cognitive knowledge pretest of the two classes has a homogeneous variant.

Table 5. Test Results for Similarity of Two Average Cognitive Knowledge

Class	N	Significance	Conclusion
Experiment	32	0,195	Not Different
Control	32		

Table 5 shows that the significance of the pretest cognitive knowledge of the two classes (0.195) is greater than 0.050, so the pretest data of the cognitive knowledge of the two classes is not different. Thus, it was concluded that the experimental class and the control class had the same initial cognitive knowledge.

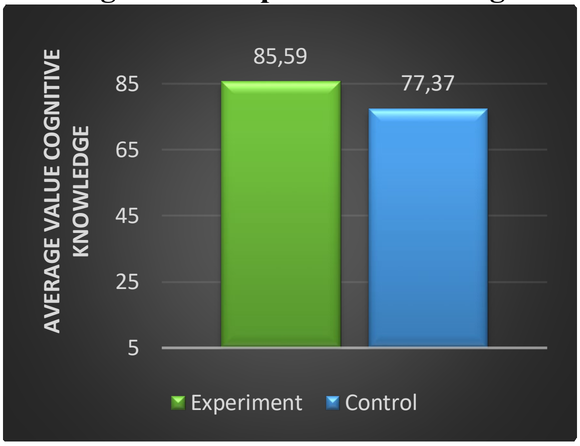
Posttest aim to measure the cognitive knowledge of students after learning atomic spectroscopy material. Recapitulation of students' cognitive knowledge posttest data in the experimental class and the control class can be seen in Table 6.

Table 6. Posttest data recapitulation of student cognitive knowledge

Class	The Number of Student	Lowest Value	Highest Value	Avarage	Standard Deviation
Exsperiment	32	75	100	85,59	8,03
Control	32	65	92	77,37	7,35

Table 6 shows the results of cognitive knowledge posttest in the experimental class and the control class where the average value in the experimental class is 85.99 higher than the control class that is 77.37. This shows that the cognitive knowledge of students after learning in the experimental class is higher than the control class. The results of comparison of cognitive knowledge of the experimental and control classes can be seen in Figure 1.

Figure 1 Comparison of Average



Metacognitive Awareness of Students

To find out more clearly whether the cognitive knowledge of the experimental class and control class students is different or not, a hypothesis test is conducted. Before testing the hypothesis, the posttest data must also be tested for prerequisites first. The results of normality test data posttest cognitive knowledge of the experimental class and the control class can be seen in Table 7.

Table 7. Test Results Normality of Posttest data Student Cognitive Knowledge

Class	Kolmogorov-Smirnov Normality Test		Conclusion
	N	Significance	
Experiment	31	0,200	Normal
Control	31	0,200	Normal

Based on the prerequisite test results of pretest data and posttest data on UV-Vis Spectroscopy in the experimental class and the control class, the two classes are normally distributed and have homogeneous variance. Therefore, the appropriate hypothesis test is used is the Independent Sample t-Test with a confidence level of 95% ($\alpha = 0.050$), the learning model as the independent variable, and the posttest value as the dependent variable. Test results with the help of the SPSS 25 for Windows

DISCUSSION

Application of Model Problem Based Learning Assisted Blended Learning on Cognitife Knowledge.

Hypothesis test results with the Independent Sample t-Test have a significance value (0,000) less 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 taught by the problem based learning model.

The combination of Blended Learning with Problem Based Learning (PBL) has a theoretical foundation. Blended Learning and PBL support each other in face-to-face learning and online learning (Delialioglu & Yildirim, 2007). PBL follows the principles of constructivism learning theory that uses a learning approach centered on student learning activities (Cindy E. Hmelo-Silver1, 2004). Other information states that blended learning must be integrated with constructive learning (Donnelly, 2006). This can be used as a basis for a theoretical blend of blended learning and PBL, evidence that the two support each other in creating a learning environment that can attract students' interests so that they can improve student learning outcomes.

The results of hypothesis testing with the Independent Sample t-Test have a significance value (0,000) smaller than 0.050, it can be concluded about the differences in cognitive learning outcomes of students who are taught with problem-based learning models assisted by blended learning and problem based learning models. That is, the problem-based learning model assisted by blended learning has a significant influence on student learning outcomes in the cognitive aspects of atomic spectroscopy material compared to the problem-based learning model. This is because it is learning with the use of the internet which is often referred to as e-learning or blended learning.

Blended learning is a combination of learning offline (face to face) and online to maximize the learning process. learning assisted by Blended learning is not only applied during the face-to-face learning process in the classroom but can also be applied when activities outside face to face with internet access. Online learning prioritizes interaction between students and students or student and teachers in online discussions conducted by students in small groups or online discussions with all students in large groups so as to give students the opportunity to apply concepts that have been obtained with unlimited time in class meetings.

Blended learning in PBL can assist students in making it easier to solve a given problem topic. Students get information not only from teacher manuals and explanations but can be accessed from various sources using the internet network. So that students in groups are more critical in finding the right solution to problems. Students are able to control their cognitive activities such as developing a learning environment and choosing strategies to solve problems, monitor the problem solving process and evaluate their entire performance. These conditions help students in the process of understanding construction in each of the phases of the problem based learning model. So that resulted in increased student learning outcomes.

CONCLUSION

Based on the results of this study it can be concluded that the application of problem based learning models assisted by blended learning can improve students' cognitive knowledge. Cognitive knowledge of students who are taught by using a model of problem based learning that is assisted by blended learning is higher than in classes that are taught with a model of problem based learning.

REFERENCES

Arends, R. I. (2012). *Learning to Teach. 9th Edition*.

Cindy E. Hmelo-Silver1, 2. (2004). Problem-Based Learning: What and How Do Students Learn? *Educational Psychology Review*, *16*(3), 235–266.

Delialioglu, O., & Yildirim, Z. (2007). Students' perceptions on effective dimensions of interactive learning in a blended learning environment. *Educational Technology and Society*, *10*(2), 133–146.

Dobrzański, L. A., & Brom, F. (2008). *E-learning on the example of materials science*. *29*(1), 99–102.

Donnelly, R. (2006). Blended problem-based learning for teacher education: Lessons learnt. *Learning, Media and Technology*, *31*(2), 93–116. https://doi.org/10.1080/17439880600756621

John, E., Kay, M., & Lynch, H. M. (2003). E-learning: emerging issues and key trends. In *Flexible Learning* (Issue September).

Kaku, M. (2011). Title Page Copyright Predicting the Next 100 Years. *Reading*.

Licker. (2003). *Dictionary of Chemistry*.

Rusman, Kurniawan D., & R. C. (2012). *Pembelajaran Berbasis Teknologi Informasi dan Komunikasi: Mengembangkan Profesionalitas Guru.* PT. Rajagrafindo Persada.

Schraw, G. (2007). The use of computer-based environments for understanding and improving self-regulation. *Metacognition and Learning*, *2*(2–3), 169–176. https://doi.org/10.1007/s11409-007-9015-8

Wonorahardjo, S. (2013). *Pengantar Kimia Analitik Modern*.