THE EFFECTIVENESS OF ICT-BASED PROBLEM BASED LEARNING IN IMPROVING HOTS

Daliana Fehabutar, Budi Jatmiko

Jurusan Fisika, Fakultas Matematika dan Ilmu Pengetahuan Alam, Universitas Negeri Surabaya
Email: dalianafehabutar@mhs.unesa.ac.id

Abstract

This study aimed to describe the effectiveness of ICT-based Problem Based Learning in improving HOTS learners. This type of research is pre experimental design consisting of two experimental class with the same treatment. The analysis technique used is the paired t test to test differences in the pre-test and post-test, n-gain analysis to look at the criteria for the increase in value, as well as independent t test to see the average gain consistency both experimental classes. ICT-based PBL models is effective when the value of the post-test was higher than the pre-test, the average value of n-gain minimal medium category, and the average gain of both the experimental class is no different. The conclusion of the research is ICT-based Problem Based Learning is effective in improving HOTS.

Keywords: Problem Based Learning, ICT, HOTS.

Abstrak

Penelitian ini bertujuan untuk mendeskripsikan keefektifan *Problem Based Learning* berbasis ICT dalam meningkatkan HOTS peserta didik. Jenis penelitian yang digunakan adalah *pre experimental design* yang terdiri dari dua kelas eksperimen dengan perlakuan yang sama. Teknik analisis yang digunakan adalah uji t berpasangan untuk menguji perbedaan nilai *pre-test* dan *post-test*, analisis *n-gain* untuk melihat kriteria peningkatan nilai, serta uji t *independent* untuk melihat kekonsistenan rata-rata *gain* kedua kelas eksperimen. Model PBL berbasis ICT dikatakan efektif apabila nilai *post-test* lebih tinggi daripada nilai *pre-test*, nilai rata-rata *n-gain* minimal berkategori sedang, dan kedua rata-rata *gain* kedua kelas eksperimen tidak ada beda. Kesimpulan yang diperoleh dari hasil penelitian dan analisis, model PBL berbasis ICT efektif dalam meningkatkan HOTS Peserta didik.

Kata kunci: *Problem Based Learning*, Berbasis ICT, HOTS.

INTRODUCTION

The times and civilization are always accompanied with the increasing demands of the world in every individual. 21st century is currently running demanding critical thinking skills, creativity, innovation, and ability to solve problems (P21, 2019). Speaking about the idea or thought, then there is a term in education, Higher Order Thinking Skills (HOTS) or higher-level thinking. High-level thinking is thinking at a higher level than just memorizing facts or say something to someone exactly like how something is presented (Heong *et al.*, 2011). HOTS includes a lot of the thinking process, such as critical thinking (Brookhart, 2010), logical, reflective, metacognitive and creative thinking (King *et al.*, 2011). High-level thinking skills by Pohl (1999) involves the ability of analysis, evaluation, and creation. High-level thinking skills by exposure above in accordance with what is needed in order to compete in the competitive 21st century and the industrial revolution 4.0.

Answering the great challenges of education in Indonesia should be able to produce the human resources (HR) quality with menggembangkan its potential. Answer from Indonesia is the curriculum in 2013 which is a refinement of the previous curriculum that has been evaluated and adapted to the needs of the nation in order to compete in this extraordinary era (Wulandari, 2016). The concept of learning from 2013 curriculum requires students to have a high level thinking skills (Higher Order Thinking Skills). Curriculum 2013 adopting the revised Bloom's taxonomy and divide into 6 levels of the thinking process. Three levels of thinking that is part of high-level thinking skills or higher order thinking that analyze aspects (C4), aspect of evaluating (C5), and aspect creates (C6), while the three other levels, namely the aspects given (C1), aspect understood (C2), and aspects of implementing (C3) included in the stages of intellectual thinking low level or lower order thinking (Anderson *et al.*, 2001; Schraw & Robinson, 2011). With 13 curriculum is expected to create a generation that has a high level thinking skills.

Istiyono study (2017) showed that the high-level thinking skills of learners one high school in Indonesia are in the category of very low 4.75%, a low 40.30%, 33.45% moderate, high and very high 19.5% 2%. The results are still dominated by low- and moderate category were also obtained from research shidiq *et al.* (2015) which showed 7.4% of students have a high level thinking skills are very low, 25.2% low, 52.7% moderate and 14, 7% higher and 0% very high. The fact that there are different from the expectations that learners SMA in Indonesia still does not meet the needs of HOTS. Based on preliminary studies, learners are able to score more than 50 only 26.38%, while the remaining 73.62% scored below 50 out of the total 100.

One of the things that cause low HOTS is a teacher teaches learners to approach one direction (conventional). On learning of the direction learners less given the opportunity to use pemikiranya further, so that when

faced with a problem that requires a high level thinking skills, such as in-depth analysis or reasoning, learners will find it difficult. Based on the assumption that it is necessary for teachers to use learning to mengantarakan learners towards higher level thinking skills (Marjan *et al.*, 2014: 3). One alternative solution that is felt to improve learners HOTS is a model of Problem Based Learning (PBL) based on ICT.

The learning model Problem Based Learning (PBL) is an active learning model that can accommodate learners to develop HOTS (Grabinger, 2002). PBL models can maximize the ability of learners to construct cognitive structures through the process, principles and basic mechanisms of the phenomenon, which help them in the search for a solution to overcome the problems faced (Schmidt, 1993). In addition to effective learning model, the learning process is also required media that support so that all the things that are abstract in the lesson can be visualized. In Permendikbud No. 22, 2016, on learning in primary education and secondary education states that the lesson plan prepared by considering the application of information and communication technology (Information and Communication Technology, ICT) is an integrated, systematic and effective in accordance with the circumstances. So as to maximize the learning process in the classroom instructional media needed to apply ICT.

Problem Based Learning (PBL) is a learning model that are learner-centered and focused on the issue, in which learners engage in authentic and unstructured problems (Savery, 2015). Learners acquire new knowledge by identifying the knowledge gaps between their current level of knowledge and level of knowledge needed to solve a given problem (Barrows, 1996; Savery, 2015). Problem Based Learning (PBL) is a learning approach that is used to stimulate the ability of learners to higher level thinking in siatuasi oriented to real-world problems, including how to learn (Abraham, Muslims and Nur Mohamad, 2000: 2). Intended pedagogical value of the PBL itself includes: exposes learners to the real problem, HOTS, interdisciplinary learning, independent learning, skills to dig up information, teamwork and communication obtained during the learners work together, discuss, compare, review and debate what they have learned (Patrick, 2009). Thus PBL directing learners to develop thinking ability is not just learning materials only. The emphasis in the PBL is on giving problems which were solved by learners with HOTS. Syntax PBL namely (1) Orientation of students to the problem; (2) Organize students to learn; (3) To lead the investigation of individuals and groups; (4) develop and present work; (5) analyze and evaluate the problem solving process (Arends, 2012). teamwork and communication obtained during the learners work together, discuss, compare, review and debate what they have learned (Patrick, 2009). Thus PBL directing learners to develop thinking ability is not just learning materials only. The emphasis in the PBL is on giving problems which were solved by learners with HOTS. Syntax PBL namely (1) Orientation of students to the problem; (2) Organize students to learn; (3) To lead the investigation of individuals and groups; (4) develop

and present work; (5) analyze and evaluate the problem solving process (Arends, 2012). teamwork and communication obtained during the learners work together, discuss, compare, review and debate what they have learned (Patrick, 2009). Thus PBL directing learners to develop thinking ability is not just learning materials only. The emphasis in the PBL is on giving problems which were solved by learners with HOTS. Syntax PBL namely (1) Orientation of students to the problem; (2) Organize students to learn; (3) To lead the investigation of individuals and groups; (4) develop and present work; (5) analyze and evaluate the problem solving process (Arends, 2012). reviewing and debating what they have learned (Patrick, 2009). Thus PBL directing learners to develop thinking ability is not just learning materials only. The emphasis in the PBL is on giving problems which were solved by learners with HOTS. Syntax PBL namely (1) Orientation of students to the problem; (2) Organize students to learn; (3) To lead the investigation of individuals and groups; (4) develop and present work; (5) analyze and evaluate the problem solving process (Arends, 2012). reviewing and debating what they have learned (Patrick, 2009). Thus PBL directing learners to develop thinking ability is not just learning materials only. The emphasis in the PBL is on giving problems which were solved by learners with HOTS. Syntax PBL namely (1) Orientation of students to the problem; (2) Organize students to learn; (3) To lead the investigation of individuals and groups; (4) develop and present work; (5) analyze and evaluate the problem solving process (Arends, 2012). Syntax PBL namely (1) Orientation of students to the problem; (2) Organize students to learn; (3) To lead the investigation of individuals and groups; (4) develop and present work; (5) analyze and evaluate the problem solving process (Arends, 2012). Syntax PBL namely (1) Orientation of students to the problem; (2) Organize students to learn; (3) To lead the investigation of individuals and groups; (4) develop and present work; (5) analyze and evaluate the problem solving process (Arends, 2012).

Information and Communication Technology (ICT) or in English is Information and Communication Technology (ICT) includes digital equipment and hardware (hardware) such as a smartphone, laptop, pad or tablet, and other technologies such as audio-visual equipment, projectors, Smart boards, and various another technology for use in education, development, information, and business trips. Including the Internet, blended learning, online learning, social media, cloud computation, learning management systems, email, and online learning opportunities (Johnson *et al.*, 2013).

Definition of Higher Order Thinking Skills (HOTS) and the different sub-categories according to experts. HOTS can be defined as the challenges and the development of the use of the mind (Newmann, 1991). Learners can improve HOTS to actively participate in activities such as making a hypothesis, collect evidence, and make arguments (Lewis & Smith, 1993). According to Bloom's taxonomy (1956), HOTS is a step beyond the understanding and application of a lower level of knowledge. Therefore, analyzing, synthesizing, and

Daliana Fehabutar, Budi Jatmiko

evaluating can be classified as HOTS. Once revised by Anderson *et al.* (2001), the synthesis is replaced by recreating and levels are above evaluate because it deemed the ultimate goal of education is to create a product (Krathwool, 2002). Analyzing (C4) means the ability to identify the components of the information and ideas for building relationships between elements (Lord & Baviskar, 2007). Evaluating (C5) is defined as the ability to judge the value of material based on the criteria of definite and enable learners to assess the data and experimental results later confirmed the conclusions obtained, while creating (C6) refers to the creation of something new, coherent or products are original through a combination various elements (Krathwohl, 2002). Based on the illustration above phrase, critical thinking and logical thinking can be combined to form a category of 'analyzing', problem solving skills and decision-making can be combined to form a category 'evaluate' (Bloom, 1956; Hershkowitz, 2001),,

METHOD

This type of research is pre experiment to describe the effectiveness of Problem Based Learning models based on ICT in improving HOTS high school learners.The design study is one group pre-test and post-test, the design of this study design using two experimental groups with momentum and impulse delivered material using problem based learning models based on ICT. Research scheme can be described as follows.

Table 1. Research Scheme

Group	Pre-test	Treatment	Post-test
experiment 1	O1	X	O2
experiment 2	O3	X	O4

Information:
O1 : Pre-test before being treated
O2 : Post-test after being treated
O3 : Pre-test before being treated
O4 : Post-test after being treated
X   : Treatment of ICT-Based Problem Based Learning

After getting the pre-test and post-test of the experimental group, were tested using a paired t-test and analysis of n-gain, Then the gain of both classes are tested by independent t test to see the consistency of the two classes.

RESULTS AND DISCUSSION

Based on the results obtained from the pre-test and post-test two experimental classes, paired t test was then carried out to see an increase on its HOTS. The following table is the results of the paired t test.

Table 2. The Paired T-test

No.	Class	t	t_{tabel}	Conclusion
1	experiment 1	14.662	2,052	H_0 rejected
2	experiment 2	15.821	2,052	H_0 rejected

Based on Table 2, the value of $t > t_{table}$ for each class. That is, the post-test value is significantly higher than the pre-test statistically in both classes. In addition, the pre-test and post-test were also analyzed with n-gain analysis to look at the criteria of being upgraded. The following table is the results of the analysis of n-gain both classes.

Table 3. Analysis of Average N-Gain

No.	Class	$\langle g \rangle$	Category
1	experiment 1	0.44	medium
2	experiment 2	0.45	medium

Based on Table 3, the average n-gain both classes are in the middle criteria. So that both qualify for HOTS said to be effective in improving learners.

After noting that the two classes using ICT-based PBL effective in improving HOTS, the second gain similarity class average tested using independent t test to see the consistency. The following table is the results of the independent t test both classes.

Table 4. T-independent Test

No.	Class	t	$-t_{tabel}$	Conclusion
1	experiment 1	-1.95	-2.00488	H_0 accepted
2	experiment 2			

Based on Table 4, the value $-t_{tabel} < t < t_{table}$, which means there is no difference in the average value of gain classroom experiment 1 and experiment 2. So by looking at these results, the gain of the second class consistently.

This is according to research conducted by several researchers associated influence of PBL against HOTS students (Kim, 2017; Dwi *et al.*, 2012; Gilani *et al.*, 2017; Kek & Huijser, 2011) that the Problem Based Learning (PBL) is one learning approaches are used to stimulate the ability of learners to higher level thinking in siatuasi oriented to real-world problems, including how to learn. Increased HOTS students in the experimental class compared to the control class was also in accordance with what was presented by Patrick (2009) and Hali (2016) for HOTS also be one of the intended focus of the pedagogical value in learning to use the model of PBL. PBL which has distinctive features make the problem-oriented learners recall previous knowledge has he had, then in small grub grub they develop knowledge-knowledge to analyze a given problem (Schmidt, *et al.*, 2011). Provision of learning problems in implementing PBL models also help in increasing HOTS by encouraging learners to mengkonstruktsi cognitive structures through the process, principles and basic mechanisms of the phenomenon, which help them in the search for a solution to overcome the problems faced (Schmidt, 1993). The use of ICT to show the problem is to add the interest of students in learning, so that they are increasingly eager to accomplish something that previously unresolved (Rotgans & Schmidt, 2011) or in other words, the motivation to learn them increased with the given problem (Huang, 2012). Motivation alone makes the learners will be actively engaged in learning and make learning more meaningful. Another advantage of PBL is to make the students build on what they have or what they have learned to other contexts direction

(Dym, *et al.*, 2005). PBL in one syntax also includes evaluating skills are included in the indicator HOTS. In which students were asked to make decisions and validate the choices made (Kunberger, 2013). Given this, the students will be trained to rethink assumptions that came into his mind, then call back memories that exist in long-term memory related assumptions so that they can make the right choice. In addition to making learners redial memory, PBL also train students to remember how to think or prepare his knowledge to problems in the future (Wood, 2015; Yassin *et al.*, 2011). PBL also has a positive effect on your creative thinking of students, because in the learning process are trained for independent study (Leary, 2012; Thomas, 2013; Putri & Jatmiko, 2018; Komariyah & Setyarsih, 2013) so as to feel more confident in making the ideas or thoughts in resolving a problem (Yoon, *et al.* 2012; Sihaloho & Ginter, 2017; Argaw, et al., 2017). PBL also train the students not only solve the problem but cut the problem so that the scope of the assumptions he thinks does not get stretched out of context (Dawson & Titz, 2013). In this case, the model PBL really covers all areas of HOTS indicator.

CONCLUSION

Based on the results of research that has been done, it can be concluded that the model of ICT-Based Problem Based Learning effective in improving HOTS learners through the paired t test, n-gain analysis and independent t test.

REFERENCES

Anderson, L. W., Krathwohl, D. R., Airasian, P.W., Cruikshank, K.A., Mayer, R.E., Pintrich, P.R., Raths, J., & Wittrock, M.C. (2001). *A Taxonomy for Learning, Teaching, and Assessing: A Revision of Bloom's Taxonomy of Educational Objectives*. (L. W. Anderson & D. R. Krathwohl, Eds.). New York: Longman.

Arends, R. I. (2012). *Learning to Teach*. New York: Mc. Graw-Hill.

Argaw, A. S., Haile, B. B., Ayalew, B. T., & Kuma, S. G. (2017). The Effect of Problem Based Learning (PBL) Instruction on Students' Motivation and Problem Solving Skills of Physics. *Eurasia Journal of Mathematics, Science and Technology Education*, 13(3), 857–871. https://doi.org/10.12973/eurasia.2017.00647a

Barrows, H. S. (1996). Problem-based learning in medicine and beyond: A brief overview. *New Directions for Teaching and Learning*, 68, 3–12.

Brookhart, S. M. (2010). *How to assess higher-order thinking skills in your classroom*. Alexadria: Association for Supervision and Curriculum Development.

Dawson, M., & Titz, K. (2012). Problem-Based Learning as A Strategy to Teach Service Quality: An assessment of on-line reviews. *Journal of Hospitality & Tourism Education*, 24(2–3), 67–72. https://doi.org/10.1080/10963758.2012.10696672

Grabinger, S., & Dunlap, J. C. (2002). *Problem-Based Learning as an Example of Active Learning and Student Engagement. In T. Yakhno (Ed.), Advances in Information Systems (pp. 375–384)*. Berlin, Heidelberg: Springer Berlin Heidelberg.

Heong, Y. M., Othman, W. B., Yunos, J. Bin, Kiong, T. T., Hassan, R. Bin, Mohaffyza, M., & Mohamad, B. (2011). The Level of Marzano Higher Order Thinking Skills among Technical Education Students. *International Journal of Social Science and Humanity*, 1(2). https://doi.org/10.7763/IJSSH.2011.V1.20

Istiyono, E. (2017). The analysis of senior high school students' physics HOTS in Bantul District measured using PhysReMChoTHOTS. In *AIP Conference Proceedings 1868*, 070008. https://doi.org/10.1063/1.4995184

Johnson, L., Adams Becker, S., Cummins, M., and Estrada, V. (2013). Technology Outlook for Norwegian Schools 2013-2018: An *NMC Horizon Project Regional Analysis*. Austin, Texas: The New Media Consortium.

King, F. J., Goodson, L., & Rohani, F. (2010). *Assessment & evaluation educational services program: Higher-order thinking skills*. Washington, DC: A publication of the Educational Services Program.

Komariyah, Nuril & Setyarsih, Woro. (2013). Penerapan Model Pembelajaran Problem Based Instruction untuk Melatihkan Keterampilan Berpikir Kritis Siswa pada Materi Kalor Kelas X SMA. *Jurnal Inovasi Pendidikan Fisika,* 02(03), 246-250.

Krathwohl, D. R. (2002). A revision of Bloom's taxonomy: An overview. *Theory into Practice*, 41(4), 212–218.

Kunberger, T. (2013). Revising a design course from a lecture approach to a project-based learning approach. *European Journal of Engineering Education*, 38(3), 254–267. https://doi.org/10.1080/03043797.2013.800020

Leary, Heather M. (2012). Self-Directed Learning in Problem-Based Learning Versus Traditional Lecture-Based Learning: A Meta-Analysis. *All Graduate Theses and Dissertations*.

Lewis, A., & Smith, D. (1993). Defining higher order thinking. *Theory into Practice*, 32(3), 131–137.

Marjan, J., Arnyana, I. B. P., & Setiawan, I. G. A. N. (2014). Pengaruh Pembelajaran Pendekatan Saintifik Terhadap Hasil Belajar Biologi dan Keterampilan Proses Sains Siswa MA Mu ' allimat

NW Pancor Selong Kabupaten Lombok Timur Nusa Tenggara Barat. *E-Journal Program Pascasarjana Universitas Pendidikan Ganesha, 4*.

Newmann, F. M. (1991). Promoting higher order thinking in social studies: Overview of a study of 16 high school departments. *Theory & Research in Social Education*, 19(4), 324–340.

Nugroho, R. A. (2018). HOTS - *Kemampuan Berpikir Tingkat Tinggi: Konsep, Pembelajaran, Penilaian, dan Soal-Soal*. Jakarta: Gramedia Widiasarana Indonesia.

P21 - The Partnership for 21st Century Learning. (2019). Framework for 21st Century Learning. Retrieved from http://static.battelleforkids.org/documents/p21/P21_Framework_Brief.pdf

Patrick, N. C. L. (2009). The Power of Problem-based Learning (PBL) in the EFL classroom. *Polyglossia*, 16, 41–48.

Pohl, M. (1999). *Learning to Think, Thinking to Learn* (1st ed.). Melbourne: Hawker Brownlow Education.

Putri, E. A. K. & Jatmiko, Budi. (2018). Implementation Of Problem Based Learning In Dynamic Fluid Lesson To Increase Problem Solving Skill Student'S Class Xi on SMAN 1 Jember. *Jurnal Inovasi Pendidikan Fisika,* 07(01), 21-27.

Savery, J. R. (2015). Overview of problem-based learning: Definitions and distinctions. In A. Walker, H. Leary, C. E. Hmelo-Silver, & P. A. Ertmer, P. A. (Eds.), *Essential Readings in Problem-Based Learning: Exploring and Extending the Legacy of Howard S. Barrows* (pp. 5-15). West Lafayette: Purdue University Press.

Schmidt, H. G. (1993). *Foundations of problem-based learning : some explanatory notes*, (27), 422–432.

Schraw, G. & Robinson, D. H. (2011). *Assessment of Higher Order Thinking Skills*. New York: Information Age Publishing, Inc.

Shidiq, A. S., Masykuri M., Susanti, E. (2015). Analisis Higher Order Thinking Skills (Hots) Menggunakan Instrumen Two-Tier Multiple Choice Pada Materi Kelarutan Dan Hasil Kali Kelarutan Untuk Siswa Kelas XI SMAN 1 Surakarta. In *Prosiding Seminar Nasional Pendidikan Sains (SNPS)*. Surakarta.

Sihaloho, R., Sahyar, S., & Marlina Ginting, E. (2017). The Effect of Problem Based Learning (PBL) Model toward Student's Creative Thinking and Problem Solving Ability in Senior High School. *IOSR Journal of Research & Method in Education (IOSRJRME)*, 07, 11–18. https://doi.org/10.9790/7388-0704011118

Thomas, L. K. (2013). *Investigating Self-Regulated Learning Strategies to Support The Transition to Problem Based Learning*. University of Wollongong.

Wood, E. J. (2015). Problem-Based Learning: Exploiting Knowledge of how People Learn to Promote Effective Learning. *Bioscience Education*, 3(1), 1–12. https://doi.org/10.3108/beej.2004.03000006

Wulandari, T. C., Juweni, & Sumadji. (2016). Penerapan Metode Penemuan Terbimbing Untuk Meningkatkan Hasil Belajar Siswa. *Prosiding Seminar Nasional Pendidikan Matematika Universitas Kanjuruan Malang* (Vol. 1, pp. 176–181).

Yassin, S. F. M., M., Rahman, S., Yamat, H.. (2011). ICT Interdisciplinary Problem-Based Learning in Pre-Service Teacher Programme. *World Applied Sciences Journal*, 15(11), 42–48.

Yoon, H., Woo, A. J., Treagust, D., & Chandrasegaran, A. L. (2014). The Efficacy of Problem-based Learning in an Analytical Laboratory Course for Pre-service Chemistry Teachers. *International Journal of Science Education*, 36(1), 79–102. https://doi.org/10.1080/09500693.2012.727041