

Analysis of Students's Higher-Order Skills through Project-Based Learning on Acid-Bases Topic

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Abstract : *This study aims to analyze higher order thinking skills through a project-based learning model on acid-base material. The project being carried out is to make natural acid-base indicators and to be able to determine the acid-base properties of solutions from the natural acid-base indicators that have been made.*

This research was conducted from January 2021 to June 2021. This research used a qualitative research method, an interpretive paradigm with 40 students in class XI IPA in Jakarta as subjects. Data collection techniques were carried out by class observation, student and teacher reflective journals, student worksheets and tests of higher order thinking skills. Based on observations, the dominant skill is analyzing skill which is equal to 83.33%, the second skill is evaluating skill which is equal to 79.16%, and the third skill is creating skill amounting to 77.50%. Based on the test results, the dominant skill is analyzing skills by 75.44%, the second skill is evaluating skills by 70.36%, and the third skill is evaluating skills by 69.58%.

Keywords : *Higher Order Thinking Skills, Project Based Learning, Acid-base*

I. INTRODUCTION

We are in the era of globalization, where many human needs apply to the use of the internet and the digital world, as a means of transaction and interaction. All aspects of people's lives today have been affected by the effects of information and communication technology. This effect opens up new competition in the world of work. Skills in technology, social emotional and higher order thinking, such as creativity and problem solving are skills needed in this era.) The ability to analyze, evaluate, and create which is included in high order thinking skills is needed by students to deal with problems in the real world (real life). By practicing higher-order thinking skills, students will become independent thinkers, able to understand complex matters which will make students accustomed to dealing with difficult problems, and able to associate new information with stored information to find a solution to a situation. which is hard to solve. Higher order thinking skills or higher order thinking skills are the ability to think at a higher level by involving mental activities such as analyzing, evaluating and creating new knowledge to determine a decision and solve a problem. Habits that students do in working on existing projects are not just memorizing and restating known information but also connecting, manipulating, and transforming the knowledge and experience they already have. Higher-order thinking skills have an important role in the teaching and learning process. If the level of thinking of students rises to a higher level it will also have a positive impact on education in Indonesia. So to develop this level of thinking we need a learning model that can increase creativity in finding new ideas or a work to get answers to a question with project-based learning. Students in project-based learning can determine their own collaborative learning process, conduct research and create creative projects that reflect the knowledge they have (Finita Dwi, 2015: 1). Stearns (in Finita Dwi, 2015: 1) states that through PJBL students experience an increase in internalizing concepts and skills related to science subjects, and have a tendency to remember and understand various information obtained through the implementation of PJBL. Project Based Learning learning model able to train students' thinking processes that lead to HOTS. The project-based learning model is a form of learner-centered learning, aiming to develop more independence in students. The chemical material chosen in this study is acid-base. This acid-base material is included in basic competency 3.10 in the 2013 curriculum which contains explaining the concept of acids and bases as well as their strength and ionic equilibrium in solution and basic competency 4.10 concerning analyzing the pH change trajectories of several indicators extracted from natural materials through experiments. Based on these basic competencies, it is necessary to develop High Order

Thinking Skills so that students are able to explain acid-base theory which involves abstract chemical reactions, can determine the nature of the solution, can determine the pH of the solution and can analyze the pH trajectory of several natural indicators, in addition to acidic matter. Language is also very closely related to everyday life. Most students cannot mention phenomena in life related to acids and bases, because students do not understand the concept of acids and bases as a result of which it is difficult for participants to apply the chemistry knowledge they gain at school to everyday life. Based on the existing elaboration, the researcher conducted an analysis of higher order thinking skills of students through project-based learning and case method on acid-base material at SMAN 31 Jakarta

II. LITERATURE REVIEW

A. Higher Order Thinking Skills

Lewis & Smith (1993) concluded that HOTS occurs when new knowledge and the information stored in memory is interconnected, reorganized, and extended to achieve goals or find possible answers in confusing situations. HOTS demand students to critically analyze knowledge, draw inferences, and make generalizations. They will also generate original communication, provide predictions, offer solutions, construct and solve problems related to everyday life, evaluate concepts, express opinions and make decisions and choices. (Rajendran, 2001: p.3-4). Bloom's Taxonomy has been implemented in the field of education in a number of ways including providing insight into the type questions asked by educators in classroom instruction and providing plans to guide educators in formulating examination questions to make sure that a range of cognitive processes are included (Reeves, 2012; Sakkir, 2019). In 2001, Anderson, Krathwhol and other colleagues revised the original version of Bloom's Taxonomy and named it Bloom's Revised Taxonomy. It then became a two-dimensional framework, dimension of knowledge types and dimension of cognitive process. The dimension of cognitive process consists of skills Remember, Understand, Apply, Analyze, Evaluate, and Create of which the last three skills are considered as HOTS.

In concluding whether an item assesses HOTS or not, Directorate of High School Development (2017) has developed an instrument of HOTS item analysis. The instrument assesses various aspects based on the characteristics of HOTS questions, which are: (1) Uses interesting stimulus that is novel and encourage students to read; (2) Uses contextual stimulus in the form of picture, graphic, text, visualization which relates to real-life situations; (3) Assesses the cognitive level of reasoning (Analyze, Evaluate, and Create); (4) The answer is not explicitly stated on the stimulus; (5) The answer choices are homogenous and logical in terms of material; (6) Each question must have one correct answer.

B. Project Based Learning

The project-based learning is a teaching model that put emphasise on assigning tasks, particularly in the form of projects that can lead students to experience an inquiry process. Hence, it is expected that students will be able to develop knowledge, skills and attitudes as the assessment basis for teachers (Thomas, 2000). Nevertheless, not all learning models resulting in a project is categorised as project-based learning. Furthermore, Heitmann distinguishes between learning ended with a project and project-based learning (cited in Kubiato and Vaculova, 2010). Learning ended with a project is an extension of the knowledge implementation which students have gained in the classroom. Generally, a project is assigned at the end of a lesson, so the project is completed without observing the inquiry process. So far, this kind of project is often assigned by teachers, and it can be done individually or in a group

The stages of the project-based learning for language learning majorly consist of three main stages, namely planning, implementation and reporting (Stoller, 2006). Furthermore, the three main stages of project-based learning result in eight learning activities as follows.

- a. Planning Planning consists of five activities, which are choosing project topic, pre-communicative activities, asking essential questions, designing project plan and creating project timeline.
- b. Implementation The implementation comprises of one activity, namely finishing the project.
- c. Reporting There are two activities in this stage, namely assessing the project results and evaluating the project as well as evaluating project result and learning activity

C. Acid Base Topic

This acid-base material is included in basic competency 3.10 in the 2013 curriculum which contains explaining the concept of acids and bases and their strength and ionic equilibrium in solution and basic competency 4.10 concerning analyzing the trajectory of change

III. METHOD

This study aims to apply the learning model with Project Based Learning to acid-base material in XI MIPA 3 and to find out the higher order thinking skills of students observed in acid material using the Project Based Learning learning model. The research method used is descriptive qualitative research method. Descriptive research is research conducted to describe or explain in a systematic, factual and accurate manner the facts and characteristics of certain populations (Sanjaya, 2013). This study aims to systematically describe the facts and characteristics of the object under study regarding students' higher order thinking skills. The subjects in this study were 40 students of class XI MIPA 3 at SMAN 31 Jakarta. To obtain the necessary data/information, statements, and facts, this study used data collection techniques such as higher order thinking skills tests, interviews, observations, and reflective journals.

IV. RESULT AND DISCUSSION

A. Result

Learning is carried out according to the steps of the project-based learning model, namely, including 1) determining fundamental questions by providing brainstorming as an initial trigger for student thinking, 2) preparing project plans containing rules of the game in carrying out task activities, 3) giving daily projects to students in the form of reports results, 4) monitoring, testing the results, and 6) evaluating experiences. In this section, an analysis of the Higher-Order Thinking Skills profile of students is presented through the project-based learning model on acid-base material. The percentage results based on observations and tests are shown in Figure 1.

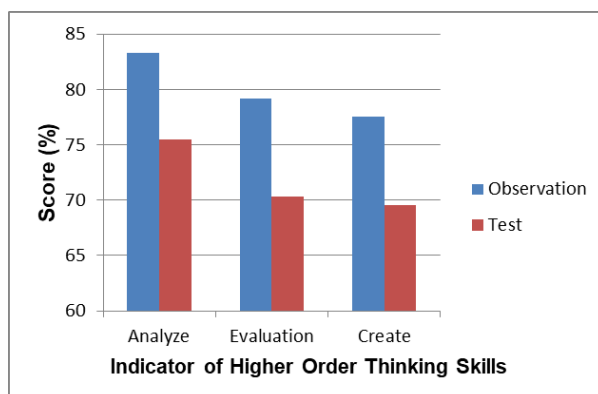


Fig 1. Higher Order Thinking Skills Profile of Learners

Based on the results of observations by observers, students' higher order thinking skills have an average value of 80%, while based on the results of the higher order thinking skills test, they have an average value of 71.79%. The different results between the observed values and the test results, because when learning students collaborate in completing projects so as to provide flexibility in conducting discussions to equate views (Van den Bergh et al., 2006), during tests students must solve problems individually which causing several aspects to escape from the analysis such as inaccurate calculations and data that must be observed, and also due to the diverse intellectual factors of students, while in observations during learning each group member complements each other's weaknesses and strengths so that collaboration occurs and the results of observations are not much different between members of the group.

B. Discussion

Based on the observation sheets and assessment tests, creative skills are low compared to other skills, this condition is because students are used to doing experiments to prove theories with the help of manuals, tools and materials that are already available. According to Feyzioglu (2009), laboratory activities that are verification in nature are not able to improve scientific thinking skills, the ability to collect data, interpret data, and analyze. According to Lunetta and Tamir in Feyzioglu (2009) students who work with guidebooks have a low opportunity for discussion skills in planning an experiment or project. The profile of higher order thinking skills observed during learning with the PjBL model is shown in table 1 with the following details

Stages of Project Based Learning	Higher Order Thinking Skills
Formulation of the problem	<ul style="list-style-type: none"> • Analyze • Evaluation
Project Planning	<ul style="list-style-type: none"> • Create
Processing and Testing Results	<ul style="list-style-type: none"> • Analyze • Evaluation • Create
Evaluation	<ul style="list-style-type: none"> • Evaluation

Table 1. Profile of Higher Order Thinking Skills in Project Based Learning

1. Analyze

Analytical skills appear in learning with a percentage of 83.33% based on learning observation sheets and 75.44% based on higher order thinking skills test questions. Assessment is carried out on several aspects, namely students can analyze how ulcer drugs can control excess stomach acid, decide on a solution related to neutralizing acidic or alkaline soils, classify samples into acidic or basic groups based on experimental results, correlate K_a values and K_b with the level of acidity and alkalinity of the solution, and analyze the causes of changes in statues containing $CaCO_3$ associated with the occurrence of acid rain.

2. Evaluation

Evaluation skills appear in learning with a percentage of 79.16% based on learning observation sheets and 70.36% based on higher order thinking skills test questions. The assessment was carried out on several aspects, namely concluding the pH of water suitable for consumption based on the pH change route of several indicators and concluding the ideal pH of river water based on the pH route.

3. Create

Creative skills appear in learning with a percentage of 77.50% based on learning observation sheets and 69.58% based on higher order thinking skills test questions. The assessment was carried out on several aspects, namely designing an experiment to determine natural acid-base indicators and preparing ingredients in the soap-making process.

V. Conclusion

Based on the results of the research and discussion, it can be concluded that the Project Based Learning learning model provides opportunities for students to produce products. The resulting product is a natural acid-base indicator. Video for making acid-base indicators and acid-base testing with natural indicators to support the learning process. According to observations, the most dominant skills are analytical skills because students have been able to formulate hypotheses, formulate questions for making projects. The second skill is evaluating because students have been able to test which materials are acids or bases, conclude experimental results, give suggestions on projects that have been made, compare any data obtained in experiments. Based on observations, the dominant skill is analyzing skill which is equal to 83.33%, the second skill is evaluating skill which is equal to 79.16%, and the third skill is creating skill amounting to 77.50%. Based on the test results, the dominant skill is analyzing skills by 75.44%, the second skill is evaluating skills by 70.36%, and the third skill is evaluating skills by 69.58%.

REFERENCES (SIZE 10 & BOLD)

- [1] Abdullah, Sani Ridwan. 2014. *Pembelajaran Saintifik untuk Kurikulum 2013*. Jakarta: Bumi Aksara
- [2] Anasy, Z. (2016). *Hots (Higher Order Thinking Skill) in Reading Exercise*. *TARBIYA: Journal of Education in Muslim Society*, 3(1), 52. <https://doi.org/10.15408/tjems.v3i1.3886>
- [3] Anderson, L.W. dan Krathwohl, D.R. (2001). *A Taxonomy for Learning, Teaching, and Assessing: A Revision of Bloom's Taxonomy of Educational Objectives*. A Bridged Edition. New York: Addison Wesley Longman, Inc.
- [4] Arends, R. I. and Kilcher, A. (2010). *Teaching for student learning : Becoming an accomplished Teacher*. Oxon : RoutledgeKarmana, I.W. 2011. *Strategi Pembelajaran, Kemampuan Akademik, Kemampuan Pemecahan Masalah, dan Hasil Belajar Biologi*. *Jurnal Ilmu Pendidikan*, 17(5), 378-386
- [5] Armstrong, Michael & Baron, A. 1998. *Performance Management : The New. Realities, Institute of Personnel and Development*, New York
- [6] Arwood, E.L. (2011). *Language function: an introduction to pragmatic assessment and intervention for higher order thinking and better literacy*. London: Jessica Kingsley Publisher
- [7] Bidokht, M. H., & Assareh, A. (2011). *Life-long learners through problem-based and self directed learning*. *Procedia Computer Science*, 3, 1446–1453.
- [8] Brears, L., MacIntyre, B., & O'Sullivan, G. (2011). *Preparing teachers for the 21st century using PBL as an integrating strategy in science and technology education*. *Design and Technology Education: An International Journal*, 16(1)Hmelo-Silver, C. E. (2004). *Problem-Based Learning: What and How Do Students Learn?* *Educational Psychology Review* , 16 (3), 235-265
- [9] Brookhart, S. M. (2010). *How to assess high-er order thinking skills in your classroom*. Alexandria: ASCD Bruner, J. S. (1977). *The Process of Education*. USA: Harvard University Press.
- [10] Laily, N.R. 2013. *Analisis Soal Tipe Higher Order Thinking Skill (HOTS) dalam Soal UN Kimia SMA Rayon B Tahun 2012/2013*. *Jurnal Unswagati*, 9(1).
- [11] Lindawati, dkk. (2013). *Penerapan Model Pembelajaran Project Based Learning untuk Meningkatkan Kreativitas Peserta didikMAN 1 Kebumen*. *Jurnal Radiasi*, Vol. 3, No. 1, hal. 42-45
- [12] Mayasari dan Adawiyah. 2015. *Pengaruh Model Pembelajaran Berdasarkan Masalah Pada Pembelajaran Biologi Terhadap Hasil Belajar dan Keterampilan Berpikir Tingkat Tinggi di SMA*. *Jurnal Pendidikan Biologi Indonesia* ISSN, 2442-3750, Volume 1 Nomor 3 2015 Banjarmasin : STKIP PGRI Banjarmasin <http://ejurnal.stkipbjm.ac.id> (diakses tanggal 27 Februari 2016)
- [13] Moh. Saifulloh, Zainul Muhibbin, dan Hermanto, 2012. *Strategi Peningkatan Mutu Pendidikan di Sekolah*. *Jurnal Sosial Humaniora*, vol. 5, no.2, hal. 1-13.
- [14] Mukminan. 2014. *Peningkatan Kualitas Pembelajaran Pendayagunaan Teknologi Pendidikan*. *Seminar Nasional Teknologi Pendidikan, 1-10* Nasution, Z. 2011. *Konsekuensi Sosial Media Teknologi Komunikasi Bagi Masyarakat*. *Jurnal Reformasi*, 1(1), 37-41. Nugroho, R. A. 2018. *Higher Order Thinking Skill (HOTS)*. Jakarta : Grasindo
- [15] Nasution, S. (2011). *Berbagai Pendekatan Dalam Proses Belajar Mengajar (Cetakan Kelimabelas)*. Jakarta: PT Bumi Aksara
- [16] OECD. 2018. *PISA 2015. PISA Result in Focus*. Paris: PISA-OECD Publishing
- [17] Oktiningrum, Wuli. 2016. "Developing Pisa-Like Mathematics Task With Indonesia Natural and Cultural Heritage As Context To Assess Students Mathematical Literacy", *Journal on Mathematics Education*. Vol. 7 No.1, Januari 2016. 1-10.
- [18] Oktarina, N. 2011. *Peranan Pendidikan Global dalam Meningkatkan Kualitas Sumber Daya Manusia*. *Jurnal Pendidikan*, 189-198.
- [19] Prasetyani, E., Yusuf, H., & Ely, S. 2016. "Kemampuan Berpikir Tingkat Tinggi Peserta didik Kelas XI Dalam Pembelajaran Trigonometri Berbasis Masalah Di SMA Negeri 18 Palembang". *JURNAL GANTANG Pendidikan Matematika FKIP*, Volume 1, Nomor 1. (hlm. 31-40).
- [20] Redhana, I.W. 2010. *Pengaruh Model Pembelajaran Berbasis Masalah Peta Argumen terhadap Keterampilan Berpikir Kritis Peserta didik pada Topik Laju Reaksi*. *Jurnal Pendidikan dan Pengajaran*, 43(17), 141-148
- [21] Sanjaya, Wina. 2013. *Penelitian Pendidikan, Jenis, Metode dan Prosedur*. Jakarta: Kencana Prenada Media Group
- [22] Sastrika, I.A.K.dkk (2013). "Pengaruh Model Pembelajaran Berbasis Proyek terhadap Pemahaman Konsep dan Keterampilan Berpikir Kritis". *eJournal Program Pascasarjana Universitas Pendidikan Ganesha Program Studi IPA*. 3, 1-10 Sungur, S., & Tekkaya, C. (2006). *Effects of problem-based learning and traditional instruction on self-regulated learning*, 99(5), 307–317
- [23] Sugiyono. (2013). *Metode Penelitian Kuantitatif, Kualitatif dan R&D*. Bandung: Alfabeta.CV
- [24] Widodo, T., & Kadarwati, S. (2013). *Higher Order Thinking Skill berbasis Pemecahan Masalah untuk Meningkatkan Hasil Belajar Berorientasi Pembentukan Karakter Peserta didik*. *Cakrawala Pendidikan*, 32(1), 161–171
- [25] Widyantini, T. 2014. *Penerapan Model Project Based Learning (Model Pembelajaran Berbasis Proyek) dalam Materi Pola Kelas VII*. Pusat Pengembangan dan Pemberdayaan Pendidik dan Tenaga Kependidikan (PPPPTK) Matematika
- [26] Widyantini, T. 2014. *Penerapan Model Project Based Learning (Model Pembelajaran Berbasis Proyek) dalam Materi Pola Kelas VII*. Pusat Pengembangan dan Pemberdayaan Pendidik dan Tenaga Kependidikan (PPPPTK) Matematika