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Implementation of Inquiry Based Learning with Oe3r Strategy and The Impacts to Students' Conceptual Understanding in Fundamental of Analytical Chemistry

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ABSTRACT

Chemistry created based on the process of how scientists work and think of under-standing a phenomenon or problem that occurs in the natural world. Those activities gained through physical and mental activities. Discoveries on Science are obtained and solved using inquiry thinking. Many inquiries-based learning strategies have been developed, one of theme's the OE3R (Orientation–Exploration–Explanation–Elaboration - Reflection) Strategy. The purpose of implementing the OE3R strategy on lecturing Fundamental of Analytical Chemistry is to determine the effectiveness and differences of students' conceptual understanding achievements. This research design using a Quasi-experiment with pretest and posttest in two groups with different treatment. The Experimental Group learns to use the OE3R strategy, then the Control Group using a conventional strategy-based lecturer method. The subject of research was a student in Fundamental of Analytical Chemistry courses at the Chemistry Department, Universitas Negeri Malang. The result shows that inquiry-based learning with OE3R strategy as innovation learning effective to make differences in students' conceptual understanding achievements in these courses.

Ilmu kimia diperoleh dari cara bekerja dan berpikir kimiawan memahami suatu fenomena atau masalah yang terjadi dalam kehidupan sehari-hari. Kegiatan memahami masalah didapatkan melalui aktivitas fisik dan mental. Penemuan sains diperoleh dan diselesaikan menggunakan cara berpikir inkuiri. Banyak pembelajaran inkuiri yang telah berkembang, salah satunya ada strategi OE_3R (Orientasi-Eksplorasi-Eksplanasi-Elaborasi-Refleksi). Implementasi strategi OE_3R pada matakuliah Dasar-dasar Kimia Analitik bertujuan untuk mengetahui efektivitas dan perbedaan hasil penguasaan konsep mahasiswa. Desain penelitian ini menggunakan *quasy experiment pretest-posttest* dengan perlakuan berbeda pada kedua kelompok. Pada kelompok eksperimen dibelajarkan dengan strategi OE_3R, sedangkan pada kelompok kontrol menggunakan strategi konvensional dengan metode ceramah. Subjek penelitian ini adalah mahasiswa peserta matakuliah Dasar-dasar Kimia Analitik di Jurusan Kimia Universitas Negeri Malang. Hasil penelitian menunjukkan bahwa pembelajaran berbasis inkuiri dengan strategi OE_3R sebagai sebuah inovasi pembelajaran efektif untuk membuat perbedaan pada hasil penguasaan konsep mahasiswa pada perkuliahan ini.

I. Introduction

Chemistry is a part of science that studies substances based on properties, reactions, energy involved in the reaction, composition, and structure. Conceptual understanding in Chemistry not just knowledge characteristic (fact, concepts, and theory), but science as chemistry also has characteristic as process and nature of science (Kean & Middlecamp, 1985). Those characteristics include in Six Domains of Science are concept, process, application, attitude, creativity, and Nature of Science (Enger & Yager, 2009). Besides that, the concepts of Chemistry refer to Three Level of Representations (3D-Chemistry) is macroscopic, (sub) microscopic, and symbolic (Johnstone, 1998). One of the topics of Chemistry that discuss in college is Fundamental of Analytical Chemistry. Analytical Chemistry is one of the topics that sue a lot of conceptual understanding and has the important role to develop understanding in another Chemistry subject (Samara, 2016). Analytical Chem-

istry is one of the topics in Chemistry that have a lot of challenge as development concept authentically (Hanson, 2017).

In general, there are five factors that cause Chemistry learning has low achievement (WAEC, 2015). One of that weakness is inability to answer the question about chemistry coherently and based on the concepts. Research on Ghana show that student doesn't make connection between Three Level of Representations, that's make student have weak foundation to learn next topics of Chemistry, especially Analytical Chemistry (Hanson, 2014). Lack of implementation representation in learning is one of the factors that make students' conceptual understanding become weak (Arsyad, 2011). Another lack of student in Analytical Chemistry courses is student can't explain the basic concepts that related with experiments (Haryani et al., 2007). Student cannot explain the reason from the phenomenon that occurs in experiment also. Student difficult to understand the topic in Analytical Chemistry because the learning method, low motivation, and students' laziness (Uwaleke, 2013). Difficulty to understanding several concept causing by transfer of matter not systematically, teacher-centered, and rarely using interactive media. That is make weak students' conceptual understanding, so they tend to memorize the concepts.

Based on the problems that showed above, students' conceptual understanding in Analytical Chemistry course still low. Conceptual understanding is important because with understanding concepts well, it will make student learn another topic in the class or applying in daily life easily. When the learning, student construct the knowledge become the whole concept, the concept that have been understood use for basic of thinking to formulate and solve the problems (Andrianie et al., 2018). Conceptual understanding is prerequisite to understand next concepts, if the prerequisite of concepts was wrong the next conceptual understanding for another concept will get some difficulty (Hidayah, 2016). Therefore, needed the learning that focus on conceptual understanding as basic of thinking to solving problems.

Implementation of inquiry-based learning giving the significant result of students' conceptual understanding (Supasorn & Promarak, 2015). Module with inquiry model effective to increase students' conceptual understanding (Pahriah & Hendrawani, 2018). The results increase significantly before and after learning by inquiry learning model. Conceptual understanding is the important aspect to knowing students' learning outcome (Sastrika et al., 2013). Guided inquiry giving significant result to conceptual understanding in science topic. The results of conceptual understanding in Experimental Group (62,29) higher than Control Group (58,96) (Zaini, 2016).

One of the alternatives that can used is science learning strategy with student-centered characteristic, that give chance to student to knowing their skills. Based on Association for the Advancement of Science (ASSI), Science-Chemistry emphasize exploration activity. Those statement reinforced by (Ristekdikti, 2015) that one of the learning characteristics in college level is student-centered. That is mean their graduates reached by process to develop exploring and finding the knowledge activity independently. Explore activity get from hands-on and minds-on activity that helping student to understand the concept in Science (Kurniawati & Diantoro, 2014). Explore process in Science getting and solving using inquiry thinking way. Therefore, Chemistry getting from inquiry thinking way. Inquiry-based learning models have been developed, including (1) LC 7E (Learning Cycle) (Eisenkraft, 2003), (2) POGIL (Process – Oriented – Guided – Inquiry - Learning), (3) MORE (Model – Observe – Reflect - Explain) Thinking Frame, (4) Five Phases (Wenning, 2005), and (5) Five Stages (Pedaste et al., 2015) and (6) Guided Inquiry Learning with OE_3R (Orientation – Exploration – Explanation – Elaboration - Reflection) strategy (Sutrisno, 2018). Inquiry based learning with OE_3R Strategy giving significant result to students' conceptual understanding is 69%. Besides that, student feel the inquiry-based learning with OE_3R strategy made the learning become meaningfully (Imas et al., 2020).

OE_3R strategy is an innovation of inquiry-based learning that based on the Six Domains of Science and 3D-Chemistry. The purpose of implementation of OE_3R strategy on lecturing Fundamental of Analytical Chemistry are to determine effectiveness and differences of students' conceptual understanding achievements.

II. Method

Design that used in this research is quasy experiment with pretest and posttest in two groups. The samples are third semester student that program Fundamental of Analytical Chemistry course in FMIPA Universitas Negeri Malang. The research using the class that have been decided before based on availability. The sample taking based on convenience to access by researcher which one class become Experimental Group that learned using OE_3R Strategy and the other class become Control Group that learned using conventional strategy with direct instruction.

Instrument that used in this research include lesson plans, student's worksheet, and conceptual understanding test. The prerequisite analysis test (normality and homogeneity test) of research data did before. Analysis data of students' conceptual understanding analyze with hypothesis test and effectivity

learning strategy. Hypothesis test aim to knowing the differences of students' conceptual understanding. Effectivity of learning analyzed using N-gain results from pretest and posttest both of groups.

III. Results and Discussion

Pretest and posttest data on both groups used to measure increasing of students' conceptual understanding in Fundamental of Analytical Chemistry course. The average of posttest result of students' conceptual understanding in both of groups not significantly different. Based on deviation standard result, show that data distribution Experimental Group closer the average score than Control Group. The average score of conceptual understanding in Experimental Group that learned with OE_3R Strategy (78) higher than before learn using OE_3R Strategy (22). Therefore, show there are effect of implementation OE_3R Strategy on students' conceptual understanding. Recapitulation data of students' conceptual understanding both of groups showed in Table 1. Prerequisite test done by normality and homogeneity test. Results of normality and homogeneity conceptual understanding pretest-posttest on Experimental and Control Groups higher than 0.500. That conclude the data was distributed normally and homogeny. Result of normality and homogeneity pretest-posttest showed in Table 2. Significant pretest result of two-equal similarity of conceptual understanding test show that both of groups have same initial conceptual understanding. Besides that, two-equal similarity test aim to know the differences pretest score both groups. Result of two-equal similarity students' conceptual understanding test show in Table 3.

Table 1. Data Recapitulation of Students' Conceptual Understanding

Result	Control Group				Experimental Group			
	Highest Score	*Lowest Score*	*Average*	*SD*	*Highest Score*	*Lowest Score*	*Average*	*SD*
Pretest	32	10	27	7,46	30	11	22	8,28
Posttesti	91	58	74	6,92	98	69	78	12,17

Table 2. Recapitulation Data of Students' Conceptual Understanding

Test	Significant Score			
	Experimental Group		*Control Group*	
	Pretest	*Post tes*	*Pretest*	*Posttest*
Normality	0,052	0,102	0,115	0,820
Homogeneity	0,074	0,090	0,074	0,090

Table 3. Results of Two-equal Similarity Students' Conceptual Understanding test

Group	Significant	Conclusion
Experimental Control	0,154	There are no differences in conceptual understanding achieved by Experimental and Control Groups

Posttest has been done to see the increasing of students' conceptual understanding after learned using OE_3R Strategy in Fundamental of Analytical Chemistry course. Based on posttest score, OE_3R Strategy more effective than conventional strategy that using direct instruction. Recapitulation of N-gain score of conceptual understanding both of groups show in Table 4. Besides that, to know the differences of students' conceptual understanding results used the hypothesis test after prerequisite test of pretest and posttest data both of groups. Hypothesis test using one-way between-group ANCOVA. Based on hypothesis test results, show that significant score (0.000) lower than 0.500, that's' mean H_0 rejected and H_1 accepted. There are differences students' conceptual understanding result between student who learned with OE_3R Strategy and conventional strategy with direct instruction in Fundamental of Analytical Chemistry course. Result of hypothesis test show in Table 5.

Table 4. Data Recapitulation of N-gain Score Students' Conceptual Understanding

Group	Average of N-Gain Score	Effectivity
Experimental	0,72	1,125
Control	0,64	

Table 5. Result of Ancova Test to Students' Conceptual Understanding

Group	Hypothesis test	
	Sig.	*Information*
Experimental Control	0,000	H_0 rejected

Conceptual understanding is one of the important aspects in every level of the learning. Good conceptual understanding show that student study well. According to Jerome S. Bruner, core of the learn is how student choosing, maintaining, and do some transformation information actively. Attention towards to information that received and what would do after getting the information to get understanding for itself (Buto, 2010). Based on (Ausubel, 1963), information (concepts, principals, and theories) could find itself as knowledge based on explore. Learn can classify into two dimensions, how students presenting the information and how students connecting the matter

that give with their cognitive structure that have already owned. If students can connect a new information with the knowledge they already owned, the learning become meaningfully. Learning was meaningfully if the information that will learned by students are construct in accordance with the students' cognitive structure, so the student can make connection between those (Ausubel, 1963).

Differences of students' conceptual understanding both of groups based on (Ausubel, 1963; Bruner, 2009) caused by several factors. *First*, learning using OE_3R strategy make student have learning experience more meaningfully than the class that learned with conventional strategy. In the orientation stage, students are trained to connecting information that have been obtained with the knowledge that already owned in students' cognitive structure. The facts that give in orientations stage stimulating students' curious. Those will create conflict in students' cognitive structure. In exploration until explanation stage, students collecting and processing facts that have been obtained into another shape (data, table, graphic, etc.) that easily understand. Besides that, in the OE_3R strategy stages, students are construct their knowledge and experience by itself gradually. Students are trained to linking the knowledge that have been obtained until get the wholes of concepts.

Information that have been obtained will be last longer when there are linking between initial concepts with the new concepts that have been learned (Septiani & Sumarni, 2014). That activity show that students do the meaningfully learning. Learning meaningfully that happen because there are physical and mentality activity that trained with OE_3R strategy. OE_3R strategy are giving the chance to students to investigating and solve some problems. Those activities make students to find the answer of their problems actively. Students are investigating with pay attention to three levels of representation to make easily to understand the chemistry's concepts. Investigate activity will attract students' interest to learn those concepts because it is understanding systematically and synchronize by the facts.

Second, students that learned with OE_3R strategy have applying the concepts that have been obtained well. Those activity, students linking the knowledge that have been obtained. Then, students giving the new problems but the content still same. Those activity, implementation in the elaboration stage in OE_3R strategy. Students apply the knowledge that have been built independently through activity in every OE_3R stages. Besides that, students can develop their idea or creativity based on the new knowledge that have been obtained. That activity make students can finish their problems with apply the concepts that have been obtained.

Students that learned using conventional strategy tend to learn not meaningfully. Students not trained to construct and linking their knowledge and experience independently. Those make students does not have a whole concept and nothing last longer. Besides that, students tend to memorize the information that showed by teacher. It is causing students interest decrease to learn the concepts based on the problem that have been showed. Posttest average score in Experimental Group (78) higher that Control Group (74). The average posttest result of students' conceptual understanding in both of groups not significantly different. Based on deviation standard result, show that data distribution Experimental Group closer the average score than Control Group. Besides that, kind of learning strategy make students become careless, apatism, and get bored quickly (Saavedra & Opfer, 2012).

OE_3R strategy is one of the learning strategies which from the begin was designed with inquiry based. According to National Science Education Standard (NSES) inquiry is the series of linking process that show how the scientist understand the nature and investigate the phenomenon. In the learning process, students must active and become center of the learning in the class (Slavin, 1989). Implementation of inquiry make students learn based on investigation orientated with teacher instruction, the students can understand the whole concepts (Perdana & Rudibyani, 2018). In this learning students faced by the relevant tasks to finished well through group or individual discussion. Discussion activity in inquiry learning model increasing students' conflict cognitive (Barrouillet, 2015). Discussion activity that students done based on information that have been collected to developing their conceptual understanding (Sari et al., 2018). That activity to solve the problem and make conclusion independently. Students actively find the information with OE_3R strategy. That are representations of scientist get the knowledge or concepts. Inquiry need a lot of assume, using critical and logical thinking, and considering alternative explanation. Besides that, OE_3R strategy involve physical and mentality activity that causing developing on students' mental and cognitive (Sutrisno et al., 2020).

Inquiry based learning with OE_3R strategy give the significant result to students' conceptual understanding is 69%. Besides that, students feel the learning using inquiry-based learning with OE_3R strategy become the learning meaningfully and hope can apply it another topic of chemistry (Imas et al., 2020). Another research shows that inquiry-based learning (Leaning Cycle) increasing students' conceptual understanding in medium category is 34% and low category is 66% (Sartika, 2018). Inquiry based learning (Learning Cycle) have aim to give students chance to

actively learn matter meaningfully (Smallhorn et al., 2015). Constructing knowledge and experience do with work and think well individually or in a group, so the students can mastery the competences that must reached in learning (Fitriyani et al., 2016).

IV. Conclusion

Based on the result of the research, there are differences in students' conceptual understanding in the group that learned by OE3R strategy with the group that learned to use conventional strategy. Besides that, implementing the OE3R strategy effective to increase students' conceptual un-distending in the Fundamental of Analytical Chemistry course. That reinforced by aver-age N-Gain and post-test score on the group that learned by OE3R strategy higher than a group that learned to use conventional strategy. Need more attention to time management needed for implementation OE3R strategy (especially exploration, explanation, and elaboration stages) so the students can construct the whole of concepts.

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