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Implementation of Project-Based Learning Resources With Multimedia to Improve Student Learning Outcomes in Teaching Cation Analysis

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ABSTRACT

The progress of information technology that is very fast now has added value in supporting learning. Teaching and learning chemistry must adapt to the latest technology to maximize learning activities. This study aims to develop an innovative project-based learning resource with multimedia to improve student learning outcomes in teaching of Cation analysis. The research was conducted at Universitas Negeri Medan at academic year 2019/2020. The study are consisted of the development of project-based learning package on Cation analysis, integration of projects and multimedia into the learning package, and implementation of a developed learning resource to improve student learning outcomes. Research results showed that an innovative project-based learning resource with multimedia has successfully developed suited for undergraduate students for the teaching of Cation analysis. The research involved 50 samples divided into class, namely the experimental class and control class. Experimental class is taught by using a developed learning resource, where the control classes are using students handbook. It has been convinced that an increase in student outcomes has been achieved in experimental class due to the aid of an innovative project-based learning resource with multimedia. The learning facilities provided in the learning resources help the students to learn Cation analysis topic. The learning outcomes obtained in experimental class (M=81.65±7.54) is higher than the control class (M=69.45±8.51). An innovative project-based learning resources with multimedia are very effective in improving student learning outcomes in Analytical chemistry.

Keywords: *Project-based learning, Learning innovation, Multimedia, Students outcomes, Cation Analysis*

1. INTRODUCTION

Increased in the learning outcomes become the main target in the implementation of the curriculum based on the Indonesian National Qualification Framework (Kerangka Kualifikasi Nasional Indonesia, KKNI) because the students are expected to master the theory that can be implemented in real life [1,2]. The adoption of the KKNI curriculum at Universitas Negeri Medan has brought a change in learning strategies, namely as an effort to bring theory closer to the actual practice of its application in life. Various strategies are carried out to bring students closer to the world of work through lectures, and the subject matter learned must connect with applications in everyday life [3]. The learning process must be improved through the implementation of innovative learning resources that can guide students to active learning and optimally motivate student to achieve their competencies in accordance with the demands of the KKNI curriculum. Learning innovation is one of the strategies that can bring students to learn optimally in achieving the desired competency targets. Innovation can be done to fulfill innovative learning resources that are used by students in learning independently, where the knowledge and skills can be built without having to depend on the presence of lecturers [4,5]. Fulfillment of project-based learning resources with multimedia is believed to be very effective in guiding students to learn actively, and has been proven to improve learning outcomes [6].

Various studies related to learning innovation have been carried out, especially those that can make students having better understand in the subject matter, can increase student motivation, and at the same time to improve learning outcomes [7-9]. Project-based learning with multimedia can increase student activity in the learning process and give students the opportunity to apply the knowledge they have into the real world [10,11]. Project-based learning can be done in laboratories, field studies, library studies, virtual via the web, problem solving, and assignments [9]. Analytical chemistry is a compulsory subject at the Department of Chemistry, FMIPA, Universitas Negeri Medan. The skills in the analytical field are one of the competencies that chemists must have, including the students who are prepared to become chemistry teachers in secondary schools. The topic of Analytical chemistry is very interesting and useful in daily life. It should be emphasized that analytical chemistry teaching material is starting to be studied in tertiary institutions because it has never been studied in secondary schools. Thus, a good strategy is needed to teach analytical chemistry to prepare the students to have sufficient knowledge and skills in the analytical field as a fulfillment of one of the competencies in chemistry [12,13]. The obstacle often faced by students is the difficulty of understanding analytical chemistry, especially if it is not practiced in the laboratory, and as a result many students have difficulties in knowing and skill in the analytical field. This may be caused by unsystematic teaching so that they lack mastering the concept of analysis. Another problem in learning analytical chemistry is if the subject matter being studied is not contextual which will result in students not knowing the correct chemical concepts. Misconception is also a problem in learning analytical chemistry. To overcome the above problems, it is necessary to have complete, systematic and applicable learning resources that can link theoretical concepts with applications in analytical work [14]. Thus, learning innovations are needed to get learning resources that can guide students interested in learning analytical chemistry. Project-based learning with multimedia is one of the choice that can be used to build understanding and mastery of educational objects. This purposes of this study is to develop innovative project-based learning resources with multimedia for Cation analysis topic, and subsequently implemented in learning to guide students to learn optimally to improve learning outcomes in Analytical Chemistry.

2. METHOD

2.1. Population and Sample

The population in this study were all students who studied Analytical Chemistry courses in the Department of Chemistry, FMIPA, Universitas Negeri Medan at second semester academic year 2019-2020. The research sample was selected purposively and grouped into two classes, namely the experimental class and the control class. The design in this study is a quasi-experimental that provides different in learning treatments for the two sample groups. The project-based learning resource package was provided with multimedia to the experimental group, and students in the control group were taught by using the text book. Other parameters such as assignment, reporting, use of study time, and evaluation were attempted the same for the two treatment groups.

2.2. Research Procedures

The research steps carried out include the development of project-based learning resources with multimedia for the topic of Cation analysis, standardization of learning resources, and implementation to improve student learning outcomes in Analytical chemistry courses, followed the procedures reported in the references [15,16]. The development of learning resources is carried out by compiling of mini projects into a learning packages that are relevant to each of the sub-topics of Cation analysis, followed by multimedia integration to facilitate students to learn Cation analysis. Standardization of learning resources is done by providing a package of learning resources to experts, and they are given the freedom to assess the quality of the content of teaching materials and provide suggestions for improvement. Implementation of learning is done by providing of teaching Cation analysis to both groups of students. Students are given assignments to produce products in the form of writing project proposals, implementing projects, and submitting project reports. Two types of tasks (Proposal and project report) are then submitted and assessed to determine the effect of providing a learning resource package for student learning outcomes. The research instrument used to obtain research data consisted of the feasibility test sheet for learning resources using criteria established by the National Education Standards Agency (Badan Standar Nasional Pendidikan, BSNP), a non-test rubric to assess student proposals and project reports scores, and the objective objective test scores obtained on the formative exams for the sub-topic of Cation analysis Group I and Cation analysis Group II. All of these results were considered as student learning outcomes in this study.

3. RESULT AND DISCUSSION

3.1. An Innovative Learning Resources for Subject of Cation Analysis

The development of innovative project-based learning resources with multimedia has been carried out to obtain innovative learning resource packages for the subject of Cation analysis. Complete chemical materials and mini project packages have been produced for the sub topics of Group Cation Analysis I and Group Cation Analysis II [17-20]. The innovation was carried out to enrich the chemistry material of the Cation Analysis topic, and continued with the integration of projects and multimedia that were used by students as innovative learning resources. The contents of the material in the sub topics of the analysis of cation group I include steps of separating cation group-I, separation and identification of cation Hg_2^{2+}, Separation and Identification of cation Pb^{2+}, Separation and Identification of cation Ag^+. Furthermore, the chemical material for the subtopics of Class II Cation analysis consists of separation steps on cation group-II, Separation and Identification of cation Hg^{2+}, Separation and Identification of Hg cation Cu^{2+}, Separation and Identification of cation Sb^{2+}, Separation and Identification of cation Sn^{2+}. Learning resources are combined with multimedia using flipbook maker software that can combine material, videos, pictures and quizzes. A brief description of the teaching material, projects and multimedia results of the innovations is summarized in Table 1.

3.2. Standardization of Innovative Learning Resources Cation Analysis Topics

Standardization of innovative learning resources as a result of development has been carried out to see the feasibility of the contents of chemical materials, projects and multimedia for the subject of cation analysis. Standardization is carried out using experts based on the criteria of teaching materials set by BSNP, and the results of standardization are summarized in Table 2. These results indicate that innovative learning resources are classified as very good criteria (M = 3.72±0.39). Each component in a row for content eligibility (M = 4.0±0.00), the eligibility of the extension (M = 3.71±0.48), the depth (M = 3.71±0.48), design eligibility (M = 3.60±0.49), and language feasibility (M = 3.60±0.51), are all in the very good category. These results showed that project-based learning resources with multimedia are feasible to use in the learning process for teaching Cation analysis.

3.3. Implementation of Project Based Learning Resources with Multimedia

Project-based learning has been implemented in both classes, namely the classroom experiment using innovative project-based learning resources with multimedia and the control class using student learning resources. The value of student learning outcomes for both treatment groups is summarized in Table 3. From these results it is known that innovative learning resources can improve student learning outcomes. The assessment of project proposals to groups of students who were taught using innovative learning resources in the experimental class (M=75.60±14.02) was higher than the control group (M=66.80±15.87). This result is also supported by project reports returned by students. Project reports returned by students have been assessed using the project appraisal rubric. The average value of student project reports in the experimental class (M=85.35±2.66) was higher than the average value of the project report in the control class (M=66.55±2.75), Learning outcomes based on formative exams in the experimental class (M = 81.65±7.54) are also higher than the control class (M = 75.00±6.92). Overall, student learning outcomes in the experimental group (M = 81.65 ± 7.54) were higher than the control group (M = 69.45 ± 8.51), and the two groups were significantly different (ttest 8.930 > Ttabel 1.679). It can be stated that innovative project-based learning resources with multimedia are very effective in improving student learning outcomes.

Table 1. Innovation of learning resources and relevant project packages integrated in the cation analysis teaching material

No	Sub Subject	Types of Innovations that are integrated into teaching materials	Multimedia title / Project title
1	Introduction to Cation Analysis	Chemical material consists of understanding cation analysis, steps that can be used for the analysis and grouping of cations, the cation identification guidelines, and cation analysis schemes	1. Project 1 Grouping Cations according to their class and properties (Cation Group I-V)
2	Preliminary reaction to cations	The chemistry material explains the steps of separating cations group-I and their reactions, steps of separating cations group-II and their reactions, and is equipped with multimedia to facilitate learning the separation of group I and II cations	1. Project 2 Reactions of cations group I and cations group II through the addition of specific anions into cations mixture
3	Analysis of cations Group I (Ag^+, Pb^{2+}, Hg_2^{2+}) (testing of silver cation (Ag^+); lead cation testing (Pb^{2+}); testing of	This sub-topic consists of enrichment of material on sub-topic analysis of group-I cations, identification of cations that are integrated into the video and projects for group-I cations namely Ag^+, Pb^{2+}, and Hg_2^{2+}	1. Project 3 Identification and separation of cation Ag^+ from wastewater samples 2. Project 4: Identification and separation of cation Pb^{2+} from tofu waste samples 3. Project 5: Identification and separation of cation Hg_2^{2+} from environmental waste

	mercury I cation Hg_2^{2+})		samples
4	Analysis of cations Group II (Hg^{2+}, Cu^{2+}, SbO^{+}, Sn^{2+}, Sn^{4+}): testing of mercury I cation (Hg^{2+}); testing of copper cation (Cu^{2+}); Antimony cation testing (Sb^{2+}); Tin cation testing (Sn^{2+})	This sub-topic consists of enrichment of cation analysis for Cation group-II, identification of Cation group-II by giving videos and sample projects in sequence to the cations of Hg^{2+}, Cu^{2+}, Sb^{2+}, Sn^{2+}	1. Project 6 Identification and separation of cation Hg^{2+} from cosmetic samples. 2. Project 7 Identification and separation of cation Cu^{2+} in river water samples. 3. Project 8 Identification and separation of cation Sb^{2+} from paint samples. 4. Project 9 Identification and separation of cation Sn^{2+} from sago pulp waste samples

Table 2. The opinions of expert respondents (l) towards the components of a project-based learning with multimedia for cation analysis topic

No	The criteria and a brief description of the components on innovative teaching materials	Respondents opinion* (*M*±*SD*), L (*n*=4)
1	- **The Content:** The suitability of learning indicators with competence, the suitability of learning objectives with indicators, the suitability of the material with the learning objectives, and the novelty of the material	4.0±0.00
2	- **The Extension:** Systematic sequence of presentation of learning material, suitability of scope of material with learning objectives, suitability of depth of contents with learning objectives, ease of understanding terms and formulations, suitability of examples or illustrations with topic, clarity of material description, and attractiveness of the learning resource	3.71±0.48
3	- **The Depth:** Clarity of project instructions, exercises and examinations, appropriateness of scope of questions with learning objectives, appropriateness of question domains with learning objectives, appropriateness of level of difficulty of questions with learning objectives, correctness of answer keys, clarity of question formulation, and clarity of discussion of answers	3.71±0.48
4	- **The Design:** Task guides and information, program performance, systematic, aesthetics, narrative and audio quality, video and / or animation quality, and evaluation and pedagogical availability	3.60±0.49
5	- **The Language:** In accordance with the development of student maturity, communicative, straightforward, coherence and wrangling of the flow of thought and logic, and the accuracy of the use of the terms symbols and symbols	3.60±0.51
	Average	3.72±0.39

Table 3. Student learning outcomes on implementing project-based learning for teaching of cation analysis.

No	The Description of the project components being assessed	Students' score (*M*±*Sdv*)	
		Experiment Class (*n*=25)	Control Class (*n*=25)
1	Preparation of project proposals, including the appropriateness of the contents of the proposal plan with the subject matter, target analytes, the selection of tools and materials, and the suitability of the proposal format.	75.60±14.02	66.80±15.87
2	Project Implementation and assessment of learning activities,those are including: Setting of experiment goal, Finding and choosing of relevant learning resources (references) that fit to the learning objectives, Plan and make project designs that are appropriate to the topic, Concentration in determining chemicals, The quality of project implementation is in line with the learning objectives, Presentation of results, data processing and conclusions based on project outcome data, Originality and novelty of project implementation activities, Contextual and aesthetic project activities, Timeliness in project planning, implementation and reporting, and The accuracy of the analysis results is in accordance with the target of the	85.35±2.66	66.55±2.75

	analyte in the sample.		
3	The objective test scores obtained on the formative exams for the sub-topic of Cation analysis Group I and Cation analysis Group II.	84.00±5.95	75.00±6.92
	Average	81.65±7.54	69.45±8.51

3.4. Discussion

Learning innovation to develop teaching resources becomes a good strategy in providing an innovative, complete and informative learning resources that can be used by students in teaching and learning activities. Innovative learning resources have been proven to guide students to the achievement of their competencies [21]. Developing of learning resources must be conducted well prepared. Consideration in the level of maturity of students and he target of competency to be achieved must be used as determining factors in the preparation of project-based learning resources. A good learning resource can be used by students effectively, efficiently and efficiently in increasing knowledge and skills in accordance with curriculum demands. The availability of innovative learning resources will be able to optimize students' independent learning, and motivate the students to learn optimally at any time and places. The results of this study have proven that an innovative project-based learning resources with multimedia can improve student learning outcomes. An innovative learning resource developed in this study facilitate the students to study chemistry. Learning through projects improve students' thinking abilities, because students are given the freedom to plan and implement projects in a guided manner [22-25]. These results confirm that there is an increase in student learning outcomes using project-based learning resources with multimedia in teaching Cation Analysis. The availability of project packages and multimedia in teaching materials facilitates students to gain an in-depth understanding of cation analysis and students can plan and implement projects properly and correctly. Students are also motivated to learn independently. Innovative learning resources have been proven to improve memory of the chemistry they learn, and ultimately to improve analytical chemistry learning outcomes [26-27].

4. CONCLUSION

Project-based learning resources with multimedia for subjects Cation analysis has been developed and standardized to produce a standard innovative learning resource to be used in the teaching Analytical Chemistry. An innovative learning package consists of 3 sub-topics, including: (1) Introduction to Cation Analysis, (2) Cation Analysis Group I (Ag+, Pb2+, Hg22+); and (3) Cation Analysis Group II (Hg2+, Cu2+, SbO+, Sn2+, Sn4+). There are 8 project packages and multimedia learning integrated into the teaching material. Expert respondents gave an excellent assessment of the quality of the developed and innovated learning resources. Implementation of learning resources in the teaching Cation analysis provides excellent results (M=3.72±0.39). It is proven to be able to guides the students to learn independently in planning and working on projects in the Cation analysis topic. The students who are taught by using an innovative learning resource have a better understanding of the Cation analysis. Student learning outcomes that are obtained from subjective evaluation from both portfolio of submitted project proposal and project reports, and from objective evaluation test in the formative test, where student learning outcomes in the experimental group (M = 81.65 ± 7.54) were higher than the control group (M = 69.45 ± 8.51), and the two groups were significantly different (ttest 8.930 > Ttabel 1.679). An innovative project-based learning with multimedia is found very effectively in building students' knowledge and skills in Analytical Chemistry.

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