The Development of Innovative Learning Material with Project and Multimedia for Redox Titration

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Abstract. The study is aimed to provide an innovative learning material with project based learning that are integrated with multimedia which will be used as a teaching support for active learning in improving student competence in chemistry. Research procedures are consisted of making standard teaching materials that contain mini project and multimedia packages for teaching redox titration topic of Analytical Chemistry, integration of multimedia and hyperlink to the main learning topic, standardization of the developed learning material, and the use of instructional materials as a support in studying chemistry topics in the class. The results of the study show that innovative teaching materials are equipped with projects and multimedia has been developed for redox titration topic. Teaching materials from the development results proved to be sufficient in helping the students to learn chemistry independently. The learning pattern has changed to be centered on the students so as to intensify teaching and learning activities.

Keywords: Innovative learning, Project based learning, Multimedia, Analytical Chemistry.

1 Introduction

The application of Indonesian National Qualifications Framework (*Kerangka Kualifikasi Nasional Indonesia*, KKNI) curriculum has played a role in bringing the change in teaching and learning strategy, as it is known that learning activities is juxtaposed with the needs skills in the working environment [1]. It is expected that skilled graduates are needed in filling the employment in accordance with the fields of study they have completed. Thus teaching methods and learning systems must also needed to adapt to the latest technological advancements that are relevant to the world of students' work and development [2]. Expertise in chemical analysis is one of the fields of science that is needed to be mastered by a chemist. With this reason, special attention in the teaching of analytical chemistry is needed to make the teaching and learning chemistry enjoyable. Every effort must be made to make teaching chemistry interesting for students, to facilitate science content is easy to learn and resulted on improving the competency in academics and skills [3]. Some strategies that have been implemented in chemistry teaching are including of using a variety of teaching-learning methods and strategies, conducting learning innovations, applying active learning, using media and multimedia learning, and giving assignments and project-based learning [4-9].

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Innovation in chemistry learning is very helpful in bringing the students closer to learning resources, so that the knowledge in the field of chemistry will be easily mastered by the students. Several types of innovations have been implemented in chemistry learning, and they are proven be able to improve learning outcomes and student competencies [10, 11]. Learning innovation through the application of projects and multimedia has also been effective to improve student learning outcomes [12]. Therefore, learning chemistry by the use of projects and multimedia is the right choice for the teaching of Analytical chemistry because it can improve critical thinking skills [13]. Project-based learning will be able to build students' knowledge through independent study [14, 15]. The learning activities through conducting the project work will develop student's creativity in problem solving. Teaching chemistry through projects also provide real experience to students because they can carefully observe the chemical phenomena that have been involved and recorded, thus the students can juxtapose the observations results with standard theories. In addition, learning through projects will be able to improve student learning independence in the planning, implementation and reporting of chemistry laboratory activities. Project-based learning with multimedia is very effective in improving student learning outcomes in chemistry [16, 17]. Teaching and learning activities through multimedia are very appropriate to be used in teaching of chemistry. The multimedia learning has been done successfully for the science field [18-20]. Multimedia in the form of video or animation of chemistry project or laboratory experiment will help the students to gain learning experience before carrying out laboratory projects or activities, so that they are easily understood and repeated to provide practical experience in learning chemistry. Multimedia in learning is also useful to avoid mistake or errors in laboratory activities, such as the use of laboratory equipment, handling of chemicals, carrying out specific reactions, recording results and safety in the laboratory [21, 22]. The purpose of this study is to provide innovative and standard teaching materials containing projects and multimedia that will be used by students as the main learning resource in preparing basic knowledge of titration. This study reveals a description of project-based teaching materials with multimedia that can improve student learning activities. Set of an innovative leaning package has been used as main instructional materials to guide the students in proposing projects relevant to the subject of Redox Titration.

2 Experimental

2.1. Population and Sample

The study was conducted at Universitas Negeri Medan in the 2018/2019 academic year. The research is involving of 23 students of Bilingual Class in the Chemistry Education Study Program, Department of Chemistry, Faculty of Mathematics and Natural Sciences.

2.2. Research Instruments

The research instrument used in this study are consisted of: (1) a set of questioners in a Likert scale (1-4) to see respondents' opinions on the feasibility and quality of innovative teaching materials, (2) a set of perception indicator (scale 0-100) to measure students' perception index on the performances of a developed learning material in relation to their learning system on project-based learning, (3) a set of observation sheets (scale 0-100) to investigate students' learning activities in project implementation, and (4) a set of evaluation sheet with indicators is

used to assess students achievements, those are covering students' activities starting from project planning, project implementation and presentation of work reports, including discussion and newness of findings.

2.3. Research Procedures

The study is assigned to be a research and development scheme on the development of innovative learning materials and implementation in the teaching of redox titration. The study is consisted of three stages, namely the developing teaching materials, standardizing teaching materials, and implementing teaching materials following the procedures described in previous studies [23, 24]. The preparation of learning material is done through enriching the teaching materials by integrating the projects examples that are relevant to chemistry topic of Redox titration followed by setting up the multimedia in to the learning set to produce a standardized Analytical chemistry learning materials. The standardization stage is carried out on teaching materials by using senior experts and senior students to see the feasibility of teaching materials for undergraduate chemistry students following the procedures previously performed [25].

2.4. Implementation in the class

Implementation of learning materials has been carried out for teaching of Redox titration topic by involving bilingual undergraduate students in the Department of Chemistry [26]. Set of standardized learning materials are distributed to students in electronic form, and it is used as a learning resources in the teaching of chemistry, followed by giving instructions on the use of learning materials for setting up their own projects, and emphasizing the project implementation. Students are given the freedom to plan their learning starting from proposing the project plan to be carried out in accordance with the sub-topics assigned. Data collection and reporting of the results of the project implementation are submitted in the form of project reports following a predetermined schedule. Observations to the learning activities are carried out by lecturers to see the progress of learning in achieving their competencies, including among them seeing the skills of the students in using laboratory equipment, the accuracy of work, compliance with work safety and cleanliness. Opinions from students were also asked in relation to the learning strategies that have been implemented in the class.

3 Results and Discussion

3.1. Description of Innovative Learning Material of Redox Titration Topic

The topic of Redox Titration is consisted of eight sub subjects. They are: (1) Introduction to Redox Titration, (2) Factors Affecting the Shape of the Titration Curve, (3) Determining Equivalent Points, (4) Color changes using indicators (non-specific redox indicators, specific indicators), (5) Preparation Steps in redox titration (solution, Sample Treatment), (6) Redox Titration with Oxidizing Compounds, (7) Redox Titration with Reducing compounds, and (8) Redox Titration Application [27]. The analysis for the sub topic is done in relation to the basic competencies and the achievement indicators suited to national curriculum of Indonesian National Qualifications Framework (*Kerangka Kualifikasi Nasional Indonesia*, KKNI). The development of the an innovative learning material with project and multimedia for redox

titration has been carried out followed the KKNI curriculum, that is the learning package for undergraduate chemistry students. The description of the sub-topic along with integrated projects in the learning package is listed in Table 1.

Table 1. List of sub-topic of Redox Titration and the innovation that are being made in the learning material.

No	Sub- Subject	Description of Innovative Learning Materials with Project and Multimedia
1	Introduction to Redox Titration	Learning material for Redox Titration, equipped with laboratory experiments, video and multimedia
2	Factors Affecting the Shape of the Titration Curve	Laboratory experiments (project) explaining factors that influence the shape of the titration curve, complemented by the use of Microsoft Excel software and Flash animation
3	Determining Equivalent Points	Laboratory experiments (project) for determining the equivalent point of redox titration by using both indicators and potentiometers, equipped with video and flash animation
4	Color changes using indicators (non-specific redox indicators, specific indicators)	Laboratory experiment (project) equipped with video, flash animation showing the color changes for end point on redox titration using indicators for non-specific redox indicators and for specific indicators
5	Preparation Steps in redox titration (solution, Sample Treatment)	Preparation steps and procedures to be followed in the preparation of standard solution, standardization procedure to obtain exact concentration of the solution, sample pretreatment for redox titration. The procedures are equipped with video, flash animation showing the step to set a project on preparation of redox titration and the relevant website and the relevant power point learning media
6	Redox Titration with Oxidizing Compounds	The laboratory experiments and the designed project on redox titration with oxidizing compounds with analysis of real samples. The subject is also equipped with video and flash animation on handling the project of redox titration with oxidizing compounds, and the relevant power point learning media
7	Redox Titration with Reducing compounds	The laboratory experiments and the designed project on redox titration with reducing compounds, and the application for sample analysis. The subject is also equipped with video and flash animation on handling the project of redox titration with reducing compounds, and the relevant power point learning media
8	Redox Titration Application	The application of redox titration for the determination of industrial samples and other samples suitable for projects implemented by students that can be carried out as mini projects

The chemistry topic has been designed to be innovative, those are enriched with relevant examples suited to the need of undergraduate chemistry students. Sets of mini projects with contextual application, the experimental worksheet, the videos example to do redox titration, learning syntax and procedures, and relevant multimedia. The projects are designed as the laboratory experiments that are required to guide the students to design their own projects related to the topic they learn. The projects are encourage to do analytical protocols related to determine target compounds in real samples. Learning syntax is provided to bring the students

on analytical procedures that have to be done in relation to the target achieved competence to motivate the students to do active learning. The multimedia is used to help the student to explore the relevant knowledge that are relevant to the subject they learn. The learning package was then integrated with suitable video animation and demonstration images with intention to make the learning material is easy to learn and understand for self learning.

3.2. Standardization of Learning Material containing Project and Multimedia

Standardization of project have been made followed the development of the learning material to obtain the learning package suited to undergraduate chemistry students based on the KKNI curriculum in Department of Chemistry Universitas Negeri Medan. The performance of the teaching material is summarized in Table 2.

Table 2. The quality of the developed innovative learning material according to respondents' opinions of Chemistry Lecturer (L) and senior bilingual chemistry students (S). Where: 4 (very agree), 3 (agree), 2 (less agree) and 1 (disagree)

No	Components criteria	Short Description of the developed learning material	Respondents Opinion		
			L (n=3)	S (n=20)	Total Average
1	Content	- The conformity of project contents with chemistry topic	4.00	3.45	3.72
		- Accurate in facts, concepts, theories, procedures and in accordance with indicators of learning achievement	3.67	3,3	3.48
		- Project tasks are up to date and follow the SI standards	4.00	3.7	3.85
2	Presentation and Support	- The consistency of serving, logical, demanding and appropriate concepts.	4.00	3.70	3.85
		- The existence of interactive thinking and communication	4.00	3.70	3.85
		- According to project learning syntax	3.67	3.45	3.57
3	Language	- Consistent with emotional thinking and social development	3.67	3.50	3.58
		- The language is dialogical, interactive and straightforward	4.00	3.75	3.87
		- The message is easy to understand	4.00	3.55	3.77
	Design	- The design layout, setting, symbols, , color, presentation, illustration, the figures and table	3.67	3.45	3.57
	Average		3.84	3.54	3.71

The learning material for redox titration is evaluated by using expert and students respondents (n=23). The opinions of the respondents of lecturers (average 3.84) and senior

bilingual students (average 3.54) are all assigned to be very good (average 3.71). The components of standards learning materials such as the Content, the presentation and support, the language and the design are all meet the right demand criteria for undergraduate chemistry learning material. The projects in the learning material are suited to the need of the students that can help the students to construct their own project similar to the project example given in the learning package. The syntax for the designed project, the presentations of video and multimedia in the learning material are suited to the thinking flow that help the students to understand the material from simple to complex contents. The language and sentence presentation in the learning package are dialogical, interactive and straight forward that conform to the message that are delivered. The chemistry contents in the learning material are clear. It is concluded that an innovated learning package can be used as a learning resource on the teaching of Redox titration topic.

Table 3 Students perception index for the performances of developed learning material in relation to their own projects

No	Indicator Assessed	Level of satisfaction (%)
1	I found it easy to understand the concept of Redox titration	92
2	The project tasks in the learning material is clear, easy to understand and relevant to contextual	94
3	The information for curiosity are provided in the learning material	93
4	Chemistry concept and project instructions in the learning material is clear and easy to follow	93
5	The challenge provided in the project is able to motivate the students to learn chemistry, invite curiosity and critical thinking	90
6	It is easy to formulate the appropriate problem and to find the solution	89
7	With assignments, illustrations, and drawings I quickly grasped the concept so that the execution of a given task was completed on time	90
8	Implementation of project-based learning motivate to discover new idea, collaborate and develop communication skills	93
9	The ability to manage the resources and equipment are improved, promote active learning, and develop creativity	94
10	The skills in doing titration (planning, action, report) are develop	93
11	The assignment of the project in this teaching material made me better trained in self-study	93

3.3. Implementation for the Teaching of Redox Titration Topic

An innovative learning materials that have been developed in this study have been implemented in the classroom for teaching Redox titration. Students are given sets of learning materials with projects and multimedia and then they are assigned to design their own projects, each of which completes at least three project packages similar or different to the sample projects available in the teaching material. Students are then asked for their opinions about the relationship of the project undertaken by students to the projects available in the teaching material. The student perception index is summarized in Table 3. The students provide positive perceptions to the developed learning materials. Students' perception index for the project-based learning with multi-media is on a scale of 89-94%. Examples of projects available in teaching materials are very helpful for students to understand the concept of redox titration. Through the freedom given to design the projects, the students can build skills in analytical chemistry. Students' creativity and students' knowledge in performing redox titrations increase. It can be concluded that the project-based learning with multi-media improve students' memory of the knowledge they learn in Analytical Chemistry.

Learning activities are also evaluated based on the ability of students to plan projects, carry out projects and report the results of projects as summarized in Table 4. The students have succeeded in planning, implementing and reporting assigned project activities. The results of student achievement based on portfolio assessments are very high (average 93.75). The results showed that the students have mastered themselves in the knowledge and skills (psychomotor aspects) to carry out the redox titration.

Table 4 Students performance based on learning activities to carry out redox titration projects

No.	Activity Assessments	Students achievements	Concluding Criteria
1.	**Pre-work:** including preparedness in the project work, proposed schedule, and safety equipments)	98.00	very good
2.	**Implementation of project:** including project completion based on project planning, data collection and data presentation, report results, and experience evaluation	92.60	very good
3.	**Implementation of experiment:** including achieved skill, systematic work, skills to use analytical tools and materials, working procedures, tidiness and cleanliness, waste management, and note taking	90.00	very good
4	**Experiment report:** including presentation of results and finding, discussion, applications, conclusion, and suggestion and further recommendation	94.40	very good
	Average value	93.75	

4 Conclusion

Study results concluded that an innovative learning materials on project-based with multi media have successfully been developed for undergraduate chemistry students. The developed learning material equipped with projects and multimedia greatly help students in building their knowledge and skills in the field of Analytical Chemistry. The learning model is very effective in guiding the students to design their own project according to the chemistry topic of Redox titration that are being taught. Project-based learning model with multimedia provided the freedom for students to develop creativity in carrying out experiments in the laboratory, guiding the students to learn independently, providing more enjoyable learning environment, and the end results are improving students performance in the knowledge and psychomotor aspects. This learning model is very appropriate to be implemented for science courses that build analytical chemistry competency.

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