Students' Creativity in Hydrocarbon and Crude Oils with RADEC Model-based Augmented Reality (AR)

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ABSTRACT. This study aims to determine how students' creativity in learning hydrocarbons and crude oils materials through the *Read, Answer, Discuss Explain, and Create* (RADEC) learning model using augmented reality (AR) media. The research method used is descriptive qualitative. The study involved 25 students of class XI in a high school in Bogor. The research instrument used was in the form of creative product assessment using the Willian indicator (1968). The aspects of creativity used are Fluency, Flexibility, Originality, Elaboration, and Evaluation. Students' creativity can be raised through the Create stage by creating Augmented Reality in various objects according to individual and group creativity. The results showed that the average creativity of the students reached 86% based on the Willian indicator instrument rubric.
Keywords: *Creativity, Hydrocarbons and Crude oils, RADEC model, Augmented Reality.*

1. INTRODUCTION

Technological improvements in every sector mark the challenges for the Indonesian nation in the 21st century. One of them is the field of educational activity, where students with skills, qualifications, and high competitivity need to be prepared for the quality of the curriculum. The abilities of the 21st century skill include creativity, innovation, critical thinking, and problem-solving [1].

The importance of the creativity of the student must be developed throughout the learning process so that it can contribute to personality and character development. Creativeness can be achieved based on the interests, pleasures, satisfaction, and job challenges of a person, not under pressure or other social circles [2]. Thus, creativity should encourage enthusiasm and motivation to learn to be more active and enjoyable. The student learning activities that highlight the aspect of creativity enable students to interact independently and solve problems in situations of learning [3].

Creativity aspects can be applied through suitable learning models. The learning model Problem-Based Learning (PBL) is one learning model that can be used to overcome active learning, solve issues, and fostering students' creativity. This learning model can increase creativity effectively rather than conventional education [4]. Besides that, another model of learning is project-based learning (PjBL) can encourage students' creativity to help students participate actively in learning [5]. However, The use of these innovative learning models does not improve the quality of education directly. The research that this learning model has several weaknesses including: first it takes a long time to understand and implement a clear and proper learning syntax in classroom teaching to avoid an optimal learning process [6]. Secondly, the teachers in Indonesia face these weaknesses in their implementation, which means that teachers often use conventional learning models [7].

Various studies on how to overcome the low creativity of students, namely by improving the teaching process through suitable learning models and media [8]. The right model and media can assist students in understanding abstract chemical concepts. Other factors make the learning of chemistry difficult, including the 3 levels of

chemistry: macroscopic, symbolic, and submicroscopic [9]. One of the chemical materials that require students to have 3 levels of representation is hydrocarbon and petroleum.

Based on several educational problems in Indonesia, the first problem achieved is the low creativity of students because the teacher does not encourage them to develop these qualifications. Second, teachers had difficulty in applying the learning syntax of all existing innovative models for use in learning in Indonesia. Third, hydrocarbon and crude oils materials are abstract and require 3 levels of representation ability.

Research by Adi et al., Pratiwi et al., Wulandari etal., showed that students' creative abilities can be developed through RADEC model processes [10, 11, 12]. Another study shows that the RADEC STEM-oriented learning model is classified as high to increase the creativity and solve problems of students [12]. In the creation phase, students are therefore asked to produce creative products in the making of animations or videos of the structured hydrocarbon structure to overcome the effects of the combustion of fuels based on the discussions and understanding of students.

3D Animations applied to learning media are a way of understanding abstract conceptual chemicals. The learning media based on Augmented Reality (AR) technology is one of the currently developed learning media. This technological AR learning media is a media that uses its media platform like a smartphone. The applications of AR media can help well view 3D animation and can increase the interests of abstract chemistry students [8]. Also, they become more actively involved in learning so that the concept of the chemistry material taught is easier for them to understand.

Based on the above description, researchers are interested to investigate the creativity of students in hydrocarbons and crude oils materials through the model of Reading-Answer-Explain- and Create (RADEC) based on augmented reality."

- How are students' creativity in hydrocarbon and crude oils materials through an Augmented Reality (AR) based RADEC learning model?

2. RESEARCH METHOD

Descriptive qualitative research is the research method employed in this research. In this study, the research design is a case study that seeks to gain a comprehensive overview of students' creativity and how the RADEC model learning can improve the creativity of students. The participant are 25 students of class XI MAN 1 Bogor, who are divided into five heterogeneous groups (5 students per group). The instrument used this research is the Willian indicator as a product test that included aspects of fluency, flexibility, originality, elaboration, and evaluation. The product being assessed is creative in the form of AR applied to various objects [13].

Especially in the *discuss* stage, the worksheets used are creativity-based questions built based on the basic competencies and indicators of Williams creativity, which has been adapted. Furthermore, the LKS draft is validated first by a validator consisting of 2 chemistry lecturers and 4 junior high school chemistry teachers. This validation is carried out to measure the suitability of the sub-indicators of creativity with the sub-indicators of the content of statements and questions in the worksheets, as well as the suitability of statements with instructions on student worksheets.

3. RESULTS AND DISCUSSION

The students' creativity is observed by researching the learning process for hydrocarbons and petroleum material. The creativity of students is to create 3D animations of hydrocarbon structures and videos to overcome or minimize the impact of combined oil on various objects in Augmented Reality (AR). The process begins with the animation and ideas on the video content. This research leads to students creating AR that can be a learning medium and become a technologically involved entrepreneurial opportunity. The results of the interpretation of AR-based RADEC learning are shown in table I.

TABLE 1. Percentage Of Implementation Of Ar-Based Radec Learning Model

RADEC stages	Percentage of Implementation	Category	Description
Read	*75%*	*Good*	*This stage can be carried out well. At this stage, the teacher provides teaching materials for hydrocarbons and petroleum-based on augmented reality.*
Answer	*100%*	*Very well*	*Activities on the answer as a whole can be carried out, although not all students answer pre-learning questions and send their answers to the teacher.*

RADEC stages	Percentage of Implementation	Category	Description
Discuss	*90%*	*Very well*	*This stage was carried out very well, even though some students did not follow due to other factors.*
Explain	*90%*	*Very well*	*This stage was carried out very well, even though some students did not follow due to other factors.*
Create	*75%*	*Good*	*The creative activity is carried out because students can plan the creation of augmented reality application works and students can make work in groups.*

Observations on the implementation of RADEC learning show that these work is going well. Students at the RADEC stage tend to become more active in learning, and other skills such as reading, problem-solving, and communication also developing by using the RADEC learning model. This corresponds to a statement from Sopandi., that RADEC can increase the involvement of students in learning activities is active and learn of difficult concept [14].

Students' Creativity

The creativity of students can be evaluated on the basis of work done individually or in groups. The task was to create 3D animations of hydrocarbon structures such as alkanes, alkenes, and alkyne and to produce videos on how to overcome the environmental and health effects of combustion in the shape of a realistic increase. These results can be demonstrated by the idea of the AR marker itself, its instruments and materials and its work methods. The products of students' work can be seen in the following picture.

Fig 1. AR the process of crude oils fraction is applied to the glass

Fig 2. AR 3D molecule animation applied on the t-shirt

The products produced include 3D animations of hydrocarbon compound structures and AR videos that are shown in objects to add entrepreneurial value.

Product assessment is performed using creative tools to evaluate whether the work is created based on Willian's creative indicators, namely aspects of Fluency, Flexibility, Originality, Elaboration, and Evaluation [13]. The results of the creative product assessment can be summarised in table II.

TABLE 2. Assessment Instruments For Creative Augmented Reality Products

Indicator	Sub Indicator	Group					Total	Maximum Total	%
		1	2	3	4	5			
Fluency	The work that is produced is creative ideas as a solution to existing problems	4	4	3	4	3	18	20	90%

Flexibility	The work produced is made of materials that are easy for entrepreneurs to create (flexible according to trends and needs).	3	4	2	3	4	16	20	80%
Originality	The resulting work is a new approach/modification of the old way.	3	4	3	3	4	17	20	85%
Elaboration	The resulting work is easy to work on and improve on an ongoing basis.	4	3	4	3	3	17	20	85%
Evaluation	The work produced has rational reasons that can be justified for decision in the group.	4	3	3	4	4	18	20	90%
Average		3,6	3,6	3	3,4	3,6	17.2	20	86%

Based on the results of the product assessment, students' creative scores and evaluations have an average value of 90%, this shows that students have very good ideas or opportunities in designing product ideas that have more quality and value and the results show that students in groups who able to decide on the idea and execute it very well. According to Wahyu., creativity is shown through a discussion process through the ideas and results they make for quality testing. Therefore, creative products will also be generated from creative ideas [3]. Then on the flexibility indicator, the average value obtained is 80%, this value is the value of other indicators, but in total the student's creativity is very good with an average gain of 86% according to the evaluation of creative products in table 2. Therefore, students' augmented reality products are creative works that will be opportunities for other technology-based products.

Thus, the use of the RADEC model can encourage students to learn independently and develop creativity so that students' learning experiences are more interesting and motivated to develop other skills. And finally, these skills will help students face the challenges of the age to come.

4. CONCLUSIONS

Based on research conducted in this study, two expert lecturers and four chemistry teachers were involved in an assessment of the feasibility of the creative product when the test was adjusted to the study activities with the sub-indicator creativity of William. This model can therefore also be used in other chemical studies to develop other skills.

The average creativity assessment of students for AR product is 86%. From the production of the product, independence can be seen in the search of ideas to decide the content and the work steps. Therefore, the use of the RADEC model can increase students' creativity in learning.

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