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Analysis of The Creativity of Senior High School Students Through The C-R-E-A-T-E Learning Model

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Abstract: This study aims to analyze students' creativity through the C-R-E-A-T-E learning model in a blended system. Voltaic Cell was chosen as the material studied because the process of making Voltaic Cells can support the development of students' creativity. The research method used was Design Based Research (DbR). The research instrument used was a creativity observation sheet according to William's creativity indicator and an assessment sheet for students' creative products which included three main skills: creating, investigating, and problem-solving skills. The results of this study indicate that the step-by-step C-R-E-A-T-E learning model implemented through a blended system supported by Google Classroom can develop students' creativity, both in terms of creative processes and creative products. It was shown from the observation results of students' creativity on the indicators of fluency, flexibility, elaboration, originality, and evaluation each included in the very good category. In addition, the average score of students' creative product assessment is also in the very good category. These results indicate that the learning model is feasible to be applied in learning as an effort to develop student creativity.

Keywords: students' creativity, the C-R-E-A-T-E model, senior high school.

Abstrak: *Penelitian ini bertujuan untuk menganalisis kreativitas siswa melalui model pembelajaran C-R-E-A-T-E dalam sistem blended. Sel Volta dipilih sebagai materi yang dipelajari karena proses pembuatan Sel Volta dapat mendukung pengembangan kreativitas siswa. Metode penelitian yang digunakan adalah Design Based Research (DbR). Instrumen penelitian yang digunakan adalah lembar observasi kreativitas sesuai indikator kreativitas William dan lembar penilaian produk kreatif siswa yang meliputi tiga keterampilan utama yaitu keterampilan mencipta, menyelidiki, dan memecahkan masalah. Hasil penelitian ini menunjukkan bahwa langkah demi langkah dalam model pembelajaran C-R-E-A-T-E yang diterapkan melalui sistem blended yang didukung Google Classroom dapat mengembangkan kreativitas siswa, baik dari segi proses kreatif maupun produk kreatif. Hal ini ditunjukkan dari hasil observasi kreativitas siswa pada indikator kefasihan, keluwesan, elaborasi, orisinalitas, dan evaluasi masing-masing termasuk dalam kategori sangat baik. Selain itu, skor rata-rata penilaian produk kreatif siswa juga berada pada kategori sangat baik. Hasil tersebut menunjukkan bahwa model pembelajaran layak diterapkan dalam pembelajaran sebagai upaya mengembangkan kreativitas siswa.*

Kata kunci: *kreativitas siswa, model C-R-E-A-T-E, SMA.*

▪ INTRODUCTION

One of the important aspects in increasing international competitiveness is creativity (Labuske & Streb, 2008). Creativity development can be done through real activities in thinking and acting creatively. This can be done through learning that can support students to see problems from various perspectives, develop their ideas and imagination, and find solutions to solve a problem (Treffinger et al., 1980).

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In the school curriculum, science is an important domain. Chemistry is an important part of science. Therefore, learning chemistry has a great potential to encourage students' thinking skills and creativity (Trivić et al., 2012). Chemistry learning which involves the development of creativity not only has a positive influence on chemistry image and students' competence, but also fosters students' motivation to become chemists (Bliersbach and Reiner, 2017). Therefore, the development of student creativity through chemistry learning is very important to be done.

Efforts to build student creativity through learning activities are still ongoing. Armitage et al. (2015), Yoon et al. (2015), Wahyu et al. (2016), Nuswowati et al. (2017) examined problem-based learning models to increase student creativity. Through problem-based learning, students are encouraged to identify problems, formulate and choose appropriate solutions, design experiments based on the solutions they choose, and evaluate the results of these experiments. This series of activities stimulates student creativity (Yoon et al., 2015). On the other hand, Insyasiska et al. (2015), Lou et al. (2017), Isabekov & Sadvrova (2018) researched project-based learning models to increase student creativity. Project-based learning models receive theoretical support from Vygotsky's social constructivism, which provides a basis for cognitive development by increasing the intensity of interpersonal interactions (Vygotsky, 1978; Davydove, 1995; Moore, 1999). Project-based learning can facilitate student to create products with a novelty value (Isabekov & Sadvrova, 2018). Through project-based learning, students are encouraged to relate knowledge and skills, actively build creativity, solve problems, foster a sense of responsibility, and collaborate (Tuan et al., 2020).

Recently, Wahyu et al. (2020) first developed the C-R-E-A-T-E model to improve student creativity. This learning model start with the stage of connecting initial knowledge (Connecting), restructure the initial knowledge (Restructuring), elaborating the restructured knowledge (Elaborating), applying the elaborated knowledge (Applying), giving project tasks (Tasking), and decision-making based on evaluation results (Evaluating), which was acronym as CREATE or the CREATE learning model. According to Sani's (2015), the C-R-E-A-T-E learning model is project-based, referring to the philosophy of constructivism so that this learning model is student-centered. In addition, the C-R-E-A-T-E learning model also fulfills the characteristics of project-based learning according to Thomas's (1999): (1) focus on problems for mastery of important concepts in lessons; (2) project development involves students in carrying out constructive investigations; (3) projects must be realistic, and (4) projects are planned by students.

Wahyu et al. (2020) first implemented the C-R-E-A-T-E learning model to improve students' creativity through learning chemistry on Voltaic Cells. In that study, the C-R-E-A-T-E model effectiveness was measured based on student answers on their worksheets, students' creative products, students' testimonials, and observers' testimonials. The results of this study indicated that the C-R-E-A-T-E model is effective to be applied in learning that aims to develop student creativity. However, no further analysis has been carried out on student creativity during the application of this learning model. Therefore, this study focuses on the analysis of student creativity during the stages of learning using the C-R-E-A-T-E learning model in Voltaic Cell learning.

The Voltaic Cell material was chosen because the learning activities in this material can support the development of student creativity. In Voltaic Cell learning, learning activities require students to be able to design something so that it can stimulate an increase in their creativity (Heliawati and Rubini, 2020). In addition, these activities can also help students to build an understanding of the use of chemical reactions to be used as a source of energy in everyday life (Asih et al., 2020).

Assessing a person's creativity cannot be done if it is only based on the creative process experienced by that person, without paying attention to the creative product. In other words, the quality of creative products is a particular priority in assessing one's creativity (Briskman, 1980). On the other hand, Tran et al. (2016) stated that if the teacher prioritizes creative products more than the creative process, students will be hindered from exploring and thinking about creative ideas. However, researchers paid little attention to the process of turning creative ideas into creative products (Oleynick et al., 2014). Therefore, researchers tried to analyze student creativity by reviewing two aspects, namely the creative process and creative product of students. Since the COVID-19 pandemic occurred, online learning has become one of the most widely used learning solutions. Blended system is an alternative solution in online learning (Bakhtiar et al., 2020). Blended learning combines the positive aspects of online and traditional learning to support the learning process independently while reducing learning time in traditional classes (Yonwilad and Sinlapaninman, 2022).

Google App for Education provides a new feature that can be utilized in online learning, namely Google Classroom (Bakhtiar et al., 2020). Through Google Classroom, teachers can design virtual class to support online learning. This can support students to learn independently and be active in their own learning process (Ana et al., 2022). Through blended learning supported by Google Classroom, students and teachers can interact directly while carrying out group discussions and other tasks carried out through web-based activities. This can support the creation of a learning environment that is not boring and interesting for students (Yonwilad and Sinlapaninman, 2022).

Based on this background, this study aims to analyze high school students' creativity in Voltaic Cells learning with the C-R-E-A-T-E learning model. An analysis of student creativity was carried out using two instruments, a creativity observation sheet and an assessment sheet for students' creative products. The results of this study are expected to complement previous research questions related to student creativity during learning with the C-R-E-A-T-E learning model. In addition, the results of this study are expected to contribute to the world of education in order to create learning that can facilitate student development. Thus, it can indirectly contribute to creating young generations who have the competence to compete globally in the current 21st century era.

▪ METHOD

Participants

The participants of this study included twenty twelfth-grade students from a senior high school in Bandung, Indonesia. These students were selected by purposive sampling with the aim of obtaining more reactions and information (Nieveen & Folmer, 2013). Three observers were involved in the process of observing students' creativity during the learning process.

Research Design and Procedures

Design-based Research (DbR) according to Reeves (van den Akker et al., 2010) was used as the research method. This method is generally used in learning studies (Herrington et al., 2007). The DbR method was taken through 4 stages adapted from Reeves: (1) problem identification, (2) development programs, (3) program trials, and (4) reflection on program implementation.

In this article, we discuss the results of the third phase of the research, where the C-R-E-A-T-E model was tried to analyze student creativity during learning. The learning process is carried out in a blended system by combining 90 minutes of face-to-face learning and asynchronous online learning via Google Classroom. Through Google Classroom the teacher guides students to prepare lessons and projects to be carried out.

Instruments

This study used two non-test research instruments. To suit research needs, researchers develop our own instruments. First, the creativity observation sheet according to William's creativity indicators (in Munandar, 2009) that was used to analyze student creativity. This instrument includes five indicators of creativity namely fluency, flexibility, originality, elaboration, and evaluation which are mapped into six stages of C-R-E-A-T-E (Connecting, Restructuring, Elaborating, Applying, Tasking, and Evaluating).

Second, an assessment sheet for students' creative products which includes three key skills. These three key skills include Creating, Investigating, and Problem-Solving skills. These three skills are used to assess creative products based on the processes students go through during their production process. Both of these instruments are used in learning the C-R-E-A-T-E model which is implemented in a blended system. Before being used, these instruments have been tested for feasibility using the expert judgment method.

Data Analysis

Data analysis of the results of observations of students' creativity and creative products assessment was carried out by categorizing the percentage of results according to Arikunto (2006) as in Table 1.

Table 1. The categorization criteria according to Arikunto (2006)

Percentage (%)	Category
81-100	Very good
61-80	Good
41-60	Deficient
21-40	Not Good
0-20	Very Not Good

▪ RESULT AND DISSCUSSION

The C-R-E-A-T-E learning model was first developed by Wahyu et al. (2020). C-R-E-A-T-E stands for learning stages namely: Connecting, Restructuring, Elaborating, Applying, Tasking, and Evaluating. The arrangement of the sequence of learning steps C-R-E-A-T-E is not without reason. The C-R-E-A-T-E learning model is a student-centered constructivist learning model. The constructivist approach encourages students

to bring their prior knowledge into the learning process. Then throughout the learning process, students reconstruct part-by-part of their new knowledge (Morphew, 2002). In addition, conceptual elaboration is needed by students to bring out the coherence of their experiences to perfect the concepts they build (Delia, 1977). Apart from these three things, Baviskar et al. (2009) mentioned four main features of the constructivist approach: (1) eliciting students' prior knowledge, (2) eliciting cognitive dissonance, (3) applying new knowledge, and (4) reflecting on the learning process. These characteristics of the constructivist approach are the basis for the arrangement of the C-R-E-A-T-E learning steps.

In addition, the abbreviation of the C-R-E-A-T-E learning steps was carried out to make it easier for teachers and students to remember the learning steps they went through. When students know step-by-step what they will go through during the learning process, students can automate themselves to learn independently and minimize their dependence on the teacher. Students can also determine when and how they will proceed to the next learning step (Voorhees and Bedard-Voorhees, 2016).

Analysis of Student Creativity Developed through the C-R-E-A-T-E Model

Table 2 shows the analysis of student creativity developed through the C-R-E-A-T-E learning model. It can be seen from the results of observations based on Williams's five creativity indicators according to Munandar (2009). This creativity analysis is based on the fluency, flexibility, elaboration, originality, and evaluation indicators that have been mapped into the six stages C-R-E-A-T-E.

In the Connecting stage, students are able to connect their prior knowledge with the phenomena given by the teacher. This phenomenon stimulates students' creative ideas because it presents various types of Voltaic Cells with different construction tools and materials. Although the ability to associate prior knowledge with creative ideas has a higher level of abstraction, students make it through. 25% of students reach the very good category and 75% of students reach the good category. This is indicated by the very high achievement of student creativity in this stage. In the Connecting stage, the teacher role is to provide direction and guidance/investigation questions to all students. This provides a stimulus in the form of information about the concepts that students already have.

The creativity indicator in the Restructuring phase is to provide several alternative solutions flexibly (flexibility). At this stage, the teacher guides students to formulate several solutions related to the given phenomenon. These solutions are in the form of creative ideas about materials around students that can be used to make Voltaic Cells. Student creativity at this stage is in the very good and good category with a ratio of 50:50. It shows that students have been able to formulate creative ideas as a solution to a problem.

The creativity indicator at the Elaboration stage is the student's ability to elaborate on the linkage of ideas with several alternative solutions (elaboration). At this stage, students are guided to be able to elaborate on their knowledge of Voltaic Cells to be developed into the principles of making Voltaic Cells from the surrounding environment. Student creativity at this stage is good and very good with a ratio of 50:50.

In the Applying stage, the creativity indicator must be achieved by students designing products from several materials around them that are different from existing

materials (originality). Based on the concepts and principles of the Voltaic Cell from around materials, students determine the materials they will use to make Voltaic Cells. This stage obtains an observation value of 100% of a very good category. The ability of students to restructure and elaborate ideas that are more substantial, makes a solid capital for students in designing products that are different from the product information they have received.

Table 2. Analysis of Student Creativity Developed through the C-R-E-A-T-E Model

No.	Syntax	Creativity Indicator	Percentage (%)				
			Very Good	**Good**	**Deficient**	**Not Good**	**Very Not Good**
1	Connecting	Connect prior knowledge with creative ideas seamlessly (*Fluency*)	25	75	0	0	0
2	Restructuring	Provide several alternative solutions flexibly (*Flexibility*)	50	50	0	0	0
3	Elaborating	Elaborating the linkage of ideas with several alternative solutions (*Elaboration*)	50	50	0	0	0
4	Applying	Designing several Voltaic Cells from several materials around them that are different from existing materials (*Originality*)	60	40	0	0	0
5	Tasking	Carrying out project assignments for making several Volta Cells from several materials that are around that are different from existing materials (*Originality*)	100	0	0	0	0
6	Evaluating	Evaluate the strengths and weaknesses of Voltaic cells that have been made as creative works (*Evaluation*)	80	20	0	0	0

The Tasking stage involves hands-on activities. At this stage, students carry out project assignments for making several Voltaic Cells from several materials around them that are different from existing materials (originality). The observation results show that 60% of students succeed in achieving creativity indicators in the very good category and the rest in the good category. This shows that hands-on activities have a positive impact on increasing student creativity because it can challenge students' adventurous spirit and grow their learning motivation (Lou et al., 2017).

In the final stage of learning, the Evaluation stage, students are guided to evaluate the advantages and disadvantages of voltaic cells that have been made as creative

products. It also aims to enable students to reflect their learning outcomes. At this stage 80% of students reach the very good category and the rest reach the good category.

Overall, students' creativity in terms of the creative process that students go through is included in the very good category. This is in line with the results of previous research that the C-R-E-A-T-E learning model is effective to be applied in efforts to develop student creativity (Wahyu et al., 2020).

Assessment of the Quality of Students' Creative Products

In this study, the assessment of the quality of creative products was assessed based on the Three Key Skills including creating, investigating and problem-solving skills. These parameters were used to assess students' creative products while still paying attention to the creative processes by students during the making process. Based on the data in Table 3, it can be seen that the overall average score of the quality parameters of students' creative products is 87%. This shows that the creative products produced by students are categorized as very good. This data shows that the application of the C-R-E-AT-E Model is effective in building student creativity.

Table 3. Assessment of the quality of creative product

No.	Creative Product Quality Parameters	Rated aspect	Description	Percentage (%)
1	Creating Skills	Fluency	Creative product can make it easier to expedite the resolution of existing problems	90
		Flexibility	Creative products are easy to carry, can be used anytime and anywhere	85
		Originality	Creative product has its own uniqueness, something new, and different from others.	80
		Elaboration	Creative product is the result of developing ideas from works that have existed before through the results of in-depth discussions and discussions in accordance with related chemical concepts.	95
		Evaluation	Creative products have several advantages, including materials that are available in everyday life, are cheap and easy to obtain, and are not complicated to handle.	95
	Average Creating Skills Score			89
2	Investigating Skills		Creative product can be used in the investigation process in the environment around students.	92

No.	Creative Product Quality Parameters	Rated aspect	Description	Percentage (%)
3	Problem Solving Skills		Creative product can be a solution to teacher's problems.	80
Average Three Key Skills Score (%)				87

How chemistry can enhance students' creativity really depends on how chemistry learning is done (Trivić et al., 2012). Therefore, the creating skills was chosen as one of the parameters in this assessment. The five aspects of creativity in this parameter show the creative process students through to produce the Voltaic Cells. In this parameter, the average percentage of the quality of students' creative products reaches 89%.Chemistry as part of science certainly requires students to have investigative skills. The parameter of investigating skills in this assessment shows that creative products can be used in the investigation process in the environment around students. Assessment of this parameter shows the highest result, namely 92%. This shows that the student's Voltaic cell supports the student's investigation of their surrounding environment.

Creativity in finding solutions is needed by a good problem solver (Jegstasd and Sinnes, 2015). Therefore, problem solving skills are needed to produce creative products that can be used as solutions to existing problems. Problem solving skills include identifying problems, brainstorming and analyzing answers, and implementing the best solutions. In this study, problem-solving skills are how students' creative products can help increase understanding of the concepts learned and can solve teacher problems. The average value of this parameter is the lowest, which is 80%.

▪ CONCLUSION

Analysis of student creativity in terms of the observation results on student creativity showed very good categories. Likewise, the assessment results of the quality of students' creative products based on the Three Key Skills parameter showed very good categories. Both of these results show that this result study is in accordance with previous research that the C-R-E-A-T-E learning model is effective for developing student creativity (Wahyu et al., 2020).

The results of this study indicate that the analysis of student creativity can be based on creative processes and creative products simultaneously. There is no one aspect that is more important than the other because both aspects are equally important in determining one's creativity. However, this study has not discussed the influence of the C-R-E-A-T-E learning model on student creativity quantitatively (using control and experimental classes). In addition, creative thinking skills as measured through creative thinking tests have not been analyzed. Therefore, further research is needed to answer these things.

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