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Developing 21st Century Skills through the Make-a-Match Method in Reaction Rate Learning

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ABSTRACT

The 21st century revolution demands individuals enhance their quality to thrive in a globalized world. Consequently, mastering critical thinking, creativity, collaboration, and communication (4C) skills has become a necessity for success in this context. This study aims to analyze students' activities during the Make a Match learning process assisted by question cards and the improvement of students' 4C skills at each stage of the process. A mixed-method approach was employed, combining qualitative and quantitative methods. The qualitative approach described student activities using observation sheets, while the quantitative approach applied a pre-experimental one-shot case study design. The participants were 26 science class XI students from SMA Darussalam Wanaraja Garut. Instruments included learning descriptions, observation sheets, student worksheets, and post-test questions. The results indicated that overall, student activity reached 96.75%, categorized as very good, with an average activity score of 3.87. The highest and lowest average activity scores were 4 and 3.5, respectively. The average 4C skills score, derived from activities and worksheets, was 91.125, also categorized as very good. Creative skills achieved the highest average score of 97.5 (very good), while critical thinking scored 87 (good). Hypothesis testing showed a significant positive influence of the Make-a-Match method on students' 4C skills. The findings underscore the effectiveness of the Make-a-Match method in fostering 4C skills, offering valuable insights for innovative learning strategies in chemistry education.

Keywords: 4C skills, make-a-match, question card, reaction rate

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1. Introduction

The Fourth Industrial Revolution (4IR), known as Industry 4.0 in the early 21st century, is dominated by nanotechnology, artificial intelligence, genetic engineering, supercomputers, and innovation. This revolution impacts human activities, including economics, industry, government, and education (Arnyana, 2019) (Farida et al., 2017). Besides, this transformation requires humans to be able to improve their quality to survive and adapt in this era of globalization (Eli & Sari, 2018) (Sari et al., 2018) (Sari et al., 2017). Also, this era requires individuals to have strong analytical thinking skills (Nurfazri et al., 2024). Hence, one way to improve human quality is through education (Aslamiah et al., 2021). Education is a place that contains generations to prepare for competition in knowledge, attitudes, and skills.

In reality, this disruption era requires students to have skills such as critical thinking, creativity, communication, and collaboration, or what is called 4C (Septikasari & Frasandy, 2018) (Arnyana, 2019). Critical thinking is a skill that can help students solve problems and make decisions (Nurfazri & Irwansyah, 2024a, 2024b). In addition, creativity is designing and developing new skills to solve problems or

innovate (Sari, 2015). Meanwhile, communication is about expressing opinions, ideas, thoughts, or new information. In this skill, students work in a structured manner to produce a product to be presented. Moreover, collaboration is a skill that requires students to be involved in teamwork, training leadership, and decision-making (Zubaidah, 2018).

Furthermore, the chemistry learning process should implement the 4C concept (Sari & Nurohmah, 2016). In chemistry material, a new paradigm is required; it means that students are given the experience of mastering chemical material and are guided to use generic science skills (Burhanudin et al., 2018). These generic science skills are required in designing students' scientific work. Thus, it is hoped that students can understand the concept, solve problems, and achieve other scientific achievements (Rosidah et al., 2017).

On the other hand, students are expected to like all aspects of the material being studied and develop generic science skills when mastering this lesson and being ready to face the 21st century era. Unfortunately, based on this requirement, students are not used to developing their generic skills in the learning process (Burhanudin et al., 2018). Consequently, students encounter several difficulties and obstacles in the chemistry learning process.

Therefore, this study intends to use a cooperative learning model to solve the problems mentioned above. This learning model is chosen to increase students' 4C skills. Besides, this research is essential to conduct because it aims to enhance students' generic science skills and improve the quality of both the processes and outcomes related to scientific work. To implement this model, students are engaged in a group system to aid the quality of their cooperation (A'yun et al., 2012).

Meanwhile, the researchers employ a Make-a-Match method. The advantages of this method include, increasing student learning activities, making students feel fulfilled because it has an element of play, increasing students' understanding and motivation to learn, training students' courage, and training students' discipline towards study time (Mariskhana, 2020). Besides, the selection of this method is supported by Aliputri (2018) research. Aliputri (2018) yields positive results, stating that implementing the Make-a-Match method could improve student learning outcomes. This can be seen in the increase in learning completeness from 51% to 94% (Aliputri, 2018).

Concurrently, the novelty of this research lies in the use of card media and the Make-a-Match method. Question cards facilitate the search for partners in the learning process using the Make-a-Match method. In addition, question cards are expected to attract attention and increase student activity in class (Aisyah, 2021).

Hence, by considering the importance of applying 4C skills to prepare students for the 4.0 revolution, the researchers conduct "Reaction Rate Learning through the Make-a-Match Method to Enhance Critical Thinking, Creativity, Communication, and Collaboration "research.

2. Research Method

This study employed a mixed method a quantitative and qualitative approach. The quantitative approach was used with a pre-experimental design, which is a one-shot case study. Also, a posttest was given to one class without a control group (Aldila & Mukhaiyar, 2020). It was used to determine the relationship between variables and the population using a mathematical model. This study's quantitative data sources were the posttest results, the student's worksheet, and the assessment rubrics from the worksheet. In addition, the source of qualitative data from this study was observation sheets.

Meanwhile, data collection techniques were obtained during the learning process, pretest-posttest results, and activeness when implementing learning using the Make-a Match method. Besides, data analysis was taken from the observation sheet with an

assessment of one until four. Also, student worksheets were assessed with a range of values of 1-100, and posttest questions adopted the normality test using the Shapiro-Wilk test and assisted by the SPSS version 25.0 program with a significance level of 0.05 (Hartono, 2008). After that, the hypothesis test was carried out using the binomial test. In addition, standard data was one requirement for a parametric test, while non-normal data would be carried out non-parametrically. The parametric tests included homogeneity tests, t-tests, and hypothesis tests.

Hence, based on the research method, three stages would be carried out: preparation, implementation, and final stages. The preparation stage was carried out from July to September at UIN Sunan Gunung Djati Bandung. The implementation stage was carried out in October at SMAS Darussalam Wanaraja Garut according to the syllabus of the chemistry subject for class XI on reaction rate material with an offline system. The final stage was carried out from October to December at UIN Sunan Gunung Djati Bandung.

3. Result and Discussion

This study was conducted using six stages, which were in accordance with the stages of the Make-a-Match cooperative learning model: stimulation, problem statement, data collection, data processing, verification, and generalization.

At the stimulation stage, students were given a video and a discourse on the phenomenon of reaction rates. Besides, students were directed to observe the video and the discourse provided. This stimulation was used to incentivize student responses. Moreover, the stimulus was information obtained by the five senses. In addition, behaviorism theory uses stimulus paired with response to explain the process of forming behavior (Fatmawati & Anjarsari, 2021) (Sari, 2018).

During this stage of stimulation, students received an average score of 100 for observing the presented rate video, indicating a very good interpretation of the material. Although students' ability to answer questions related to the material had an average score of 3.73, most students were able to answer them well. At the stimulation stage, the 4C skills measured were creative thinking skills with creative thinking indicators (Sari et al., 2016), where students tended to explore something that had not been done. In this case, students had a desire to explore material that pupils had not learned, which are the reaction rate material. The student activities can be seen in Figure 1.

Figure 1. Student Activities at the Stimulation Stage

At the problem statement stage, after students had been given a stimulus in the form of discourse and videos about reaction rates, they were asked to write down problem formulations and hypotheses based on the formulated problems. During this stage, students discussed with their peers to collaboratively formulate issues and hypotheses. Most students formulated problems related to the factors influencing reaction rates based on the discourse provided. This indicated that students successfully connected the given discourse with the problem formulations they aimed to address. According to Watson (2015), students need to be able to formulate problems to proceed to subsequent stages effectively.

During the problem statement phase, the mean score for students' performance on the worksheet was 84, indicating good interpretation. This outcome resulted from students' joint endeavours during peer

discussions, culminating in a consistent issue formulation which is "What are the factors that influence reaction rates?" Nonetheless, the explanations presented were consistent with the established issues. Bethyka, et al (2016) emphasized that students are expected to propose temporary answers or hypotheses as a basis for generating ideas or responses to the given questions.

At the data collection stage, the teacher presented material on reaction rates to the students. The procedures and rules for the card-pairing activity were then explained. Based on the observation sheet results, students' attentiveness to the teacher's explanation achieved an average score of four, with a very good interpretation. At this stage, all students focused intently on the teacher's explanation. The classroom atmosphere was conducive; no students were distracted or inattentive. The 4C skill was measured as creativity, assessed through indicators such as students' ability to gain broad insights from books or other information media and their active participation during the learning process (S. Sari et al., 2016). Besides, students exhibited a profound comprehension of reaction rates and the methodologies for the card-pairing activity, attaining an average score of 100 with a very good interpretation.

The next stage was the data processing stage, during which students were given question cards according to their groups. Students were asked to analyse the questions and began searching for matching card pairs (Make-a Match). Based on the observation results, students demonstrated strong abilities in discussing, socializing with group members, and finding card pairs. These skills earned an average score of four, interpreted as very good interpretation. During learning, students were highly active during the process of observing and finding card pairs. Although the cards held by students contained both questions and answers, the Make-a-Match method created enjoyable classroom activities. This method could increase students' engagement in the learning process, mainly during the card-matching phase.

Also, this coincided with the advantages of the Make-a-Match approach mentioned by (Majid & Nur, 2020), who noted that it helped pupils grasp material in a pleasant and engaging classroom atmosphere. At this stage, the 4C skills (Critical Thinking, Creativity, Collaboration, and Communication) were measured. Indicators of creativity included students independently finding solutions, exploring new approaches, and comparing them with previous methods, especially when analyzing card pairs. Critical thinking was reflected in students' ability to determine appropriate actions and socialize effectively, such as strategizing how to find card pairs (Ainun & Dina, 2021).

Communication was assessed through students' ability to share thoughts and information during discussions. Collaboration was measured by their productive teamwork and problem-solving interactions within their groups. The data processing stage achieved an average score of 90, with a very good interpretation. The use of the Make-a-Match method effectively fostered teamwork and precision in finding card pairs, as noted by (Fuad, 2018). Documentation of the data processing stage further highlights these outcomes.

The next stage was verification. During this stage, students who found their card-matching pairs submitted the findings to the teacher to confirm their accuracy. At this moment, pupils could pair their cards appropriately. Moreover, pupils displayed great analytical skills and efficiency in finding their pairs, as it did not take them long to finish the work. As a result, the students achieved an average score of 100, indicating a very good interpretation.

The final stage of the Make-a-Match method was the generalization stage. After completing the learning activities and verification, students were asked to answer questions provided in the worksheet. These included five essay questions that each student was required to complete. The average score at this stage was 90, indicating a very good interpretation. Although each student worked

on their worksheet, they were allowed to discuss their answers with group members. However, in calculation-based questions, some students did not include units in their answers, which resulted in less-than-perfect scores. An example of a Make-a-Match card can be seen in Figure 2.

Figure 2. Make-a-Match Card Learning Media

Furthermore, students' 4C skills were developed using worksheets supported by question card media aligned with the stages of the make a match method. The graph of 4C skill development can be seen in Figure 3.

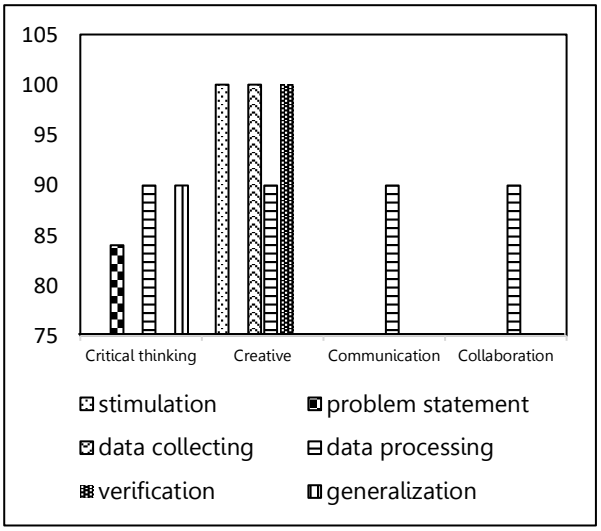

Figure 3. Graph of 4C Skill Development

In this study, following the implementation of the Make-a-Match method, students were given questions to evaluate their understanding of the material. After the method was applied, a posttest was conducted, consisting of eight multiple-choice questions that passed the validity test. The posttest scores were used to measure the development of students' 4C skills and to test the study's hypothesis.

A hypothesis test was conducted to determine whether there was a significant improvement in 4C skills. Before performing the hypothesis test, a normality test was carried out to verify whether the data was normally distributed or not. If the data met the normality criteria, a homogeneity test was conducted. When the data was found to be homogeneous, the process continued with a t-test. If one or both datasets were not normally distributed, a nonparametric test, specifically a median test, was used instead.

The normality test was conducted to determine whether the data obtained was normally distributed or not. The data was considered generally distributed if the standard normal or significance value was more significant > 0.05. Conversely, it was classified as not generally distributed if the significance value was < 0.05.

Meanwhile, the results of the Shapiro-Wilk normality test for the posttest data showed a significance value of 0.000 < 0.05. This indicated that the data was not normally distributed. As a result, the next step in the data analysis was to use the Wilcoxon test to test the hypothesis.

The binomial test was included in the non-parametric test, which was used to replace the t-statistic test if the assumption of n was small, and the data was not normally distributed. The determination of whether to accept or reject the hypothesis is based on the following criteria. The first is H0, which is that there is no effect of applying the Make-a-Match method assisted by question cards on the development of students' 4C skills. The second is Ha, which is that there is an effect of applying the Make-a-Match method assisted by question cards on the development of students' 4C skills.

From the findings of this research, the results of the binomial test showed a significance value of 0.031 < 0.05. Therefore, the null hypothesis (Ho) was rejected, and the alternative hypothesis (Ha) was accepted. This conclusion confirmed that the application of the Make-a-Match method assisted by

question cards significantly affected the development of students' 4C skills.

4. Conclusion

The implementation of the Make-a-Match method assisted by question cards was highly successful, evidenced by a 96.75% activity rate, categorized as very good. Students demonstrated significant development in 4C skills (critical thinking, creativity, communication, and collaboration), with an overall average score of 91.125 in the very good category. Creative skills achieved the highest average score (97.5), while critical thinking skills scored 87. Additionally, students' ability to complete worksheets and post-test questions averaged 94 and 82.14, respectively, both interpreted as very good. The hypothesis test results ($p = 0.031 < 0.05$) confirmed a significant improvement in students' 4C skills, validating the effectiveness of this learning approach.

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