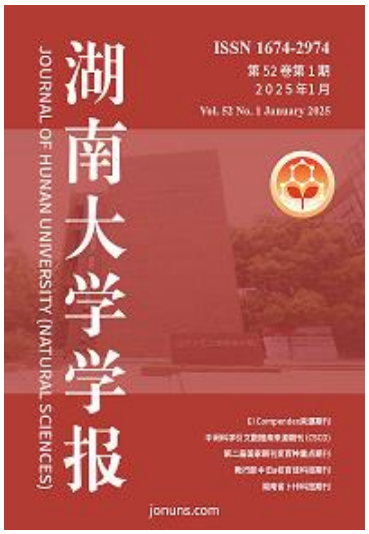

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Implementation of the REAKSI Learning Model on the Collaboration Skills of Chemistry Education Students

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Abstract: The problem of chemistry learning that often occurs is the discussion of macroscopic, submacroscopic, and symbolic materials, which is considered difficult by students. Therefore, collaboration skills are needed to make it easier for students to understand chemistry materials. The current learning model is mostly designed to encourage students' collaboration skills. The solution to this problem is to design a learning model that encourages student collaboration, namely, the REAKSI learning model based on the STEM approach. REAKSI represents Research Formulation (R), exploration (E), analysis (A), classification (K), synthesis (S), and implementation (I). This study aimed to implement a new learning model called the REAKSI learning model to improve students' collaboration skills. The novelty of this research is a new learning model that can be used as an innovation in 21st century learning, which is quantitative research using the lesson study method. The samples used were chemistry education students at the University of Riau, Sultan Syarif Kasim State Islamic University, and Riau Islamic University, who were selected using purposive sampling. Data were collected through observations using a Likert-scale questionnaire. Data analysis: The REAKSI learning model based on the STEM approach is more effective in developing collaboration skills from 77% to 90% with a high category. This effectiveness is obtained because the REAKSI learning model includes steps that direct students to engage in collaborative learning activities.

Keywords (English): Collaboration, Effectiveness, Learning Model, REAKSI

REAKSI學習模式對化學專業學生合作技能的實踐

摘要：化學學習中經常出現的問題是對宏觀、亞宏觀和符號材料的討論，被學生認為是困難的。因此，學習中需要協作技能，讓學生更容易理解化學材料。目前的學習模式主要是為了鼓勵學生的協作能力。解決這個問題的方法是設計一種鼓勵學生協作的學習模式，即基於STEM方法的REAKSI學習模式。REAKSI 代表研究公式（R）、 探索（E）、 分析（A）、分類（K）、綜合（S）、實施（I）。本研究旨在實施一種名為REAKSI學習模式的新學習模式，以提高學生的協作能力。本研究的創新之處在於提出了一種新的學習模式，可以作為21世紀學習的創新。樣本為廖內大學、蘇丹薩利夫卡西姆州立伊斯蘭大學、廖內伊斯蘭大學的化學教育專業學生，採用立意抽樣法選出。數據是透過觀察李克特量表問卷收集的。數據分析以STEM方法為基礎的REAKSI學習模式在培養協作技能方面更為有效，高類別協作技能的培養率從77%提高到90%。這種有效性是因為
REAKSI 學習模式有指導學生在學習中進行協作活動的步驟

关键词：協作、有效性、學習模式、REAKSI

1. Introduction

Human resources in the 21st century are required to master various skills, one of which is innovation [1]. Hadinugrahaningsih et al. (2017) stated that there are three categories of 21st century skills, namely learning and innovation skills, which include communication and collaboration skills, problem-solving and critical thinking, and creativity and innovation [2]. Educators play a very important role in preparing for learning to develop these 21st century skills. In the learning process, teachers are expected to develop 21st century competencies, one of which is collaboration skills [3].

Students often consider chemistry learning difficult. This is because chemical materials are macroscopic, submacroscopic, and symbolic [4]. Therefore, students must actively learn to facilitate their understanding of the material. The chemistry learning process that has occurred in several schools tends to ignore student activities in class and emphasizes the knowledge aspect only. Educational activities that should integrate cognitive, affective, and psychomotor dimensions have been ignored, and some of our educational practices in schools emphasize cognitive training aspects alone. Therefore, teachers must create a learning atmosphere in such a way that students work together in a positive learning environment.

Learning efforts that direct students to be active should be able to direct students so that they have harmony with fellow students, respect each other's opinions, respect the person speaking, responsibility, willingness to sacrifice, accommodation, and magnanimous. The methods considered capable of moving the learning process involve collaboration. However, in several universities and schools, students' collaboration skills in chemistry are often ignored. Hesse et al. (2015) defined collaboration as a goal-oriented, mutually beneficial process used to solve problems, leverage strengths, resolve differences, and educate individuals involved through shared responsibility for outcomes [5]. Collaboration involves students working together to achieve their specific learning goals [6].

Efforts to solve these problems involve implementing learning that can improve students' communication skills. One of the learning patterns that can be used is the application of the REAKSI learning model based on the STEM (Science, Technology, Engineering, and Mathematics) approach. The REAKSI learning model is an acronym for the Research Formulation of Themes, Exploration, Analysis, Clarification, Synthesis and Implementation.

The REAKSI learning model is a new model that was developed based on the components of the STEM

approach. The components of the STEM approach include accustoming students to identifying questions and problems in life, investigating natural phenomena, explaining natural phenomena, designing and drawing conclusions based on evidence regarding the issues obtained [7].

The results of Mu'minah & Aripin (2019) show that the application of STEM-based learning can improve 21st century skills, especially collaboration skills [8]. Therefore, researchers are interested in raising the title Application of the REAKSI learning model to improve the collaboration skills of chemistry education students.

2. Literature Review

2.1. Collaboration Skill

Hesse et al. (2015) define collaboration as a goal-oriented and mutually beneficial process that is used to solve problems, increase strengths, overcome differences, and educate individuals involved through shared responsibility for the outcomes of the collaborative process [9]. Collaboration involves students working together to achieve their specific learning goals [6]. Cheruvelil et al. (2014) stated that collaboration is a specific type of social interaction and learning process in which group members can actively and constructively solve problems [10].

According to Pheeraphan (2013), collaboration is an interaction between students who work together to solve a problem with the responsibility of each group member to communicate or compromise in the group to solve the problem as a common interest of the group [11]. Lelasari et al. (2017) state that collaboration is a process of working together, coordinating, and containing elements of positive dependence in a group that leads to a common goal to be achieved [12]. Junita & Wardani (2020) stated that collaboration skills are one of the skills that invite students to actively contribute to working together and interacting during learning so that learning will be easier to understand [13]. Collaboration skills can be applied in learning, which invites students to be active and communicative in working together and making compromises (Hinyard et al., 2018).

According to Indraswati et al. (2020), interpersonal skills are the most important basic skills, especially for collaborating with friends and family in social relationships [14]. According to Najib (2011), some indicators of collaboration are respecting others' opinions, providing support, sharing opinions, deliberating, prioritizing common interests, being democratic, liking mutual cooperation, and working together in groups [14].

2.2. REAKSI Learning Models

The REAKSI learning model is designed with reference to several learning theories such as Ausubel, Vygotsky, Brunner, Piaget and andragogy. The basic theory for developing the REAKSI learning model was obtained. The REAKSI learning model developed was based on the components of the STEM approach. The components of the STEM approach allow students to identify questions and problems in life, investigate natural phenomena, explain natural phenomena and design, and draw conclusions based on evidence regarding the issues obtained [7]. Integration of learning using the STEM approach begins with identifying real problems that occur in the environment using high-level thinking and problem-solving skills so that conclusions can be drawn in an effort to solve the problem [14]. The components of the STEM approach match the real world and can create active and cohesive learning so that students can unite abstract concepts from each aspect to solve problems [15].

All the components and characteristics of the STEM approach are packaged in the formula, explore, analyze, classify, synthesize, and implement (REAKSI) learning model. The characteristics of the REAKSI learning model include syntactic and social systems, reaction principles, support systems, instructional impacts, and accompanying impacts [16]. The syntactic REAKSI learning model includes the following.

1. Research Formulate: Students formulate the problems found in a phenomenon.
2. Exploration: deepening and expanding students' understanding and conceptual skills. Through new experiences, students develop deeper knowledge and explore more information.
3. Analyze: Students analyze the causes and effects of a phenomenon.
4. Clarification: Students clarify problems in a phenomenon or case.
5. Synthesis: Students designed several solutions that can be used as alternative solutions to this phenomenon.
6. Implementation: Students apply the design that has been made to deal with the problem and draw conclusions from the results.

3. Research Methodology

The research method used was lesson study to improve learning [19]. Lesson study has three main stages in this research, namely plan do and see/ reflection [20]. For more details, please refer to Fig. 1.

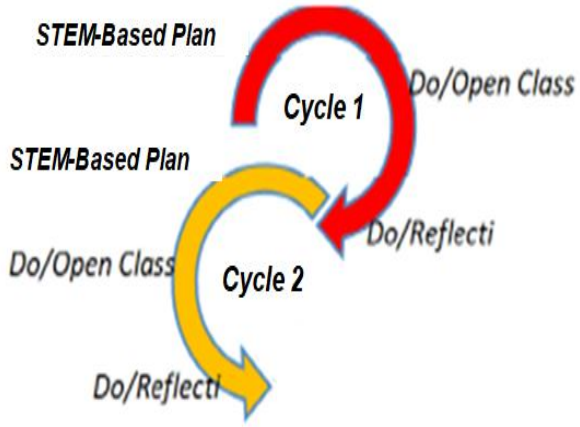

Figure 1. Research Design Using Lesson Study

In the planning stage, problems in the class are identified, and learning plans are made. At the implementation stage, one teacher acts as the implementer of the learning design, and the other teacher acts as an observer. Furthermore, at this reflection stage, the teacher and observer held discussions related to learning to redesign better learning and re-implement it in the class in the next round [21]. The population in this study was chemistry education students in the Riau Province. Sixty-one students participated in the study was 61 students. It consisted of 37 chemistry education students from Riau University with hydrocarbon material, 20 students from Sultan Syarif Kasim State Islamic University of Riau with paper chromatography material, and four students from Riau Islamic University with complex compound material. The researcher determined the class of the research samples using purposive sampling.

Data collection techniques were carried out using the results of critical thinking skills tests and observations of students' collaboration skills. Collaboration indicators include respecting others' opinions, providing support to friends, prioritizing common interests, sharing with others, and getting used to discussing problems [15]. After the data were collected, quantitative descriptive data analysis was carried out, namely, describing the data based on facts and circumstances. The final analysis converts the 21st century skills data with the effectiveness guideline table in Table 1.

Table 1. Effectiveness Guidelines for the REAKSI Learning Model [22]

% 21st Century Skills Test Results for Students (p)	Effectiveness
$0 \le p < 41$	Very Low
$41 \le p < 56$	Low
$56 \le p < 66$	Medium
$66 \le p < 80$	High
$80 \le p < 100$	Very High

4. Result And Discussion

The research stage begins with the planning stage. The plan stage aims to prepare for learning using the REAKSI learning model. Activities carried out at the planning stage included preparing REAKSI learning model devices, aligning perceptions with team teaching, and preparing supporting facilities to improve students' collaboration skills.

In the do stage, namely, the implementation of research to determine the effectiveness of the REAKSI learning model on the communication skills of chemistry education students. Communication skills data were obtained by filling out observation sheets. Data from the learning observation results were obtained at each meeting using the REAKSI learning model based on the STEM approach. The results of the observations of students' communication skills from each sample are shown in Table 2.

Table 2. Percentage Collaboration Skills cycle 1

No	Collaboration indicators	Percentage		
		Sample 1	Sample 2	Sample 3
1	Respect other people's opinions	82%	80%	80%
2	Giving support to friends	77%	80%	76%
3	Prioritize common interests and share with others	80%	78%	75%
4	Get used to discussing to solve problems	76%	80%	75%

Table 2 shows that the percentage of collaborative skills of chemistry education students was quite good, with an overall percentage of 77%.

This is because the REAKSI learning model has stages of theme formulation and exploration that direct students to discuss, exchange ideas, and collaborate to explore problems. At this formulation stage, the initial step in learning is to determine the topic of the problem to be solved in groups. At this stage, the lecturer determines the theme and learning material to be discussed. For example, in basic chemistry 1 lectures, the lecturer determines that the theme and lecture material are hydrocarbons. Students in small groups will then determine topics related to hydrocarbons. For example, students may choose the topic of air pollution. In addition, this activity encourages students to think critically about problems.

The results of the theme-formulation stage are presented in Table 3.

Table 3. Formulation of learning themes

Sample	Results of the Theme Formulation stage
Sample 1	Characteristic of Carbon Compounds
Sample 2	RF Chromatography
Sample 3	Types of Complex Compounds

The initial stage of the STEM-based REAKSI learning model is to formulate and train students to collaborate in defining the problems they find. These results are in line with the findings of Supeno et al. (2016) that students who are cognitively involved in defining a problem can be actively involved in the next learning process [23].

In the Exploration stage of the STEM-based REAKSI learning model, students have the opportunity to be directly involved with the phenomena or problems that occur around them. They could work together and communicate in groups to test the predictions of their questions. Students can also observe and explore ideas through literature review activities. Students were asked to draw conclusions based on their discussions in their own language. An example of the exploration carried out by students is to explore the characteristics of carbon compounds, namely primary, secondary, tertiary, and quaternary carbon atoms. The exploration stage in the syntax in the REAKSI learning model trains students to explore problems using various relevant sources. This is relevant to Barthelemy et al. 's (2015) finding that learning is basically an effort by educators to help students carry out learning activities to explore knowledge [24].

After cycle 1 stage was completed, the see stage was performed. This stage aimed to reflect on the learning process using the STEM-based REAKSI learning model. From this reflection stage, suggestions and improvements were obtained for implementation in the next cycle. The suggestions obtained in Cycle 1 are listed in Table 4.

Table 4. Results of cycle 1 reflection.

Component
Lecturer involvement is still quite dominant
There are still many students who are less involved in collaboration
Some students are dominant in collaborating

Cycle 2 begins with the planning stage. Preparation for learning cycle 2 was carried out to obtain better results than cycle 1. Plan activities to design learning that can teach students and is student-centered. Preparing students to actively participate in the learning process so that learning objectives can improve their collaboration skills.

At the do stage of cycle 2, the implementation of learning was better than that of cycle 1. The effectiveness of the REAKSI learning model on the collaboration skills of chemistry education students has begun to be observed. This is because there was an improvement in the learning process based on the results of the reflection at the end of cycle 1. Observations of student collaboration skills were also carried out in Cycle 2 to see changes compared to Cycle 1.

The results of the observations of student collaboration skills in Cycle 2 are shown in Table 5.

Table 5. Percentage Data on Collaboration Skills in cycle 2

No	Collaboration indicators	Percentage		
		Sample 1	Sample 2	Sample 3
1	Respect other people's opinions	95%	88%	86%
2	Giving support to friends	90%	90%	83%
3	Prioritize common interests and share with others	94%	85%	82%
4	Get used to discussing to solve problems	95%	85%	84%

The improvement in collaboration skills in cycle 2 occurred because learning through discussion in the Exploration, Analysis, Clarification and Synthesis stages of the REAKSI model can improve students' collaboration skills. This is because in the REAKSI learning model integrated with STEM, students exchange opinions to find a suitable solution to the given problems. These results are relevant to Chalim et al. (2019), who showed that the implementation of STEM-based learning provides opportunities for students to explore knowledge in group activities, thus allowing them to exchange ideas and help each other in solving the problems given [25]. These results are relevant to the research results of Mu'minah & Aripin (2019), which show that the implementation of STEM-based learning can improve 21st century skills, especially collaboration skills [8].

The results obtained are relevant to Lestari et al. 's (2018) finding that the use of STEM-based learning can improve students' communication, collaboration, critical thinking, and creativity skills and abilities [26]. In addition, the use of STEM-based teaching materials has an important influence on improving students' ability to master concepts, collaboration, and science literacy skills [27]. This can be an alternative for teachers implementing classroom learning to improve students' creativity, critical thinking, communication, and collaboration. As in Sayekti and Suparman (2020), it was proven that STEM-based LKPD can improve critical thinking and collaboration skills [28].

STEM learning has several stages in its implementation: observation, new ideas, innovation, creativity, and society [29]. The stages of STEM learning were combined into the stages of the REAKSI learning model. Through this REAKSI learning model, learning can run more effectively because it is carried out with group activities, such as discussions, product

synthesis, and presentations or implementation of results. At the Formulation, Exploration and Analysis stages, the REAKSI learning model is implemented by giving students problems and demanding them to be able to collaborate and communicate in solving problems through group discussion activities. The Clarification and Synthesis stages were carried out by preparing the results of the group discussions through product synthesis. The results of the discussion were presented in groups in front of the class. This allows students to work collaboratively, be involved in problem solving, design products, and carry out implementation and reflection. This can help develop collaboration and communication skills.

The REAKSI learning model provides stimuli to students through the presentation of everyday life problems. This can direct students to collaborate to solve them. This result is in line with previous research showing that the application of problem-based learning models can improve students' collaboration skills through group discussions, allowing them to be actively involved in learning activities and solving problems together.

Based on Aini and Aini (2023), STEM learning can be used to analyze students' communication skills as very good, with an average of 81.55% [30]. This is because students make presentations based on the results of the group discussions. Each group was asked to present a project synthesis at the synthesis stage of the REAKSI learning model. Other groups also ensure understanding of the concepts presented by other groups and must be clear and vocal when communicating the results of the presentation. The research results obtained are also relevant to expert opinion that the application of STEM-based learning is better in helping students develop 21st century skills such as communication and collaboration [31]. Based on this, it can be seen that STEM learning can improve students' communication and collaboration skills.

Learning through discussion in the Exploration, Analysis, Clarification and Synthesis stages of the REAKSI model can improve students' collaboration skills. This is because in the REAKSI learning model integrated with STEM, students exchange opinions to find a suitable solution to the given problems.

These results are relevant to Chalim et al. (2019), who showed that the implementation of STEM-based learning provides opportunities for students to explore knowledge in group activities, thus allowing them to exchange ideas and help each other in solving the problems given [25]. The development of collaboration skills with a well-organized group learning system supported by STEM-based learning can be more effective in developing collaboration skills, especially in responsible indicators [32].

5. Conclusion

Findings

Based on the results of the research conducted, it was found that the REAKSI learning model could improve the collaboration skills of chemistry education students. The results of the improvement were obtained because the STEM learning stages were combined with the stages of the REAKSI learning model. The stages of Theme Formulation and Exploration in the REAKSI learning model make a major contribution to students' collaboration skills because they encourage in-depth discussions of problems. The increase in collaboration skills in this study was 77% in cycle 1 and 90% in cycle 2. The REAKSI model can be used as an alternative to improve students' 21st century skills. This research is an innovation in the preparation of human resources in the 21st century learning era. This research is also relevant to other studies, such as Cedere et al. in 2022, which states that learning using an STEM-based learning model improves students' collaboration skills.

Research Limitations

This study is a test of the effectiveness of a newly developed learning model, namely the REAKSI learning model, but it is limited to students' collaboration skills.

Recommendations For Future Research

Therefore, it is recommended that research be conducted with wider variables so that an effective STEM-based REAKSI learning model can be obtained.

Declarations

Author Contributions

The following statements should be used:

Conceptualization: I. I. and M. E. .; methodology, I.I, E.S, Z.Z; validation, I.I, M.E, E.S, Z.Z.; formal analysis, I.I, M.E, E.S, Z.Z.; investigation, I,I.; resources, I,I.; data curation, I.I, M.E, E.S, Z.Z; writing—original draft preparation, I.I, M.E, E.S, Z.Z; writing—review and editing, I.I, M.E, E.S, Z.Z; visualization, I.I, M.E, E.S, Z.Z; supervision, I.I, M.E, E.S, Z.Z; project administration, I.I, M.E, E.S, Z.Z; funding acquisition, I.I, M.E, E.S, Z.Z. All authors have read and agreed to the published version of the manuscript.

Data Availability Statement

The data presented in this study are available upon request from the corresponding authors.

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