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Implementation of the REMAP-CIRC Learning Model Toward High School Students' Learning Outcomes in Acid-Base Topics

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Abstract

Students' difficulty in understanding abstract and complex acid-base concepts requires the implementation of appropriate learning strategies. This study aims to evaluate the effectiveness of the Reading Concept Map-Cooperative Integrated Reading and Composition (REMAP-CIRC) learning model in improving students' learning outcomes on acid-base topics. This research employed a pre-experimental method using a one-group pretest-posttest design. The participants consisted of 33 eleventh-grade students (Class XI-4) enrolled in the science track at State Senior High School 17 Samarinda during the 2024/2025 academic year. Data were collected through pretest and posttest instruments, as well as student response questionnaires. The data were analyzed using the Wilcoxon test to determine significant differences between pretest and posttest scores. The results showed that the average student score increased from 28.18 (pretest) to 73.64 (posttest). The N-Gain value was 0.61, categorized as moderate, while the effect size was 3.14, indicating a very high effect. In addition, the student response questionnaire showed a positive response with an average percentage of 79.84% (good category). Based on these results, it can be concluded that the REMAP-CIRC learning model is effective in improving students' learning outcomes on acid-base topics.

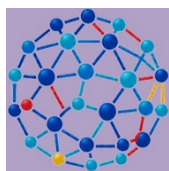
Keywords: acids and bases, effectiveness, learning outcomes, learning models, REMAP-CIRC

INTRODUCTION

Critical thinking and reading skills are key prerequisites for academic success, which significantly influence student learning outcomes (Saputra et al., 2025; Suciono, 2021). In the realm of science, mastering this skill is essential, particularly in chemistry, where the majority of concepts are both abstract and hierarchical (Elfrida & Shelly, 2023; Silalahi et al., 2022; Hidayati & Julianto, 2025). A subject often regarded as challenging for students. It is the theory of acids and bases. Students' difficulty in understanding the abstract and complex nature of acid-base theory requires the application of appropriate learning strategies (Priliyanti et al., 2021; Sarianti et al., 2022). This topic involves complex concepts from various theories (Arrhenius, Brønsted-Lowry, Lewis), which require deep and structured understanding. Difficulties in linking these abstract concepts often become a major obstacle to improving student learning outcomes. Therefore, learning strategies that can bridge these difficulties are a top priority (Setiawan, 2025).

To overcome the challenges of understanding abstract concepts, strategies that encourage active engagement, collaboration, and concept visualisation are needed. One promising approach is the REMAP-CIRC, which stands for Reading and Concept Mapping integrated with Cooperative Integrated Reading and Composition blended learning method. This model integrates critical reading and concept





mapping (REMAP) with structured group work (CIRC), which has been proven effective in facilitating knowledge construction and reflection (Fentika, 2025; Irawan et al., 2024; Pangestuti, 2017; Warfa, 2016). The combination of concept map visualisation and collaborative discussion enables students to organise complex information and deepen their understanding, thereby potentially improving overall learning outcomes.

Although the effectiveness of the REMAP-CIRC model has been tested in various fields, its specific application and effectiveness in acid-base theory material have not been adequately explored in the literature. Acid-base material, with its abstract and complex characteristics, is well-suited to be tested with models that focus on concept visualisation and collaboration, such as REMAP-CIRC. This limitation indicates an important gap (Wardana et al., 2017; Sholahuddin et al., 2023). Hence, this research seeks to evaluate the effectiveness of the REMAP-CIRC instructional model in improving students' academic achievement learning outcomes in acid-base theory through empirical testing. These results are expected to contribute methodologically to the teaching of challenging chemistry concepts.

Based on the theoretical and empirical studies discussed above, it can be identified that students still encounter significant difficulties in understanding abstract chemistry concepts, particularly in acid-base theory. Previous studies have demonstrated that collaborative and concept-mapping-based learning models can improve students' conceptual understanding and engagement (Zubaidah et al., 2020; Warfa, 2016; Sholahuddin et al., 2023). However, the specific implementation of the REMAP-CIRC learning model in acid-base learning has not been widely explored. Therefore, this study aims to evaluate the effectiveness of the REMAP-CIRC learning model in improving students' learning outcomes on acid-base topics.

METHODS

The research methods covering the research design, data collection and instrument, and data analysis conducted in this study explained in this section.

1. The Research Design

This research adopted a quantitative approach through a pre-experimental design, utilizing a one-group pretest–posttest design. Under this design, a single group was administered a pretest, followed by the treatment (implementation of the REMAP-CIRC model), and then given a posttest to measure changes in learning outcomes (Creswell & Creswell, 2018; Ary et al., 2018).

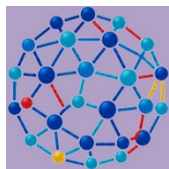
2. Data Collection and Instruments

Participants in this research were drawn from Year 11 learners who were taking elective Chemistry classes at State Senior High School 17 in Samarinda City. This study employed a cluster random sampling technique, through which the research sample was selected, and the sample in this study was Year 11-4 in the even semester at State Senior High School 17 in Samarinda City for the 2024/2025 academic year, consisting of 33 students.

This research employed multiple research instruments, including pretest and posttest items, learning activity observation sheets, and student response questionnaires. The pretest and posttest instruments were complemented by student response questionnaires to support data collection, which were used to measure the effectiveness of the REMAP-CIRC learning model used during the learning process. Observation sheets for teachers and students were utilized to assess the practicality of implementing the REMAP-CIRC learning method.

The test instruments were developed based on a table of specifications that covered key indicators of acid-base concepts, including Arrhenius, Brønsted–Lowry, and Lewis theories. This study





hypothesises that there is a significant difference in students’ learning outcomes before and after the implementation of the REMAP-CIRC learning model.

3. Data Analysis

Data analysis techniques included descriptive statistics, normality testing using the Shapiro–Wilk test, and hypothesis testing using the Wilcoxon signed-rank test. In addition, N-Gain analysis was used to determine the level of improvement in learning outcomes, and effect size analysis was conducted to measure the magnitude of the treatment effect

The effectiveness of the REMAP-CIRC model was measured using the N-Gain test on student learning outcomes. Before the N-Gain analysis, prerequisite tests (normality and homogeneity) were conducted. The prerequisite testing plays a crucial role in deciding whether the data analysis will be conducted using parametric or non-parametric statistics (Usmandi, 2020).

To assess learning improvement after the intervention, the N-Gain analysis was employed. The calculation of N-Gain followed the formula: (posttest score minus pretest score) divided by (maximum score minus pretest score) × 100%. It is then grouped according to the categories in Table 1 (Anggraeni et al., 2021).

Table 1. Normalised N-Gain Category

Average Gain	Category
$0.7 \leq g \leq 1$	High
$0.3 < g \leq 0.7$	Medium
$0 \leq g \leq 0.3$	Low

If the N-Gain value satisfies the moderate criterion ($0.3 < g \leq 0.7$), further analysis is carried out by calculating the effect size in order to determine the degree of effectiveness of the teaching model. The effect size is determined by multiplying the difference between the average posttest and pretest scores by 100%, after which the results are grouped based on the criteria listed in Table 2 (Olii et al., 2024).

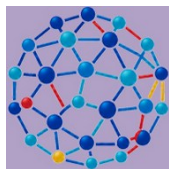
Table 2. Effect Size Interpretation

Score	Category
$ES > 1.10$	Very High
$0.75 < ES \leq 1.10$	High
$0.40 < ES \leq 0.75$	Medium
$0.15 < ES \leq 0.40$	Low
$ES \leq 0.15$	Very Low

Before their implementation, the instruments underwent a validation process through expert judgment. This validation involved two academic supervisors and three examiners who possess expertise in chemistry education and learning evaluation. The purpose of this process was to ensure the appropriateness of the content, the alignment between items and learning indicators, as well as the clarity and relevance of the language used in the instruments. Therefore, the instruments fulfilled the criteria of content validity.

In addition, the reliability of the instruments was ensured through careful and systematic construction based on a detailed table of specifications, which maintained the consistency of measurement across all items. Although statistical reliability testing, such as Cronbach’s Alpha, was not conducted, the instruments are considered sufficiently reliable for use in this study due to the rigorous expert validation process and adherence to standardized instrument development procedures.





RESULTS AND DISCUSSION

This study was conducted at State Senior High School 17 Samarinda in class XI-4 with 33 students participating. The study consisted of two meetings, namely the first meeting was conducted with a pretest followed by learning activities, then the second meeting was conducted with learning activities ending with a posttest.

Table 3. Average Student Scores

Written Test	\bar{X} Score	Category
Pretest	28.18	Very Low
Posttest	73.64	Moderate

As presented in Table 3, student learning outcomes increased from the very low category to the sufficient category after the application of the REMAP-CIRC instructional model. An N-Gain test was then employed to assess the effectiveness of the intervention. Prior to performing this analysis, the normality of the data was assessed using the Shapiro–Wilk test in SPSS on both pretest and posttest scores (Table 4).

Table 4. Normality Test

Class	Data	Sig.	Distribution
XI-4	Pretest	0.148	Normal
	Posttest	0.001	Non-normal

Table 4 indicates that the pretest data followed a normal distribution, while the posttest data did not. Given that the significance level was less than 0.05, the data did not meet the assumption of normality (Usmadi, 2020). Accordingly, to determine the differences between pretest and posttest scores, a non-parametric analysis was carried out, with the outcomes presented in Table 5.

Table 5. Non-parametric tests

Analysis	Score
Wilcoxon W	532.500
Z value	-5.027
Asym.Sig (2-Tailed)	0.000

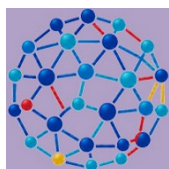
Table 5 indicates that the Asymp. Sig. (2-tailed) value is 0.000, demonstrating a statistically significant difference between students’ learning outcomes before the intervention (pretest) and after the intervention (posttest), given that the obtained significance value was ≤ 0.05 . Consequently, an N-Gain analysis was performed, and the results are shown in Table 6.

Table 6. N-Gain Test

Class	N-Gain	Criteria
XI-4	0.611	Medium

As presented in Table 6, the obtained N-Gain value was 0.611, which is classified within the moderate category. This result suggests that the application of the REMAP-CIRC instructional model demonstrated effectiveness in enhancing students’ learning outcomes in the subject matter studied. Although the observed improvement did not reach the high category, the result demonstrates that the REMAP-CIRC model makes a positive contribution to students’ conceptual understanding. This result





is consistent with previous studies indicating that cooperative learning combined with concept mapping can significantly improve students' conceptual understanding (Zubaidah et al., 2020; Warfa, 2016).

The effectiveness of the REMAP-CIRC model can also be attributed to the integration of cognitive and social learning processes. The concept mapping component enables students to visually organize abstract concepts, which is particularly important in learning acid-base theory that involves hierarchical and interconnected concepts. Meanwhile, the Cooperative Integrated Reading and Composition (CIRC) component promotes peer interaction and discussion, allowing students to clarify misconceptions and reinforce their understanding through social negotiation.

Although the results show a significant improvement, the N-Gain value remains in the moderate category. This suggests that while the REMAP-CIRC model is effective, there is still room for optimization, such as increasing the duration of implementation or integrating additional learning supports. Furthermore, the use of a one-group pretest–posttest design limits the ability to compare the effectiveness of this model with other instructional approaches. These findings are consistent with previous studies indicating that cooperative learning combined with concept mapping can significantly improve students' conceptual understanding (Zubaidah et al., 2020; Warfa, 2016). Additionally, student-centered learning approaches have been shown to enhance engagement and learning outcomes in chemistry education (Sholahuddin et al., 2023).

The use of structured group discussions and visual representations of concepts enables students to organize knowledge more effectively and develop a deeper understanding. Therefore, the learning model can be considered effective in improving learning outcomes. Based on these results, an effect size analysis was subsequently conducted, with the results presented in Table 7.

Table 7. Effect Size Test

Σ Post-test	Σ Pretest	Σ Post-Pre	SD	Effect Size	Category
73.64	28.18	45.46	14.46	3.14	Very High

As shown in Table 7, the effect size obtained for class XI-4 was 3.14, which is categorized as a very high effect. This result confirms that the implementation of the REMAP-CIRC learning model exerts a strong influence on the variables examined, particularly in enhancing students' learning outcomes. A large effect size suggests that the observed improvements were significant both statistically and in terms of practical application within the learning context. Consequently, the REMAP-CIRC instructional model may be regarded as highly effective in supporting students' mastery of the material studied.

Furthermore, the very high effect size suggests that the learning model has a strong practical impact on students' learning outcomes. This is supported by Anggraeni et al. (2021), who emphasize that interactive and engaging learning environments can significantly enhance student motivation and achievement.

Supporting evidence of effectiveness in this study was gathered through a student response questionnaire administered during the implementation of the REMAP-CIRC learning model. The questionnaire was designed to capture students' perceptions regarding comfort, engagement, ease of understanding the material, and the extent to which the learning model supports the achievement of instructional objectives. The findings from the student response questionnaire are illustrated in Figure 1.



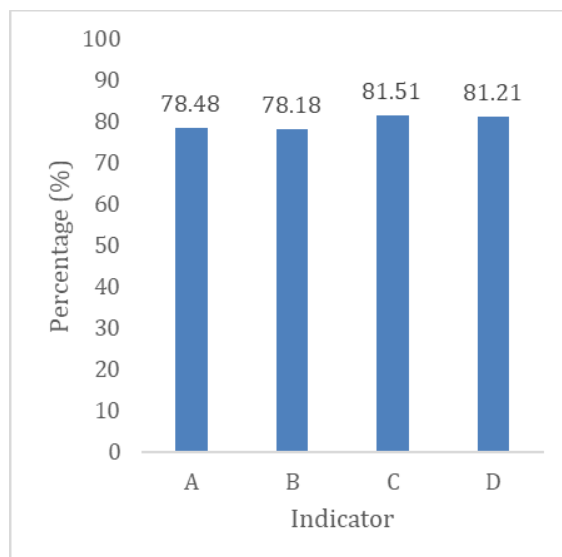
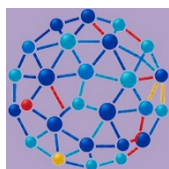


Figure 1. Results of the Student Response Questionnaire

Description:

A: Ease of understanding learning content, B: Active participation in content, C: Advantages of the learning model, D: Interest of the student in learning models.

The results of the student response questionnaire showed an average percentage of 79.84%, categorized as good, for learning activities conducted using the REMAP-CIRC model. This result suggests that students experienced greater ease in understanding the material, demonstrated higher levels of engagement, and regarded the learning model as appealing and motivating. Therefore, the positive student responses support the observed improvement in learning outcomes by contributing to a more conducive and effective learning atmosphere.

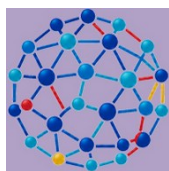
The implementation of the REMAP-CIRC learning model in instructional activities resulted in an increase in students' average learning outcomes. This improvement indicates that the REMAP-CIRC approach is effective in facilitating students' understanding of abstract acid–base theory concepts. These results are consistent with previous research (Zubaidah et al., 2020), which shows that the application of the REMAP model can improve students' conceptual understanding because they are trained to read actively and compile concept maps as a form of knowledge visualization.

The improvement in average learning outcomes shows that students gained a better understanding of acid-base material. This is evident from students' active participation during the learning process, as they engaged in more in-depth reading of the provided texts, discussed important concepts with group members, and created concept maps as visual aids. This strategy helped students integrate the information they obtained and form a more meaningful understanding.

Additionally, the magnitude of the effect size demonstrates that even though the average N-Gain is not exceptionally high, the overall influence of the REMAP-CIRC learning model on student learning is classified as very high. Therefore, the REMAP-CIRC model can be regarded as a highly promising and effective teaching strategy. Positive student responses, including interest, motivation, and satisfaction, serve as important indicators of learning effectiveness. These results reinforce the view that the success of an intervention cannot be measured solely by cognitive outcomes, as well as by how engaged and motivated students were while actively participating in the learning activities.

In addition, similar results were reported by Sholahuddin et al. (2023), who found that student-centred learning approaches contribute positively to learning outcomes in acid-base material. The





moderate N-Gain obtained in this study indicates that the REMAP-CIRC model is effective in facilitating conceptual change, even though further optimization is still possible.

The results indicate that the REMAP-CIRC instructional model applied to acid–base theory effectively improved students’ average learning outcomes. The N-Gain of 0.61 corresponds to a moderate improvement, while the effect size of 3.14 reflects a very high effect. In addition, this is supported by data from student response questionnaires, with an average of 79.84% in class XI-4, which is classified as good.

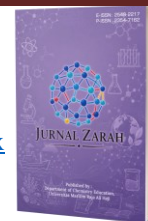
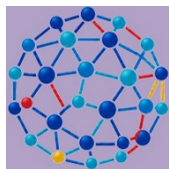
CONCLUSION

The result of this study demonstrates that the implementation of the REMAP-CIRC learning model in acid-base topics effectively improves students’ learning outcomes. This is evidenced by the increase in student scores, a moderate N-Gain value, and a very high effect size. Positive student responses further support the effectiveness of this learning model. These results imply that the REMAP-CIRC learning model can be used as an alternative instructional strategy for teaching abstract chemistry concepts, particularly acid-base theory. It is recommended that teachers apply this model to enhance student engagement and conceptual understanding. Future research is suggested to employ more rigorous experimental designs, such as control group comparisons, to obtain more comprehensive results.

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