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Reduction of Misconceptions for Grade XI IPA Students on Buffer through Remedial Using Conceptual Change

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Abstract

This study aimed to analyze the results of reducing misconceptions among SMA Negeri 5 Palu students on the buffer material using the conceptual change learning strategy. This research is a type of pre-experimental research with a research design that is One group pretest-posttest design. This study contained one experimental group, namely students whose learning outcomes did not reach the minimum completeness criteria (MCC), then given a pre-test to determine the initial state of the experimental group, then given treatment, and given a post-test. Testing student misconceptions data using CRI. The results showed that the average percentage of students, who knew the concept (KC), did not see the idea (DKC), and misconceptions (MC) before the application of conceptual change learning strategies were 38.1%, 45.2%, and 16, respectively. 6% and the percentage of students knowing the concept (TC), not understanding the idea (NKC), and misconception (MC) after the application conceptual change learning strategies respectively 87.4%, 12.6%, and 0%. So it can be concluded that the average percentage reduction in misconceptions of grade XI IPA SMA Negeri 5 Palu on the buffer material through remedial using the conceptual change learning strategy was 16.6%.

Keywords: Reduction, misconception, remedial, learning strategy, conceptual change, buffer solution.

Introduction

An innovative, interactive, inspiring, fun, challenging, and motivating learning process for students can be achieved by using a curriculum by the learning process. The government has changed the curriculum by the learning process by updating the old curriculum into a new curriculum, namely Curriculum 2013 (Kementerian Pendidikan & Kebudayaan, 2017).

The 2013 curriculum was developed to improve the strengthening of learning patterns. Strengthening learning patterns resulted in the understanding of learning materials. The most important learning process is achieving learning objectives to understand what they have learned (Erza, 2017).

Understanding concepts is fundamental for students to understand what they are learning. Concepts are a person's means of clarifying an object and a network of thoughts to determine principles and rules, all of which are the basis for how a network of studies can be structured to determine a person's thinking. Complex understanding of students' ideas is inconsistent with scientific conceptions, such as misconceptions (Khoirul & Suyono, 2015; Kurniawan et al., 2020).

Misconceptions are misconceptions that are not by scientific understanding. Misconception can be interpreted as an interpretation of concepts in an unacceptable statement or idea that is not by scientific knowledge (Santyasa et al., 2010)

Misconceptions often occur in subjects with concepts and a high level of understanding. Topics that contain many ideas and require a high level of experience include chemistry subjects (Suparno, 2013).

Chemistry is a branch of science that studies the properties of matter, the structure of matter, changes in matter, laws, and principles that describe changes in matter and concepts and theories (Santoso et al., 2018). The chemical materials taught in the 2013 curriculum in class XI are hydrocarbons and petroleum, thermochemistry, reaction rates, chemical equilibrium, acid, base solutions, salt hydrolysis, buffer solutions, and solubility products and colloidal systems (Ibrahim, 2012).

A chemistry teacher at SMA Negeri 5 Palu stated that some of the chemistry subject matter was difficult for students to understand. Therefore, it is

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necessary to form an understanding to build the right concept. One of the indicators is that the learning outcomes are still below the minimum completeness criteria (KKM). In 5 High School Palu, the KKM that must be achieved is 75. However, student scores are unsatisfactory from several daily test results: the low completeness score of 30.4% and the highest completeness score of 69.5%. One subject matter that is considered difficult for students to understand and creates misunderstandings is the buffer solution material. This happens because of the internal factors of students and external factors are learning carried out by the teacher. Teachers tend to use the lecture method and are less varied, so students are passive in learning. This condition is that students do not understand the teacher's concepts. This situation has implications for daily tests; students give answers that are not by the concepts being taught, it is assumed that misconceptions occur in students.

Misconceptions in students show students' understanding of inaccurate concepts. The use of wrong concepts, the confusion of different concepts, and the hierarchical relationship of the concepts are incorrect. Students who are still in the stage of cognitive development tend to have misconceptions about abstract material. Abstract material makes it difficult for students to understand and often misunderstand the concept of the material (Suparno, 2013).

Buffer has actual and abstract properties. The abstract nature of this material lies in the microscopic aspects contained in the solution. In addition, the buffer solution material is complex; the complex nature of this material lies in its relationship with previously studied material which is a prerequisite in learning this material. The prerequisite materials include acid-base and equilibrium. The material characteristics can trigger students' difficulties understanding concepts and even misconceptions in the buffer solution material (Fitria & Suyono, 2016).

One of the learning strategies that can minimize misconceptions is the conceptual change learning model. The conceptual change learning model is more suitable to straighten out a misunderstanding. This is due to a learning strategy that starts with exploring students' conceptions before taking part in classroom learning and requires students to perfect the knowledge they already have and change, rearrange or replace the wrong expertise they have with new, more correct knowledge (Rahmawati & Suyono, 2012).

The conceptual change learning model has the following learning phases: (1) showing students' conceptions, (2) creating conceptual conflicts, (3) equilibration processes, (4) concept reconstruction. The stage of conceptual conflicts and equilibration processes is the stage where students can experience changes in concepts through cognitive accommodation. Concept changes will occur if someone is not satisfied with the existing ideas. However, dissatisfaction alone is not enough to replace old statements with new ideas, so it can be concluded that the conceptual change learning model as remedial learning can allegedly be used as a way to reduce misconceptions (Khoirul & Suyono, 2015).

Remedial is re-teaching with learning materials that may be repeated or supplementing with general questions and exercises. Remedial can be said as remedial teaching is a unique form of teaching that functions to heal, correct or make a sound. In this case, improvement is directed at achieving optimal results according to each student's ability through the entire teaching and learning process. Learning activities carried out by teachers are said to be remedial if they aim to help students who have difficulty understanding concepts or misconceptions in learning material. Referring to this explanation, restorative programs can reduce misunderstandings using the conceptual change learning strategy (McLure et al, 2020).

The misconception problems above encourage researchers to reduce misconceptions for class XI IPA SMA Negeri 5 Palu students on the buffer solution material after students follow remedial using the conceptual change learning strategy.

Methods

This research is a type of pre-experimental research. Pre-experimental research does not use a control class so that external variables can affect the results of this study. The research subjects involved in this study were class XI students of SMAN 5 Palu who learned about the buffer solution material. The number of students is 12 students, consisting of 3 boys and three girls from class XI IPA5 and three boys and three girls from class XI IPA6. The age range of the research subjects ranged from 17-18 years.

The research design used one group pretest-posttest design. The method of this study contained one experimental group, namely students whose learning outcomes did not reach the KKM, then was given a pretest to determine the initial state of the experimental group, then was given treatment and was given a posttest (Sugiyono, 2015).

Table 1. Research design one group pretest-posttest design

Group	Pretest	Treatment	Postest
Experiment	O_1	X	O_2

description:

O_1 = *pretest*

X = Conceptual change learning strategy

O_2 = *posttest*

Determination of students' misconceptions using the certainty of response index (CRI) method,

accompanied by statements of students' confidence levels in answering questions, the rubrics can be seen in **Tables 2** and **3** (Santoso & Supriyadi, 2015).

Table 2. A person's confidence index in answering concept questions

Scale	Confidence level	% of Guess
0	Guess the answer	100 % guess the element
1	Guess the answer is almost right	The guess element is between 75 – 99 %
2	Not sure	The guess element is between 50 - 74 %
3	Sure	The guess element is between 25 – 49 %
4	Almost sure	The guess element is between 1- 24 %
5	Certainly	0 % guess the element

Tabel 3. Determination of student status including in the know the concept, do not know the idea or misconception group

Low CRI Index (less than or equal to 2.5)	High CRI Index (>2.5)
Correct answer but low CRI index means don't know the concept	Correct answer and high CRI means knowing the concept
Wrong answer and low CRI means don't know the concept	The wrong answer, but high CRI means a misconception

The CRI score given by the students on each question indicates the level of certainty of the answer, a low CRI (1 or 2) shows the students' lack of confidence in the concept of answering a question. Students answer only based on guesswork because they do not know how to answer the questions. On the other hand, a high CRI (3 or 4) reflects the students' high confidence and concept certainty in answering questions. Students will answer the questions because they have mastered the concept of answering the questions given (Prodjosantoso et al., 2019).

Determination of which concepts are best understood by misconceptions by the respondent group can be done by identifying misconceptions in groups. The identification of misconceptions is based on the average CRI index of respondents who answered correctly (CRIB) and the average CRI index of respondents who responded incorrectly (CRIS), and the fraction of respondents who answered correctly (Fb)

Calculation of CRIB, CHRIS, and Fb values using the formula:

$$CRIB = \frac{total\ number\ of\ CRI\ of\ correct\ answers}{number\ of\ students\ who\ answered\ correctly}$$

$$CRIS = \frac{total\ number\ of\ CRI\ of\ incorrect\ answers}{number\ of\ students\ who\ incorrect\ correctly}$$

$$TF = \frac{number\ of\ students\ who\ answered\ correctly}{total\ number\ of\ students}$$

Description:

TF = True fraction

Based on the CRIS value, it is stated that a misconception occurs if 2.5 < CRIS 5 and the degree of impact of the illusion is declared strong if the CRIS value is significant and the Fb value is small (Hakim et al., 2012). The data collection technique in this study used a test technique before and after implementing the conceptual change model.

Result and Discussion

Students' conception before remedial learning is conducted using the c1 conceptual change learning model

The data of students' conceptions before applying the conceptual change learning model obtained from giving seven items of questions are depicted in **Figure 1**. The average percentage of students' misconceptions in forming a buffer solution is 41.5 %, with the highest rate of misconceptions found in question number 2 regarding the formation of a solution. Buffer from a weak acid and strong base is 50 %, but there is no misconception for questions number 3 and 5 regarding the concept of pH buffer solution. Meanwhile, students' understanding of the concept of the change in pH of the buffer solution occurred delusions of 8.4%, and the highest percentage of misconceptions was found in question number 7, which was 17 %.

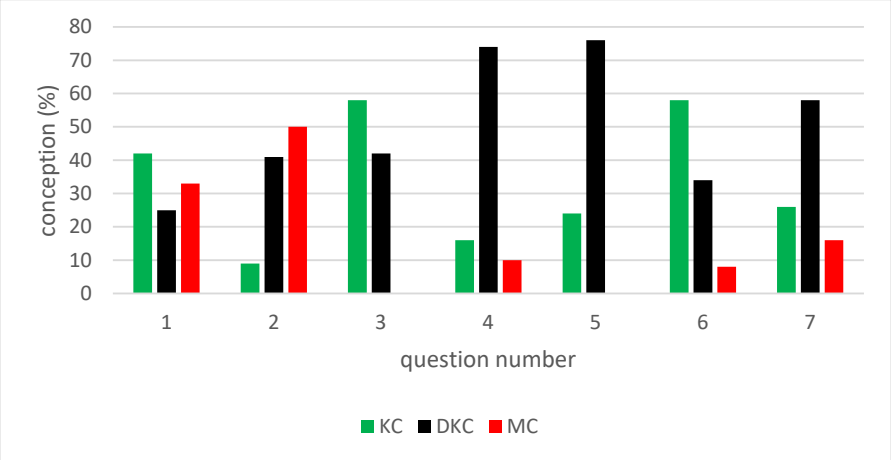

Figure 1. The student's conception of the buffer solution before the application of the conceptual change model: know the concept (KC), don't know the idea (DNK), and misconceptions (MC)

The analysis results showed that some students answered questions with the wrong concept, so that the student's answers were terrible, but the CRI level was high. The CRI score given by students on each question shows the level of certainty of the solution. Low CRI (1 and 2) indicate students' lack of concept confidence in answering a question, whereas high CRI (3 and 4) reflect high confidence and concept certainty in students answering questions. The student answers the question incorrectly, but the student's faith or CRI is high, the student has declared a misconception (Bayuni et al., 2018).

Students' preconception data on the buffer solution material are presented in **Table 4**. The average percentage of students who know the concept, do not understand the idea, and misconceptions on the buffer material are 38.1, 45, and 16.6 %, respectively. This shows that students answered concepts incorrectly by students accompanied by a high confidence level. In other words, several students have misconceptions about the buffer solution material. The causes of misunderstandings can come from students, teachers, textbooks, contexts, and teaching methods (Becker et al., 2013; Shehu, 2015).

Table 4. The results of the preconception data analysis of experimental class students on the material buffer

No	Concept	Percentage (%)		
		TK	TTK	MK
I	Formation of buffer	25.0	33.5	41.5
II	The pH of the buffer	58	42	0
III	Properties of buffer and pH	31.3	60.3	8.4
	Average	38.1	45.2	16.7

Based on the data in **Figures 2** and **4**, it can be explained that as many as students experience misconceptions in concept I, namely number 1 by 34.6 % and two by 50 %, concept II, no students experience misunderstandings, and concept III students experience misunderstandings of 8.4 %

Identifying misconceptions in groups is used to determine the concept that is thought to have the most vital misunderstanding from the three concepts tested. Identification is based on CRIB, CRIS, and Fb data for each test item that presents the concepts in the buffer solution material. CRIB, CRIS, and Fb data calculated from the results of the experimental class pretest are shown in **Figure 2**.

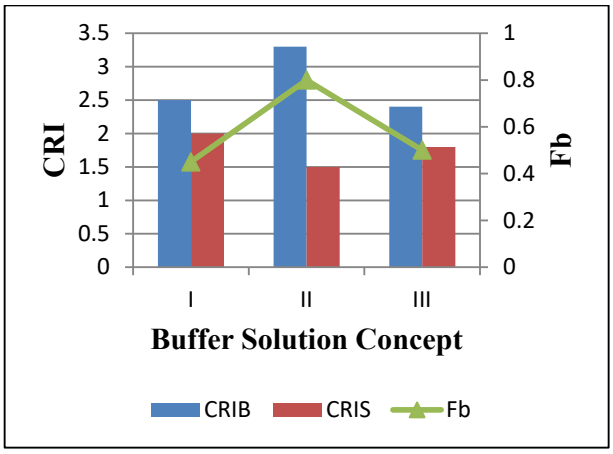

Figure 2 CRIB, CRIS, and Fb pretest experimental class students on buffer solution material materi

Description:
CRIB = total CRI of correct answers
CRIS = total CRI of incorrect answers
Fb = true fraction

Based on **Figure 2**, all concepts have a CRIS value 2 and Fb < 0.5. According to Hasan et al. (1999), there is a misconception if the CRIS value is 2.5 < CRIS 5. The degree of impact of the misunderstanding is substantial if the CRIS value is significant and the Fb value is small. The pretest results obtained from the experimental class can be seen that all students have misconceptions.

Remedial learning is done using a conceptual change learning model to improve or change students' misconceptions and strengthen students' concepts. In the first meeting, the enhanced concept was forming a buffer solution. Learning begins with the teacher giving conceptual change worksheets to students to express their initial conception of creating a buffer solution; this activity is reflected in phase 1, which expresses students' initial concepts. The students' initial concept is a concept that students assess as having misconceptions. Disclosure of students' initial conceptions is helpful to find out students' obstacles in learning the concept of buffer solution.

The second phase of the conceptual change learning strategy is to create a conceptual conflict which is carried out for 40 minutes with teacher activities inviting students to look at the statements in the conceptual conflict phase on the worksheet to check the truth and conclude. These statements require deep understanding. After the teacher gave answers in the form of instructions on the conceptual change worksheet, students experienced disequilibration because of the discrepancy between the initial concept and the new concept they received. Next, the teacher guides students to answer temporary conclusions about the correct image.

A total of 12 students with details of 6 students from class XII IPA 5 and 6 students from class XII IPA 6 who are still experiencing misconceptions in making temporary conclusions are given remedial action. Re-improvement in providing correct statements about conceptual statements so that students can conclude correctly. Remedial activities were carried 15 minutes out of 40 minutes at the stage of creating conflict conditions. The improvement is that students can perfectly complete the concept of forming a buffer solution.

Furthermore, the equilibration stage, namely the assimilation and accommodation process, was carried out for 20 minutes. According to Sirakaya & Cakmak (2018), assimilation does not cause schema changes but develops schemas. The 12 students who participated in the lesson left 3 students from class XII IPA 5 who still couldn't conclude correctly on the concept of forming a buffer solution.

The last stage reconstructs student concepts and is carried out for 25 minutes. The teacher checks student answers and directs students to build a correct understanding of reinforcement about the idea of buffer solution by guiding students to learn the formation of buffer solutions from strong acids and weak bases, solid bases, and weak acids. The teacher closes the lesson by giving directions for students to make conclusions.

The second face-to-face repeats the previous stage, and the total time required is 50 minutes. Two concepts have been improved, namely, the concept of pH in the manufacture of buffer solutions and the idea of the pH properties of the buffer solution. The 12 students who took part in the lesson left four from class XII IPA 5 and 2 from XII IPA 6 who still could not conclude correctly on the concept of changing the pH of a buffer solution. Then the teacher directs students to build a correct understanding of reinforcement about the nature of change in a buffer.

Student data after remedial learning is carried out using the conceptual change model

The student's conception profile for each number of questions after applying the conceptual change learning model is depicted in **Figure 3**, which shows that most students already know the concept. However, there are still students who do not understand the idea, and there are no misconceptions in the posttest results. Items that still leave students not knowing the concept are found in questions number 3, 5, 6, and 7.

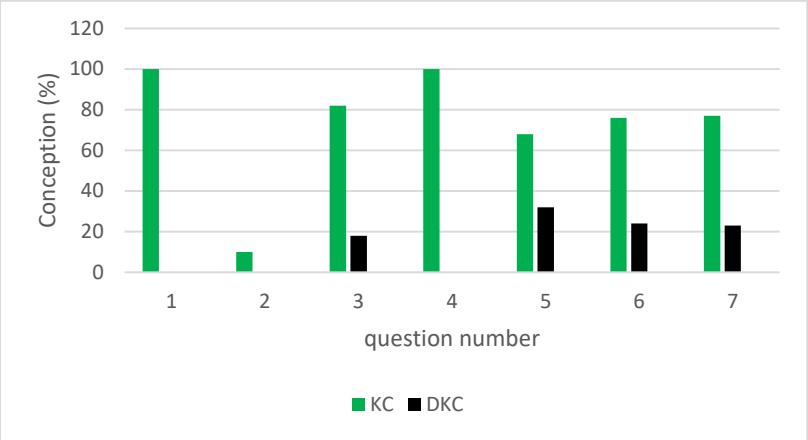

Figure 3. Percentage of students who know the concept (KC), do not know the idea (DNK), and misconceptions (MC) after the application of the conceptual change learning model

The analysis results show that most students have understood the concepts being taught to answer questions correctly with a high level of confidence or CRI. The average percentage of students who know the idea is 87.4%, and students who do not understand the concept of 12.6%. The analysis results showed that students who did not realize the idea answered the questions incorrectly, and the level of confidence or CRI was low. Students who do not understand the concept are students who initially experience misconceptions.

Table 5. The results of the conceptual data analysis of experimental class students on the buffer material

No	Concept	Percentage (%)		
		TK	TTK	MK
1	Formation of buffer	100	0	0
2	pH in making buffer	83	17	0
3	The nature of the change in pH of the buffer	79.25	20.75	0
	Average	87.4	12.6	0

Table 5 shows the average percentage of students who know the concept, do not know the idea, and misconceptions are 87.4%, respectively; 12.6%; and 0%. Applying students' conceptual change learning model can reduce misconceptions up to 0% but leaves 12.6% not knowing the concept (forgetting). In general, students' responses to the idea of buffer material in class XII IPA experienced a reduction.

Profile students' misconceptions about the buffer solution material after applying the conceptual change learning model, based on CRIB, CRIS, and Fb data for each test item that presents the concepts of the buffer solution material. CRIB, CRIS, and Fb data calculated from the experimental class posttest results are shown in **Figure 4**.

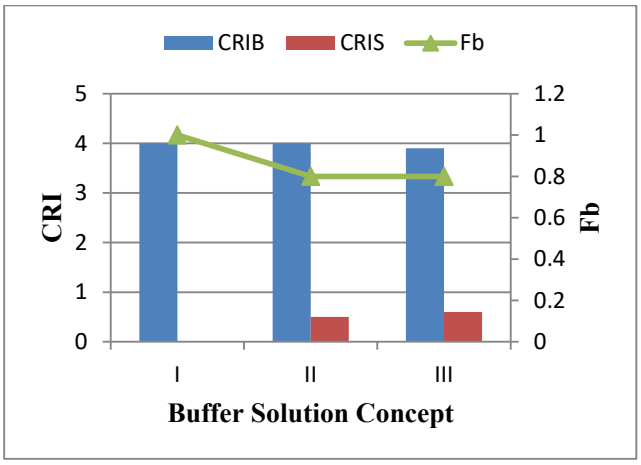

Figure 4. The profile of the experimental class students' misconceptions on the buffer solution material after participating in learning with the conceptual change model

description
CRIB = total CRI of correct answers
CRIS = total CRI of incorrect answers
Fb = true fraction

Based on **Figure 4**, all concepts have a CRIS value of 0.6 and Fb 1. According to Hasan (1999), it is stated that a misconception occurs if the CRIS value is 2.5 < CRIS 5 and the degree of impact of misunderstanding is declared strong if the CRIS value is significant and the Fb value is small. . The pretest results obtained from the experimental class can be seen that all students do not experience misconceptions. Based on the posttest results in the experimental class, concepts 1, 2, and 3 for the buffer solution material, students did not share misconceptions with a low CRIS value of 0.6.

The remedial application uses a conceptual change model; in general, the average percentage reduction of students' misconceptions on the buffer solution material can be seen in **Table 6**.

Table 6 The percentage reduction of students' misconceptions on the buffer material

No	Concept	Misconception (%)		
		Pretest	Posttest	Reduction
1	I	41.5	0	41.5
2	II	0	0	0
3	III	8.4	0	8.4
Average		16.7	0	16.7

Misconceptions caused by teachers usually occur because teachers teach only by speaking and writing on the blackboard, rarely allowing students to express their opinions. Teachers sometimes help students understand the material being studied more efficiently; the explanations given by the teacher are straightforward to simplify the material. The essential concepts of the material are not conveyed; this makes students misunderstand the essence of the material and causes misconceptions.

Conclusions

The conclusion that can be drawn from this research is that the average percentage reduction in misconceptions of class XI IPA SMA NEGERI 5 Palu on buffer material through remedial using the conceptual change learning model is 16.7%.

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