Cooperative integrated reading and composition (CIRC) with mind mapping strategy and its effects on chemistry achievement and motivation

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Contents

Abstract

The aim of this research was conducted to determine the effects of Cooperative Integrated Reading and Composition (CIRC) with mind mapping strategy on the student's achievement and motivation of 11th-grade Secondary students in Pekanbaru Indonesia regarding topics related to colloid. This research employed a pre test / pos test quasi-experimental design. This study was carried out with two groups, a study group (were instructed using CIRC with mind mapping method) while a control group (approached with conventional teaching method). Data for achievement were collected using Colloid Conceptual test and motivation data were collected using a questionnaire. The data were analyzed used SPSS 20.0 statistic program in term of descriptif, frequency, aritmathic means, and standar deviation. Unclear sentence inferential statistical analysis used t-tests and MANOVA to identify differences in achievement and motivation of the treatment and control groups. The findings show that there are differences in the achievement of students who used Cooperative Integrated Reading and Composition (CIRC) with mind mapping strategy, and no significant difference in motivation. This research has identified a learning strategy that can improve students' achievement in chemistry that needs to be applied, so that they can enhance their learning experience and achievement in chemistry lesson.

Keywords: Chemistry, Chemistry Achievement, CIRC, Learner Motivation, Mind Mapping

Introduction

Quality in science education is education that can produce students with the basic ability to learn, and can become pioneers in innovation and creation in science. Improving the quality of education can be done in various ways, such as the expansion and improvement of curriculum, structuring teacher, textbook procurement support, and improved methods of teaching and learning strategies. Osbrone, Simon, and Collins (2003) states, internal factors that influence the process of learning includes attitudes towards learning, learning motivation, learning concentration, learning outcomes retaining, self-confidence, learning material elaboration, learning outcomes exploration, study habits and students' ambition fulfilment.

Due to the fact that teacher is one of the factors have a major impact and the most important factor in determining the learning environment. Teachers have a duty to motivate, guide and provide learning facilities for students to achieve the learning objectives. Kamisah, Wahidin and Subhan (2013) stated that teacher pedagogical content knowledge is still low. Teacher as an instructor requires the right steps in the delivery of subjects. Teachers should have a better understanding on teaching and learning (Yigit, 2015) to lead the learner organize reviews their knowledge by using different methods and technique.

One of the external factors that can influence the learning process is teachers as educators (Danielson, 2006). Teachers' skills in managing the teaching process are crucial to the learning outcomes of the students (Sardiman, 2003). Therefore, teachers must motivate and guide students through a variety of ways that lead to the learning objectives. Teachers have a responsibility to look at everything that happens in the classroom to assist in the development of students (Slameto, 2003). It is widely asserted by educational researchers that teachers' teaching experience is usually able to improve their skills in selecting suitable methodologies and strategies in the teaching process (Fuller, 1969; Berliner, 2005) and the methods and strategies used are clear and appropriate. Typically, strategies of excellent teachers use student-centred activities (Owens, 2006; Debevec, Shih & Kashyap, 2006).

One way to motivate students is through the environment system that should be created so that students would be interested in education and increase student activity with the method prescribed (D'Souza & Maheshwari, 2010). Moreover, the effectiveness of teaching depends on the extent to which teachers are able to achieve their teaching objectives to help students to learn what is being taught. At this point effective pedagogical strategies could increase awarnesses of the importance learner center (Kamisah et al., 2013).

Chemistry is a subject that have an abstract topic (Burrows & Mooring, 2015), an abstract concept will lead learners to have preconception (Hakim, Liliasari, Kadarohman & Syah, 2016) student have difficulties in comprehending chemistry concept and principles (Temel & Ozcan, 2016) to understanding the topic of chemistry requires learner understand the related concept develops knowledge structure (Burrows & Morring, 2015). Temel and Ozcan (2016) stated that to build a well-organised conceptual framework in chemistry, learner should prefer meaningful

learning. Teacher should be applying a strategy that actively engaged student in the learning process. Chemistry education especially on colloid topic only presents information about the matter that is available in scientific information without correlating to the daily life. Presentation of topics using lecture method makes students generally assume that science is a boring subject. Kamisah, Lilia and Zanaton (2007) stated that perception shown by students towards science in general is negative or low, unattractive and difficult to understand. One of the active learning that put student active to think and actively involve in learning is cooperative learning with mind mapping. Gupta and Pasrija (2012) declare Cooperative Learning as an efficient technique to change students into active learners.

CIRC with Mind Mapping as a Strategy in teaching

A study has suggested that cooperative learning helps in improving students' comprehension (Hafizah et al., 2010). In the cooperative integrated reading and composition with mind mapping strategy, students are assigned to groups for different readings. In the learning process, every student will work in group that involves cognitive activities such as reading to each other; making predictions about the conclusions in reading and writing it in the form of a mind map (Figure 1). Students work in groups as a team to capture the whole main idea and other skills. According to Elaine and Melissa (2004) each group is responsible in ensuring that all team members work in groups to read and write.

Research Methodology

Research Design

This research can be put under the category of quasi-experimental study which focusing on the teaching of chemistry. The design of the research according to Cresswell (2012) is the design of pre-test and post-test.

Table 1. Research Design

Group	Pre-test	Teaching Strategies	Post-test
Treatment	T1	X1	T2
Control	T1	X2	T2

Table 1 shows the design of the study by Campbell and Stanley (1979); T1 represents the pre-test treatment group and the control group. The T2 represents the post-test for the treatment group and the control group. X1 dan X2 represent teaching strategies given to the treatment and control groups. Treatment group used the integration of cooperative learning instructional strategies in reading and writing and a mind map while the control group used conventional instruction.

Intervention related to experimental group

In teaching using cooperative integrated reading and writing with mind mapping strategy, students was write in the form of a mind map after they are done with the discussion on ideas or keywords in the reading material, Creativity in making a mind map is up to each group to design the mind map. It aims to develop and enhance students' thinking skills in finding the ideas of each individual and write them in a unique and coloured form of mind maps. More details can be seen in Figure 2 below:

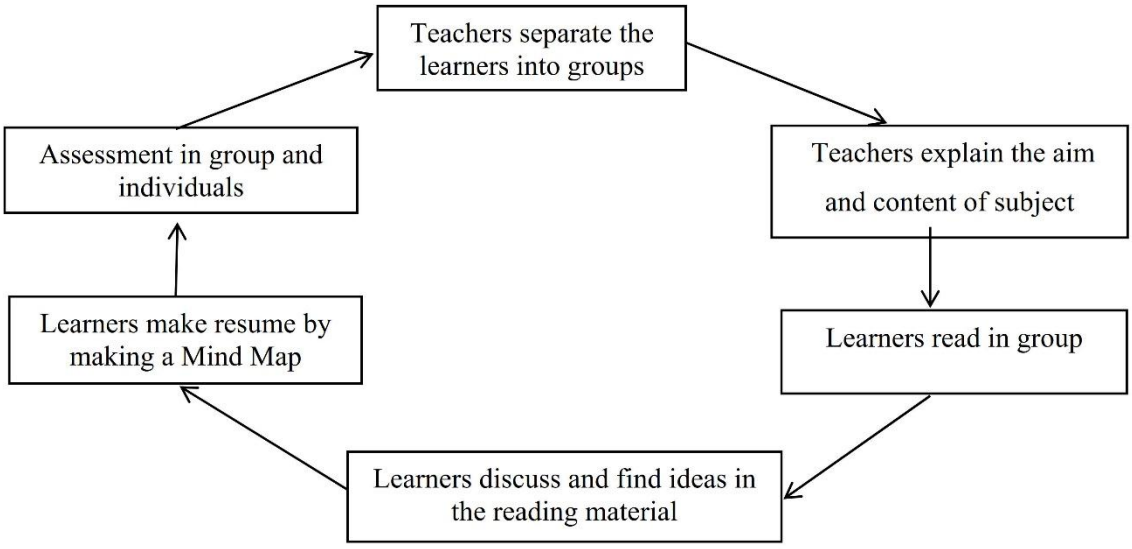

Figure 2. Flowchart of the Cooperative Integrated Reading and Composition with Mind Maps

This learning strategy used cooperative learning methods. Learning activities during teaching and learning is to form a group, read, analyze literature, discuss, create mind maps, and presentations. Pre-tests were made in the first week of implementation; students in the experimental group were informed of the group works required by CIRC and mind mapping strategy. We explained how the groups would be

established, duties would be assigned and the activities would be carried out (such as deciding on the name of the group, etc.). In the second till the fifth week of implementation, Sentences and texts in the worksheets handed out to students were read in the scope of reading (students to read accurately the texts in their own worksheet and then make small discussion for comprehending the topic) and create mind maps (groups were asked to write down the sentences on the paper that was handed out to group and making a map). Finally; the researcher entered performance exerted by groups in the previous activities on each group's scoreboard and the most successful group was awarded in class in the fifth week. Pos-tests were made in the sixth week of implementation.

Sample Research

For the sampel, 64 students from 2 different classes were chosen for study. Both classes have similar academic performances and are taught by the same Chemistry teacher. The sample consists of students at Senior High school of Darul Hikmah who are from XI science1 (32) class and XI science2 class. Next, XI science1 class was randomly determined as treatment group by infusing learning strategies in cooperative reading and writing with mind maps and XI science2 class as the control group with conventional teaching strategies.

Research Instrument

a. Chemistry Achievement Test

Students' performances in chemistry were measured by test that posed in the pre-test and post-test. The test were designed by the researcher in collaboration with the teachers at the school and based on chemistry syllabus. The construction of the achievement test is in accordance with the Test Determination Schedule based on Bloom's Taxonomy skills level.

Table 2. Determination of Pre- and Post- Achievement Test

Category	Cognitive				No Item
	C1	C2	C3	C4	
Classifying rough suspension, true solution, and colloids		1			2
	1				
		6			8

Classifying the types of colloids based on dispersed phase and dispersing phase	2				
Describing the role of colloids in cosmetics, foods and pharmaceuticals industry				2	4
		1			
			1		
Explaining liofil and liofob colloids			1		3
	1				
		1			
Describing the characteristics of colloids				3	6
			1		
		2			
Explaining the manufacturing process of colloids by trial			1		2
		1			
Total Item					25

b. Motivation Questionnaire

The motivation questionnaire is prepared for both groups. Section A collects data on the students' background. Section B collects data on students' motivation that was divided into two parts which are intrinsic and extrinsic motivation. Motivation section contains 31 items that provide information on the students' intrinsic motivation (16 items) and extrinsic motivation (15 items).

Table 3. Constructs of Motivation Questionnaire

Constructs Measured	Item	Total item
Intrinsic Motivation	B1,B4,B6,B8,B9,B11,B13, B15,B17,B19, B21,B20,B22,B24,B26,B29	16
Extrinsic Motivation	B2,B3,B5,B7,B10,B12,B14, B16, B18, B23,B25,B27,B28,B30,B31	15

Validity and Reliability

Validity and reliability of the instruments are necessary elements in study, where they referred to the extent to which the instrument measures what it is to be measured or the extent to which the instrument is accurate and precise (Anastasi & Urbina, 1997).

a. Validity of Chemistry Achievement Test

Table 5 shows that the difficulty index of the chemistry achievement test questions is at a moderate level. Thus, the difficulty of the question is balanced and almost complete. The value of the Discriminant Index for every question item in the chemistry achievement test was between 18.18% and 100%. This shows that every item has a discriminant index between levels of bad and very good. The value of the difficulty index of each item in the chemistry achievement test was between 35.90 and 69.23. Karno (1996) noted that the best difficulty index that should be used for each item is moderate level. In this research each item of the test performance at a moderate level. From the analysis, there are some questions that were modified to balance the questions to be at average level in overall status, and the questions developed can be used to measure chemistry achievement.

Table 4. Discriminant Index and Difficulty Index Value of Chemistry Achievement Test

Topic	Question no	Discrimination Index (%)	Difficulty Index	Difficulty Index Interpretation
Colloid	1	63.64	48.72	Moderate
	2	81.82	61.54	Moderate
	3	54.55	69.23	Moderate
	4	18.18	66.67	Moderate
	5	27.27	66.67	Moderate
	6	72.73	64.10	Moderate
	7	100.0	66.67	Moderate
	8	54.55	64.10	Moderate
	9	81.82	69.23	Moderate
	10	100	66.67	Moderate
	11	36.36	35.90	Moderate
	12	81.82	46.15	Moderate
	13	100	53.85	Moderate
	14	90.91	61.54	Moderate
	15	72.73	66.67	Moderate
	16	72.73	56.41	Moderate
	17	81.82	64.10	Moderate
	18	63.64	64.10	Moderate
	19	45.45	58.97	Moderate
	20	72.73	61.54	Moderate
	21	36.36	61.54	Moderate
	22	54.55	66.67	Moderate
	23	18.18	46.15	Moderate
	24	90.91	58.97	Moderate
	25	72.73	58.97	Moderate

b. Validity of Motivation Questionnaire

The Cronbach's Alpha value was used to obtain the reliability for every construct in resarch. The results of the analysis were shown in Table 5.

Table 5. Reliability Index of Motivation Questionnaire

Construct	***Cronbach's Alpha* (>0.6)**
Intrinsic motivation	0.792
Extrinsic motivation	0.752

Based on Table 5, the Cronbach's alpha reliability index for students' intrinsic motivation aspect towards chemistry (16 items) is 0.792. Additionally, the Cronbach's alpha reliability for students' extrinsic motivation aspect towards chemistry (15 items) is 0.752.

Results

Descriptive Analysis

Descriptive statistics analysis was conducted during the post-test to show the mean difference of the achievement scores results and students' motivation results after treatment was done. Analysis of the descriptive statistics on the post-tests' mean scores can be seen in the following descriptions.

Students' Achievement Mean Scores According to Groups

Table 6 shows that the treatment group obtained mean value of (mean = 76.63 and SD = 11.042) while the control group obtained a value of mean = 58.25 and SD=10.358. It can be observed that the treatment group obtained a higher mean value than the control group.

Table 6. Mean Scores and Standard Deviation of Students' Achievements According to Groups

Group	**N**	**Mean**	**Standard deviation**
Treatment	32	76.63	11.042
Control	32	58.25	10.358

Students' Motivation Mean Scores According to Groups

Table 7 shows that the intrinsic motivation of treatment group obtained a mean score of (mean = 3.94 and SD = 0.323) while the control group obtained a mean score of (mean = 3.81 and SD = 0.340). It can be observed that the treatment group obtained a higher mean value than the control group.

Table 7. Mean Scores and Standard Deviation of Students' Motivation According to Groups

Motivation	Group	N	Mean	Standard Deviation
Intrinsic	Treatment	32	3.94	0.323
	Control	32	3.81	0.340
Extrinsic	Treatment	32	3.38	0.510
	Control	32	3.36	0.462

For extrinsic motivation, the treatment group obtained mean score of (mean = 3.38 and SD = 0.510) and the control group obtained mean score of (mean = 3.36 and SD = 0.462). Thus the treatment group has higher mean value than the control group.

Inferential Analysis

Students' Achievement According to Groups

Independent t-test was conducted to determine the differences in students' achievement according to groups. The independent t-test results are shown in Table 8 below.

Table 8. Independent T-Test Results of the Difference in Students' Achievement According to Groups

Group	N	Mean	Standard Deviation	t	Degree of Freedom	Sig.(2-tailed)
Treatment	32	76.63	11.042	6.866	62	0.0001
Control	32	58.25	10.358			

Table 8 shows that the main effect of method is significant based on the value of t=6.866 ($p < 0.05$). In terms of the mean, the treatment group (mean=76.63 and SD=11.042) had higher achievement than students in the control group (mean=58.25

and SD=10.358). This shows that the null hypothesis (Ho1) that states that there is no significant difference in student achievement based on the group is rejected. It can be concluded that there is no significant difference in achievement between treatment group and control group.

The Differences in Students' Motivation According to Groups

MANOVA analysis was carried out to identify the differences in students' motivation according to groups. Before the MANOVA analysis was conducted, the researchers first conducted tests to determine the homogeneity of variance-covariance matrix using Box's M test. Box'M test analysis can be seen in Table 9 below.

Table 9. Box'M Differences in Students' Motivation According to Groups

Box's M	F-Value	Degree of Freedom 1	Degree of Freedom 2	Sig. (2-tailed)
8.393	0.905	9	176205.994	0.519

Table 9 shows that there is no significant variance-covariance among the dependent variables for all levels of the independent variable with the Box's M=8.393 and sig=0.519 ($p<0.001$). This means that the variance-covariance of the dependent variable is homogeneous across the independent variables. Therefore, MANOVA tests can be carried out to see the difference in students' motivation according to groups (Pallant, 2007). MANOVA analysis results can be seen in Table 10 and Table 11 below.

Table 10. *Wlilks' Lambda* Differences in Students' Motivation According to Groups

Effect	*Wilk's Lambda*	F-value	D.K between groups	D.K in group	Sig.(2-tailed)
Group	0.976	1.537	3	708	0.219
Test time	0.995	0.335	3	354	0.716
Group*Test time	0.999	0.063	3	124	0.939

Table 10 shows that there is no significant difference in students' motivation according to groups and time with the value of Wilks' = 0.999, F (0.063) =0.939 (p>

0.05). Motivation based on both groups obtained a value of Wilks' = 0.976, F (1.537) = 0.219 (p>0.05) whereas the motivation that depends on test time obtained a value of Wilks' = 0.995, F (0.335) = 0.716 (p>0.05). This shows that the null hypothesis (Ho2) that states that there is no significant difference in student motivation according to groups is accepted. More details of the MANOVA analysis on the difference for every aspect of students' motivation according to groups can be seen in Table 11 below.

Table 11. MANOVA Differences in Students' Motivation According to Groups

Source	Dependent Variable	Type III Total Squares	Degree of Freedom	Mean Squares	F-Value	Sig. (2-tailed)
Group	Intrinsic motivation	0.369	1	0.369	2.818	0.096
	Extrinsic motivation	0.015	1	0.015	0.073	0.787
Test time	Intrinsic motivation	0.027	1	0.027	0.210	0.648
	Extrinsic motivation	0.077	1	0.077	0.367	0.546
Group*Test time	Intrinsic motivation	0.015	1	0.015	0.113	0.738
	Extrinsic motivation	0.001	1	0.001	0.004	0.949
a. R Squared = 0.025 (Adjusted R Squared = 0.001)						
b. R Squared = 0.004 (Adjusted R Squared = -0.021)						

Table 11 shows that there is no significant effects on the motivation of both groups in terms of the students' intrinsic motivation (F=2.818, p>0.05) and extrinsic motivation with the value of F=0.073 and sig=0.787 (p>0.05). Additionally, there is no significant difference of overall time on the students' motivation in terms of intrinsic motivation with F=0.210 and sig=0,648 (p>0.05) and extrinsic motivation with F=0.367 and sig=0.546 (p>0.05). Furthermore, the results of the analysis showed that there is no significant effect of the interaction between group and test time with F=0.113 and sig=0.738 (p>0.05) for intrinsic motivation and F=0.004 and sig=0.949 (p>0.05) for extrinsic motivation. Therefore, it can be concluded that there was no significant difference in intrinsic and extrinsic motivation of the students based on group and time. Thus, there was no significant difference between the intrinsic motivation of students in the treatment group and the control group.

Discussion

The findings indicate that there is a difference between the treatment group's performances with the control group's for the employment of cooperative integrated reading and composition with mind mapping strategy. This strategy makes students more interested in following the process of teaching and learning. While teaching and learning process is carried out, students who do not understand the concept of the reading materials pose questions, thus class is actively discussing on the subject matter, (Orbanic, Dimec & Cencic, 2016; Alsharif, 2014) constructivist teaching could enhance student knowledge and linked their knowledge with experience. According to Slavin (2008), the advantages of cooperative integrated reading and composition with mind mapping strategy learning model integrate the advantages of cooperative learning with reading and writing amongst these students, thus improving their skills in solving the questions of a story or concept, applying simple implementations and motivating student learning because of the group work. In addition Kamisah et al., (2013) state that concept mapping that embedded into chemistry learning, it's would increase students' science thinking skills

In addition, complex learning activities to develop creative thinking are found to be quite effective in the treatment groups, (Kamisah et al., 2013) the way of student thinking skills have change significantly. Where students were assigned reading materials and given tasks to make some notes on their reading using mind maps. Buzan (2009) stated that the mind map is a way to register a creative, effective and will literally map the mind as well as a route map to memory that allows us to organize facts and thoughts such that the natural way the brain involved since the beginning. This study is also consistent with the findings of Donald and Barbara (2003) who found that student achievement increased while learning using mind maps, in addition to the Donald and Barbara (2003) also found that by using this learning strategy can facilitate students in learning and understanding which can produce ideas that can connect one concept to another concept. Yigit (2015) found that flow map method is valuable to gathering the cognitive structure outcomes of the students. Soika and Reiska (2014) by using concept mapping for assessement students can received higher marks for abstract chemistry-based sentences.

In the treatment group, the teacher acts as a guide. All of these efforts will not be successful if the teacher does not play a guiding role and acts as a mere informer. To implement active learning, students should have the opportunity to be involved by engaging themselves in their own learning activities. In conducting activities, learning materials are always needed. Teachers as guides need to manage all the learning materials that are necessary and related. According to Pintrich (1996), shared experience of cooperative learning can improve learning performance compared with individual learning. Infusing the learning of reading and writing cooperatively is a cooperative learning. Groups that established good rapport involving cognitive activities will be able to make predictions for summary and writing it. Elaine and Melissa (2004) states that each group is responsible for ensuring that all team members work in groups for reading and writing acivities.

The findings from the motivation study showed that in overall, there was no significant difference between the treatment group's motivation and the control group's, Cindy and Kamisah (2016) to enhance students motivation, more practical and suitable approaches and strategies have to applied. Likewise, there was no significant difference between the treatment group's motivation and the control group's motivation in terms of intrinsic or extrinsic motivation. These findings were parallel and supportive of the findings and views by Kassaian and Ghadiri (2011) that a student who has a kind of pressure and a high motivation (Vandergrift, 2005) in learning possesses awareness and it's probably they interested in his studies and showing determination to achieve success in learning. Woolfolk (2004) also noted that the benefits of intrinsic motivation are to actively engage students in their assignments grow and develop the concept of motivation in students so that they can educate themselves throughout their lives, as well as using the cognitive skills, which is to think critically about what have been learned.

In addition, instilling extrinsic motivation may be effective for individuals who are more easily adapt to the system of awarding points or rewards such as gifts, where it can encourage good behaviour among students. According to Covington (2000), what distinguishes intrinsic and extrinsic motivation is based on what is the most effective way in motivating students. According to Suciati (2005), students' motivation is defined as persistence that is not easily broken before achieving success although facing a lot of obstacles. This study also found that intrinsic motivation that is reflected in the mean score for the treatment class is higher than the mean score

for the control class; this suggests that intrinsic motivation of the treatment class that used the cooperative integrated reading and writing with mind maps strategy is higher than the control group that used conventional learning. The results may be affected when different strategies are used, thus students from the treatment group have been pushing themselves to achieve good results and solve problems in learning.

Conclusion and Implication

According to the finding obtained from this research, teaching and learning with the integration of cooperative learning strategies in reading and writing with a mind map to increase student achievement and motivation was effective. The students were revealed to have significant increase in their achievement and motivation. Results of this research indicate that the integration of cooperative learning strategies in reading and writing with a mind map has a positive impact on students' achievement and motivation. There is a significant difference in achievement between the treatment group with the infusion of learning reading and writing with a mind map and the control group with conventional teaching, while there are no significant differences in motivation between treatment group and control group.

Application of the CIRC with mind mapping for science education in school practice will require teachers to provide instruction and example in the construction of mind maps and observing students' comprehension of the reading material. Moreover, to apply this strategy the levels of ability of the students in the groups should be a concern for teachers in the teaching and learning process. Customary teaching habits that only deliver information or by using lectures and discussions are too familiar for the students thus causing high dependence of students to teachers, therefore causing students to be more focused on the information provided by teachers, without developing creativity of their own mind. For students, making a mind map is a capability that can be leveraged to learning. Therefore, teacher training is needed to improve the information and skills to be used in teaching strategies that enable students to learn creatively and independently.

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