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The Effect of Chemo-Entrepreneurship Oriented Inquiry Module on Improving Students' Creative Thinking Ability

Citra Ayu Dewi[1], Ratna Azizah Mashami[2]

[12] Institut Keguruan dan Ilmu Pendidikan (IKIP) Mataram, Jln. Pemuda No. 59A Mataram 83126, INDONESIA.
Citra Ayu Dewi[1], email: ayudewi_citra@ikipmataram.ac.id, ORCID ID: 0000-0001-9381-9645
Ratna Azizah Mashami[2], email: ratnamashami@ikipmataram.ac.id

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ABSTRACT

The ability of students' creative thinking is not well developed by learning that only focuses on convergent thinking training without giving students problems to face. Therefore, students have difficulty in developing creative thinking ability. Therefore, it is necessary for a learning program to improve student creative thinking ability. This study aims to improve students' creative thinking ability through chemo-entrepreneurship oriented inquiry module (COIM). We used a quasi-experimental research method with a pre-experimental design that involved pretest and posttest of one group. This research was conducted in Chemistry Education Department FPMIPA IKIP Mataram in the fall semester of 2017-2018 academic year. The research subject was 20 students. The findings of the research showed that theCOIM is effective in the learning and teaching process with indicator of percentage given at the pre-test and post-test recapitulation report. The report showed that originality indicator increased from 42% to 60% and were categorized as quite creative. Similarly, fluency indicator increased from 51% to 75% and were categorized as creative, Flexibility indicator also increased from 46% to 65% and were categorized as creative. Lastly, elaboration indicator increased from 60% to 77% and were categorized as creative. This means that the COIM was effective in improving students' creative thinking ability.

Keywords: COIM, creative thinking ability.

INTRODUCTION

Creative thinking is one of the fundamental educational outcomes in the 21st century as the world's economic growth is now innovation-driven (Robinson, 2011). Given the demand for the creativity in the future work force, schools are expected to teach and assess creativity (Voogt & Roblin, 2012). Creative thinking is classified as high order skill and can be seen as a continuation of basic skills (Rudyanto, 2016).The ability of creative thinking is helpful to create an idea or find an alternative solution to solve a problem that occur in

Corresponding author e-mail: ayudewi_citra@ikipmataram.ac.id

everyday life. Mahmudi (2010) explains that creative thinking is important because one of the abilities desired by the world of work. This suggests the ability of creative thinking is important to improve.

Creative thinking contains four aspects that include fluency, flexibility, originality, and elaboration (Anwar, Shamim-ur-Rasool, & Haq, 2012). Choridah (2013) gives detailed description of characteristics of creative thinking including a process of originality (ability to make new ideas); fluency (ability to express more than one idea); flexibility (ability to produce different ideas); elaboration (ability to detail ideas). (Siswono, 2010) stated that creative thinking is a process that brings up a new idea for challenging problems. Creative thinkers carry out of ordinary thinking patterns and be able to free themselves from the dominant patterns that have been stored in their brain (Langrehr, 2006). Creative thinking creates opportunities for the development of student personality through efforts to increase concentration, intelligence, and self-confidence (Al-Uqshari, 2005).

However, the current conditions of students' creative thinking ability in Indonesia have not been well developed and are still categorized low. The PISA results for creative thinking ability of Indonesian students ranked 64th out of 65 participating countries in 2012 and ranked 66th out of 74 countries in 2015. The PISA score is an evident for low level of creative thinking of Indonesian students that changed from 382 in 2012 and 386 in 2015 (PISA, 2012). The research results of Wang et al (2017) was an indicator for low level of creative thinking of students that showed originality about 1,57%; flexibility about 1,12%; fluency about 1,03%; elaboration about 0,73%. That means that students had low level of creative thinking ability according to the criteria developed by Brookhart (2010). Faelasofi (2017) stated that the ability of students'creative thinking is low on the aspect of fluency 75%, flexibility 25%, and originality 25%. This results shows low level of students' creative thinking ability according to the scores of three aspects in creative thinking. Based on the indicators of creative thinking, Siswono & Novitasari (2007) categorized creative thinking ability in five level that include level 4 (very creative), level 3 (creative), level 2 (quite creative), level 1 (less creative), and level 0 (not creative). Students are categorized at level 4 as long as they are able to fulfill the three components of creative thinking (fluency, flexibility, and originality). Students can be categorized at level 3 when they are able to fulfill the two components of creative thinking (fluency and flexibility or fluency and originality). Students are categorized at level 2 if they are able to fulfill one component of creative thinking (originality or flexibility). Students are categorized at level 1 if they are able to fulfill the component of fluency only and students are categorized at level 0 if when they are unable to fulfill any of the components of creative thinking.

Creative thinking ability can be trained and developed continuously (Bono, 2007). Students' ability of creative thinking can be developed through education so students have the ability to access and process data and able to find many possible answers to problems (Jamaluddin, 2011). The creative thinking ability can be developed through high order thinking oriented learning (Sudjana, 2010). In an effort to develop students' creative thinking ability, teachers need to create non-authoritarian learning environments where students can easily express their ideas, ask questions or generate their own questions. To encourage students' meaningful learning in such environments, teachers can give challenging problems to students, make teachingfun to students and give rewards to ones who express creative ideas (Suriyani, Hasratuddin, & Asmin, 2015). One effective alternative solution in improving students' creative thinking ability is through the implementation of Chemo-Entrepreneurship Oriented Inquiry Module (COIM).

Inquiry-based learning is one major learning strategy that is given in the science standards and professional development documents (Arisa & Simamora, 2014). Inquiry learning is one of the learning method that can be applied for teaching science (Dewi &

Mashami, 2018). According to Supartono & Anita (2009), is successful in teaching chemistry as students can participate directly in the scientific process in short time. To prepare students with skills in the world of work (vocational skills) creative thinking ability is needed. One of the lessons that have the potential for improving students' creative thinking ability in entrepreneurship is chemo-entrepreneurship (CEP).

CEP approach is a method used in chemistry teaching and is by that is applicable to daily life. In this approach, students are provided with knowledge and skills in turning raw material into a valuable product by applying chemistry theories into a way of visualization. In this way, students are expected to improve their ability of creative thinking (Wijayati & Rengga, 2009). CEP is a teaching approach used in chemistry that aims to related the theory in chemistry with the real object/phenomenon around human's lives. Therefore, besides learning chemistry, application of CEP approach in the instruction process will enable the students to understand the basic concepts of chemistry theory more easily. It gives students an opportunity to learn the process of turning raw material into valuable products based on chemistry concepts. Hence, it will motivate students to enhance their entrepreneurship spirit. The implementation of CEP instructional approach in chemistry teaching makes learning interesting and joyful (Supartono, 2006). Creative thinking is one skill out of other skills that can be developed through using CEP approach in chemistry teaching. Creative thinking is a typical ability needed for someone to survive, wherever he lives and whatever his profession is. Hence, it is necessary to use CEP instructional approach not only for increasing academic success and learning but also for helping those people for solving daily life problems (Bentley, 2012).

The results of the study conducted by Dewi & Mashami (2018) listed some problems associated with students' chemistry learning. First, students found some basic chemistry subjects such as colloidal matter difficult to understand due to the characteristics of macroscopic, microscopic and symbolic colloidal. Also, the instructor did not associate lesson material with everyday life. Another problem listed in the study was that the teaching materials were not prepared for the purpose of attracting students' attention. Teaching three aspects of colloidal material that included macroscopic, microscopic through chemo-entrepreneurship can make it easier for students to understand the subject matter because that approach help students to associate material with everyday life. Thus it can be concluded that the development of chemo-entrepreneurship oriented inquiry modules is needed for teaching colloidal material for prospective chemistry teachers and students at IKIP Mataram. Involving the interrelationships between concepts and daily life will make learning chemistry more meaningful and enjoyable.

Previous studies such as Kurniawan (2013) and Deta & Widha (2013) stated that teaching through guided inquiry model can improve students' creativity. Students learn about 10% of what they read, 20% of what they hear, 30% of what they see, 50% of what they see and hear and hear, and 90% of what they do (Supartono & Anita, 2009). Research conducted by (Rusilowati, 2009) showed that students' creativity can develop when they like and be interested in science. In addition, Yahya (2014) said that students' creativity increases through project-based learning. According to Suciati, Vincentrisia, and Ismiyatin (2015), students creativity can be improved through using the 5E Learning Cycle model in lesson implementation.

Many researchers conducted research on creative thinking and discussed the factors that affect creative thinking. Gregory, Hardiman, Yarmolinskaya, Rinne, and Limb (2013), for example, discussed that students' creative thinking ability develop by the help of several factors used in classrooms including giving chances to students to ask questions. Classrooms often give too little chances for students to think creatively. However, the abilities of creative thinking and problem-solving can be shaped in various ways. For example, instructor can

encourage students to find connection between different ideas and give students chance to offer various solutions to complex problems (Brooks, 1999; Sternberg & Williams, 1996). Treffinger, Schoonover, & Selby (2012) suggested encouraging students to explore, question, experiment, manipulate, listen, and solve the problems they face in order to improve their creativity. Additionally, students will learn better, be more critical in thinking, and be able to think creatively if they learn in a safe environment (Brookfield, 2017). A safe environment will make students feel more comfortable to deliver their opinion and ideas, to take risks, to be open to changes, and to be creative.

This study aims to improve students' creative thinking ability through implementation of chemo-entrepreneurship oriented inquiry module (COIM). COIM model is based on inquiry processes in learning and chemo-entrepreneurship approach. The learning steps in the COIM model are problem orientation, formulating problems, writing hypotheses, making observing and collecting data through chemo-entrepreneurship activities. The results of implementation the COIM model in the classroom and the indicators in creative thinking ability including a process of originality, fluency, flexibility, and elaboration are described in this article.

METHODS

We used a quasi-experimental research method with a pre-experimental design that focused on chemo-entrepreurship oriented inquiry module (COIM) implementation in studying, learning and teaching to improve students' creative thinking ability. This research aimed to improve students' creative thinking ability by using the COIM model. Data in this research is students' creative thinking ability indicator that can be measured through student's ability to solve the designed test.

The form of pre-experimental design in this study was One Group Pretest-Posttest Design (Sugiyono, 2013). The shape of the design is illustrated in Table 1.

Table 1. *Pre-experimental design*

Subject	Pretest	Posttest
One Group	O_1	O_2

Information: O_1 = Pretest value before learning through COIM. O_2 = Posttest value after learning through COIM.

This research was conducted in Chemistry Education Department FPMIPA IKIP Mataram in the fall semester of 2017-2018 academic year. The research subject was 20 students. The sampling technique in this study is saturated sampling, namely the technique of determining the sample if all members of the population are used as samples (Sugiyono, 2013).

a) Validity of the creative thinking instrument

The creative thinking instrument is validated by an expert before it was applied. The instrument was validated using the validation sheet based on five scoring Likert scale items including: 5 = very valid, 4 = valid, 3 = quite valid, 2 = less valid, 1 = invalid. Obtained score from the validators is converted into five-scale qualitative data (Bahtiar, & Prayogi, 2012) as shown in table 2.

Table 2. *The validity criteria of the instrument of creative thinking ability*

Interval (Va = validity level)	Criteria
Va> 4,21	Very valid
3,40 <Va< 4,21	Valid
2,60 <Va< 3,40	Quite valid
1,79 <Va< 2,60	Less valid
Va< 1,79	Invalid

An instrument of creative thinking ability is considered as valid when the minimum of validity degree is valid. If the validity degree is less than valid, that means the instrument has to be revised. The results obtained from the validation test by experts about 4.25% with category very valid. After the instrument of creative thinking had been validated by experts, it was applied to the students who had taken basic chemistry courses. The trial results were analyzed using the Rasch Model Minister statistic. The results showed that the probabilities of all items were above 5%. Thus, it can be concluded that all ten items are valid as shown in table 3.

Table 3. *The validity Rasch Model*

DIF class specification is: DIF=$S1W1

Person CLASSES	SUMMARY DIF CHI-SQUARED	D.F.	PROB.	BETWEEN-CLASS UNWTD MNSQ	t=ZSTD	Item Number	Name
10	2.8666	9	.9693	1.3216	.7771	1	E1
10	3.7002	9	.9300	1.3439	.8161	2	E2
10	1.5118	9	.9971	.3864	-1.5715	3	E3
10	3.1772	9	.9568	2.1287	1.9797	4	E4
10	1.0084	9	.9994	.2034	-2.4639	5	E5
10	1.4163	9	.9977	2.0141	1.8301	6	E6
10	1.3591	9	.9981	.5932	-.8595	7	E7
10	3.9172	9	.9168	3.1346	3.1069	8	E8
10	2.1917	9	.9880	.5800	-.8995	9	E9
10	1.6292	9	.9961	.5851	-.8840	10	E10

b) Reliability of the creative thinking instrument

The reliability of the instrument was analyzed using a statistics method called Rasch Model K-R 20 (Cronbach Alpa).The reliability value for 10 items was 0.81 with very high criteria as shown in table 4.

Table 4. *The Reliability Rasch Model K-R 20*

SUMMARY OF 18 MEASURED Person

	TOTAL SCORE	COUNT	MEASURE	MODEL S.E.	INFIT MNSQ	INFIT ZSTD	OUTFIT MNSQ	OUTFIT ZSTD
MEAN	12.1	8.0	.01	.51	.97	-.1	1.01	.0
P.SD	4.8	.0	1.15	.04	.50	1.1	.56	1.1
S.SD	5.0	.0	1.18	.04	.52	1.1	.57	1.1
MAX.	19.0	8.0	1.70	.60	1.95	1.8	2.26	1.9
MIN.	4.0	8.0	-2.03	.47	.28	-2.1	.30	-2.0

REAL RMSE .55 TRUE SD 1.01 SEPARATION 1.82 Person RELIABILITY .77
MODEL RMSE .51 TRUE SD 1.03 SEPARATION 2.03 Person RELIABILITY .81
S.E. OF Person MEAN = .28

Person RAW SCORE-TO-MEASURE CORRELATION = 1.00
CRONBACH ALPHA (KR-20) Person RAW SCORE "TEST" RELIABILITY = .81 SEM = 2.13

c) The effectiveness of the COIM model

The effectiveness of the COIM model was evaluated through students' improvements of creative thinking ability. Creative thinking ability is evaluated using the scoring technique adapted from Ismaimuza creative thinking essay test, where the highest score is 4 and the lowest score is 0. The indicators of creative thinking ability in this study are originality, fluency, flexibility, and elaboration. The score is calculated using the following equation (Rahman, 2017):

$$x = \frac{The\ Acquired\ Score}{The\ Maximum\ Score} x\ 100\%$$

With the following criteria:
81—100 =Highly creative
65—80 = Creative
40—64 = Quite creative
< 40 = Less creative

FINDINGS

Creative thinking ability in this research consisted of originality, i.e., having new ideas to solve the problem, fluency, i.e., generating many ideas in various categories, flexibility,i.e., the ability to produce various ideas and elaboration, i.e., the ability to detail ideas (Kim, 2006). The creative thinking ability result in this research is shown in Table 5 below.

Table 5. *Summary for descriptive analysis result*

Component	Pre-test	Post-test
Maximum Score	70	80
Minimum Score	20	60
Range	50	20
Average	45,75	72,25
N	20	20

The table 6 below compares the pre-test and the post-test results. The pre-test results shows that there were 16 students in the less creative category (36.2 %), 2 students in the quite creative category (4.6%), 2 students in the creative category (4.6%), meanwhile there was none in highly creative category. After the treatment, the post-test shows that there were 8 students in the highly creative category (28.9%), 6 students in the creative category (21.7%), 6 students in the quite creative category (21.7%), and none in less creative category. The table 6 below compares the number of students at each category.

Table 6. *Students creative thinking ability test*

Component	Pre-test	Post-test
Less Creative	16	0
Quite Creative	2	6
Creative	2	6
Highly Creative	0	8
N	20	20

The percentages for each creative thinking ability indicator was reported for pre-test and post-test as shown in table 7.

Table 7. *Percentage of Creative thinking ability indicator*

Creative thinking ability indicator	Pre-test (%)	Post-test (%)
Originality	42	60
Fluency	51	75
Flexibility	46	65
Elaboration	60	77
N	20	20

Based on the results shown at table 7, students' creative thinking ability increased. This can be seen from creative thinking ability indicator percentages reported for pre-test and post-test. For the pre-test, students' originality was 42%, fluency was 51%, flexibility was 46%, and elaboration was 60%. Meanwhile, for the post-test, the creative thinking ability increased for each indicator. Students' originality increased to 60%, fluency increased to 75%, flexibility increased to 65% and elaboration increased to 77%.

DISCUSSION and CONCLUSION

The data analysis results showed that creative thinking ability for all indicators increased after the students were taught using the COIM model. Therefore, from that research, we can safely say that the COIM model is effective for improving students' creative thinking ability. The COIM model can give students opportunity to turn raw material into valuable products based on the chemistry concepts. Hence, it motivates students to enhance their entrepreneurship spirit. However, the results of the study also shows that the increase in originality indicators is still at low category compared with other indicators (fluency, flexibility, and elaboration). This is because original/unique/new thinking is the essence of creativity. This statement is in line with Azzam's opinion (Brookhart, 2010) as he stated that creativity is a process of producing original and valuable ideas. Furthermore, Mednick (Treffinger et al., 2012) explains that creativity is the process of combining existing ideas with unusual and original new ideas. When viewed from a cognitive point of view, creativity is categorized into the highest cognitive level, namely the ability to create (Brookhart, 2010). Therefore, being creative (being able to produce original ideas) is not an easy matter. New and original ideas will be formed if someone really knows, understands, be able to apply, analyze, and evaluate each aspect that is relevant to the problem that is to be solved.

In the process of classroom learning, students are grouped heterogeneously to facilitate discussions and share information about issues of knowledge and understand the concepts. The steps of the COIM model were explained earlier namely: 1). problem orientation; 2). problem formulation; 3) writing hypotheses; 4) making observations and collecting data through chemo-entrepreneurship activities. The COIM learning model in chemistry learning process provide meaningful experiences for students in the form of knowledge or information presented in simple real events. Additionally, it provides positive benefits in strengthening students' understanding regarding natural phenomena that occur. Thus students are able to find out the concepts or information that exist and directly apply into the test that measures creative thinking skills (Kusuma, 2010). The COIM learning model aims to study the process of turning natural materials into products so that students more easily understand the concept being taught and grow entrepreneurship spirit in learning chemistry. In addition, students can practice making bar soap which makes it easier for them to understand and remember the material that had been taught.

Developing creative thinking ability for students requires an instructor who is also creative. The creative instructor is a person who is able to realize students' abilities and guide students in accordance with the expected purposes (Carter & McRae, 2014; Craft, Hall, & Costello, 2014; Sternberg & Williams, 1996). Creative instructors will seek for new strategies

to develop potentials of the students. The instructor should attempt to create a comfortable and pleasing learning environment for the students in a way that enable them to explore all the abilities they have. The creative thinking ability is one of the four skills needed in the 21st century. The 21st century individuals need to have competence in five main skills, namely: (1) being able to adapt (adaptability); (2) having complex communication skills (complex communication skills); (3) having problem-solving skills (problem-solving skills); (4) having self-management and self-development skills; and (5) a system of systems thinking (Kim, 2006). Supartono (2006) stated that chemo-entrepreneurship-based chemistry learning model provides opportunities for students to be creative and motivate students to solve problems by introducing chemistry materials as part of everyday life.

The results are supported by Listari (2018) who found the average value of the experimental class was 74% and the average result of the control class was 71, 35%. The application of Chemo-entrepreneurship oriented PBL to the concept of the colloidal system has a good influence on student learning outcomes. It was based on 2.593 t-tests> t-table 1, 669 with the average cognitive results of the experimental class being 76.95 and the control class being69.33. For classroom effectiveness the experiment group was 74.59 and control group was67.29. Based on the results of the study it can be concluded that there is an influence of chemo-entrepreneurship-oriented model on student chemistry learning outcomes. It is in line with the results found by Marwah, Dewi & Mashami(2018) as they found that the experimental class were 63%, 74% and the control class were 66%, 68%. The results of the study showed how chemo-entrepreneurship based TAI type cooperative learning model increased students' entrepreneurial motivation. So it can be concluded that there is a positive relationship between chemo-entrepreneurship-based TAI type cooperative learning model and entrepreneurial motivation. Andriani, Muhali & Dewi (2018) stated that the application of the Chemo-entrepreneurship oriented POE (Predict-Observe-Explain) learning model had significant effect on students' conceptual understanding. Nurwahidah, Suryati & Dewi (2017) who used chemo-entrepreneurship oriented PBL, found that the value of sig. (2-tailed) 0,000 <0,05 for creative thinking ability with an average value of experimental class post-test of 89% and control class of 74%. They concluded that teaching through chemo-entrepreneurship oriented PBL model has a positive effect on the students' creative thinking ability. Zubaidah, Fuad, Mahanal, & Suarsini (2017) showed that there was a difference in students creative thinking skills for different models where highest creative thinking skills were exhibited by the students who were taught using the Differentiated Science Inquiry integrated with mind Map model. Mirzaie, Hamidi, Anaraki (2009) stated that use of science activities and brainstorming teaching method, teachers can increase their children capacity with respect to the core dimensions of creativity; fluency, flexibility, originality and elaboration.

Finally, it can be concluded that the implementation of Chemo-entrepreneurship oriented inquiry module (COIM) can improve students' creative thinking ability in learning and teaching process. The percentage given at the pre-test and post-test recapitulation report is evident for this conclusion. Pre-test score was 42%for originality, 51% fluency, 46% for flexibility, and 60% for elaboration. Meanwhile, during post-test, the creative thinking ability increased for each indicator. Students' ability about originality increased to 60%, their fluency increased to 75%, their flexibility increased to 65% and their ability of elaboration increased to 77%. This research implies that implementation of Chemo-entrepreneurship oriented inquiry module (COIM) is one good option for improving students' creative thinking ability. This learning model should be implemented in various fields of education. Research with the same topic should be conducted in the future within different subject matters and in different contexts.

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