Improving creativity of prospective chemistry teacher through chemoentrepreneurship oriented inquiry module on colloid topics

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Abstract. This study investigates the effect of Chemoentrepreneurship Oriented Inquiry Module (COIM) a colloid topic to enhance students creativity in teaching chemistry subject. The work was quasi-experimental, including pretest-posttest control group design. The used instrument is in the form of a description test, specially designed to determine the creativity of students. The results showed the use of COIM was effective as proven by 1) increase in student creativity index from 60 to 79, and 2) N-Gain level of attainment was in the range of 0.5 with a medium category. Overall, concluded that the use of Chemoentrepreneurship Oriented Inquiry Module effectively can enhance.

1. Introduction
The colloid is one of the learning topics in basic chemistry courses that are very important to be taught to students because it is a highly contextual topic. Sub-chapters in the colloid topic include dispersion systems, types of colloids, colloid properties and the application of colloids in everyday life. As in the properties and application of colloids in various fields, it is needed to have teacher-centred learning [1]. Colloid concepts also include chemical characteristics that are summarized in three levels: macroscopic, microscopic and symbolic [2]. The macroscopic level is the easiest because it can be seen visually and more accessible, depending on the extent of sensory use. While the microscopic level requires analysis since everything that happens cannot be seen by the invisible or applied theory cannot be proven visually. Further symbolic is a description of a process [3]. To prepare the students in the 21st century must become the driving issues the improve of all pathways and levels of education [4]. A high demands to the qualified teacher an outcome of qualified education, so that students' thinking skills are provided by quality education. One of the skills students required this time is creativity thinking [5].

The main problem faced by Most lecturers in Departement of Chemistry Education of FPMIPA IKIP Mataramis difficulty in teaching basic chemistry, especially on the colloidal system. One of the difficulties is to relate the concept to a student's daily life. In addition, teaching materials used by lecturers often does not contain the application of the concepts studied. It is necessary to prepare the college graduates to be qualified and skilled so that they can fulfill the market demand. Chemistry is one of the science that the application is very much in everyday life and has the potential to be developed into an entrepreneur in the field of chemistry especially on the colloidal system. Some of the examples
are making shampoos from aloe vera, candy from seaweed, milk making from corn, from palm water and making jam from pineapple[6].

This study aims to improve the creativity of prospective chemistry teacher through Chemoentrepreneurship Oriented Inquiry Module (COIM) on colloid topic. Thus, in addition, students also have a chance to learn the process of processing a material into a useful product, economic value and foster entrepreneurship spirit.

2. Methods

2.1. General Background of Research

The pre-experimental design was used in this study. There were no control variables and the samples were not randomly selected. The form of pre-experimental design in this study was One Group Pretest-Posttest Design. The shape of the design is illustrated in table 1[7].

Table 1. Pre-experimental design

| Subject          | Pretest | Posttest |
|------------------|---------|----------|
| One Group        | O₁      | O₂       |

Information:
O₁ = Pretest value before learning using COIM.
O₂ = Posttest value after learning using COIM.

2.2. Sample of Research

The study was conducted at IKIP Mataram, Pemuda street No. 59A Mataram West Nusa Tenggara. The first semester students of Chemistry Education Study Program was being the subject of this study. The study instrument used was the creativity test using essay in the form of an essay with the aim to know the improving creativity of perspective chemistry teacher after learning using COIM on the colloid topics.

2.3. Instruments and Procedures

Instruments and Procedures Instruments used in this learning activity included the syllabus, lesson plans, Chemoentrepreneurship Oriented Inquiry Module, and test items. The instruments had been previously validated by two experts/science education experts and two education practitioners (chemistry education lecture). The validation was done by giving scores to each component on the validation sheet with the score range of 1–4. A score of 1 indicated "not valid," 2 indicated "less valid," 3 indicated "valid," and 4 indicated "very valid." The data analysis of the validation results was done by calculating the average scores from the experts and practitioners. The validation showed the following scores: 3.75 (valid) for the syllabus, 3.70 (valid) for the lesson plan, 3.80 (valid) for the Chemoentrepreneurship of Inquiry Module, and 3.89 (very valid) for the test items. The reliability test was also performed for the essay test instrument for creative thinking. The reliability test involved 70 students who were asked to finish 12 questions that had previously been validated. The score of the 96 students was then tested using Cronbach's alpha with SPSS statistics program 18.0 for Windows. The reliability test showed that the score was 0.84 (very high reliability, acceptable). The test instruments of creative thinking that were valid and reliable were used for collecting data on creative thinking. Data collection was done twice, pretest and posttest, on COIM (Chemoentrepreneurship Oriented Inquiry Module).

2.4. Data Analysis

The scores of creative thinking had converted into a range of 0–100. Then, normality and homogeneity tests were performed on the data. The study procedure was carried out, among others: a) The initial stage of the study, by conducting tests on creativity tests on students who have taken the course of Fundamental Chemistry. Furthermore, students are taught to using of chemoentrepreneurship Oriented Inquiry Module during the learning process takes place. After the learning activities are completed, posts
are conducted to measure students' creativity in the material being taught. b) The final stages of the study, by analyzing the data obtained and preparing the study report. This study used the N-Gain test with the aim to measure the increase of creativity of students before and after learning using Chemoentrepreneurship Oriented Inquiry Module on colloid topics.

3. Results

The learning model used is a Chemoentrepreneurship Oriented Inquiry consist of 4 stages of activity are problem orientation, formulating problems, submitting hypotheses, observing & collecting data through chemoentrepreneurship activities. These stages are presented in Chemoentrepreneurship Oriented Inquiry Module (COIM) presented in figure 1.

![Figure 1. Chemoentrepreneurship Oriented Inquiry Module](image)

Based on product effectiveness test that has been done so that the result of the final test of the students after the learning through the COIM. Implementation scenarios were pretest and final test (posttest). From this final test result (posttest) is used to know the improvement of student creativity on colloid topics as data that Chemoentrepreneurship Oriented Inquiry Module ineffective chemistry lesson or not. The data of the effectiveness of COIM can be seen in detail in table 2.

| No | Group | n | Ideal score | Value | Minimum value | Maximum value | Average |
|----|-------|---|-------------|-------|---------------|---------------|---------|
| 1. | Pretest | 25 | 100 | 58 | 62 | 60 |
| 2. | Posttest | 25 | 100 | 75 | 82 | 79 |
Based on the calculation analysis of student creativity, the average value of student creativity of the effectiveness of COIM can be seen in figure 2.

![Figure 2. Value of student creativity](image)

Figure 2 shows that the creativity of students after using Chemoentrepreneurship Oriented Inquiry Module is obtained an average value of 79 thus if the data range is above 75% then it can be categorized to be effective.

| No | Group      | N  | Ideal score | Minimum value | Maximum value | N-Gain |
|----|------------|----|-------------|---------------|---------------|--------|
| 1. | Pretest    | 25 | 100         | 58            | 62            | 0.5    |
| 2. | Posttest   | 25 | 100         | 75            | 82            |        |

To know the existence of student creativity improving before and after using Chemoentrepreneurship Oriented Inquiry Module the procedure of using N-Gain test was performed. It was found that the gain level of N-Gain is in the range of 0.5 with the medium category as shown in Table 3. The difference of students' average creativity on pretest and posttest is caused by using Chemoentrepreneurship Oriented Inquiry Module, where the learning steps used in Chemoentrepreneurship Oriented Inquiry learning are students doing observation to find the problem, students formulate the related problem with natural phenomena, students experiment and try to prove through hypotheses, observe and analyze and convey conclusions, in this learning also students are encouraged to be more active in learning, finding new ideas, always responding to opinions of friends and giving opinions in solving problems. So when working on the problem, students have enough information to do the test questions. This is in line with research conducted by Mursiti, et al. [8] shows that learning using CEP approach and use of simulation game as CET media is very effective to improve student creativity. Learning using constructive and inquiry-oriented collaboration CEP can improve student learning outcomes [9]. Research states that CEP learning tools developed are valid, effective and can enhance students creativity and science process skills [10]. The result of other research [11] stated that there is a significant between mastery of concept and creativity together with problem-solving ability.

4. Discussion

Based on this study it can be seen that learning by using Chemoentrepreneurship Oriented Inquiry Module can improve student creativity. In addition, Chemoentrepreneurship Oriented Inquiry Modules
are eligible to be used as a learning resource and students provide a positive view of COIM. Boden[12] states that creative thinking is the ability to produce brilliant new ideas and values. Creative thinking about new things, the ability to create something, to implement new forms, to produce a lot of imaginative skills or to make something that is already new to something new[13]. Furthermore, Abraham[14] stated that creative thinking is a form of self-expression in a unique way. Students' creative thinking skills which are different from one another require a learning condition involving a learning experience so that the potential of creative thinking can develop [15]. Creative thinking can be incorporated into learning by the teacher, so the teacher must be able to carry out the development mandate the same skill to students. This is reinforced by the opinions of Wheeler et al[16], stated that the teacher's task is to provide the best teaching to get relevant thinking skills. Creative thinking skills are very important to be considered [17]. Seyihoglu&Kartal[18] stated that to the challenges of a dynamic and uncertain modern life, it is necessary to develop the ability to think creatively. In fact, this ability to creative thinking is the foundation of science [19].

Various indicators of creative thinking have been expressed by several experts. According to Vlassi&Karaliot[20] there are five indicators of creative thinking, namely, (1) fluency, the ability to produce ideas, ways, suggestions, questions, and alternative answers smoothly within a certain time; (2) flexibility, the ability to produce ideas, answers, or questions, where ideas or answers are obtained from different points of view by changing the way of thinking and approach used; (3) authenticity, the ability to produce phrases, ways, or ideas to solve problems or create unusual and unique parts or elements that are not thought of by others; (4) elaboration, the ability to enrich, develop, improve, describe or specify the details of objects, ideas, products, or situations to make it more attractive; and (5) metaphorical thinking, the ability to use comparisons or analogies to make new connections.

The existence of modules made as interesting as possible to make students the spirit of reading colloids concepts let alone chemoentrepreneurship (CEP) oriented learning makes students more enthusiastic learning [21]. This is in line with Agustini's findings that chemistry learning model with chemoentrepreneurship (CEP) approach can improve learning motivation, entrepreneur interest, and student learning outcomes [22]. Meanwhile, Prayitno et al[23] indicated that the CEP-oriented SETS-oriented learning chemistry module is feasible to be used in chemistry learning with scores on the 95.00 aspects of graphics, presentation aspect 95.33, language aspect 95.00. And the results of module testing at MA Mu'allimin Mu'allimat showed 20% motivation improvement, 25% entrepreneur interest, and 79% student learning result. Module trials in MAN Rembang improved students' learning motivation, entrepreneur interest, and students' experimental class learning outcomes by 27%, 17% and 66%, respectively, while control classes improved by 0.4%, 11%, and 24%, respectively.

The study that has been done by Rusilowati[24] showed that students' creativity can be grown by making IPA props interesting and liked by the students. Guided inquiry method can improve students' creativity [25-26]. In addition, students' creativity increases through project-based learning [27]. According to Vincentrisia[28] that student creativity can be improved through the LC 5E learning model. Guided inquiry methods have a significant effect on improving student achievement and participation in social learning better than conventional learning methods [29-31]. In addition, Özdemir&Işık[32] says that the use of inquiry strategies and science process skills has an effect on inquiry-based science activities in elementary school teachers. Meanwhile, Aktamis[33] argued that inquiry-based learning had a significant effect on learning outcomes, science process skills and student attitudes compared with traditional learning methods. Tthere are differences in students' creative thinking skills for different models [34]. The highest creative thinking skills of the students are taught using a distinguished science investigation integrated with mind map model.

5. Conclusion

The effectiveness of using Chemoentrepreneurship Oriented Inquiry Module can be improving prospective chemistry teacher's creativity. This can be proven through the result of the statistical test of N-Gain that is obtained by a mean value equal to 0.5. Thus the Chemoentrepreneurship Oriented Inquiry Module was effectively categorized used in the learning process. The difference of students' average creativity on pretest and posttest is caused by using Chemoentrepreneurship Oriented Inquiry Module,
where the learning steps used in Chemoentrepreneurship Oriented Inquiry learning are students doing observation to find the problem, students formulate the related problem with natural phenomena, students experiment and try to prove through hypotheses, observe and analyze and convey conclusions, in this learning also students are encouraged to be more active in learning, finding new ideas, always responding to opinions of friends and giving opinions in solving problems. So when working on the problem, students have enough information to do the test questions.

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