



ISSN 0852-601X  
e-ISSN 2549-838X

Available online at  
<http://www.pancaranpendidikan.or.id>

*Pancaran Pendidikan FKIP  
Universitas Jember  
Vol. 9, No. 1, Page 73-80, February, 2020*

**Pancaran Pendidikan**

DOI:  
[10.25037/pancaran.v9i1.274](https://doi.org/10.25037/pancaran.v9i1.274)

## **STEM-CP (Science, Technology, Engineering, Mathematics, and Contextual Problem) Based Colloid Textbook to Increase Creative Thinking Skill for Chemistry Learning in Senior High School**

**N Hasanah\*<sup>1</sup>, Sutarto<sup>1</sup>, Nuriman<sup>1</sup>, A S Budiarmo<sup>1</sup>**  
**<sup>1</sup>University of Jember, Jember, Indonesia**  
Email: [nikmatilhasanah2019@gmail.com](mailto:nikmatilhasanah2019@gmail.com)\*

### **ARTICLE INFO**

#### **Article History:**

*Received Date: 1<sup>st</sup> January 2020*

*Received in Revised Form Date:  
10<sup>th</sup> January 2020*

*Accepted Date: 15<sup>th</sup> January 2020*

*Published online Date 01<sup>st</sup>  
February 2020*

#### **Key Words:**

**STEM-CP, Colloid Textbook,  
Creative Thinking Skill.**

### **ABSTRACT**

Colloid is a chemistry subject matter which is closely related to our daily life. Most of the teachers apply colloidal learning in their classroom only by requiring the students to read and memorize. It gives less opportunities for the students to think creatively and they also lack understanding the benefits of learning colloidal subjects. This study aimed to apply Colloid textbooks based on STEM-Cp (Science, Technology, Engineering, Mathematics and Contextual problems) to train creative thinking skills for chemistry learning in senior high school. This research used the Quasi Pretest-Posttest experiment without the control class. The research instrument used was a test of creative thinking skills. The effectiveness of textbook shown that each component of creative thinking, such as fluency, flexibility, elaboration and originality thinking gets percentage of 89.20%, 86.31%, 80, 98%, 80.09% and N-gain score of students get value  $\geq 0.7$  which is 72.22% of students in the high category and 27.78% of students in the medium category.

**Copyright © Hasanah et al, 2020**, this is an open access article distributed under the terms of the Pancaran Pendidikan Journal license, which permits unrestricted use, distribution and reproduction in any medium, provided the original work is properly cited

### **INTRODUCTION**

The complexity of life and competition in the 21<sup>st</sup> century creates challenges for education. The education world responds by making 21<sup>st</sup>-century skills a global goal of education. 21<sup>st</sup> Century skills consist of three major components, namely Thinking, Acting, and Living in the World [1]. Various reforms and innovations are carried out to realize skills-oriented education in the 21<sup>st</sup> century, including STEM education which

provides opportunities for teachers to demonstrate concepts, principles, and techniques from science, technology, engineering, and mathematics in an integrated way in the development of products, processes, and systems [2]. In STEM learning, students at secondary education are challenged to perform authentic engineering tasks, as a complement to science learning through projects that integrate science (including chemistry), engineering, technology, and mathematics [3].

One of the four 21st century skills, creative thinking becomes a strength and an attraction [4]. Creative thinking belongs to one type of higher level thinking skills. Creative thinking is a mental process that leads to new knowledge, new approaches, new perspectives, or new ways of understanding things [5]. Creative thinking was defined as the process of obtaining ideas that emphasize aspects of fluency, flexibility, originality, and elaboration in thinking [6].

Chemistry is one of the pillars of science, technology, and industry [7]. Colloid is a part of the chemistry subject matter that closely related to creative thinking skills [8]. The syllabus of grade XI in Basic Competency (KD) number 3.15 states that there are three sub-competencies. First, students should be grouping various types of colloidal systems; students should be able to explain colloidal properties and their application in daily life. In the following KD, KD number 4.15, it states that the students should be able to make food or other products in the form of colloids or involving colloidal principles [9].

Colloids are closely related to daily life, a lot of materials represent a good example of colloids such as ink, paint, soap, jelly, etc., so it is quite easy to provide learning following the expected basic competencies. After exploring the concept of colloid, students should be able to apply it to solve contextual problems [10]. Based on the results of the study, 75% of students could not solve contextual problems with a maximum [11]. They stop doing the tests and felt they had solved the problem, when they can solve the problem mathematically, even though the mathematical solution has not answered the situation of the requested context problem. It shows that some students have not been able to comprehend the benefits of learning chemistry.

Based on the description above, a new approach is needed, namely STEM-Cp (Science, Technology, Engineering, Mathematics, and Contextual Problem), in guiding students who are trained using their chemical knowledge to create innovative products that are capable of solving problems in the community. Observation results at school showed that in learning the concept of colloid, a textbook used only contains a summary of the material, a collection of formulas, examples, and exercises. The textbook has not demonstrated the usefulness of colloid learning in students' real lives. It is starting from the facts above, that an STEM-Cp based colloid textbook is needed.

## **METHODOLOGY**

This research is a one-group experiment, which is the one-group pretest and posttest design. The sample of this study was 36 science students of XI grade. All students were given a pretest about colloid to measure the level of student's early understanding. After that, students are guided by the teacher studying colloid matter from STEM-Cp based colloid textbook. Finally, students are given a posttest to measure their creative thinking skills after studying by STEM-Cp based colloid textbook. Data collecting techniques in this study used the test method. The test consists of eight essay

questions covering the four indicators of creative thinking skills namely fluency, flexible thinking, elaboration and original thinking [12].

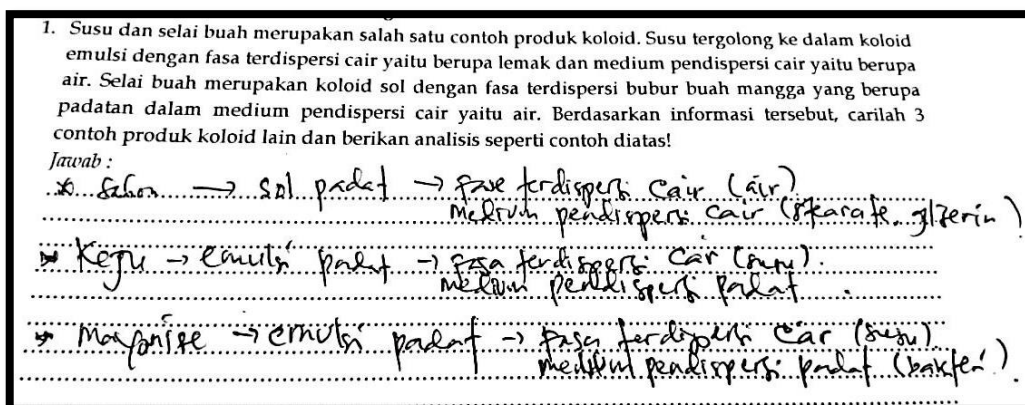
**RESULT AND DISCUSSION**

The percentage of pretest and posttest results for each indicator of creative thinking skills is presented in the following table.

Table 1. The Result of Students' Creative thinking skills of pretest and posttest

Creative thinking skills criteria	Percentage of pretest	Percentage of posttest
Fluency	20,17%	89,20%
Flexibility	29,62%	86,31%
Elaboration	10,72%	80,98%
Originality	29,44%	80,09%

Fluency is a student's ability to find many ideas related to the problems or given phenomena and also the ability to express or analyzing every idea they have [13]. Table 1 shows that STEM-Cp based colloid textbooks train fluency components for students. An example of students' posttest answers related to the fluency component is posted below:



Translation:  
 Milk and fruit jam is one example of colloidal products. Milk is an emulsion with fat as liquid dispersed phase and water as liquid dispersing medium. Fruit jam is a sol with mango pulp a solid dispersed phase and water as a liquid dispersing medium. Based on the information, look for 3 examples of other colloidal products and provide an analysis like the example above!  
 The students must provide three examples of colloidal products that existed in daily life then mention the type of colloid in each sample and provide an appropriate analysis related to the dispersed phase and the dispersing medium in each of the examples given.

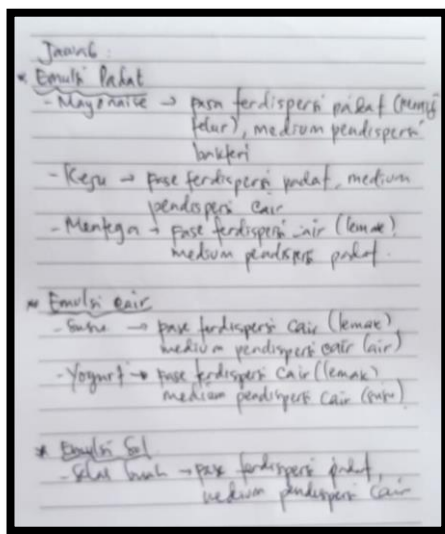
**Figure 1.** Students' posttest answers related to the fluency component

Figure 1 is an example of the answers that got the maximum score because the students had been able to provide three examples of colloidal products that existed in daily life then mention the type of colloid in each sample and provide an appropriate analysis related to the dispersed phase and the dispersing medium in each of the examples given.

Flexible thinking skills is a student ability to solve a problem given to the phenomenon from various points of view and flexibility in determining the most dominant ideas to be applied as a solution to the problem of existing phenomena [14]. Flexible thinking skills (flexibility) are the ability of students to classify things that are different and produce answers and interpretations that vary with a phenomenon. Based on Table 1, STEM-Cp based colloid textbooks prove to train students' ability to think flexibly (flexibility). An example of students' posttest answers related to the flexibility component is posted below:

2. Ani mengidentifikasi produk-produk koloid yang terdapat dalam kehidupan sehari-hari. Dia ingin mengelompokkan koloid-koloid tersebut dengan pengelompokan yang sesuai. Ani mengetahui bahwa koloid digolongkan berdasarkan fasa terdispersi dan medium pendispersinya. Dengan memanfaatkan pengetahuan yang Anda miliki, Bantulah Ani untuk menggolongkan produk-produk koloid yang ditemui dalam kehidupan sehari-hari! Berikan minimal 3 penggolongan produk-produk koloid disertai alasannya! *Jawab :*

Translation: Ani identified colloidal products found in her daily life. He wanted to classify the product according to colloidal type. That colloids were classified based on the dispersed phase and the dispersing medium. Using your knowledge, help Ani to classify colloidal products! Give a minimum of 3 classifications of colloidal products and explain your answer!



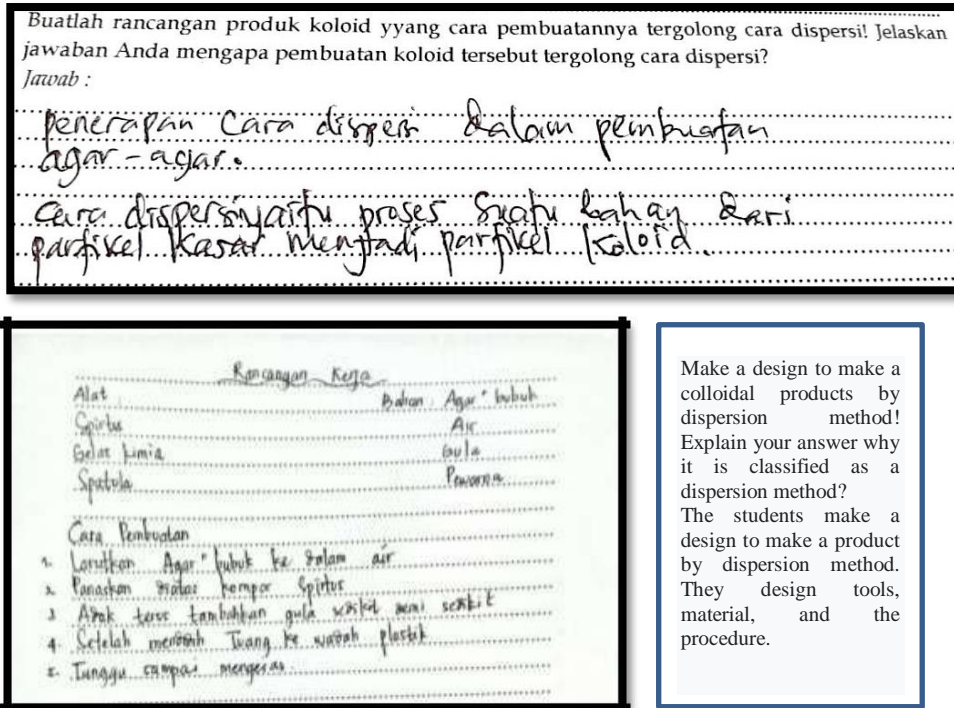
Translation:  
 Answer:  
 • Solid emulsion  
 -mayonaisse : The dispersion phase is solid, the dispersion medium is bacteria  
 -cheese : The dispersion phase is solid, the dispersion medium is liquid  
 -butter: The dispersion phase is liquid (fat), the dispersion medium is solid  
 • Liquid emulsion  
 -milk : The dispersion phase is liquid (fat), the dispersion medium is liquid (water)  
 -Yogurt : The dispersion phase is liquid (fat), the dispersion medium is liquid (milk)

**Figure 2.** Students' posttest answers related to the flexibility component

Based on Figure 2, students had been able to classify colloidal products in daily life according to the appropriate category. The student provided reasoning along with the answer for the classification of colloidal products by mentioning the dispersed phase and the dispersing medium of each given colloidal sample. It is because in STEM-Cp based colloidal textbooks have been trained to students related to the classification of colloidal systems based on the dispersed phase and the dispersing medium accompanied by examples of colloidal products, so students have no difficulty in answering the question. Repeated information made students easy to remember. Knowledge is stored and recalled whenever it is needed. According to the theory of information processing, information is transferred to short-term or long-term memory.

Short-term memory duration is very limited, and it requires repetition so that the information received can last a long time [15].

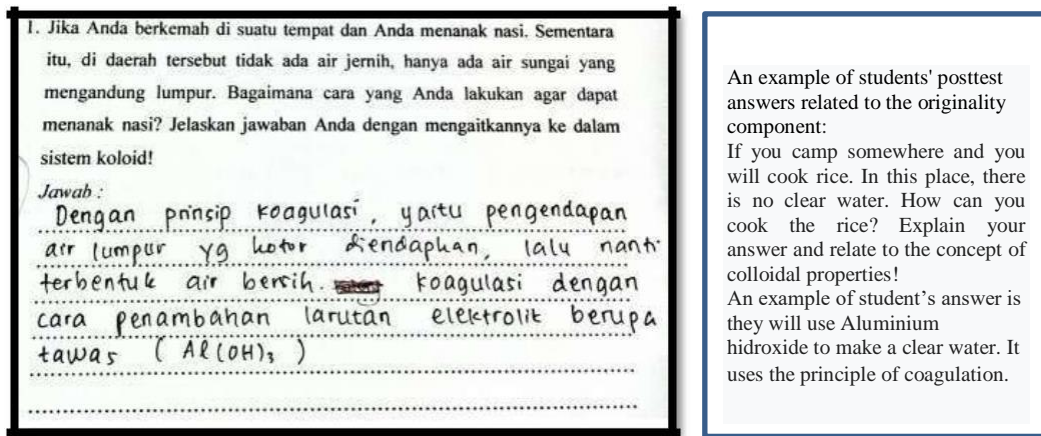
Elaboration thinking skills are a student's ability to develop ideas by providing detailed steps and developing, adding, enriching an idea to produce a final product [16]. Based on Table 1, elaboration thinking skills can be trained by using STEM-Cp based colloidal textbooks to practice creative thinking skills during the trial process. The following is one of the students' posttest answers related to the elaboration thinking component in Figure 4.44 below. It is an example of students' posttest answers related to the flexibility component.



**Figure 3.** Students' posttest answers related to the elaboration component

The students could answer these questions easily because they had been trained to develop ideas. These ideas have been selected by preparing an experimental design including tools and materials, and the procedures. It relates to training creative thinking skills, students are given the freedom to develop, enrich the ideas chosen by arranging experimental designs related to the proposed colloidal product. Following inquiries and instructions in STEM-Cp based colloid textbooks, students compiled a colloidal yogurt-making experiment through information search on the internet. It refers to the activities of training elaboration thinking skills. Therefore, to measure elaboration skills, students were proposing ideas of colloidal products then composing an appropriate experimental design. Based on Jean Piaget's theory of cognitive development, the students in high school are at the stage of formal operations where they are no longer depend on things that are direct and real, also able to think abstractly and perform logical thinking [17].

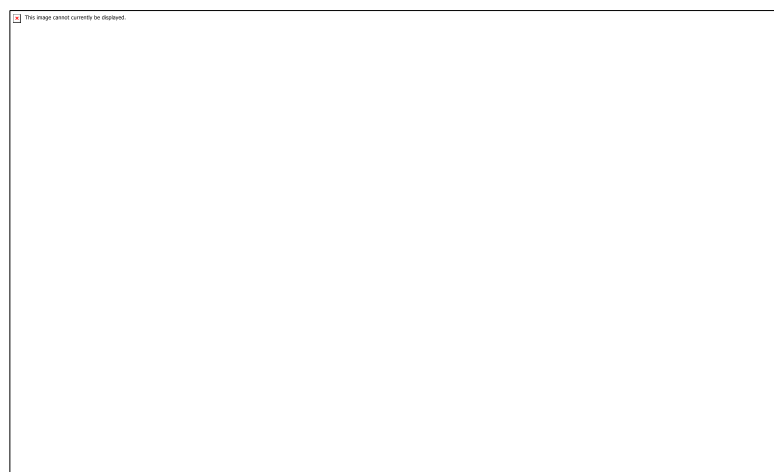
Original thinking skills are students' ability to give innovative ideas related to a given phenomenon, also think of unusual ways, and make unusual combinations [18]. An example of students' posttest answers related to the originality component is posted below:



**Figure 4.** Students' posttest answers related to the originality component

Based on Figure 4, it showed students could answer these questions easily because they had previously been trained through STEM-Cp based colloid textbooks. They discussed the stability of colloids in the emulsion system which is often termed emulsifier properties. Soap is one example of colloidal emulsifiers. Based on this analysis, students could analyze examples of other emulsifier substances in the colloidal system, so that these questions could be answered easily. It is related to the process of assimilation and accommodation that happened to students. A knowledge that has been previously known to be assimilated to then-new knowledge received is accommodated, which causes modifications in the cognitive structure of students and results in intellectual growth. In addition to these aspects, the ability to think originality can be seen from unique ideas to solve the problem [19].

STEM-Cp based colloid textbooks can train all components of creative thinking because there is a significant increase in the results of the pretest and posttest in each component of creative thinking. The graph below gives a comparison of the pretest-posttest result.



**Figure 5.** Creative thinking skills of pretest and posttest answer students

Based on data, the N-gain score of students gets the value  $\geq 0.7$ , which is 72.22% of students in the high category and 27.78% of students in the medium category. This data shows that the pretest value of creative thinking skills indicators of some students is in the very low category. This indicates that the creative thinking skills of students prior to the application of colloid teaching materials based on STEM-Cp are relatively low. However, after the application of colloid textbook based on STEM-Cp, the creative thinking skills of student is increase. This can be detected from the posttest score that given after treatment.

Based on these data, it showed that student's creative thinking skills were relatively low before learning using colloid teaching materials based on STEM-Cp, and increased after that. It proves that student's cretive thinking skills can improve if they use STEM-Cp based optical teaching materials. Because of the student's creative thinking skills increase, students can apply optical concepts to solve contextual problems in their daily life.

## CONCLUSION

The STMCpE-based colloid textbook was declared to be effective in training creative thinking skills. Each component of creative thinking included fluency, flexibility, elaboration, and originality get a percentage of  $\geq 75\%$  in the high or very high category. Limitations of this study are using a questionnaire to investigate creative thinking skills for efficiency the time. However, it is not an effective method to gain accurate data, so an authentic assessment is needed to assess students' skills

## REFERENCES

- [1] Greenstein 2012 *Assessing 21st Century skills: A guide to evaluating mastery and authentic learning* (Thousand Oaks CA: Corwin)
- [2] Chesky N Z and Wolfmeyer M R *Philosophy of STEM Education: A Critical Investigation* (New York: St. Martin Press )
- [3] Bybee R 2013 *The case for STEM education: Challenges and opportunity* (Arlington VI: National Science Teachers Association (NSTA) Press )
- [4] Sudarma M 2013 *Mengembangkan Keterampilan Berpikir Kreaif Mengembangkan Keterampilan Berpikir Kreatif* (Jakarta: PT Raja Grafindo Persada )
- [5] Eragamreddy N 2013 Teaching Creative Thinking Skills *International Journal of English Language & Translation Studies* 1(2) 124–145
- [6] Ananda P M & Azizah U 2016 Development Student Worksheet Oriented Problem Based Learning to Train Creative Thinking Skills in Chemical Equilibrium Matter *UNESA Journal of Chemical Education* 5(2) 392– 400
- [7] Cetingul I and Geban O 2011 Using Conceptual Change Texts with Analogies for Misconceptions in Acid and Bases *H U Journal of Education* 41: 112-123

- [8] Cardellini L 2012 Chemistry: Why the subject is difficult? *Areas Emergentes De La Educacion Quimica* **241**: 1-6
- [9] Kemendikbud 2016c *Permendikbud No.24 Tentang Kompetensi Inti dan Kompetensi Dasar* Jakarta: Kementerian Pendidikan dan Kebudayaan
- [10] Sumarti S S Supartono & Dini H H 2014 Material Module Development of Colloid Orienting on Local Advantage-Based Chemo-Entrepreneurship to Improve Students' Soft Skill *International Journal of Humanities and Management Sciences (IJHMS)* **2**(1)
- [11] Zulkardi M L and Hartono Y 2013 Unfinished Student Answer in PISA Mathematics Contextual Problem. *IndoMSJME* **4**(2): 188-193
- [12] Munandar S 2012 *Pengembangan Kreativitas Anak Berbakat* Jakarta: Rieneke Cipta
- [13] Prasad S & Rao D 2009 *Creative Thinkin of School Student* New Delhi: Discovery Publishing House
- [14] Filsaime D K 2008 *Mengungkap Rahasia Berpikir Kritis dan Kreatif* Jakarta: PT. Prestasi Pustaka Karya
- [15] Slavin R E 2000 *Cooperative Learning Theory Research and Practice* Boston: Allyn and Bacon
- [16] Zubaidah S 2016 Keterampilan Abad ke-21: Keterampilan yang Diajarkan Melalui Pembelajaran *Isu-Isu Strategis Pembelajaran MIPA Abad 21* Dipresentasikan pada Seminar Nasional Pendidikan Kalimantan Barat
- [17] Schunk D 2012 *Teori-Teori Pembelajaran: Perspektif Pendidikan* Yogyakarta: Pustaka Belajar
- [18] Ardeniyansah and Rosnawati R 2018 Implementation of Problem Based Learning in terms of Student Mathematical Creative Thinking *Journal of Physics Conf. Series* 1097
- [19] Rostiawati T 2014 Konsep Pendidikan John Dewey *Jurnal Manajemen Pendidikan* **2**(2) 18-21