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Profile of Students' Creative Thinking Skill on Colloid Materials Through Chemistry Flipbooks

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Abstract: This research aims to describe creative thinking skills of 19 XI grade students of Darul Quran Mojokerto Senior High School. This study used explanatory sequential mix methods quantitative and qualitative to provide of students' abilities. Analysis of creative thinking skills is carried out through the results of creative thinking tests before and after using chemistry flipbooks and analysis of the results of making colloidal products. The instruments used was creative thinking pretest-posttest question sheet and colloid product assessment sheet accompanied by a scoring rubric that has been validated and declared valid for being used as a test to measure creative thinking skills. The average percentage results for each indicator are 95.62% for fluency, 77.20% for flexibility, 73.25% for originality and 87.71% for elaboration. The percentage for creative thinking level is 79% for very creative and 21% for creative. The results of this study are expected to be used as a basis for designing learning that can train creative thinking in other subjects.

Keywords: Colloid; Creative thinking; Flipbook

Introduction

Technological advances have an impact on all aspects of life, one of them is education. These developments resulted in the effort needed by humans to meet their needs also increased (Dewanto et al., 2018; Redhana, 2019). Likewise in the field of education, the development of thinking is needed in order to produce better quality human resources to balance the capabilities possessed with the challenges of life that will be faced. Efforts to balance students' abilities are by formulating 4C skills (critical thinking, creativity, collaboration and communication) or commonly known as 21st century skills. These four skills are very important, but the research focus is on students' creative thinking skills.

Creative thinking is an important part of high order thinking skills (HOTS) in science learning (Kutlu & Gökdere, 2015; Stephenson & Sadler-Mcknight, 2016; Zhou et al., 2012). Creative thinking is a thinking skill in the form of developing ideas to produce a new thought (Rusmini et al., 2023). Creative thinking can produce innovative students who can provide alternative solutions to complex problems (Gilakjani & Ahmadi, 2011). Creative thinking skills are synonymous with students' ability to master fluency, flexibility, originality and elaboration (Dewi & Mashami, 2019; Zubaidah et al., 2017). Based on pre-research conducted in class XI SMA Darul Quran, 65% of the students fall into the less creative category, with 25% of the other students even falling into the uncreative category. These results indicate the low creative thinking skills of students.

Creative thinking ability can occur as a result of individual interactions with the environment. A person can influence and even be influenced by the environment in which he is. In this case the environment can be a supporting or inhibiting factor for individuals in creative thinking (Tayuda & Siswanto, 2020). The conclusion is that creative thinking can be trained through learning at school. One of them is in chemistry subject. Chemistry is a branch of natural science that discusses what, how and why natural phenomena can occur in relation to the properties of substances, the structure of substances, changes in substances, energy in a substance and related theories and laws (Chang & Overby, 2011; Effendy, 2016; Huddle & Pillay, 1996).

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Chemistry is often considered a difficult subject. This is because chemistry has many abstract and complex concepts. Many students still have limited abstract thinking abilities that require more effort to understand chemistry.

In chemistry subjects, teachers can design learning as well as to train students' creative thinking skills, for example in colloid material. Colloid material is composed of concepts and practical activities. Teachers can guide students to determine creative ideas in applying the properties of colloids so that they are able to produce colloid products learning process is learning media. The learning media used to train creative thinking skills is chemistry flipbooks on colloid material.

Chemistry flipbook is a digital media that has characteristics such as opening a physical book with pictures, animations and videos so that it can attract students' attention (Setiawan et al., 2020; Sriwahyuni et al., 2019). E-module chemistry based on creative thinking skills using Kvisoft Flipbook Maker is effective for use in making students have high-level thinking skills in the form of creative thinking skills (Romayanti et al., 2020). Based on these results, it is important to conduct research that aims to determine the profile of students' creative thinking skills through the use of chemistry flipbooks on colloid material.

Method

This research uses mixed method which combines quantitative and qualitative research methods. The design mix method used is explanatory sequential mix methods. The explanatory sequential mix method is collecting data quantitatively and then ending with qualitative data collection to assist in analyzing the data (Creswell & Creswell, 2018).

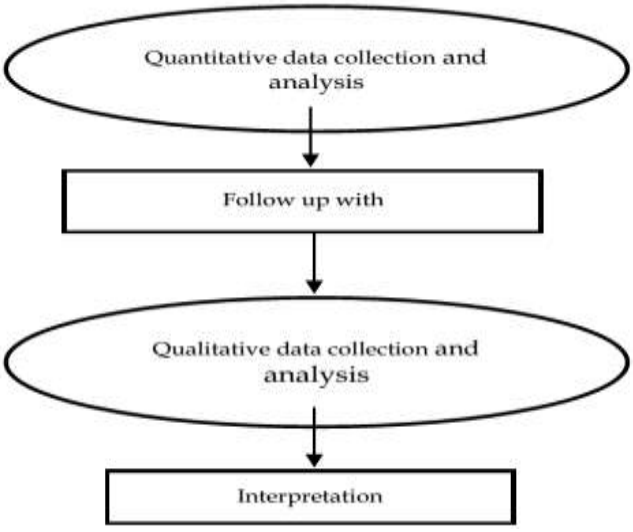

Figure 1. Explanatory sequential design

Quantitative research was conducted to process creative thinking pretest-posttest data and colloid product evaluation results, while qualitative research was conducted to describe data from creative thinking pretest-posttest results and colloid product evaluation. Analysis of creative thinking skills is carried out through the results of creative thinking tests before and after using flipbook chemistry and analysis of the results of making colloidal products. The subjects of this study were 19 students from grade 11 who had not received colloid material. Research design and method should be clearly defined**.**

The research instruments used were creative thinking pretest-posttest questions and worksheets for making colloidal products that had been validated by experts. According to Munandar (2014), these instruments are adapted to creative thinking indicators including fluency, flexibility, originality and elaboration. Creative thinking assessment is calculated using a scale of 0-3 according to the assessment rubric that has been made and has been validated by experts. The results of the value of creative thinking are then interpreted into categories of creative thinking skill levels according to table 1.

Table 1. Creative Thinking Level Criteria (Riduwan, 2015)

Percentage (%)	Criteria
81-100	Very creative
61-80	creative
41-60	Creative enough
21-40	Not creative
0-20	Very not creative

Result and Discussion

Chemistry flipbook is a learning media which has physical form like a book that can be flipped through. Chemistry flipbook is equipped with pictures, video, audio and animation and is interactive. Chemistry flipbook on colloid material can be used to train creative thinking. Chemistry flipbook is equipped with an info soft skills feature which contains directions related to indicators of creative thinking. Then equipped with exercises that include indicators of creative thinking to train creative thinking. The chemistry flipbook is also equipped with worksheets for making colloid products which are arranged according to indicators of creative thinking.

Fluency which means students can mention various ideas (more than 1); flexibility means that students can provide many choices of solutions with various points of view; originality means that students can provide answers with their own uniqueness or modifications of other answers; elaboration means that students can

describe ideas mentioned such as detailed explanations or steps (Darwanto, 2019).

Pretest-Posttest Creative Thinking

Analysis of students' answers on each indicator is explained as follows.

Fluency

On fluency indicator, students are asked to name the components of the salad which include colloids along with an explanation of the dispersed phase and the dispersion medium.

Student's Answer:
Cheese : dispersed phase → liquid;
dispersing medium → solid.
Milk : dispersed phase → liquid;
dispersing medium → liquid.
Mayonaise : dispersed phase → liquid;
dispersing medium → liquid.

Figure 2. Fluency score 3

Based on the students' answers in Figure 2 stated that students can name >2 components of the salad with the dispersed phase and the dispersing medium correctly. Based on the assessment rubric described in the attachment to the student's answers above, a score of 3 is obtained.

Student's Answer:
Mayonaise : dispersed phase → liquid;
dispersing medium → liquid.
Cheese : dispersed phase → liquid;
dispersing medium → liquid.

Figure 3. Fluency score 2

Based on students' answers in Figure 3 stated that students were able to name ≤2 components of the salad together with the dispersed phase and the dispersing medium correctly. Based on the assessment rubric described in the attachment to the student's answers above, a score of 2 is obtained.

Student's Answer:
Mayonaise and cheese

Figure 4. Fluency score 1

Based on students' answers in Figure 4 stated that students can name the components of the salad without being accompanied by the dispersed phase and the dispersing medium correctly. Based on the assessment rubric described in the attachment to the student's answers above, a score of 1 is obtained.

Student's Answer:
there are many components such as fruits

Figure 5. Fluency score 0

Based on students' answers in Figure 5 stated that students could not name the components of the salad correctly. Based on the assessment rubric described in the attachment to the student's answers above, a score of 0 is obtained.

Flexibility

On flexibility indicator, students are asked to explain solutions that can be used to purify water more than 1.

Student's Answer:
1). River water is put into the container and then added with alum. then let the water run until clean. In this process, the coagulation process occurs, namely the deposition of dirt by alum. dirt is precipitated so that the water becomes clean.
2). At first the river water is filtered to separate it from the large impurities. then the filter results are distilled by boiling and then the steam produced is condensed.

Figure 6. Flexibility score 3

Based on students' answers in Figure 6 stated that students can mention more than 1 way to purify water and connect one of the ways with the colloid concept. Based on the assessment rubric described in the attachment to the student's answers above, a score of 3 is obtained.

Student's Answer:
River water can be purified by filtration and can be boiled to remove dirt particles

Figure 7. Flexibility score 2

Based on students' answers in Figure 7 stated that students can mention more than 1 way to purify water, but the relationship with the colloid concept is not explained. Based on the assessment rubric described in the attachment to the student's answers above, a score of 2 is obtained.

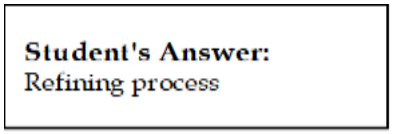
Student's Answer:
Refining process

Figure 8. Flexibility score 1

Based on students' answers in Figure 8 stated that students can mention only 1 method of purifying water and the relationship with the colloid concept is not explained. Based on the assessment rubric described in the attachment to the student's answers above, a score of 1 is obtained.

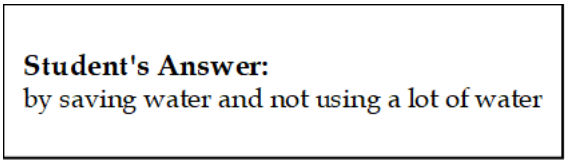
Student's Answer:
by saving water and not using a lot of water

Figure 9. Flexibility score 0

Based on students' answers in Figure 9 stated that the students did not mention the water purification solution but mentioned efforts to prevent water shortages so that the answers mentioned were wrong. Based on the assessment rubric described in the attachment to the student's answers above, a score of 0 is obtained.

Originality

On the originality indicator, students are asked to formulate an original way of purifying water by modifying or combining the methods that have been taught.

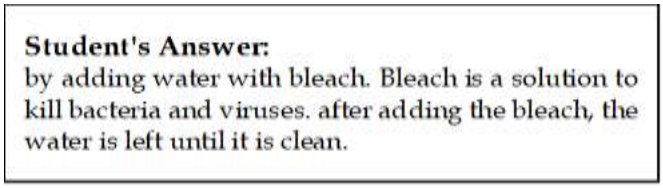
Student's Answer:
by adding water with bleach. Bleach is a solution to kill bacteria and viruses. after adding the bleach, the water is left until it is clean.

Figure 10. Originality score 3

Based on students' answers in Figure 10 stated that students can mention how to purify water which has not been taught during the lesson, namely through the bleach method. Based on the assessment rubric described in the attachment to the student's answers above, a score of 3 is obtained.

Based on students' answers in Figure 11 stated that students can mention how to purify water by modifying the method that has been taught, namely in the form of combining two methods including filtering and distillation. Based on the assessment rubric described in the attachment to the student's answers above, a score of 2 is obtained.

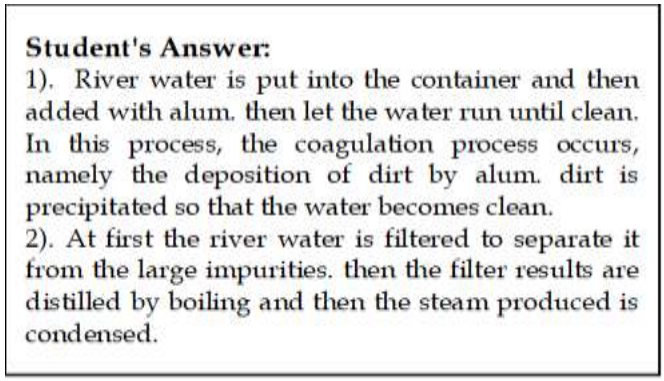
Student's Answer:
1). River water is put into the container and then added with alum. then let the water run until clean. In this process, the coagulation process occurs, namely the deposition of dirt by alum. dirt is precipitated so that the water becomes clean.
2). At first the river water is filtered to separate it from the large impurities. then the filter results are distilled by boiling and then the steam produced is condensed.

Figure 11. Originality score 2

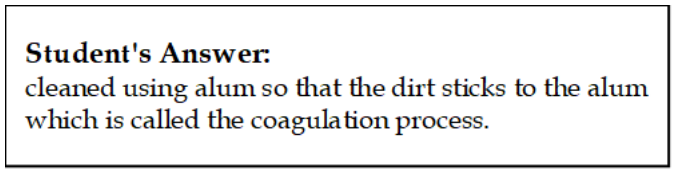
Student's Answer:
cleaned using alum so that the dirt sticks to the alum which is called the coagulation process.

Figure 12. Originality score 1

Based on students' answers in Figure 12 stated that students can mention how to purify water that is not modified and has been taught during the lesson, namely using alum. Based on the assessment rubric described in the attachment to the student's answers above, a score of 1 is obtained.

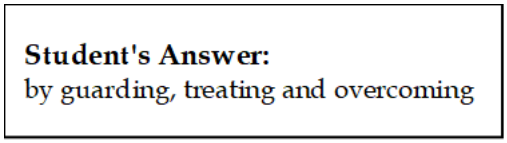
Student's Answer:
by guarding, treating and overcoming

Figure 13. Originality score 0

Based on students' answers in Figure 13 stated that the students mentioned how to prevent a water crisis and did not explain how to purify water so that the answers they wrote were wrong. Based on the assessment rubric described in the attachment to the student's answers above, a score of 0 is obtained.

Elaboration

On elaboration indicator, students are asked to be able to explain the water purification process completely and detail.

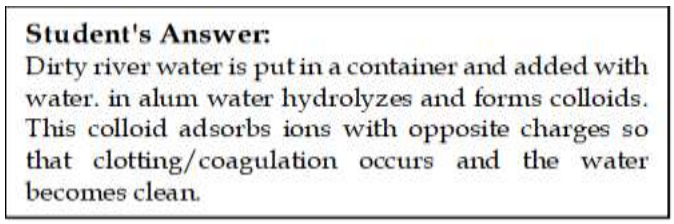
Student's Answer:
Dirty river water is put in a container and added with water. in alum water hydrolyzes and forms colloids. This colloid adsorbs ions with opposite charges so that clotting/coagulation occurs and the water becomes clean.

Figure 14. Elaboration score 3

Based on students' answers in Figure 14 stated that students can mention how to purify water in detail and

completely. Based on the assessment rubric described in the attachment to the student's answers above, a score of 3 is obtained.

Student's Answer:
1). River water is put into the container and then added with alum. then let the water run until clean. In this process, the coagulation process occurs, namely the deposition of dirt by alum. dirt is precipitated so that the water becomes clean.
2). At first the river water is filtered to separate it from the large impurities. then the filter results are distilled by boiling and then the steam produced is condensed.

Figure 15. Elaboration score 2

Based on students' answer in Figure 15 states that students can mention how to purify water in full but not in detail. Based on the assessment rubric described in the attachment to the student's answers above, a score of 2 is obtained.

Student's Answer:
clean water using alum. alum is as removing dirt called the coagulation process

Figure 16. Elaboration score 1

Based on students' answer in Figure 16 stated that students can mention how to purify water, but it is not detailed and incomplete. Based on the assessment rubric described in the attachment to the student's answers above, a score of 1 is obtained.

Student's Answer:
save water by using water only for essential things

Figure 17. Elaboration score 0

Based on students' answers in Figure 17 stated that students can mention how to purify water, but it is not detailed and incomplete. Based on the assessment rubric described in the attachment to the student's answers above, a score of 0 is obtained.

Table 2. Result of Pretest-Posttest

Fluency (%)		Flexibility (%)		Originality (%)		Elaboration (%)	
Pre	Post	Pre	Post	Pre	Post	Pre	Post
11.40	91.23	19.30	78.95	1.75	62.28	12.28	92.99

Then calculations of the percentage each score on each indicator are carried out. The percentage calculation results for each indicator are described in table 2.

Results of Making Colloidal Product

In the activity of making colloid products, students were formed into 4 groups and made different colloid products for each group. Each group is given a worksheet that includes indicators of creative thinking. On question 1, students are asked to name examples of colloids in everyday life that are possible to make. This question is used to measure fluency indicators. Question 2 is used to measure originality indicators in which students are asked to choose one of the colloid examples in question 1 to make and design the product concept. The product concept is made as original as possible according to students' creativity by modifying existing colloidal products. Furthermore, question 3 is used to measure flexibility and elaboration indicators. In question 3 students were asked to write down various alternative procedures for making the product in full and detail. The last question students were asked to make conclusions in the form of determining the type of colloid in the product that had been made accompanied by an explanation of the dispersed phase and the dispersion medium. The results of the colloid product assessment score for each indicator in each group are explained in Figure 18.

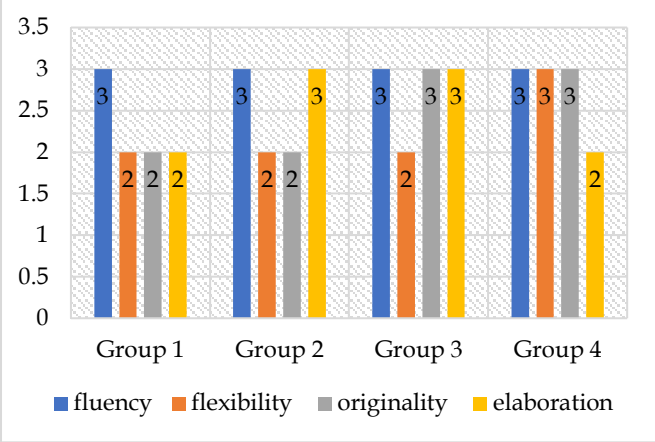

Figure 18. Colloid product assessment score results

On question number 1 all groups obtain a score of 3 indicating that all groups could correctly name examples of colloids in everyday life. In question number 2, which measures the originality indicator, groups 1 and 2 get a score of 2, while groups 3 and 4 get a score of 3. Group 1 makes a product in the form of mayonnaise with a modification of the dispersing agent, namely using lime to get an originality score of 2. In this case, group 1 obtained an originality score of 2 because only 1 aspect modification was carried out, namely the dispersing agent. Group 2 made a product in the form of

mayonnaise with modifications of the taste, namely cheese flavor. In this case group 2 got an originality score of 2 because only 1 aspect modification was made, namely on the taste aspect while the dispersion phase still used vinegar. Furthermore, group 3 obtained an originality score of 3 because they modified colloid products in 2 aspects, namely dispersing agents and flavors. Group 3 made a mayonnaise product with a modified dispersing agent using lemon and mayonnaise flavor called tartar sauce which was made by combining other ingredients. Group 3 gets an originality score of 3 because the modifications made to the product are more than 1. Group 4 made a product in the form of mayonnaise with modifications to the dispersing agent, namely using lime and the mayonnaise flavor was spicy. Group 4 gets an originality score of 3 because the modifications made to the product are more than 1.

The flexibility indicator in question number 3 for all groups received a score of 2. This was because all groups mentioned the procedure for making products in 2 ways. Whereas on the originality indicator groups 1 and 4 got a score of 2 and groups 2 and 3 got a score of 3. Score 3 was obtained because the explanation of the manufacturing procedure was complete and detailed while score 2 was obtained because the explanation of the manufacturing procedure was complete but not detailed enough. on the elaboration indicator groups 1 and 4 get a score of 2 while groups 2 and 3 get a score of 3. a score of 2 is given because the procedure for making colloidal products written by students is complete but not detailed. a score of 3 is given because the procedure for making colloidal products written by students is complete and detailed. Based on the results of the creative thinking posttest and the result of making colloidal product for each indicator, the average percentage is obtained according to table 3.

Table 3. Result of Each Creative Thinking Indicator

Fluency (%)	Flexibility (%)	Originality (%)	Elaboration (%)
95.62	77.20	73.25	87.71

Based on the description of the results above, the indicator that obtained the largest proportion was fluency with a proportion of 95.62%. These results indicate that students have been able to think of more than 1 answer ideas (Febrianti et al., 2016). Then on the flexibility indicator students get a proportion of 77.20%. In this indicator, students have been able to provide various alternative ways. This percentage may be obtained due to the inaccuracy of students in understanding the questions so that they solve the questions in only 1 way of solving them. Less thorough students in reading questions caused by students not used to working on creative thinking questions (Rasnawati et al., 2019). Furthermore, the originality indicator obtained the lowest average proportion of 73.25%. Creative thinking indicator with the lowest score obtained on the originality indicator (Mirnawati et al., 2021; Rahman et al., 2020). According to Herlina et al. (2019) this could be due to students who are afraid of answering incorrectly if they are different from other friends. Apart from that, it is also possible because of the habits of students who plagiarize the work of friends so that they have not been trained to formulate something that is pure from the results of the thought itself. The originality indicator is a determining indicator of a person's level of creativity due to the organization of ideas found which are difficult for many people to have (Firdaus et al., 2018). The last indicator, namely elaboration, obtained a percentage of 87.71%. These results explain that students have been able to convey ideas that were made in detail and completely. By mastering the elaboration indicators well, it can enable students to communicate the results of their ideas in detail (Fajriah & Asiskawati, 2015). Elaboration indicators are most easily trained through project-based learning in which project activities have been carried out in the form of making colloidal products so that students are given the opportunity to think about everything from the tools and materials needed, formulating manufacturing procedures to making conclusions from the products that have been made (Candra et al., 2019; Noviyana, 2017; Nugroho et al., 2017).

The results of the average percentage of the posttest and the results of making colloid products are then interpreted in table 1. The level of students' creative thinking is explained in the following table.

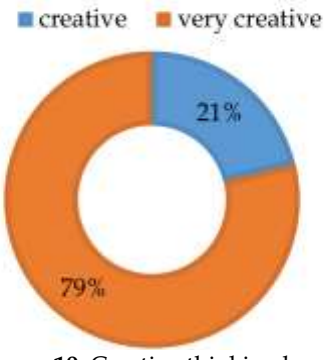

Figure 19. Creative thinking level

Based on the research that has been done, it is obtained that students with very creative thinking levels are 15 people and 4 people are creative thinking levels. Every human being has different abilities and ways to realize their creativity in different ways (Siswono, 2008). In this case training students' creative thinking is very important to do because creative thinking also has benefits in life.

Conclusion

Based on the results of data analysis, it can be concluded that the average percentage for each indicator of creative thinking is 95.62% for fluency, 77.20% for flexibility, 73.25% for originality and 87.71% for elaboration. The percentage for creative thinking level is 79% for very creative and 21% for creative.

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Author Contributions
Saniyyatul Awaliyah contributes to conceptualize the research idea, develop the products, analyze data, and write the articles. Rusmini is as a supervisor to as a supervisor to guide the research process from idea generation to data analysis and review the article.

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Conflicts of Interest
Authors declare no conflict of interests.

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