JPSI 10(1):138-150, 2022
Jurnal Pendidikan Sains Indonesia
e-ISSN: 2615-840X p-ISSN: 2338-4379

Analysis of Student's Creative Thinking Ability Based on Gender Perspective on Reaction Rate Topic

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DOI: 10.24815/jpsi.v10i1.23064

Article History: *Received: October 11, 2021* *Revised: December 18, 2021*
Accepted: December 28, 2021 *Published: January 17, 2022*

Abstract. Everyone has different creative potential. These differences can be influenced by experience, thinking patterns, ways of determining points of view, and other factors, including gender. This study aims to describe the profile of student's creative thinking skills from a gender perspective. The subjects were 450 SMA and MAN students at Semarang City by purposive sampling. The method used in this research is descriptive based on a comparative quantitative approach by using a test instrument. The test used in this study is a description test which consists of 10 questions arranged using Taxonomy Marzano. Test was analysis using a scoring rubric to identify students creative and analytical thinking. The results showed that the creative thinking skills between male and female students generally did not significantly differ. The differences in the characteristics of creative thinking skills can be seen in the fluency, flexibility, and elaboration indicators, while on the originality indicator, there is no significant difference. Differences in characteristics in this study are caused by differences in reasoning patterns between male and female students in solving given chemical problems. Male students tend to express many ideas and varied reasoning answers, while female students detail the solutions they put forward.
Keywords: creative thinking, gender, the reaction rate

Introduction

In 21st century educational paradigm had implications to changes in the learning system. It needs to be done so that students are always developing and be able to compete in the global world. 21st century learning by emphasizing on improving students' thinking skills (Center, 2010). Students are required to be able to formulate problems, as well as think analytically, creatively, and collaborate in solving the problems (Farisi, 2016). Based on this statement, chemistry learning also needs to facilitate the development of students' thinking levels.

Higher-order thinking skills as thinking skills that do not only require the ability to memorize or know, but require other higher abilities including critical, creative thinking, and problem-solving skills (Lissa, et al., 2012). Creative thinking skills need to be developed in learning, because with creative thinking students are able to spur students in analyzing problems and finding new concepts logically based on their knowledge and learning experience. Through creative learning, students are expected to be able to process abstract and complex chemical information into new and original knowledge (Liliasari, 2005). Alghafri & Ismail (2014) stated in their research that critical and creative learning strategies are very effective in improving students' thinking skills in Malaysia.

One of the factors that determine the competitive power of a nation is the creativity of its human resources. Creativity is needed in every area of life to design something, create change, solve problems that aim to improve the quality of life. Thus, education must be directed to produce quality human beings, compete, and have noble character and good morals (Siswanto and Ratiningsih, 2020). Critical thinking and creative thinking are the essence of educational goals and become necessary for students to face the real world (Toledo and Dubas, 2016). Creativity is a product of the ability to think creatively. Efforts to develop students' creative thinking skills are necessary, given the importance of creativity (Munandar, 2016).

Everyone has the potential constantly to develop their thinking skills. One of the potentials possessed by a person is creative potential. One's creative potential is the basis for developing creative thinking skills. Everyone has different potential and characteristics of creative thinking. The development of one's creative thinking skills will continue to develop along with the maturity of one's mindset and cognitive structure (Aini and Hasanah 2019). Maturity of thought patterns and cognitive systems is related to understanding one's concept of something. According to Trianggono (2017) there is a constructive relationship between creative thinking ability and understanding concepts. The relationship between thinking creatively and understanding the concept can be an excellent collaboration to solve a problem. In the context of solving chemistry problems, everyone has a different understanding of concepts and creative thinking skills so that everyone will provide different innovative solutions to the problems given. Differences in creative patterns that occur can be caused by each person's experience who is different in solving a problem. Different mindsets and points of view can also cause these differences in assessing a problem (Du et al., 2020).

Chemistry learning aims to train thinking and reasoning in drawing conclusions through investigation, exploring, experimenting, showing similarities, differences, and consistency and inconsistency. Some of the problems faced in Chemistry learning are that students' problem-solving skills are still low. Students often experience failure in solving problems that require divergent answers. Students tend to answer questions using only one way or according to the teacher's example without trying to find different alternative solutions. The level of students' persistence in solving problems is still low, affecting their creative thinking skills, which are still low.

Creative thinking is the ability to solve complex problems, both individual, social, and other global problems and connect with knowledge, motivation, finding problems, finding new ideas, and evaluating (Greenstein, 2012; Lince, 2016; Wang, 2011). Someone can think creatively if that person has a unique style of thinking in solving problems and finding new knowledge (Ritter et al., 2020). New knowledge in creative problem solving requires good imagination and thinking skills. Students' thinking skills can be trained through discussion in the learning process. This process is expected to be able to form quality students in creating new and unique ideas.

The stated that creative thinking skills are skills in developing or finding original, aesthetic and constructive ideas, which are related to concepts that emphasize intuitive and rational thinking aspects, especially in using information and materials to explain (Al-khatib, 2012). With the original perspective of the thinker. Measurement of creative thinking skills includes fluency, flexibility, originality, and elaboration (Nuswowati and Taufiq 2015). The development of creative thinking in students is influenced by many factors, including a certain willingness, ability, intelligence, teacher readiness, student readiness, and the learning methods used. Another critical factor is the student's gender. Gender differences certainly cause physiological differences and affect psychological differences in learning. So that male students and women certainly have many differences in studying chemistry.

Based on the observations and interviews result with several high school teachers in the Semarang City, the learning process in the classroom still tends to the teacher center learning, so students did not explore their knowledge because students' thinking processes tend to memorizing only. The test instrument used by teachers in assessing student learning outcomes also still measures low thinking skills. Students only receive knowledge passively and then remember it during exams. The test used by the teacher was generally a multiple choice test, so that the thinking process of students in answering test questions has not been measured properly. Multiple choice tests are less precise in measuring high-level abilities, because students only choose one of the alternative answers presented in multiple choice. A suitable test used to measure students' creative thinking skills was the essay form test. Because description test can measure students' analytical skills in answering questions, so the results can represent students' ability (Amalia and Susilaningsih 2014). Based on the interview results with high school teachers in the Semarang City, the chemistry scores of female students are higher than male students because female students tend to be more patient in answering questions than male students.

Concerning learning in schools involving male and female students, it is expected that there will be no gender inequality. As stated by Fakih, gender bias can be defined as the formation of social and cultural traits or characters of men and women that benefit men and harm women (Fakih 2004). Although formally in the 1945 Constitution, the rights of men and women are not distinguished, in reality, they are very different. Various studies have been conducted to explain how Indonesian women, including education, always experience inequality in various aspects. Muthalib in Yeni explained that in textbooks, there are many pictures and sentence formulations that do not reflect gender equality. "Let's say the image of a pilot is always a man because the job as a pilot requires skills and strengths that men "only" own." "Father reads the newspaper and mother cooks in the kitchen" and not vice versa. "Father cooks in the kitchen and mother reads the newspaper" is still often found in many textbooks or even examples of sentence formulations conveyed by the teacher in class. The formulation of the sentence reflects the feminism and domestic work for women while masculine and public work for men (Asmaningtias 2012). Based on the background above, the author wants to examine how the actual impact or influence of gender on students' creative thinking abilities.

Methods

This research is quantitative research with a comparative descriptive method. The subjects in this study were 450 SMA and MAN students, consisting of 150 male students and 300 female students by purposive sampling. The research was conducted from August to September 2021. The instrument used to collect data was a description test consisting of 10 questions compiled using Marzano's Taxonomy. The test instrument has been declared valid by 3 experts, 2 chemistry lecturers and 1 expert lecturer in evaluating chemistry learning. The results of expert validation regarding the concept correctness and the indicators suitability developed in the test instrument obtained an average index of 0.97 with the smallest index 0.85 and the largest index 1. While construct validation by analyzing the test results of students using the SPSS, the test instrument is stated valid and the test instrument has a Cronbach's Alpha value of 0.798 so it is declared reliable because the Cronbach's Alpha value is more than 0.600. The test is used to determine students' creative thinking skills based on gender. The indicators of creative thinking skills used in this study are fluency, flexibility, originality, and elaboration. The test results are

then analyzed quantitatively using the scoring guidelines that have been made, as shown in Table 1.

Tabel 1. Scoring guidelines

Question	Score				
	5	4	3	2	1
Sum-Sum porridge is a traditional food served with liquid brown sugar. A porridge seller was ready to go to the market, but apparently, he forgot to make liquid brown sugar. The seller has to melt 1 kg of brown sugar, but the seller owns not have much time to arrive on time at the market. Explain how the seller must do so that he can melt the sugar quickly. Relate your answer to the concept of factors that affecting reaction rate.	• Seller heat sugar with water at a high temperature because the higher the temperature, the faster the reaction rate. • Before heating the sugar, first, the sugar is cut into small pieces because the smaller the particle size, the larger the surface area, so the reaction rate will be faster. • Seller heats the water, after the water boils, then add the sugar. It is related to the minimum energy for the reaction to take place. • Seller does stirring during the process of melting brown sugar so that the reaction takes place faster	Students can mention 3 points from the answer key correctly	Students can mention 2 points from the answer key correctly	Students can mention 1 point from the answer key correctly	None of the students' answers matches with the answer key

The research instrument used was a description test consisting of 10 questions arranged using Taxonomy Marzano on the reaction rate topic. The instrument was used to analyze students' creative thinking skills based on the Torrance test criteria (Siswono, 2008), adapted from Guilford and Merrifield. The indicators of creative thinking ability are in Table 2.

Table 2. The Indicators of Creative Thinking Ability

Indicator	Explanation
Fluency	Students can provide many relevant answer of chemical problems with a smooth flow of thought
Elaboration	Students can provide detailed information and expand on a given problem area

Flexibility	Students can use several ways to solve problems or provide several correct answers
Originality	Students can answer chemical problems using their language or unique idea

Results and Discussion

This study involved high school students at Semarang City. Before carrying out the research, the researcher arranged several instruments in the form of a description test. This test aims to determine the students' creative thinking ability. The results of these tests were used to collect data. The data obtained is the result of students' answers that have been corrected using scoring guidelines based on the creative thinking ability test indicators. The results are shown in Tables 3 and 4.

Table 3. Average Score of Students' Creative Thinking Skills

Indicators	Average Score	
	Male	Female
Fluency	4.5	4.2
Elaboration	7	7.2
Flexibility	6.2	5.9
Originality	8.2	8.2

Table 4. Descriptive Statistics of Students' Creative Thinking Skills

Gender	Score	Average Score
Male	25.9	58.9
Female	25.5	57.9

Solving chemical problems requires divergent reasoning. Everyone has their way of solving problems. The chemical problem-solving test consists of 10 questions on the reaction rates topic. Based on the data results analyzed, several facts were found on the students' creative thinking abilities. The researcher saw that male and female students' overall creative thinking ability did not have a significant difference. The average score of creative thinking skills between male and female students is not too far apart or equivalent. There was no significant difference between male and female students in the four aspects of creative thinking skills (Perdana, et al., 2019).

Comparison of the characteristics of creative thinking skills between male and female students in the context of thinking processes and creative patterns through indicators of creative thinking skills will be presented as follows:

Fluency Aspect

The fluency aspect is the ability to produce many ideas (Al-Oweidi, 2013). So , it can be said that the fluency aspect is related to a person's ability to provide many possible answers, ideas, and solutions to a given problem. Based on the results of research conducted by Sugiyanto, it is known that the students' creative thinking ability is highest in the fluency aspect (Sugiyanto, et al., 2018). Based on the research that has been done, it can be seen in Table 3 that there are differences in the score of the fluency aspect between male and female students.

The difference in the characteristics of the fluency aspect between male and female students can be seen in answering the problem given of reaction rate. The majority of male students gave many possible answers related to the problem and were correct in chemical concepts, while most female students only gave 1-2 possible answers. The difference in characteristics when think, male brains are more likely to work using declarative memory than females (Abraham et al., 2014). It means that the male brain is very active in using long-term memory to explore related knowledge and facts. The male subject will find it easier to express many ideas based on this related knowledge and facts. Male students were found to be better using scientific reasoning to solved problem, building concepts and using theory (Ayodele, 2016; Eliasson, et al., 2016; Perdana, et al., 2019; Tsai, 2013). The following are question examples used in the assessment.

Rani ingin merebus sebuah kentang yang telah ia beli dari pasar untuk diberikan kepada adiknya. Sebelumnya untuk merebus satu kentang utuh diperlukan waktu selama 15 menit, karena adik Rani sudah menangis ingin memakan kentang sehingga Rani harus bisa memasak kentag lebih cepat dari biasanya. Berikan rekomendasi cara yang harus Rani lakukan agar dapat merebus kentang lebih cepat kaitkan jawaban Anda dengan faktor yang mempengaruhi laju reaksi.

Figure 1. Question examples

Based on the problem in the figure above, students are asked to find a way to make the potatoes ripen quickly by considering the reaction rate factor. Based on the results of the analysis of student answers, it is known that female students tend to give one alternative answer, while male students tend to provide many more detailed alternative answers from various aspects of reaction rate factors. The female students' answers tend to focus only on cutting potatoes into smaller pieces, the factor that affects the reaction rate is the surface area. In contrast to the answers given by male students. Male students tend to give alternative answers so that the potatoes cook quickly, namely: by soaking the potatoes until they are completely submerged which is related to the area of the contact area and the collision theory, then increasing the temperature to increase the speed of movement of the reactant molecules. The comparison of student answers can be seen in the figure 2a and 2b.

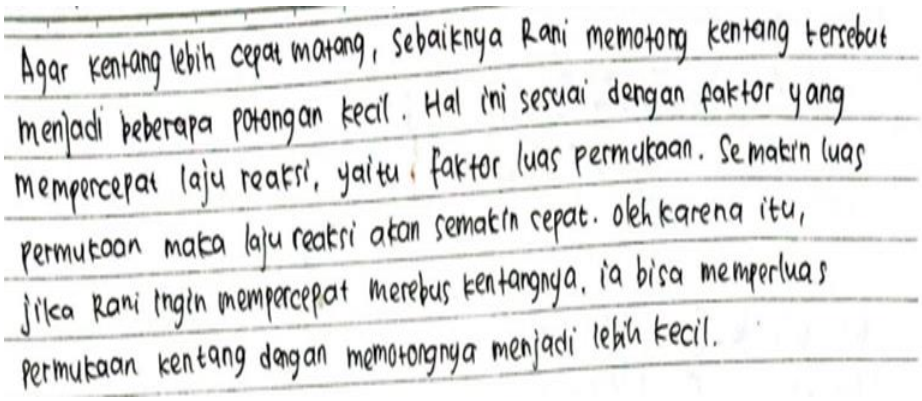

Agar kentang lebih cepat matang, sebaiknya Rani memotong kentang tersebut menjadi beberapa potongan kecil. Hal ini sesuai dengan faktor yang mempercepat laju reaksi, yaitu faktor luas permukaan. Semakin luas permukaan maka laju reaksi akan semakin cepat. oleh karena itu, jika Rani ingin mempercepat merebus kentangnya, ia bisa memperluas permukaan kentang dengan memotongnya menjadi lebih kecil.

Figure 2a. Female student answer

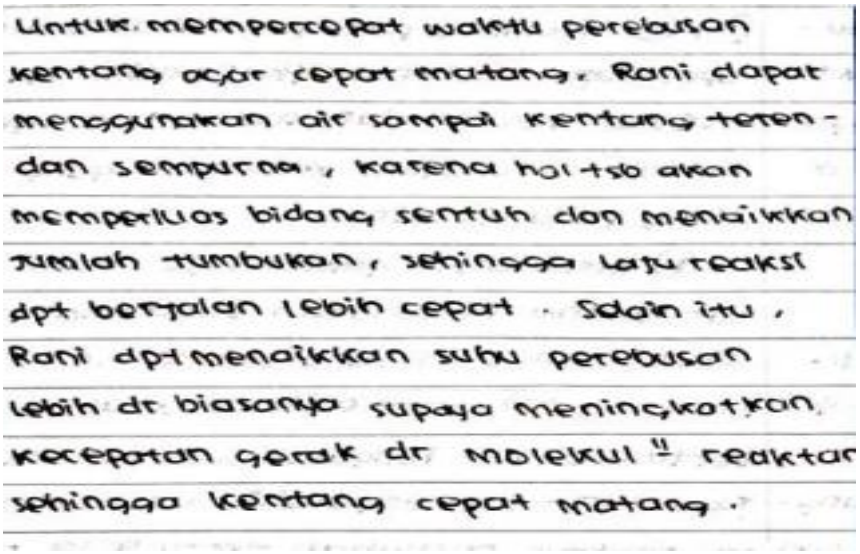
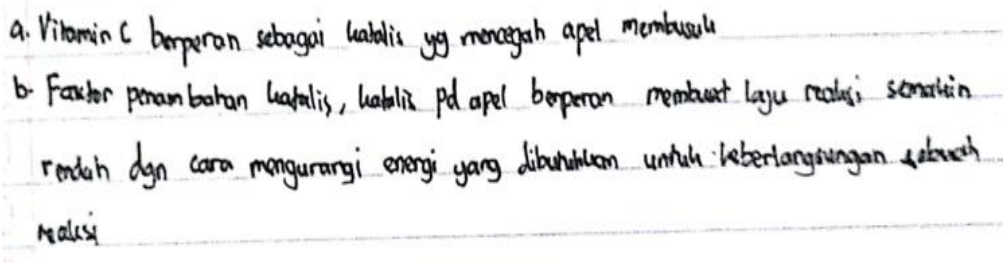

Untuk mempercepat waktu perebusan kentang agar cepat matang, Rani dapat menggunakan air sampai kentang teren-dan sempurna, karena hal tsb akan memperluas bidang sentuh dan menaikkan jumlah tumbukan, sehingga laju reaksi dpt berjalan lebih cepat. Selain itu, Rani dpt menaikkan suhu perebusan lebih dr biasanya supaya meningkatkan kecepatan gerak dr molekul" reaktan sehingga kentang cepat matang.

Figure 2b. Male student answer

Flexibility Aspect

The flexibility aspect relates to a person's ability to provide answers, solutions, and alternatives outside of general answers. It can be said that people who have high flexibility aspects can provide out of the box variations of answers but are still conceptually correct. Students give many various answers (Astuti, et al., 2020). Based on the research that has been done, it can be seen in Table 3 that there are differences in the score of the flexibility aspect between male and female students.

The flexibility aspect is also closely related to the fluency aspect of the thought process. The more ideas or alternative answers are given to answer the problem, the more likely variations of answers outside the general answer (out of the box) are still conceptually correct. In the aspect of fluency, it appears that most male students provide many ideas or alternative answers to the problems given. Male students tend to use the left brain when learning and thinking and focus more on logical thinking so that they are more innovative, creative and competent in empowering creative thinking skills than female students (Perdana et al. 2019; Zeyer 2018; Zubaidah et al. 2017). The variation answers given are different from the general answer. For example, there is a problem with car glass condensation; many of the male students explained the condensation process from various perspectives; some also provided alternative solutions to reduce the impact of condensation in various ways. Female students were only able to give answers according to their general answers to the process of condensing and the solution. The different answers of male and female students can be seen in Figure 3a and 3b.


a. Vitamin C berperan sebagai katalis yg mencegah apel membusuk

b. Faktor penambahan katalis, katalis pd apel berperan membuat laju reaksi semakin rendah dgn cara mengurangi energi yang dibutuhkan untuk kebertangsungan reaksi

Figure 3a. Female student answer

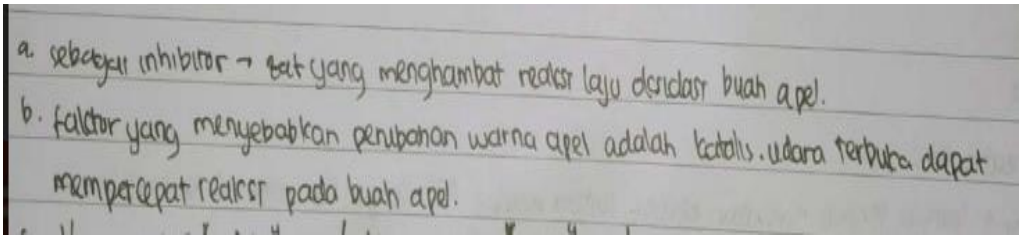


Figure 3b. Male student answer

Based on the figure above, there are different of female and male student answers The answers of male students regarding the function of vitamin C tend to be different from the majority of female students' answers. Most of the female students mentioned that the factor was only referred to as a catalyst while the male students mentioned the answer to the function of the inhibitor. This inhibitor functions as an inhibitor of the oxidation process in apples so that vitamins are inhibitors between apples and air.

Originality Aspect

Originality is the highest characteristic of creativity because originality requires novelty and uniqueness in creating an innovative thought product (Al-Oweidi, 2013). So, it can be said that the originality aspect is related to a person's ability to provide innovative and unique ideas (Kaufman and Beghetto, 2009). Students participate in an active process to create innovative solutions toward the problem through their experiences (Birgili, 2015).

Innovative means that it has novelty and renewal characteristics, meaning that the ideas expressed are entirely new or have not existed before. Unique has a different meaning from others that the idea expressed is an idea that is different from most people, not the same as other people's thoughts. However, it is still acceptable and still conceptually correct. Several studies have shown that teachers may lack understanding of creativity and associate creativity only with originality (Shubina and Kulakli, 2019). Based on the research that has been done, it can be seen in Table 3 can be known that originality has the highest score. It is in line with the research by Wiwik et al., precentage of originality aspect is 43,1% and the highest between the other aspects (Ernawati et al., 2019). There is no significant difference in scores of originality aspect between male and female students. The study result is different from other study, that states at adolescent, female students generate more novel and original ideas than male students (Hong et al., 2013; Kani Ulger and Morsunbul, 2016; Lau and Cheung, 2010; Mullineaux and Dilalla, 2009).

The originality aspect is challenging to appear and develop because, in the originality aspect, it must have a strong character to be different from others. The originality aspect is also challenging to judge because it is unsure whether the answer given is a novelty or something new. In the assessment, what is used as the benchmark is only from the uniqueness of the answer. The uniqueness is assessed based on the answers given by one student compared to other students' answers. The originality score will also be higher if the answer is entirely different from other students' answers but still conceptually correct. Based on the answers on the chemistry tests that have been carried out, it can be seen that only a few answers were judged as unique, although there were some parts of the answers that were similar. Both male and female subjects have the same tendency in terms of originality.

Elaboration Aspect

The elaboration aspect relates to a person's ability to transform ideas in a detailed form. The elaboration aspect requires the ability to make details of these problems. Based

on the research that has been done, it can be seen in Table 3 that there are differences in the score of the elaboration aspect between male and female students.

The elaboration aspect allows students to add details to the answers given. Based on the percentage of indicators between male and female students, it can be seen that female students have a higher percentage than male students in the elaboration aspect. Female students scored higher in Elaboration than male students (Hong et al. 2013). Female students have better communication skill than male students whose have good visio-spatial skill, so that female student give more detailed in their answer (Perdana et al. 2019). It is happening because the observation of the answer pattern is given during the problem-solving test. However, most female students only provide 1-2 alternative answers or solutions; female students always give long and detailed explanations. Male students provide many alternative answers but do not provide details of these answers, so that the value on the elaboration aspect is low. These results are in line with the research result by Abraham et al., when using their creative thoughts, females use more areas in the brain that are involved in the theory of mind and the reference process (Abraham et al. 2014). So, it can be possible that the reference process supports the creation of thoughts to make details of the answers given. The different answers of male and female students can be seen in Figure 4a and 4b.

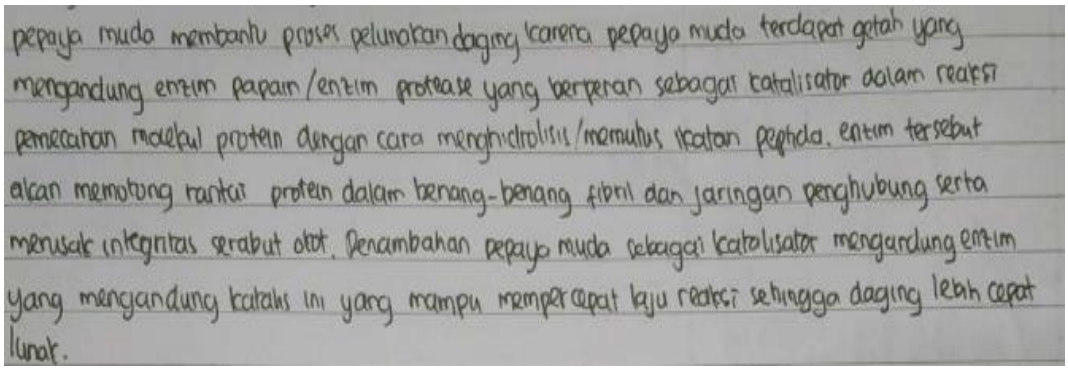

pepaya muda membantu proses pelunakan daging karena pepaya muda terdapat getah yang mengandung enzim papain/enzim protease yang berperan sebagai katalisator dalam reaksi pemecahan molekul protein dengan cara menghidrolisis/memutus ikatan peptida. enzim tersebut akan memotong rantai protein dalam benang-benang fibril dan jaringan penghubung serta menusak integritas serabut otot. Penambahan pepaya muda sebagai katalisator mengandung enzim yang mengandung katalis ini yang mampu mempercepat laju reaksi sehingga daging lebih cepat lunak.

Figure 4a. Female student answer

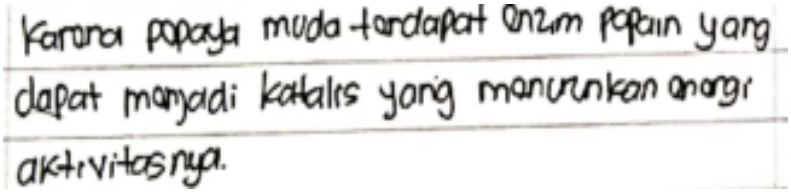

Karena papaya muda terdapat enzim papain yang dapat menjadi katalis yang menurunkan energi aktivitasnya.

Figure 4b. Male student answer

Based on the picture above, it is clear that female students are more detailed in answering questions. Based on questions related to tenderizing meat using papaya leaves, the answers given by male students tended to be simple without detailed explanations regarding the function of enzymes. The female student explained in detail the function of the papain enzyme and its mechanism of action to make meat softer quickly.

Creative thinking is essential in the learning process and students have to mastered it (Rochmad, et al., 2018). Many factors influence creative thinking skills including the selection of accurate learning strategies, methods and techniques (Shubina and Kulakli 2019; Wu et al. 2018). Learning strategies should be chosen from a series of demonstrations, problem-based learning or role-playing activities. Assessment techniques are also very important so as not only to assess the final results but also the thinking

process of students (Birgili 2015). The nature and structure of assignments or assessments given to students have a significant impact on the development of students' potential and thinking abilities. In some aspects of creative thinking, gender differences have an effect (Gunawan et al. 2017). Gender differences affect creative thinking, critical thinking skills and the attitudes towards science (Shubina and Kulakli 2019; Wan and Lee 2017). The results of another study stated that gender differences did not affect test results and students' creative thinking abilities, but there were some significant differences between genders in self-perception (Potur and Barkul 2009; Torrance 1983). In order to increase creativity level of pedagogical students one should widely involve them into various activities (Kashapov, et al., 2019).

Conclusion

Based on the result and discussin, it can be concluded that everyone has different creative potential, both from the point of view and the characteristics of creative thinking they have. A person's creative thinking skills are influenced by personal characteristics, the character of the problem, and the point of view. A person can develop creative thinking skills by knowing what elements of creative thinking skills stand out. In general, men and women have comparable creative thinking characteristics, but in particular, have differences in various aspects of their creative thinking skills. Men are good in certain aspects, while women also are good in other aspects. Each individual has the same potential to develop creative thinking, so there needs to be a form of comprehensive learning to engage his creative thinking skills.

Acknowledgement

The authors are grateful to Southeast Asian Ministers of Education Regional Open Learning Centre (SEAMOLEC) for providing financial assistance to carry out this research.

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