



Connecting Students' Critical Thinking Skills with Conceptual Knowledge in Learning the Organic Compounds Stability by Using Marvin Sketch as a Tools to Adjust the Era of Society 5.0

Lusia Narsia Amsad¹(✉), Liliasari Liliasari², Asep Kadarohman²,
and Ratnaningsih Eko Sardjono²

¹ Chemistry Education Study Program, Universitas Cenderawasih, Jayapura, Indonesia
lusianarsiaamsad@fkip.uncen.ac.id

² Postgraduate School, Universitas Pendidikan Indonesia, Bandung, Indonesia

Abstract. In order to learning about organic compound stability in era of society 5.0, students have to integrate their conceptual knowledge and ability to work with technologies as a tools. It is also need plentiful skill, such as critical thinking. This research aimed to find the connection between students' critical thinking and conceptual knowledge using Marvin sketch. The students must connect all the knowledge and skills with technologies using Marvin sketch to understand the stability of organic compound. The participant were eighteen students from one state university in Indonesia. The study was using descriptive research. It used the nonparametric correlation test. The result show there is a connection between students' conceptual knowledge with the critical thinking skill. It found that the Marvin sketch as a tools have the impact in learning the stability of organic compounds.

Keywords: students' critical thinking · conceptual knowledge · organic compound · Marvin sketch

1 Introduction

Learning the Organic compounds stability is a very challenging matter for students. It is because the complexity in learning about this subject. The students should have clear understanding about conceptual knowledge of stability of Organic compounds [1]. The basic concepts that have been studied before by students is bond strained, density of electron in bond, solubility, structure of compounds, functional group, boiling and melting point of compounds and the energy of compound bonding include the entropy energy and heat energy [2, 3].

Therefore, students have to extend their capability in thinking critically in learning this subjects. Students used critical thinking skill in solve problem of stability of Organic compounds in order to consider the things that affected the stability of organic compounds. They develop their ability in making prediction the possibility of Organic compounds' structure or the product compounds that may be produced from a type of reaction in terms of the stability of the Organic Compounds [4–6]. Several previous research shown that students critical thinking was increasing their capability in problem solving [7–9].

In line with the changes in global education as a result of the formation of the current 5.0 era demand the need for mastery of technology by students [10–15]. Students understanding about ICT (Information, Communication and Technology) will lead them to become someone who can survive in this era. Mastery of technology by students is expected to help them develop their critical thinking skills. They can also be helped in understanding concepts by using computers and existing applications. This leads to the formation of a 5.0 society that is ready to become a super smart society [14–18].

There are several applications that can assist in learning Organic chemistry [19–23]. One of the applications is Marvin sketch [24, 25]. Based on the previous we known that there are a lot research about critical thinking skills, conceptual knowledge in Organic subject. Contrary, there is no research that study stability of Organic chemistry. Therefore, in this research we would like to study about connection between students' conceptual knowledge and students' critical thinking skill learning the stability of organic compound that assisted by using Marvin sketch.

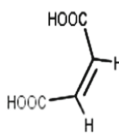
2 Method

The research was conducted at one state university in Papua. The research had eighteen (18) students as the participant in this research. The students were in the third semester. The students already taken Basic Organic Chemistry 1 and 2. The type of the method of the research is descriptive, while we used nonparametric correlation test to connected students' critical thinking skills and conceptual knowledge about the stability of organic compounds. The instrument used an essay test with the explanation. The questions were obtained the concepts that related with stability of organic compounds such as: bond strained, density of electron in bond, solubility, structure of compounds, functional group, boiling and melting point of compounds and the energy of compound bonding. The critical test about stability of organic compounds using the Marvin sketch assisted to shown organic compounds structure in 3D. Figure 1 shows an example of a given problem for the students:

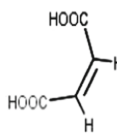
The tests given to students is based on question about stability of organic compound. Students answers from the tests will be the data of this research. The tests consist of two parts. Each part of the test has 3 questions. Students' answer classification based on students' answer. If the students' explanation in the answer is right that it will correctly (get top score) but if the answers is not right or no answer at all that will classified wrong or not good and do not get full score). From 3 items of each test divide into concept of structure of compounds, steric hindrance in compounds, name of compounds, melting

Conceptual Knowledge Essay Test

- There are two compounds of Fumaric Acid and Maleic Acid with the following compound structure:



Fumaric Acid
trans-2-butenedioic Acid

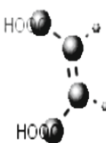


Maleic Acid
cis-2-butenedioic Acid

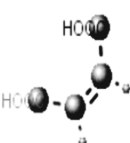
Both compounds have the same chemical formula $C_4H_4O_4$. What is different is the arrangement of atoms and groups around the double bond in the two compounds. Maleic acid is a form of the cis-isomer in which the two carboxylic acid groups are on the same side of the double bond. Whereas in Fumaric Acid, the two carboxylic acid groups are located on different sides of the double bond and bond to different atoms. Based on the description above. Which of the two compounds is the most stable? Explain your answer.

Critical thinking Essay Test using Marvin Sketch

- Show where is the 3D structure of Fumaric Acid and Maleic Acid from these compounds? Also Complete this table by using Marvin sketch and guess the compounds that have the more stability.



A



B

Name of compounds	Melting Point (°C)	Solubility in Water (25°C)
A:	139
B:	7

Fig. 1. Example of conceptual knowledge essay test and critical thinking essay test using Marvin Sketch

and boiling point, solubility in water, energy of molecules and stability of compounds. In order to obtain the correlation between students' critical thinking skill by using Marvin Sketch and students' conceptual knowledge about stability of organic compounds then the statistics used for Spearman rank correlation at significance level $\alpha = 0.05$. Spearman rank correlation coefficient value will determine the connection [26].

Table 1. Results of students' conceptual knowledge in stability of Organic compounds.

Concepts	Average of students' grades
Name of Compounds	88
Structure of Compound	86
Steric Hindrance	64
Melting & Boiling Point	70
Solubility in Water	72
Energy of Molecules	64
Stability of Compounds	60

3 Result and Discussion

3.1 Results of Students' Critical Thinking Skill and Conceptual Knowledge Tests About Stability of Organic Compounds

Figure 2 shows that the results data test about conceptual knowledge test of the students. The conceptual knowledge that have been shown in the question were about structure of compounds, steric hindrance in compounds, name of compounds, melting and boiling point, solubility in water, energy of molecules and stability of compounds. It is the same with the previous research that show the same concept in understanding about stability of Organic compound [1, 27].

Table 1 shows the results of students' conceptual knowledge in stability of Organic compounds. Based on the Table 1 we found that average in students' grade is highest in the concepts about name structure. While the lowest in the concepts about stability of ncompounds. It is shown that students still have huge problems when they have to solve the problems about stability of organic compounds.

The other test that given to the students is the critical thinking skill test using the assisted of Marvin Sketch. The test contains about the stability of organic compounds. Meanwhile, the concepts that is questioning in this test similar with the conceptual knowledge test. Results of critical thinking skill test that using the Marvin Sketch as the assisted presented in Table 2.

From Table 2 we found that students' grade in the test of critical thinking skill that assisted by Marvin Sketch in work with this test. Table 2 shown that the average of students' grade increase from the results of conceptual knowledge test. However, the highest of students' grade found still in given the name of compounds and the lowest in the concepts about energy of bonding in molecule.

Table 2. Results of students' critical thinking skills test that is using Marvin Sketch as the assisted in solve problems about stability of Organic compounds.

Concepts that use the Marvin Sketch	Average of students' grades
Given The Name of Compounds	100
Valid Structure of Compound	98
Steric Hindrance Based on Structure	78
Melting & Boiling Point Based on Structure	86
Solubility in Water Based on Polarity	80
Energy of Bonding in Molecule	76
Comparative Stability of Compounds	76

Table 3. Results of connection between students' critical thinking skills with conceptual knowledge in learning the organic compounds stability by using Marvin sketch

Variable	Correlation coefficient (r)	<i>p</i>
Students' critical thinking skills with conceptual knowledge in learning the organic compounds stability	0.936**	0.000

**Significant Correlation at 0.01 Level

3.2 Connection Between Students' Critical Thinking Skills with Conceptual Knowledge in Learning the Organic Compounds Stability by Using Marvin Sketch

Table 3 shows the results of connection of students' test of conceptual knowledge test and critical thinking skills test by using Marvin Sketch. Table 3 show the analysis by using statistic Spearman rank correlation.

Table 3 shows based on the correlation test that there is a correlation between students' critical thinking skills with conceptual knowledge in learning the organic compounds stability by using Marvin sketch. Result in Table 3 using the Spearman rank correlation as the test to analyze the connection of critical thinking skill and conceptual knowledge of the students [26].

Figure 2 shows that the similarity in result between students' average grades in conceptual knowledge and critical thinking skill by using Marvin Sketch. The use of Marvin Sketch in critical thinking skill test show the assist to the students' that can have good grades. This is in line with research which states that visual media assistance can improve students' conceptual [28]. The results of the test show when assisted by Marvin sketch, students; average grades increase. The provision of media/software in learning is known to affect cognitive processes in students [29].

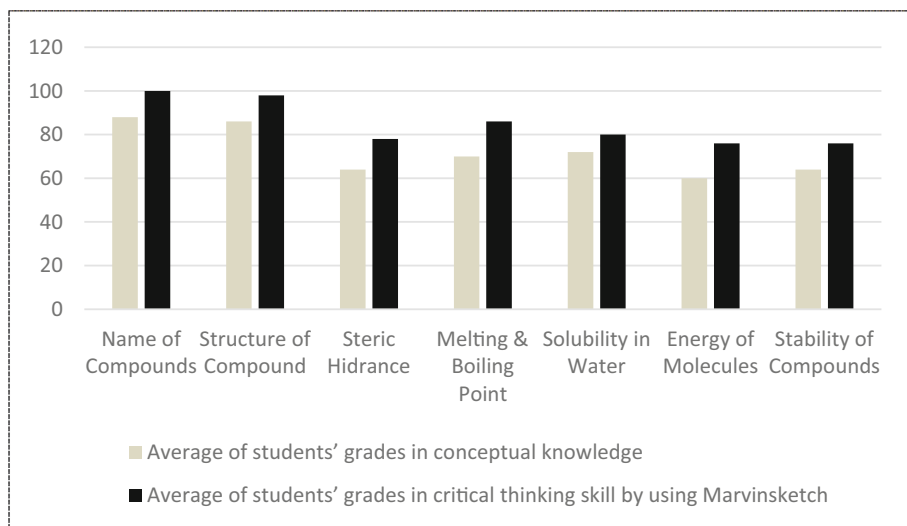


Fig. 2. Students average grades in conceptual knowledge and critical thinking skill by using Marvin Sketch

4 Conclusion

The result show there is a connection between students' conceptual knowledge with the critical thinking skill. It found that the Marvin sketch as a tools have the impact in learning the stability of organic compounds.

Acknowledgments. Authors wishing to acknowledge students' in one state university in Papua to supported in this research.

References

1. F. Zaragoza Dörwald, The Stability of Organic Compounds *Side React. Org. Synth.* 35–58, 2015.
2. N. E. Bodé and A. B. Flynn, Strategies of Successful Synthesis Solutions: Mapping, Mechanisms, and More *J. Chem. Educ.* **93** 593–604, 2015.
3. E. S Domalski and E. D. Hearing, Heat Capacities and Entropies of Organic Compounds in the Condensed Phase Volume II *J. Phys. Chem. Ref. Data* **19** 881–1047, 1990.
4. C. A Cloonan and J. S. Hutchinson, A chemistry concept reasoning test *Chem. Educ. Res. Pract.* **12** 205–9, 2011.
5. M. Stieff, M. Ryu, B. Dixon and M. Hegarty, The role of spatial ability and strategy preference for spatial problem solving in organic chemistry *J. Chem. Educ.* **89** 854–9, 2012.

6. E. Wieland and W. Hummel, Formation and stability of 14 C-containing organic compounds in alkaline iron-water systems: preliminary assessment based on a literature survey and thermodynamic modelling *Mineral. Mag.* **79** 1275–86, 2015.
7. L. N. Amsad, S. Liliyasi, A. Kadarohman and R.E. Sardjono, Recognizing students' abilities to work through synthesis organic pathways *J. Phys. Conf. Ser.* **1157**, 2019.
8. N. S. Stephenson and N. P. Sadler-Mcknight, Developing critical thinking skills using the Science Writing Heuristic in the chemistry laboratory *Chem. Educ. Res. Pract.* **17** 72–9, 2016.
9. J. C. Sloop and P. Coppock, Benefits of Using a Problem-Solving Scaffold for Teaching and Learning Synthesis in Undergraduate Organic Chemistry I Benefits of Using a Problem-Solving Scaffold for Teaching and Learning **10**, 2016.
10. H. I. Elim and G. Zhai, Control system of multitasking interactions between society 5.0 and industry 5.0: A conceptual introduction & its applications *J. Phys. Conf. Ser.* **1463** 0–8 2020.
11. S. Gürsoy, Scientometrics Analysis Method for Society 5.0 1–28, 2021.
12. C. M. Ferreira and S. Serpa, Society 5.0 and Social Development: Contributions to a Discussion *Manag. Organ. Stud.* **5** 26, 2018.
13. V. Forum, Society 5.0 2021 *Soc. 5.0 2021*, 2021.
14. M. E. Gladden, Who will be the members of Society 5.0? Towards an anthropology of technologically posthumanized future societies *Soc. Sci.* **8**, 2019
15. B. Aquilani, M. Piccarozzi, T. Abbate and A. Codini, The role of open innovation and value co-creation in the challenging transition from industry 4.0 to society 5.0: Toward a theoretical framework *Sustain.* **12** 1–21, 2020.
16. A. Islam, M. Islam, M. U. Hossain Uzir, S. Abd Wahab and A. S. Abdul Latiff, The panorama between COVID-19 pandemic and Artificial Intelligence (AI): Can it be the catalyst for Society 5.0? *Int. J. Sci. Res. Manag.* **8** 2011–25, 2020.
17. C. Narvaez Rojas, G. A. Alomia Peñafiel, D. F. Loaiza Buitrago and C. A. Tavera Romero, Society 5.0: A Japanese concept for a superintelligent society *Sustain.* **13**, 2021.
18. Y. Zengin, S. Naktiyok, E. Kaygın, O. Kavak and E. Topçuoğlu, An investigation upon industry 4.0 and society 5.0 within the context of sustainable development goals *Sustain.* **13** 1–16, 2021.
19. K. Laxman Computers & Education A conceptual framework mapping the application of information search strategies to well and ill-structured problem solving *Comput. Educ.* **55** 513–26, 2010.
20. R. L. Van, D. H. Van, J. Mulder and P. Nieuwland, Using a Web Application To Conduct and Investigate Syntheses of Methyl Orange Remotely, 2013
21. S. I. Mier, C. Kalinski, M. Umkehrer, L. Weber, J. Kolb, C. Burdack, G. Ross, P. Ag and G. Straße, On the industrial applications of MCRs : molecular diversity in drug discovery and generic drug synthesis 513–22, 2010.
22. H. Chen, J. She, C. Chou, Y. Tsai and M. Chiu, Development and Application of a Scoring Rubric for Evaluating Students' Experimental Skills in Organic Chemistry: An Instructional Guide for Teaching Assistants, 2013
23. N. Otnasap, Quantum Computer and Applications for the Society 5.0 7 22–32, 2021.
24. D. Ghersi and M. Singh, MolBLOCKS: Decomposing small molecule sets and uncovering enriched fragments *Bioinformatics* **30** 2081–3, 2014.
25. C. H. C. Da Costa, F. F. Dantas Filho and F. M. Gonçalves da Silva Cordeiro Moita, Marvinsketch E Kahoot Como Ferramentas No Ensino De Isomeria *Holos* **1** 31, 2017
26. C. Spearman, Spearman's rank correlation coefficient *Royal geographical society* vol 15 pp 72–101, 2009.

27. I. W. Suja, I. W. Redhana and I. B. N. Sudria, Mental Model of Prospective Teachers on Structure and Properties Correlation of Organic Compounds *J. Phys. Conf. Ser.* **1503**, 2020
28. Q. Wang, H. L. Woo, C. L. Quek, Y. Yang and M. Liu, Using the Facebook group as a learning management system: An exploratory study *Br. J. Educ. Technol.* **43** 428–38, 2012.
29. R. Blonder, M. Jonatan, Z. Bar-Dov, N. Benny, S. Rap and S. Sakhnini, Can You Tube it? Providing chemistry teachers with technological tools and enhancing their self-efficacy beliefs *Chem. Educ. Res. Pr. Chem. Educ. Res. Pr.* **14** 269–85, 2013

Open Access This chapter is licensed under the terms of the Creative Commons Attribution-NonCommercial 4.0 International License (<http://creativecommons.org/licenses/by-nc/4.0/>), which permits any noncommercial use, sharing, adaptation, distribution and reproduction in any medium or format, as long as you give appropriate credit to the original author(s) and the source, provide a link to the Creative Commons license and indicate if changes were made.

The images or other third party material in this chapter are included in the chapter's Creative Commons license, unless indicated otherwise in a credit line to the material. If material is not included in the chapter's Creative Commons license and your intended use is not permitted by statutory regulation or exceeds the permitted use, you will need to obtain permission directly from the copyright holder.

