



Effect of Learning Organic Chemistry through Blended Learning on Environmental Awareness among Pre-Service Chemistry Teachers

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Abstract. To increase the environmental awareness of pre-service chemistry teachers (PSCTs), Organic chemistry learning has been carried out using the Organic Chemistry Learning Module loaded with the character of caring for the environment through blended learning (BL). This study was conducted to investigate whether the Organic Chemistry Course taught by using BL affected environmental awareness, investigate the correlation between the attitude and behavior of PSCTs, and describe they perceptions of the implementation of BL. A validated self-assessment instrument was used to measure the attitudes and behavior of PSCTs. The pretest-post Test technique was used to evaluate PSCTs learning outcomes. User perception was collected using a questionnaire. 75 PSCTs were involved and enrolled in the BL. The results showed that BL could increase PSCTs' awareness of the environment; there was a strong correlation between attitudes and behavior with a correlation coefficient of 0.996 with a significance level of 0.001, and they gave positive responses to BL on the topic of organic chemistry, which means that they accepted the implementation of BL very well. The results indicate that BL can be used as an alternative method for future learning and is suitable for strengthening good attitudes and behavior toward the environment.

Keywords: Blended Learning, Online Learning, Environmental Awareness, Behavior, Attitude.

1 Introduction

After the Covid-19 pandemic emerged, face-to-face learning that was commonly applied was disrupted. In the current COVID-19 epidemic, where face-to-face learning cannot be carried out typically, online learning is a priority alternative. One type of learning that combines face-to-face learning with online learning is BL. BL was chosen because it was not entirely conducted online but combined with face-to-face learning in class to complement the material that had yet to be conveyed. BL has a significant influence on learning to increase the effectiveness and efficiency of learning [1]. BL not only reduces the distance between students and educators but also increases the interaction between the two parties [2]. The technology applied in BL is often intended to produce optimal performance by students [3].

Some studies reported that implementing BL in mathematics teacher candidates has developed the characteristics of curiosity, hard work, creativity, and

communication among students [4]. The recognition of students who take classes with three types of learning, including BL, online learning, and face-to-face, according to students, they have been able to learn more effectively with BL compared to other modes of learning [5]. Besides that, it is environmentally friendly due to being paperless. By using this learning mode, students have been trained to protect the environment and have made students aware that using paper continuously has an impact that can be detrimental to preserving nature. Paper is produced from trees. Cutting down trees will reduce the supply of oxygen to the earth. Therefore, BL has become a learning trend towards green chemistry. Green chemistry aims to make students aware of the environment and improve attitudes and behavior towards the environment, especially in using organic chemicals so that they can participate in preserving the environment. Green chemistry is also part of environmentally friendly chemical products and processes covering all aspects of chemical processes that reduce adverse effects on human health [6].

On the other hand, almost all developing countries have unsatisfactory environmental problems [7]. The same case was found in Indonesia [8]. The problems encountered include low environmental awareness of the community, the increasing use of plastic materials, Styrofoam, soft drink containers, pampers, and various other persistent organic pollutants that harm the increase in the amount of waste that has accumulated in the environment [9]. The use of pesticides, herbicides, fungicides, and household cleaning materials also has an effect that worsens environmental conditions, animals, and even the quality of human life [10]. The dependence of many modern people on plastic-based materials is also getting higher [11], the pollution is also increasingly worrying [12]. The increasing use of natural and synthetic organic chemicals in all aspects of life to improve the quality of life has brought benefits and caused severe environmental degradation in various places [13].

The chemicals described above were previously studied materials for learning organic chemistry studied by PSCTs. Research on PSCTs who have participated in organic chemistry learning without applying deliberate learning to increase environmental awareness found that there was no significant difference between attitudes and behavior towards the environment of PSCTs and pre-service non-chemistry teacher students [14]. Most pollutant chemicals come from organic chemicals used by humans in everyday life, such as fuels, solvents, plastics, pesticides, and household cleaning materials. Although research on the handling of waste management continues to be carried out, efforts to raise awareness among the public to reduce environmental pollution need to be carried out through education. In Indonesia, one of the goals of National education is to increase awareness of the environment (<https://www.kemdikbud.go.id>).

Therefore, increasing environmental awareness is internalized in the education curriculum of elementary up to tertiary education. To foster concern for the environment for student participants, ideally, the teacher as an educator becomes a role model that students can imitate. It is known that the personality of students is correlated with teacher performance [15]. For this reason, FKIP USK, as an educational institution that produces teachers, needs to prepare teachers with good environmental awareness.

Efforts to improve attitudes and behaviors that care for the environment must be continued through BL during the COVID-19 pandemic. The organic chemistry

learning module, which contains values to increase awareness of the pre-existing environment, is transferred to the BL platform by the link <https://blendedlearning20.wordpress.com>. The application of BL is investigated to learn whether the application of BL in BL lectures affects improving the attitudes and behavior of PSCTs for the environment, what is the correlation between the attitudes and behavior of PSCTs towards the environment through the application of BL, and how is the response of PSCTs to the implementation of BL. The results of this study are expected to illustrate that BL can be a lesson that can improve the excellent character of PSCTs towards the environment so that it can produce recommendations that BL can be a lesson for the transformation of good values.

2 Method

2.1 Research Design

This applied research was conducted to investigate the effect of BL implementation on environmental awareness increase among PSCTs. The research was conducted during the odd semester of 2020. The research subjects were 75 PSCTs enrolled in organic chemistry learning in the introductory chemistry course II Department of Chemistry Education Faculty of Education and Teacher Training, Universitas Syiah Kuala. They are first-year students in the odd semester of the 2019-2020 academic year. Prior to the implementation of BL, a platform was prepared through <https://blendedlearning20.wordpress.com>. On the BL platform, a reading material module has been provided for learning activities. This learning activity is equivalent to 300 minutes of face-to-face class meetings on the normal learning conditions before the COVID-19 pandemic occurs. It describes the learning objectives, rules for using modules, and learning evaluation tools. On the platform, online self-assessment instruments have also been provided to measure the attitudes and behavior of PSCTs towards the environment and the responses of PSCTs to the implementation of BL.

2.2 Research instrument

Self-assessment modules and instruments on the platform are modules that have been prepared by Sulastri [16]. This self-assessment instrument has also been used by Ridha [14]. The difference is that before the COVID-19 epidemic, in last year's study, this module was in hard copy form. In this study, the module was transferred to the BL platform. The content of this module discusses alkane hydrocarbons, alkenes, alkyne and cyclo-alkane compounds, alcohols, phenols, thiols, ethers, aldehydes, ketones, carboxylic acids and their derivatives, amines and amides, carbohydrates, proteins and fats related to nomenclature, physical properties, chemical reactions, isomers, sources of compounds and being able to understand the benefits, uses, impacts of their use on human health and environmental sustainability, as well as the recent phenomena related to these hydrocarbons perspective character.

The self-assessment instrument uses a Likert scale. The categories (Table 1.) of attitudes and behaviors measured are sustainable development, global warming,

alternative energy sources, waste management, environmentally friendly lifestyles, fossil fuels, synthetic polymers, pesticides, herbicides and household cleaning chemicals, organic chemical pollutants, and the handling of chemical experimental wastes in the laboratory.

Table 1. The details of categories and subcategories.

No	Categories	Sub Categories
1	Sustainable Development	Preserving the environment for a better life in the future
2	Environmental Issues	Global warming / Emissions of gasses/greenhouse gasses Alternative energy sources Waste management Environmental slogans/lifestyle Environmental Pollution by Organic Chemicals
3	Environmental Pollution by Various Organic Chemicals	Synthetic polymers Pesticides, herbicides, and chemical waste from household cleaners Refrigerator/aerosol POPs chemicals Waste of chemical experiment materials in the laboratory

There are 25 items used to evaluate attitude and 49 items to evaluate behavior. The level of the Likert scale gradation of attitude towards the environment is that I have not realized it (score 1), I have realized it but have not had the desire to do it (2), I have realized but am not sure that I can do it (3), I have realized and have planned to do it (4), and being aware and able to do so (5). The level of gradation on the Likert scale of behavior towards the environment is I never do it (score 1), I rarely do it (score 2), I do it often (score 3), and I always do it (4). Before and after implementing BL, students take pre and posttests through the online form on the BL platform. To understand how students perceive BL, students also fill out a perception questionnaire online.

The data obtained from the measurement of attitudes and behavior were tabulated to obtain the average percentage of aspects and behavior before and after the implementation of BL. Furthermore, the data were analyzed using SPSS version 22. Kolmogorov Smirnov's statistical analysis has been carried out, and the results have shown that the data could be more homogeneous. Therefore, the correlation between attitude and behavior was analyzed using nonparametric analysis statistics. The results of the data normality test using the P-plot showed that the data were normally distributed.

3 Results and Discussion

After the data was tabulated, the t-test was carried out to determine whether there was no significant difference between the pre and posttest on the attitude of the PSCTs.

The results in Table 2 show that mean pretest <from posttest = descriptively, there is a significant difference between the pretest and posttest scores.

Table 2. T-test results (paired sample) attitude.

	Mean	N	Std Deviation	Std. Error Mean
Pair 1 Pre-attitude	92.59	75	18.792	2.170
Post attitude	161.227	75	40.5138	4.6781

The correlation coefficient between pretest and posttest is 0.182 with a significance level of $0.119 > 0.05$, indicating no relationship between pretest and posttest variables. Followed by a Paired Samples Attitude Test, Since the Sig. (2-tailed) value is $0.000 < 0.001$, then H_0 is accepted. There is a significant difference between the pretest and posttest scores. Alternatively, by comparing between t count = 14.342 and t table on DF 74, If t count $>$ t table H_0 is accepted, t count = 14.342 $>$ t table = 1.99, it means that H_0 is accepted. There are significant differences in student attitudes towards the environment before and after BL learning.

Table 3. T test results (paired sample) behavior.

	Mean	N	Std Deviation	Std. Error Mean
Pair 1 Pre perilaku	141.00	75	33.836	3.907
Post perilaku	131.960	75	25.8266	2.9822

There is a relationship between pre-and post with a significance level of $0.000 < 0.05$. There is a difference between the values of pre and post-behavior with a significance level of $0.022 < 0.05$, t table = 2.337, and t count = 1.99 H_0 accepted. However, from the results (Table 3) of the comparison of both attitudes and behaviors, changes in attitude are more significant than the environmental awareness behavior of students after participating in the implementation of BL. Furthermore, the correlation between attitude and behavior is investigated. The results of nonparametric statistical analysis (Spearman's rho show a strong correlation between attitudes and behavior with a correlation coefficient of 0.996 with a significance level of 0.001.

The meaning is that implementing BL contributes to improving the attitude of PSCTs towards the environment. Blended learning can be an alternative to learning that can strengthen the values of goodness in students. Lalima and Kiran explained that BL can help students practice good skills and attitudes through online experiences [16]. Especially if videos can be watched directly by students at BL, it will provide an accurate picture for students to make them better. Lalima also added that through BL, the all-round development of personality is targeted [16]. In BL, the student gets the full opportunity for all-round development of the personality. All aspects of personality are developed through BL; interaction via the internet helps in the correct type of value development. In previous research [16], it took two months or longer to change attitudes and behavior through projects that were done together. By BL in this study, the joint project was carried out via an internet connection, which saves time and simplifies direct communication between students.

After PSCTs participate in learning through BL. They were given a questionnaire. To obtain information on their perceptions of the implementation of BL, PSCTs are asked to read and understand the content of the blended learning media on the BL platform link. After students finish observing the available media, and start learning by reading the content of the material and answering the questions given to prove that the student has opened the learning media that the researcher has made. The results of student responses are, they stated that the implementation of BL makes PSCTs not bored to learn, feel happy, and be happy to study longer than usual. Based on the research results, 77.9% of PSCTs stated that BL is a new learning for them. 84.2% of these PSCTs also stated that they strongly agreed that this BL made it easier for them to learn and operate. PSCTs that were sampled were future chemistry teacher candidates. After PSCTs apply this blended learning learning, they want to apply it when teaching to become a teacher later. Overall, the category of using blended learning is excellent. As many as 81% of students think positively, it can be concluded that its use is accessible to students.

4 Conclusion

The initial attitude of PSCTs has entered the pretty good category, but after implementing BL, the attitude of PSCTs has increased significantly. Then, the behavior of PSCTs has also increased by implementing BL. This phenomenon shows that BL learning can improve attitudes and behavior to increase students' environmental awareness. Based on this research data, attitude correlates with behavior. Student attitudes will affect their daily behavior.

The application of blended learning on the topic of introductory organic chemistry shows that in the process, it can change PSCTs' perceptions of organic chemistry, make learning activities more interesting with new features there are various videos of environmental pollution, and can motivate PSCTs to seek further knowledge about environmental conditions and can develop environmental awareness to continue to protect the environment. The response of PSCTs to the application of BL learning on the topic of organic chemistry is classified as very good, and they also want to apply BL in their learning, which they will do later when they become teachers.

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