The Relationship of Ethnochemistry-Based Learning Experience with Students' Critical Thinking Skills Based on Gender

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Abstract-The study aims to analyze the relationship between ethnochemistry-based learning experiences and students' critical thinking skills based on gender. The number of samples was 50 chemistry education students (35 women and 15 men) and were determined through the cluster random sampling technique. This study adopted quantitative research with a survey method and employed a CAEQ (Chemistry Attitudes and Experiences Questionnaire) as the ethnochemistry-based learning experience research instrument. The data were analyzed by regression test at a significance level of .05. The result reports 1) chemistry education students' critical thinking skills (CTS) based on gender are higher than their ethnochemistry-based learning experiences, and 2) there is no significant relationship between ethnochemistry-based learning experiences and critical thinking skills based on gender. The survey findings were also strengthened by the interview results, which demonstrate the implementation of ethnochemistry-based learning and critical thinking skills still needs to be developed in the planning, implementation, and evaluation stages to improve students' soft skills and hard skills.

Index Terms-Ethnochemistry-based learning experience, critical thinking skills, gender differences, chemistry education students.

I. INTRODUCTION

Learning chemistry in college is orientated to 3 main domains: cognitive, affective, and psychomotor. These three domains of learning outcomes are relevant to 21st-century skills since they are references for learning in the industrial revolution 5.0 era. 21st-century learning skills include problem-solving, critical thinking, communication and collaboration, and creative thinking skills (Patonah et al., 2021; Wahyudiati, 2022). Problem-solving skills as one of the 21st-century learning outcomes characteristics are reflected in students' learning experiences. Learning experiences will determine students' learning outcomes by activating them in constructing knowledge, skills, and attitudes independently to experience meaningful learning. However, previous research presented the classroom learning process tends to take place in one direction and is dominated by lecturers. The student learning experience is not optimal, affecting students' soft and hard skills underdevelopment (Syafrial et al., 2022; Irwanto, Rohaeti, & Prodjosantoso, 2018). Therefore, the learning experience is one of the essential factors influencing the chemistry learning outcomes in universities.

A learning experience is an important aspect of processing students' knowledge, attitudes, and skills to generate qualified and competent graduates who are capable of the job market competition (Cheung, 2011; Sumardi, Rohman, & Wahyudiati, 2020; Fadli & Masnun, 2020). Through a problem-solving-oriented learning experience, it is believed could train students' problem-solving abilities through a scientific method (Wahyudiati, Sutrisno, and Louise, 2019; Fadli & Irwanto, 2020). In addition, one of the best ways for students to understand the concept easily is through the habituation of learning that are integrated with their daily life experiences or what is known as local wisdom. Integrating chemistry learning with students' local wisdom creates contextual learning by combining chemistry with culture; the ethnochemistry approach. Putting the ethnochemistry approach into practice could train students to advance their ability to formulate research problems and hypotheses and prove hypotheses so that students achieve the expected chemistry learning objectives optimally (Sumardi & Wahyudiati, 2021). However, research studies that examine ethnochemistry-based learning experiences are still minimal and focus more on cognitive learning outcomes (Wiwit, Ginting, & Firdaus, 2013; Osborne, Simon & Collins, 2003). Moreover, this research is important because contextual learning experiences will develop students' critical thinking skills because of their active involvement in constructing knowledge and skills independently.

Critical thinking is defined as an individual's ability to solve problems logically and systematically. Problem-solving-based learning activities could form students' critical thinking skills by nurturing their curiosity, identifying or addressing the problems logically, and working on students' collaboration and communication skills (Bandyopadhyay & Szostek, 2019;

Wahyudiati, Sutrisno, & Louise, 2019). In addition, laboratory activities can stimulate students' critical thinking skills to train them to investigate, analyze research results, present research results, and express opinions appropriately (Aljaafi, 2019). Consequently, there is a relevance between the chemistry learning experience and critical thinking skills through contextual learning related to students' local wisdom.

Providing contextual learning experiences such as ethnochemistry-based learning experiences is a solution to improve students' critical thinking skills. However, the previous research revealed the factual conditions of chemistry learning activities in higher education are more focused on achieving cognitive learning outcomes, while the development of students' critical thinking skills is still neglected (Tiruneh et al., 2018; Wahyudiati, 2021). Likewise, implementing the ethnochemistry learning approach in universities is rarely done since the learning activities tend to be memorization (Wahyudiati & Fitriani, 2021; Wahyudiati et al., 2020; Fadli & Masnun, 2020; Sumardi & Wahyudiati, 2021). In addition to the approach and learning environment factors, various research found the relevance between the learning experience and critical thinking skills based on gender (Cheung, 2007; Villafane, Garcia, and Lewis, 2014). There was even a relevance between the learning experience and critical thinking skills based on grades levels (Zeidan and Jayosi, 2014). Unfortunately, studies related to the relevance of ethnochemistry-based learning experiences with critical thinking skills from a gender dimension were never conducted. Therefore, it is crucial to investigate the relationship between ethnochemistry-based learning experiences and the critical thinking skills of chemistry education students based on gender.

II. METHOD

This study used employed quantitative approach with survey methods (Creswell, 2000). A cross-sectional survey design was used to obtain quantitative data, and a focus group interview technique was utilized to verify the quantitative data. The purpose of using a cross-sectional survey design was to measure the relationship between two or more variables in describing factual conditions (Cohen, Manion & Morrison, 2007). The total sample was 50 chemistry education students (35 women and 15 men) and was determined through a cluster random sampling technique in the chemistry education department of Mataram State Islamic University. Data were collected through surveys and interviews (Teddlie & Tashakkori, 2009). The instrument for measuring critical thinking skills was the Oliver Hoyo's rubric (2003), consisting of five indicators: (1) analysis, (2) attitude towards scientific investigation, (3) application of scientific attitude, (4) attitude towards chemistry, and (5) chemistry learning experience. Meanwhile, the ethnochemistry-based learning experience instrument was the CAEQ questionnaire or Chemistry Attitudes and Experiences Questionnaire (Coll, Dalgety, & Salter, 2002). It was then developed into an ethnochemistry-based CAEQ instrument. Before using the developed research instrument, it was first examined through expert validation and empirical validation to measure the level of instrument reliability. Furthermore, Cronbach's alpha coefficient value was obtained at = .86 > .70 so that the research instrument met the reliability requirements (Hair, Black, Babin, & Anderson, 2006). Finally, the data were analyzed by employing a regression test to ascertain the relationship between ethnochemistry-based learning experiences and the critical thinking skills of chemistry educations students.

III. FINDINGS

The average value of Ethnochemistry-based learning experience (ELE) and critical thinking skills (CTS) of chemistry education students based on gender was determined based on the average score and standard deviation as shown in Table 1. Based on the data analysis, the level of ELE was lower with a mean value of 87.48, while the mean value of CTS for chemistry education students was 89.80 (see Table 1).

Table 1. Mean Value of ELE and CTS

The aspect measured	N	Mean	SD
ELE	50	87.48	4.97
CTS	50	89.80	4.34

The regression test results shows no significant relationship between ELE and CTS for chemistry education students based on gender with a p-value higher than 0.05 (Table 2). The null hypothesis was accepted and H_a was rejected.

Table 2. Results of ELE and CTS Regression Tests by Gender

Uji	df	F	Sig
Regression	2	.958	.391

IV. DISCUSSION

Results of the research showed no difference in cultural expertise (CE) and scientific attitudes (SA) based on gender.These Based on the results, the average value of the ethnochemistry-based learning experience for chemistry education students (87.48) tended to be lower than the average value of their critical thinking skills (89.80). These results are similar to Bart et al.'s study (2015), which proved that male and female students' critical thinking skills have significant differences. The indicators of critical thinking skills measured in this study include analytical skills, attitudes towards scientific investigations, application of scientific attitudes, attitudes towards chemistry, and chemistry learning experiences. The average value of students' critical thinking skills was high (89.80). It means that attitudes towards chemistry and students' chemistry learning experiences positively impact students' critical thinking skills. This impact is caused by lecturers performing innovative learning models in learning activities and prioritizing problem-solving. This condition is supported by previous research, which confirmed the activation of students in learning activities is appropriate to be taught using innovative learning models such as problem-based learning models (Wahyudiati et al., 2020; Hugerat & Kortam, 2014; Zeldin, Britner, & Pajares, 2008; Fadli and Irwanto, 2020).

Engaging students' positive attitudes toward chemistry learning is influenced by the development of critical thinking skills and is also shaped by the student's learning experience (LE).

Moreover, problem-solving-based learning activities allow students to be actively involved in formulating and proving problems to create meaningful learning. Likewise, the results of research conducted by Sutrisno, Wahyudiati, & Loiuse (2019), Ayyildiz & Tarhan (2012), Sumardi, Rohman, & Wahyudiati (2020) asserted inquiry-based learning affects the problem-solving abilities improvement and critical thinking skills. In addition, Wahyudiati's (2022) and Villafane's (2002) studies indicated that female students' CTS tend to be higher than male students because female students have more positive interest, persistence, curiosity, and chemical attitude than male students (Garcia, & Lewis, 2014).

Moreover, the current research findings are supported by the results of the interviews as follows:

According to LS (lecturer), "male students have less interest and motivation in completing assignments compared to female students, so the impact on critical thinking skills of female students tends to be higher than male students."

HI (female) said, "I am very interested and challenged to be actively involved in chemistry lessons because it is relevant to community daily life experiences, especially by combining the concepts of chemistry with local wisdom."

Furthermore, GA (male) stated, "I am encouraged to do more practical activities by integrating chemical material with local wisdom than participating in the classroom learning. "

Another interesting finding showed no significant relationship between ethnochemistry-based learning experiences and critical thinking skills based on gender. The implementation of ethnochemistry in learning is reflected in integrating chemical concepts with students' daily lives, both in the form of local wisdom values and the resulting cultural products. Likewise, Rahmawati and Taylor (2017), Sutrisno, Wahyudiati, and Louise (2020), and Wahyudiati (2020) pointed that integrating culture in learning will help students relate the subject matter to their daily experience and make them more comfortable and excited. In addition, the application of ethnochemistry can increase students' learning interest and motivation by describing and integrating chemistry concepts relevant to cultural traditions (Wahyudati, 2022; Rickey & Stacy, 2000; Treagust et al., 2004). In applying ethnochemistry, the students' involvement in actively constructing relevant knowledge to their everyday lives (their culture) could increase a sense of nationalism and love for their culture (Sumardi & Wahyudiati, 2021). The result of no significant relationship between the ethnochemistry-based learning experience and the critical thinking skills of chemistry education students is caused by the few integration of chemistry material with local wisdom. So, the impact on students' critical thinking skills cannot be acquired optimally. Various previous research results also narrated that the learning environment and learning strategies significantly improve students' chemistry learning experiences, positively impacting students' learning outcomes (Ayyildiz & Tarhan; 2012; Calik et al., 2014).

Ethnochemistry-based learning experiences and students' critical thinking skills positively correlate with learning outcomes. This condition is backed up by the results of research conducted by Patonah et al. (2021), Wahyudiati et al. (2020), and Wahyudiati (2022), that critical thinking skills and ethnochemistry-based learning experiences could encourage students to be actively involved in constructing knowledge to improve the chemistry education students' academic achievement. Thus, it is essential to implement approaches or learning models that prioritize problem-solving activities based on local wisdom to create a more meaningful chemistry learning experience. A more meaningful learning experience for students will be one of the main factors that will affect students' critical thinking skills. Therefore, it is hoped that educational institutions can facilitate lecturers to design and implement chemistry learning with innovative and ethnochemistry-based learning models.

V. Conclusion

To summarize, this study comes to the conclusions: 1) Critical thinking skills (CTS) of chemistry education students are higher than ethnochemistry-based learning experiences (ELE), and 2) there is no significant relationship between ethnochemistry-based learning experiences and critical thinking skills based on gender. The survey findings were also supported by interviews that unveiled the implementation of ethnochemistry-based learning and critical thinking skills still need to be improved in the planning, implementation, and evaluation stages. Hence, higher education institutions and lecturers need to adopt chemistry learning that is oriented toward developing soft and hard skills through implementing an ethnochemical approach to learning.

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