

# The Correlation of Undergraduate Course Research Experience and Critical Thinking Skills

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This research aimed to analyse the correlation of undergraduate course research experience and critical thinking skills in the context of laboratory research. The undergraduate courses in this research were basic chemistry, plant-determination, photochemistry, drug, food, and cosmetic analysis. The students in a pharmacy department developed critical thinking skills during their time, making and using solvents, determining plant, analysing the fractionating active compound, and analysing active compounds. This research was qualitative descriptive research and used observation and interviews to collate data. Eighteen students made up the sample population. The critical thinking skills were divided into low, middle, and high categories (percentage). The data show the same interval in mean, standard deviation, and category percentage in every category with the same participants. The descriptive analysis used observation and interview in four undergraduate courses during laboratory research experiences. The study shows a positive correlation between critical thinking skills in the pharmacy laboratory and the undergraduate course.

**Keywords:** *Correlation, Course-Undergraduate research, critical thinking skill.*

## Introduction

The transferable skills were sought to prepare the students for real-life situations. These situations were selected to give students different real-life situations from the classroom learning situation (Bennet et al., 2002; Calderhead et al., 2012; Day et al., 2013; Pope & Denicolo, 2000). Every university or higher education provider needs to prepare their students with transferable skills including critical thinking, problem-solving, creative thinking, cooperation, and good communication skills including Information Communication Technology (ICT) knowledge (Deacon & Hajek, 2011; Setiawan et al., 2018; I. Thomas, 2009). To do this, they need to design the learning process in the classroom and outside the classroom for different situations. These transferable skills can be undertaken, for example, in a science-



learning context during undergraduate course research and practicum in laboratories. The main purpose of undergraduate course's experience of research practice is experience applying the scientific approach, developing knowledge in theory and balancing this with practicum skills, to improve research experience and practicum skills, to increase critical thinking skills, to increase problem-solving ability, and to learn the nature of science (Brewer et al., 2009; Byers et al., 2002; Hauhart & Grahe, 2015; Wenning, 2006).

Based on the Centre for the Advancement of Pharmacy Education (2013) and the Accreditation Council for Pharmacy Education standards (2016), universities or higher education providers in pharmacies must be able to prepare their students for critically thinking (Brewer et al., 2009; Education, 2015; Maudsley & Strivens, 2000) to solve complex patient problems, to analyse and produce equipment for pharmacy practice, and to solve environmental problems in pharmacy locations. These aims have become the vision and mission of the pharmacy department of Universitas Hamzanwadi. For preparing the students, education outcomes encourage instructional methods that include theory with didactic and simulations and experiential activities (Martin et al., 2016; Persky et al., 2019). For theory, faculties employ multiple teaching approaches for helping students learn these skills (Holland, 2019; Noe et al., 2015; Steinert et al., 2016).

The pedagogic approach that we have developed should become necessary for all students (Guise et al., 2012; Harris & Hofer, 2011; Richards et al., 2007). Theory and experimental learning in which conduct in research experience could be related (Bringle & Hatcher, 1995; A. Y. Kolb & Kolb, 2005; Lopatto, 2007). So the ability to transfer theoretical knowledge and apply it to the research experience or practicum skill becomes necessary for students. Knowing the relationship between theoretical knowledge and research experience in the learning process is needed for faculties. Faculties can change or developing their curricula based on this knowledge. So, an active reflection in a learning process becomes highly important (Barhoumi, 2015; Dewey, 1986; A. Y. Kolb & Kolb, 2005; D. A. Kolb, 1976; Linn et al., 2015; Shields, 1995). Therefore, first, we need to understand how they correlate of course-undergraduate student research experience toward critical thinking skill students in a laboratory, then understand the correlation of theoretical knowledge with student's research experience.

The Knowledge of that correlation becomes a basis for considering the curricula, content, method, and assessment in a learning process. So, we know the material or research side that we have emphasized in every course-undergraduate student. In the pharmacy department of Universitas Hamzanwadi, research experience or practicum skill was planned by the student since the first semester to the sixth semester. In this research, we focused on four practices include basic chemistry in the first semester, plant-determination in the second semester, photochemistry in the fourth semester, and drug, food, and cosmetic analysis in the fifth semester. Every practicum has special characterize and distinguish each other. Otherwise, every practicum related to each other and became a basic skill for another practicum. A student



in the pharmacy department got these skills to step by step during their semesters, such as the ability for making and using solvents in basic chemistry, determining plant in plant-determination, using solvent, and specific plant for the fractionating active compound in photochemistry. The last is analyzing the active compound in drug, food, and cosmetic analyzes. For analyzing active compounds, a student must have the ability and skill for preparation sample, preparation solvent and reagents, and active fractionation compound. So, from this explanation, basic skills and their correlation, also critical thinking skill in every practicum is immediately needed for increasing quality of the learning process.

This research focused on four course-undergraduate research experiences during at least three years since the first semester. We emphasized our observations and interviews with the same participant. A variety research on undergraduate student in improving the critical thinking skill included model, method, and measurement of critical thinking skills (Caldas et al., 2019; Ewertsson et al., 2015; Jones & Lerner, 2019; Setiawan et al., 2018; Stephenson et al., 2019; Tutticci et al., 2016). But none of our best knowledge focused on the correlation of course-undergraduate since the first semester. The objective of this research was to analyze the correlation of undergraduate research experience towards critical thinking skills in pharmacy laboratory. To know the correlation, we can easier to choose and implement the model or method or educational approach, adequately based on our conditions. The current research was aimed at answering the following questions: 1) How the descriptive explanation of observation results of student's ability in critical thinking skills in pharmacy laboratory, 2) How the correlation of course undergraduate research experience towards essential skills of thinking in pharmacy laboratory.

## **Methods**

### ***Design***

This research was qualitative descriptive design with an inductive approach (Kemperaj & Chavan, 2013; Liu, 2016; D. R. Thomas, 2006; Van Wyk, 2012). Observation, interviews, and questioners were used for data collection (Morgan et al., 2017; Morsy, 2017; Nassaji, 2015).

### ***Participants***

Pharmacy students from the first semester to the fifth semester in the pharmacy department at Universitas Hamzanwadi, East Lombok, participated in this research. They planned all practicum that focused on this research since the first semester. In other words, all participants are a third-year student of the pharmacy department who programs this course-undergraduate research experience. About 18 students participated in this research, divided into 14 women and 4 men, all between 19-21 years of age.



### ***Critical Thinking Skill in Laboratory***

In this study, critical thinking explained higher cognitive skills, knowledge of theoretical concepts, and attitudes of participants in the laboratory. The options of critical thinking in this research focused but not limited in analysis, inference, evaluation, explanation, interpretation, and inquisitiveness (CARVALHO et al., 2015; O'Halloran et al., 2017; Steinert et al., 2016; Stephenson et al., 2019; Živkovič, 2016). All the items will be analyzed by observation and interviews.

### ***Data Collection***

Data of correlation of four course-undergraduate research experiences in the laboratory included basic chemistry, plant-determination, photochemistry, and drug, food, and cosmetic analyzed were collected by observation and interviews. Also, critical thinking skill in the laboratory was collected by observation, too.

### ***Data Analysis***

Data observation from the correlation of course-undergraduate and critical thinking was analyzed by qualitative description and range category of critical thinking skill in laboratory-based on a percentage of the total sample (n=18). Mean, and standard deviation (SD) were used to assess the critical thinking skill of the student and their performance on the individual grade achievement.

### **Results and Discussion**

#### ***The Qualitative purpose Description of course-undergraduate and critical thinking***

The curricula of the pharmacy department, Universitas Hamzanwadi, have programmed the course-undergraduate research experience from the first semester to six semesters during the undergraduate time. In the seventh semester, students have focused on real research. During one semester, there are two or three practicum courses that have to be programmed by students. The critical thinking skill in the laboratory has gotten by the student in the first semester and developed with increasing their semester. This skill should be increased step by step during their time in the pharmacy department.

The range category in this research divided into three categories, including the low, middle, and high category (Brannen, 2017). This range based on the critical thinking skill options included analysis, inference, evaluation, explanation, interpretation, and inquisitiveness.



a. Basic Chemistry

Low Category: the students have less ability to solve problems or questions that lecture given in the practicum learning process, even in the pretest or posttest activities. They also have less ability to analyze the formula that they used in making solvents. They still not understanding the kinds of solvent, the function, how we divided the solvent and reagent, and how we use the solvent and reagent in the laboratory. They lack in evaluation, interpretation, and inquisitiveness of practicum results that they reported.

Middle Category: the students can solve the questions or problems in pretest and posttest activities, can analyze and choose the formula that they used in making solvents, understanding solvent include kinds and functions, also using in a laboratory. They are still quite enough in evaluation, interpretation, and inquisitiveness.

High Category: the students have the comprehensive ability to solve questions or problems, in analyzing and choosing formula to make solvent and reagent, in understanding the kinds, function, and using solvent and reagent in a laboratory. They can evaluate and interpretation of the data and inquisitiveness.

b. Plant-Determination

Low Category: the students have less ability to determine and use the determination key. Therefore they lack in verification plant or sample.

Middle Category: the students have enough ability to determining and using the determination key. Therefore they can verify the plant or sample but in a long duration.

High Category: the students have the ability and comprehensive understanding in determining and using the determination key, therefore they can comprehensively verify the plant or sample.

c. Photochemistry

For photochemistry, this research focused on fractioning active compounds in the sample. For this understanding, the student must have the ability to making and using solvent and reagents and determining the plants. If they lack these skills, they will fail in fractioning the active compounds, of course. They failed in choosing the extraction method with a specific solvent, reagents, and plants. Finally, they failed in using an identification method for fractioning the active compounds. So, only students who have a high category can do this skill. The student in the middle category must try more and more.

d. Drug, Food, and Cosmetic Analysis

Drug, food and cosmetic analysis practicum is the highest level of student skill laboratory in analyzing active compounds. This critical thinking skill was an advanced skill than another. For analyzing the active compounds, the student must have comprehensive knowledge and laboratory skill in making and using solvents and reagents, determining plants, and fractioning active compounds. Same as in photochemistry, the only student with comprehensive knowledge and laboratory skill can do this critical thinking skill in a pharmacy laboratory.

***Number of Critical Thinking Skill in Laboratory***

The number of critical thinking skills in laboratory-based on qualitative analysis with the total sample was 18 students. The mean and standard deviation of basic chemistry for this sample was 78.09 and 8.96, respectively. 75.01 as mean and 9.01 as SD for plant determination, 77.29 as mean and 12.57 as SD for photochemistry, and 77.19 as mean and 15.95 as SD for drug, food, and cosmetic analysis. Then, the number of critical thinking skills in the laboratory show in Table 1.

**Table 1. Number of Critical Thinking Skill in Laboratory for Course-Undergraduate Research Experience**

Course-Undergraduate Research Experience	Category Percentage (n=18)		
	Low n (%)	Middle n (%)	High n (%)
Basic Chemistry	2 (11.11%)	6 (33.33%)	10 (55.55%)
Plant-Determination	4 (22.22%)	5 (27.78%)	9 (50%)
Photochemistry	3 (16.67%)	5 (27.78%)	10 (50%)
Drug, food, and cosmetic analysis	3 (16.67%)	5 (27.78%)	10 (50%)

In the qualitative description, students in the low category were samples who lack in analysis and inference. For the middle and high category, students were samples which can evaluate, explanation, interpretation, and inquisitiveness. The analysis and inference aspect needs basic laboratory skill. The undergraduate students got this skill in the first year of their studies, basic chemistry, and plant determination practicum, respectively, in this research. The ability and the comprehensive knowledge of solvents, reagents, determining and using determination key, choosing and analyzing formulas that they used were vitally needed for the higher practicum, including photochemistry and drug, food, and cosmetic analyzes practicum. Otherwise, the ability in evaluation, interpretation, and inquisitiveness also needed for the real research and real-life of students after they graduate. Therefore, the main purpose of a learning process to transferable skill to real-life situations can be achieved (Brewer et al., 2009; Byers et al., 2002; Hauhart & Grahe, 2015; Wenning, 2006). The results strengthened by the category percentage of course-undergraduate research experience above. The students in the low category in basic



chemistry and plant-determination practicum become a low category in the higher practicum. Also, the percentage of middle and high categories in the higher practicum (photochemistry and drug, food, and cosmetic analyzes) have the same percentage. This result means that critical thinking skills in basic course-undergraduate which taken in the first year studies have influences highly on the higher courses-undergraduate. So, the pharmacy department should be given; they are focused on basic course-undergraduate for increasing critical thinking skills in the pharmacy laboratory.

From the number of critical thinking skill laboratory, the mean and standard deviation range for four course-undergraduate research experience focused on this research show the same interval range. The interval range 75-78 for the mean. Also, the interval range for mean and standard deviation in the basic skill laboratory, which got by the student in their first year, was not high enough. For the higher practicum, they have the same mean, and standard deviation was not high enough. For the category percentage of these courses also show the same interval percentage.

Moreover, in higher practicum, including photochemistry and drug, food, cosmetic analysis show the same category percentage in low, middle, and high category with the same participants, generally. Therefore, based on these data, courses-undergraduate research experiences have a positive correlation to increase the critical thinking skill in the laboratory. There was one participant that has increased in the analysis aspect of critical thinking skills in higher practicum, better than basic practicum. Counseling action in a learning process by giving extra attention and developing comprehensive knowledge to the student has been done continuously. But the improvement and increasing comprehensive knowledge is not an easy thing and achieved in a short time. An achievement in a learning process needs more struggle and improvement continuously (Schmoker, 2018).

Furthermore, for future research, we will analyze the interview result and verbatim of the individual participant, also the questioners of the participant. This result will be used to consider the proper method, model, or educational approach for increasing the critical skill in a laboratory for course-undergraduate research experiences. The further result will be used as basic in considering a review of curricula in health faculty.

## **Conclusion**

The descriptive analysis of observation and the number of critical thinking skills in four courses-undergraduate research experience show a positive correlation toward critical thinking skills in the pharmacy laboratory. Basic skills in basic chemistry and plant-determination practicum highly influenced critical thinking skills in the next practicum in a higher year of a learning process.



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