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Investigating the Meaningful Learning in Chemical Separation Practicums: A Quantitative Approach

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Abstract
Meaningful learning has an important element that is finding advantages in obtaining various information comprehensively, thereby ultimately improving learner's abilities. This aspect can provide information to understand and enhance meaningful learning. The purpose of this research is to analyze meaningful learning in the chemical separation practicum for the Chemistry Education students at FKIP UNTAN. The type of research used is quantitative descriptive with a survey method. Data collection tools in this analysis are questionnaires and interview guidelines. The questionnaires and interviews were administered after the practicum was completed. The number of students for the questionnaire was 58 people consisting of 26 people who were interviewed, including course instructors, laboratory heads, laboratory assistants, and student representatives from classes A1, A2, A3. The research results, in terms of the affective aspect, were 64% in the good category. In terms of the cognitive aspect, a percentage of 73% was achieved in the good category, while the affective-cognitive aspect had a percentage of 66% in the good category. Based on the data obtained, it can be concluded that learning in this chemical separation practicum is meaningful.

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INTRODUCTION

Chemistry is one of the fundamental branches of science that specifically studies the existence of matter in terms of its structure, abstract properties, and the energy changes accompanying them (Subagia, 2014). Its principles are based on the characteristics of the chemistry itself, namely: (1) some chemical concepts are abstract; (2) chemical concepts are generally simplifications of the actual state; and (3) chemical materials and concepts are interconnected sequentially and hierarchically (Kurniawati & Amarlita, 2013). The subject of chemistry, as one branch of science, has two inseparable aspects: chemistry as a product (chemical knowledge in the form of facts, concepts, principles, laws, and theories) discovered by scientists, and chemistry as a process of scientific work (Wardani, 2013).

Abstract chemical materials require reasoning and imagination, so there is a need to better understand abstract chemical materials through discussions or direct field practices such as laboratory experiments by students (Husita, 2017). In chemical separation practicum, the phenomenon commonly encountered is the process of separating or purifying a compound or group of compounds with related chemical compositions, both on a laboratory scale and in industry (Cahyani et al., 2021).

Practical work is essentially conducted to enhance all three domains of meaningful learning, namely cognitive, affective, and psychomotor, although, the emphasis is on the psychomotor domain. Evaluating the implementation of practical work is necessary because evaluations can serve as considerations for determining or making specific policies, which begins with a systematic data collection process (Al-Bari & Saputri, 2020).

Meaningful learning is a learning process where new information is connected to the existing understanding structure of learners during the learning process. Meaningful learning occurs when learners attempt to link new phenomena with their existing knowledge and relate it to the subject matter, thereby generating new concepts. Meaningful learning is enjoyable and has the advantage of obtaining comprehensive information, ultimately enhancing learners' abilities (Najib, 2016). In the perspective of the course instructors, they strive to maximize the available time because conducting chemical separation practicums requires a considerable amount of time. This difficulty makes it challenging to ensure that all students can focus on both the theory being learned and the practical aspects in the laboratory, ensuring alignment with meaningful learning domains.

The learning domain in meaningful learning occurs when all active domains, including cognitive (thinking) and affective (feeling) aspects, and psychomotor (doing) are actively involved. Students must use cognitive and affective strategies to perform laboratory work (psychomotor), which means these ideas can be easily applied.. Therefore, the Meaningful Learning in the Laboratory Instrument (MLLI) was developed to measure meaningful learning in the cognitive and affective domains, as well as measure students' expectations of meaningful learning in laboratory practicums (Galloway & Bretz, 2015). However, there are challenges that students face during laboratory sessions, which can reduce their enthusiasm for the practicum. These challenges include the lengthy duration of the practicum, reluctance to use glass laboratory equipment, and insufficient participation in task allocation within the laboratory.

Additionally, Rahman (2011) stated that laboratory practicums contribute significantly to students' development, with over a 50% improvement in students' knowledge, skills, and character competencies. Thus, laboratory practicums are crucial in developing students' abilities. The MLLI instrument provides an opportunity for laboratory assistants to assess meaningful learning in the context of their specialized undergraduate laboratory instruction. Laboratory assistants can use the MLLI to assess current student experiences and use the data as evidence to improve the curriculum and/or pedagogy to generate more meaningful learning, i.e., enhancing cognitive experience, enhancing affective experience, and improving integration of all these aspects (Galloway & Bretz, 2015).

In the study by Williams et al. (2022), it was shown that in the cognitive domain, all expectations exceeded 50% on the pretest, indicating anticipation of meaningful learning. Meaningful learning involves connecting new information to relevant concepts within an

individual's cognitive structure. The cognitive structure includes facts, concepts, and generalizations that students have learned and remembered (Rahmah, 2018).

Thus, it can be concluded that meaningful learning should be achievable and applicable to learners. Based on the literature reviewed, there has been no measurement of meaningful learning in practical work, particularly in Indonesia, as it was found through searches on Google Scholar and other journal search applications. However, the role of meaningful learning is highly anticipated by researchers in laboratory practicums (Williams et al., 2022). Based on the above description, researchers are motivated to conduct a study titled "Analysis of Meaningful Learning in Chemical Separation Practicum." The results of this research are expected to provide information and insights into meaningful learning in the Chemical Separation Practicum.

METHOD

The type of research used is quantitative descriptive research. In this research, descriptive refers to quantitative description because it uses measures, numbers, or frequencies (Sukmadinata, 2006), aimed at describing perceptions as they exist. Descriptive research does not involve treatment or manipulation but describes a condition as it is (Diannisa et al., 2023). Thus, the data obtained are genuinely derived from research results using questionnaires and interviews with respondents in the analysis of meaningful learning among Chemistry Education students of FKIP UNTAN, Class of 2021.

The research method used in this study is survey research. The survey is a research method that uses questionnaires as data collection instruments, to obtain information about several respondents considered to represent a specific population (Ardiansyah, 2010). This research was conducted at the Department of Chemistry Education of the Faculty of Teacher Training and Education, Tanjungpura University, Pontianak. The subjects of this study were Chemistry Education students from the 2021 class, totaling 59 students consisting of 3 classes: A1 with 23 students, A2 with 25 students, and A3 with 11 students.

Data collection techniques are the most important steps in research because the primary objective of this step is to gather data. To support the analysis needs in this research, one way to obtain data and information is through indirect communication, which is a technique that uses channels or means to convey a message to a distant or large number of recipients using a medium (Effendy, 2002). In this research, indirect communication is facilitated through the use of a questionnaire as a data collection technique.. A questionnaire is a method of data collection by distributing a list of questions about a problem or aspect to be studied. To obtain data, the questionnaire will be distributed to respondents to gather their responses to the list of questions (Narbuko, 1997). In this study, the type of questionnaire used is a closed-ended questionnaire, which consists of questions or statements with a certain number of specific answers as options. In this data collection technique, the questions are based on the results obtained so that respondents can freely choose their answers without coercion or influence from any external party. The instrument used is the MLLI (Meaningful Learning in the Laboratory Instrument). Meaningful Learning in the Laboratory Instrument (MLLI) was developed to measure meaningful learning in the cognitive and affective domains, as well as measure students' expectations in laboratory practicums (Galloway & Bretz, 2015). The questionnaire in this study uses a Likert scale as follows:

Table 1. Likert Scale Assessment

Answer	Score
Strongly Disagree	1
Disagree	2
Neutral	3
Agree	4
Strongly Agree	5

(Sugiyono, 2011).

According to Effendy (2002), face-to-face communication occurs when communicators and communicants face each other during interaction. In such situations, communicators can directly observe and assess communicants, leading to it being known as direct communication. In this research, direct communication is facilitated through a semi-structured interview guide. This guide consists of a set of 5 questions initially, which can be further developed based on the types of questions and the depth of information desired.

Instrument validity testing essentially refers to the degree to which an instrument measures what it is supposed to measure, or the precision of its measurements. Validity pertains to the accuracy of the assessment tool about the concept being assessed, ensuring that it truly measures what it should. The accuracy of instrument selection significantly impacts the objectivity and validity of assessment results, ultimately providing objective and valid information about the quality of education (Alfianika & Sitohang, 2022). The instrument used is adopted from MLLI, so the validation conducted on the instrument relates only to the language aspect. This language validity is divided into two parts as follows: MLLI instrument validity is a test of validity in terms of English language translated into Indonesian, consisting of 30 statements. Validation was conducted by three lecturers, including two language experts from the English language education department and one lecturer from the Faculty of Mathematics and Natural Sciences (FMIPA).

The validity of the interview guide was determined by selecting 5 questions out of the 60 collected questions for course lecturers, laboratory assistants, students (practicum participants), and laboratory heads. The validity testing and question selection involved two examiners from the Chemistry Education program. The result was 5 questions each for course lecturers of the chemical separation practicum, laboratory assistants, students (practicum participants), and laboratory heads.

The first step in data analysis is scoring. Scoring is done using a Likert scale to determine the value of each question. A 5-point rating scale is employed, with each scale having different ratings. The Likert scale is utilized to measure meaningful learning in the chemical separation practicum for Chemistry Education students at FKIP Untan. Then, the scores of answers obtained from each respondent are aggregated. The questionnaire results are calculated using the percentage formula as follows (Sugiyono, 2017):$P=F/n \times 100\%$

Explanation:
P: Percentage
F: Average score
n: Total maximum score
When presented as a percentage, these values are classified into calculation criteria.

Table 2. Meaningful Learning Categories

%Score	Category
81-100	Very Good
61-80	Good
41-60	Fair
21-40	Deficient
0-20	Very Less

(Riduwan, 2008)

RESULTS AND DISCUSSION

From the research findings (Najib and Elhefni, 2016), it is stated that students' learning outcomes after using Meaningful Learning can be considered high and more successful. Students who scored 80 or above amounted to 37 out of 50 students. This is also evidenced by students being able to express everyday experiences such as diligence, honesty, discipline, not easily complaining, and staying enthusiastic. Students can mention characteristics of enthusiasm in work and perform tasks according to the realities of daily life that they experience. From these research findings, it can be concluded that meaningful learning in chemical separation practicums plays a crucial role in meaningful learning analysis for students.

In this section, we will elaborate on the research results and discussion based on the main and supporting data obtained through questionnaires and interviews. According to Sugiyono (2017), descriptive statistics are intended to describe and analyze collected data rather than draw general conclusions. Descriptive statistics can be interpreted as describing the data generated without the need to draw conclusions that apply to the general public, but rather to draw factual conclusions from the data. The presentation of data analyzed in this descriptive analysis is through percentage calculations. The questionnaire was distributed and filled out from October 6, 2023, to October 15, 2023. A total of 58 respondents were collected, comprising 23 from class A1, 25 from class A2, and 10 from class A3.

The questionnaire, containing 30 statements, includes affective, cognitive, and affective cognitive aspects. The affective aspect comprises components related to feelings of pleasure or displeasure towards attitude objects (Muhali, 2013). Pleasure is a positive aspect, while displeasure is negative. The cognitive aspect comprises perceptual components related to knowledge, views, beliefs, which are linked to how people perceive attitude objects (Byrne, 2005). The summary of the average analysis of meaningful learning in the chemical separation practicum for Chemistry Education students at FKIP Untan is depicted in Figure 1.

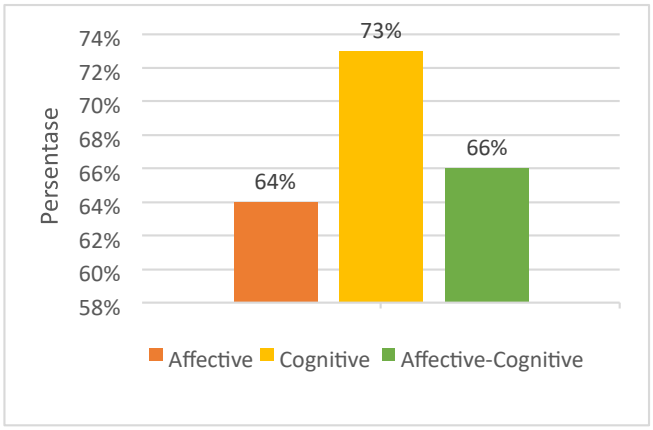

Figure 1. Summary of Average Meaningful Learning in Chemistry Education Students

Figure 1 presents the average results of the sum of all aspects from classes A1, A2, and A3, representing data for all Chemistry Education students of the 2021 class. The results indicate that the affective aspect has a percentage of 64%, the cognitive aspect has a percentage of 73%, and the affective-cognitive aspect has a percentage of 66%. Therefore, the criteria for meaningful learning in the chemical separation practicum for Chemistry Education students of the 2021 class, based on each of these aspects, fall into the "good" category. The criteria for the success of the learning process are assessed based on these results. Learning outcomes that should be used as the basis for assessing the success of the learning process are authentic, lasting, useful, and meaningful for students (Astuti, 2023). This aligns with research conducted by Rosana (2013), which states that the achievement criteria for cognitive and affective variables of 61% fall into the "high/good" category.

The interview results indicate that meaningful learning is related to the theory learned and its application by students, especially in the chemical separation practicum. Students stated, "There is a connection, such as examples of anion and cation separation theory, from the theory taught, which is applied in the chemical separation practicum." This is supported by the interview results from laboratory assistants, who stated, "The purpose of this practicum is to train students in using laboratory equipment and materials and understanding the concepts learned," and by course lecturers who stated, "Students master lab techniques and improve the theories taught." This is also consistent with the interview results from the laboratory head, who stated, "Basic skills in the material must be mastered in the practicum, which is, of course, obtained from the theory learned." The data results obtained from each affective, cognitive, and affective-cognitive aspect of meaningful learning in classes A1, A2, and A3 are displayed in Figures 2, 3, and 4.

Affective Aspect

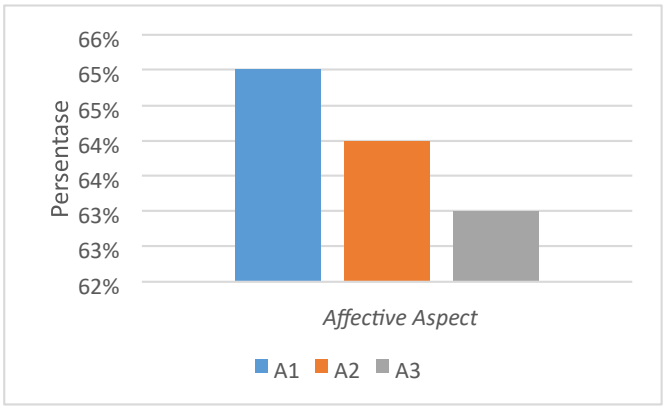

Figure 2. Summary of Meaningful Learning in Affective Aspect of Chemistry Education Students

Based on the data obtained from classes A1, A2, and A3, meaningful learning in the affective aspect falls into the "good" category at 65%, 64%, and 63%, respectively. In this research, the affective aspect exhibits a lower percentage compared to the data from the cognitive and affective-cognitive aspects. The affective domain plays a crucial role in determining an individual's learning success; those lacking interest in a particular subject may find it challenging to achieve optimal study outcomes. Conversely, individuals with a strong interest in a subject are expected to attain optimal learning outcomes (Rasyid & Mansur, 2007).

The affective aspect pertains to a cognitive domain that encompasses behavioral characteristics such as feelings, interests, attitudes, emotions, or values. Targets of the affective domain include perseverance, precision, and the ability to solve logical and systematic problems. This domain is characterized by behaviors related to emotional aspects such as feelings, values, interests, concerns, motivation, and attitudes (Qadar et al., 2015).

Therefore, it can be concluded that in meaningful learning, the utilization of the affective domain tends to be lower because this domain involves assessing behavioral characteristics such as attitudes, interests, self-concepts, values, and morals. Attitude is a complex psychological concept that represents an individual's evaluation of a particular object, person, or issue. Attitude scale assessments are commonly used to evaluate learning outcomes in the affective domain. Developing attitude scale assessments for students is necessary to determine changes in their attitudes during the learning process (Saftari & Fajriah, 2019). *Cognitive Aspect*

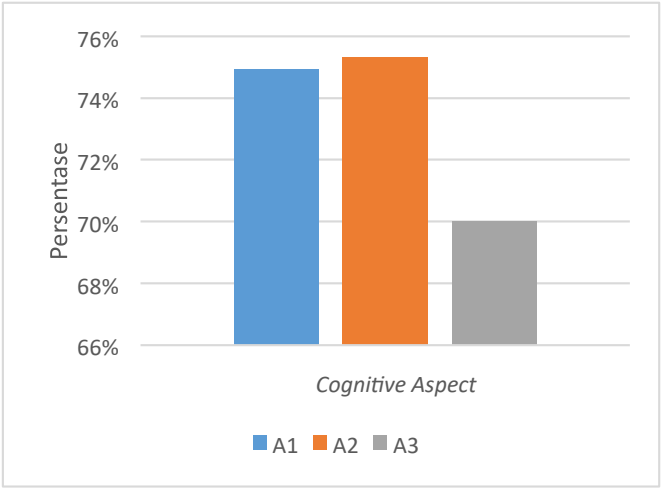

Figure 3. Summary of Meaningful Learning in Cognitive Aspect of Chemistry Education Students

Based on the data obtained from classes A1, A2, and A3, which are 75%, 75%, and 70%, respectively, in terms of the cognitive aspect, all fall into the "good" category. This aligns with research by Hamid (2014), which suggests that a percentage range of 61%-80% falls into the "good" category. The data from these three classes are consistent, indicating that meaningful learning tends to be dominant in the cognitive aspect, with a higher percentage across all classes. This suggests that in meaningful learning, students primarily engage their knowledge in understanding the learning process. This aligns with the understanding that the cognitive aspect encompasses students' knowledge (Mawardi et al., 2022). Furthermore, understanding concepts (cognitive), according to Bloom as cited in Anggarini (2012), is defined as the ability to absorb the meaning of the material or content being learned. Therefore, it can be concluded that meaningful learning in the chemical separation practicum tends to be predominantly focused on the cognitive aspect itself.

According to Nurbudiyani (2013), the cognitive domain includes mental activities (brain) such as thinking ability, understanding, memorization, application, analysis, synthesis, and evaluation. The purpose of measuring the cognitive domain is to obtain accurate information about the level of achievement of instructional objectives by students, especially at the levels of memorization, understanding, application, analysis, synthesis, and evaluation. The benefits of measuring the cognitive domain are to improve the quality or enhance the performance of students in the cognitive domain, particularly at these levels of cognitive function.

Affective-Cognitive Aspect

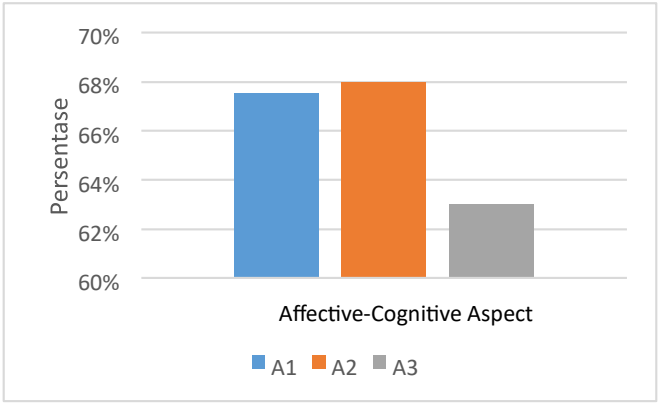

Figure 4. Summary of Meaningful Learning in Affective-Cognitive Aspect of Chemistry Education Students

Based on the data obtained from classes A1, A2, and A3, the percentages for the affective cognitive aspect are 68%, 68%, and 63%, respectively. The affective-cognitive aspect of this research data indicates the division of MLLI instruments into several items. Statements from items 25 to 30 represent the affective-cognitive aspect because these statements involve both affective and cognitive aspects. Thus, the three aspects obtained are the affective aspect, cognitive aspect, and affective-cognitive aspect. In this case, there is no involvement of the psychomotor aspect because the MLLI instrument is used to assess whether a learning experience is meaningful, and analyzing meaningful learning occurs after the completion of the practicum. Psychomotor skills are more related to practical skills performed according to Bloom's understanding (Rahman, 2020), which states that psychomotor skills contribute to the development of fundamental mental, physical, and social abilities as drivers of higher-level abilities in individuals.

Based on the explanation above, it is evident that the affective, cognitive, and affective cognitive aspects each play a role in meaningful learning in the chemical separation practicum. The analysis shows that meaningful learning in the chemical separation practicum for Chemistry Education students at FKIP UNTAN falls into the "good" category, with an overall average percentage of 64% for the affective aspect, 73% for the cognitive aspect, and 66% for the affective-cognitive aspect. This is also supported by the interview results regarding the understanding of objectives and practices in understanding meaningful learning in the chemical separation practicum, in line with Prastowo's opinion (2013:37) that using the environment will result in meaningful learning processes and outcomes for students because they are confronted with real-life events and situations.

CONCLUSION

In conclusion, meaningful learning in the chemical separation practicum for Chemistry Education students at FKIP UNTAN falls into the "good" category, with the affective aspect averaging 64%, the cognitive aspect averaging 73%, and the affective-cognitive aspect averaging 66%. This indicates that students engage meaningfully in connecting theoretical knowledge with practical applications in the laboratory setting. The study highlights the importance of both cognitive and affective domains in achieving meaningful learning

outcomes. While cognitive aspects focus on knowledge acquisition and understanding, affective aspects, though slightly lower in percentage, play a crucial role in shaping students' attitudes, interests, and motivation toward learning. The integration of both cognitive and affective aspects contributes to a comprehensive and meaningful learning experience.

Furthermore, the research methodology, employing quantitative descriptive research and survey methods, proved effective in assessing students' perceptions and experiences regarding meaningful learning in the chemical separation practicum. The use of validated instruments such as the MLLI provided reliable data for analysis. Additionally, interviews with course lecturers, laboratory assistants, and students provided valuable insights into the connection between theoretical concepts and practical applications, further enriching the study findings.

The findings of this study underscore the importance of meaningful learning in laboratory practicums and its potential impact on students' knowledge, skills, and attitudes. It also highlights the need for continuous evaluation and improvement of laboratory instruction to enhance meaningful learning experiences. Future research could explore additional factors influencing meaningful learning outcomes and investigate strategies for optimizing meaningful learning in laboratory settings. Overall, this study contributes to the growing body of literature on meaningful learning in science education, particularly in the context of laboratory practicums.

RECOMMENDATIONS

Students should actively evaluate the meaningfulness of their learning experiences to foster enthusiasm for learning and enhance its application in their daily lives. This can be accomplished by comprehending the objectives and outcomes of the learning activities they participate in. To ensure that meaningful learning continues to be implemented effectively, or even exceptionally, it is important for lecturers to maintain a good relationship with students as an effort to enhance their academic performance. Additionally, it is crucial to sustain meaningful learning by consistently applying well-implemented meaningful learning theories.

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