JPPIPA 11(3) (2025)

Jurnal Penelitian Pendidikan IPA

Journal of Research in Science Education

http://jppipa.unram.ac.id/index.php/jppipa/index

Description of Meaningful Learning in Basic Chemistry Practicum for Chemistry Education Students

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Received: May 03, 2024
Revised: January 16, 2025
Accepted: March 25, 2025
Published: March 31, 2025

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DOI: 10.29303/jppipa.v11i3.7564

Abstract: This study aims to describe meaningful learning in basic chemistry practicum of chemistry education students of FKIP UNTAN. The method used in this research is quantitative descrptive method. Quantitative data were collected using Meaningful Learning in the Laboratory Instrument (MLLI) instrument to measure students' affective and cognitive experiences after learning in the laboratory. This study also used interview guidelines to collect more in-depth information about meaningful learning experiences for chemistry education students in basic chemistry practicum courses. This study involved 51 first semester students of Chemistry Education of FKIP UNTAN who had completed basic chemistry practicum courses, laboratory heads, laboratory assistants,and lecturers teaching basic chemistry practicum courses. The results showed that all aspects were rated as good. With percentage scores of 67% for affective aspects, 75 % for cognitive aspects, and 67% for affective-cognitive aspects, resulting in an overall average score percentage of 72%. Based on these findings, it shows that first semester chemistry education students have achieved good meaningful learning trough their learning experiences in basic chemistry practicum.

Keywords: Affective; Cognitive; Critical thinking; Practicum method; Student ability

Introduction

Chemistry is part of natural science that is obtained and developed based on experiments to find answers to questions what, why, and how about natural phenomena, especially those related to the composition, structure, abstract properties, transformation, dynamics, and energetics of substances (Kemdikbud, 2016). In chemistry, the ability to master basic concepts is needed because the concept of learning chemistry is abstract and tiered so that it must be fulfilled to learn many concepts at a higher level (Armalasari, 2017). In the learning process, many aspects affect the quality of a learning process. One important aspect that gives a big influence is the use of learning media that is in accordance with the characteristics of students (Abadi, 2016). Gasong (2017) states that teaching and learning is an educational activity (Sapulete et al., 2023). To support the ability to learn chemistry which is abstract and tiered, practicum is needed as a supporting tool in delivering material to students (Yanti & Sutrisno 2024). This is in line with the results of research by Mamlok et al. (2012) which shows that practicum activities have an important role and benefits in the science curriculum (Pratama & Rohaeti, 2024). Learning objectives include the development of aspects of attitudes, knowledge, and skills elaborated for each unit of education (Basir et al., 2024). One of them is practicum which plays an important role (Tommy et al., 2024).

Practical activities are application activities of the theories that have been learned to solve various problems through experiments in the laboratory (Wiratama & Subagia, 2014). Djamarah (2005) states that the practicum method is a learning process in which students are given the opportunity to experience themselves or do it themselves, follow a process, observe

How to Cite:
Lestari, S., Erlina, Lestari, I., Masriani, & Ulfah, M. (2025). Description of Meaningful Learning in Basic Chemistry Practicum for Chemistry Education Students. *Jurnal Penelitian Pendidikan IPA*, *11*(3), 106–114. https://doi.org/10.29303/jppipa.v11i3.7564

an object, analyze, prove and draw their own conclusions about an object, condition or process of something, so that students can answer the question "how is the process?" consisting of what elements, which way is better, how can the truth be known, all of which are obtained through inductive observation.

According to Nirmala et al. (2018) Practicum activities consist of three main stages: pre-practicum, core practicum, and post-practicum. Pre-practicum is a preparatory stage carried out by students by studying concepts and making work plans. The next stage is the core activities carried out in accordance with the agreed objectives and work design. This activity involves the use of glassware, instruments, and materials with varying levels of safety and risk. The last stage is post-practicum to analyze data analysis of experimental results to obtain appropriate conclusions. This practicum series is a learning formulation that has been considered effective, because it not only improves students' conceptual and cognitive understanding, but also forms technical skills such as manipulation, observation, data collection, processing and analysis (Mukti, 2018).

Basic chemistry practicum is one of the mandatory practicums for Chemistry Education students of FKIP UNTAN (Hadiwangsa et al., 2024). Basic chemistry practicum is the first practicum course taken by Chemistry Education students. In Basic Chemistry practicum, basic things are taught such as providing tools and materials, performing existing experimental procedures, then compiling experimental reports (Sutarno et al., 2017). Then Ericka et al. (2005) mentioned that Basic Chemistry practicum activities are specifically designed to help students develop various process skills such as observing, classifying, measuring, using tools, communicating results, analyzing, identifying variables, formulating hypotheses, designing experiments and conducting experiments.

Educators hope that students will be able to understand more broadly the theory of Basic Chemistry courses taught by educators. However, according to experts, this hope has not been realized as it should be (Kurniasih & Sani, 2015). The implementation has many weaknesses, obstacles and gaps that occur. Among them, there is no significant relationship between the ability to understand concepts with experimental skills and vice versa and this can occur in Basic Chemistry courses is that the motivation of students to take part in learning is still lacking, and the availability of facilities and infrastructure is still limited in delivering abstract material (Wahyudiati, 2016). An effective way is needed to help students improve their understanding of chemistry as a whole, understand the relationship between concepts and experiments and the benefits of practicum in everyday life (Pratama & Sukasih, 2024). So educators need to analyze the value of learning done in the laboratory during practicum which makes learning more meaningful (Asni et al., 2020). Kurniawati (2017) said that meaningful learning acts as a measure of cognitive, psychomotor and affective aspects in students. The skill aspect (psychomotor) is an aspect related to physical activities such as observing, questioning, trying, reasoning, presenting and creating. Physical activity can be realized by doing scientific work, namely by carrying out practicum activities.

In line with the opinion of Hofstein (2014) states that practicum makes learning more meaningful, because students act directly in making observations on their experiments. Meaningful learning acts as a measure of cognitive, psychomotor and affective aspects in students. According to Ausubel (1978) that meaningful learning has benefits, namely, information that is learned meaningfully is easier and longer remembered and new information or new theories that have been associated with previous relevant concepts can improve students' understanding of concepts that have been mastered so as to facilitate the teaching and learning process for similar material later.

Although in laboratory activities students are accentuated to develop hands-on skilss through students acting directly in the practicum process and making observations, there is no clear evidence-based information regarding how important laboratory activities are for students (Galloway & Bretz, 2015a; Galloway & Bretz, 2015b). According to Talino (2022) and Rakhmalinda (2024), so far the practicum has been more oriented towards the development of psychomotor aspects. Meanwhile, aspects such as cognitive, affective and the integration of affective, cognitive and psychomotor learning to provide meaningful learning experiences for students are less considered (Galloway & Bretz, 2015b). If laboratory activities are considered to provide meaningful learning experiences as many people assume, then research findings are needed to prove the extent to which students gain meaningful learning from these activities (Galloway & Bretz, 2015a). Galloway et al. (2015b) attempted to fulfill this need through the Meaningful Learning in the Laboratory Instrument (MLLI). MLLI focuses on the concept that true learning requires affective, cognitive aspects of learners' thoughts and actions. Cognitive is the behavior that emphasizes on the intellectual, such as knowledge and thinking skills (Ridani & Arianingrum, 2024). Affective emphasizes more on the feeling aspect, such as interest and attitude. With this, MLLI on the basis of meaningful learning realizes cognitive aspects or only affective aspects in practicum, with several physical activities such as observing, questioning, trying,

reasoning, presenting, and creating. The advantage of this instrument is that it focuses on the affective and cognitive aspects of students in the laboratory related to practicum, which is known as meaningful learning in the laboratory (Grove & Bretz, 2007).

Meaningful learning is a process of linking new information to relevant concepts contained in one's cognitive structure (Rahmah, 2013). According to Davis (1993), learning is an active process of building phenomena in the environment, connecting the knowledge mastered with new knowledge, knowledge will become meaningful when displayed in some framework. According to Ausubel (1978) through meaning, (1) science teaching is integrated with ethical education; (2) the presentation of concepts/theories does not stop until the understanding of concepts but is interpreted so that students can see the connection between what they learn and the norms and situations of life which include technology, basic values of life, society and the environment. According to Yamin (2007) meaningful learning is an approach in managing the learning system through active learning ways towards independent learning. Meaningful learning occurs when students play an active role in the learning process and are ultimately able to decide what to learn and how to learn it. According to Yekta et al. (2004), concept mapping strategy can significantly improve memory while learning and create meaningful learning.

According to Burhanuddin et al. (2010) there are three benefits of meaningful learning, namely: (a) Information that is learned meaningfully is easier and longer to remember; (b) New information that has been associated with previous relevant concepts can improve previously mastered concepts so as to facilitate the next teaching and learning process to provide similar lessons; (c) Information that has been forgotten after having been previously mastered still leaves a mark so as to facilitate the teaching and learning process for similar subject matter even though it has been forgotten. Meanwhile, according to Mukthi (2018) meaningful learning using the practicum method is very good in developing meaningful experiences because the practicum method is a method or method in which the teacher and students together do an exercise or experiment to find out the effect or effect of an action. Sumiati et al. (2007) say that practicum provides opportunities for students to conduct their own experiments on the process in question. There is an independent opportunity for students to conduct experiments so that students can prove and witness curiosity about the theory with a specific purpose. The purpose of meaningful learning with the practicum method is to improve students' affective, cognitive, and psychomotor abilities (Putra et al., 2021).

Method

The type of research conducted is descriptive quantitative which has the aim of describing Meaningful Learning in Chemistry Education Students of Tanjungpura University class of 2023 in Basic Chemistry Practicum. Quantitative descriptive research aims to describe the condition as it is using size, numbers, or frequency (Sukmadinata, 2006; Diannisa et al., 2023). The location in this study was at the Faculty of Teacher Training and Education, Tanjungpura University with research subjects as many as 51 students in the first semester of Batch 2023 of the Chemistry Education Study Program, FKIP, Tanjungpura University and a number of interview respondents, namely 2 lecturers teaching basic chemistry practicum courses, 1 head of the chemistry laboratory, 8 laboratory assistants, and 12 students who were divided into 4 people with the highest final score, 4 people with the middle final score, and 4 people with the lowest final score in basic chemistry practicum.

In collecting data in this study using an instrument in the form of MLLI assessment instrument developed by Galloway et al. (2015b) to measure meaningful learning that focuses on affective and cognitive aspects of students, where each question has been adapted to the concept of basic chemistry practicum. This MLLI consists of 30 questions divided by 8 questions with affective aspects, 16 questions with cognitive aspects, and 6 questions with affective-cognitive aspects, equipped with a 5-point Likert scale (Strongly disagree = 1, Disagree = 2, Neutral = 3, Agree = 4, and Strongly agree = 5). Before being used in this study, the MLLI assessment instrument was first validated by 3 experts, including 2 language experts namely English lecturers FKIP UNTAN and 1 content expert namely FMIPA UNTAN lecturer.

The second instrument is an interview guideline. This interview guideline is used to obtain information from respondents, namely lecturers, laboratory heads, laboratory assistants, and representatives of students in accordance with the assessment or point of view of the basic chemistry practicum carried out. Of the four groups of respondents, 5 questions each were given according to their understanding or role in basic chemistry practicum. For interview guidelines have been validated by 2 lecturers of Chemical Education FKIP UNTAN.

After obtaining data based on the MLLI assessment instrument, the results of participant responses will be calculated and recapitulated using the formula:

$$P = \frac{F}{n} \times 100\% \quad (1)$$

Description:
P = persentage
F = score obtained
n = maximum score

Then, after obtaining the results of the participant response count, it will then be grouped into several criteria in table 1.

Table 1. Percentage Criteria for Meaningful Learning

Percentage (%)	Meaningful Learning Criteria
0 - 20	Very Less
20.1 - 40	Less
40.1 - 60	Enough
60.1 - 80	Good
80.1 - 100	Very good

The research flow chart is presented in Figure 1 below.

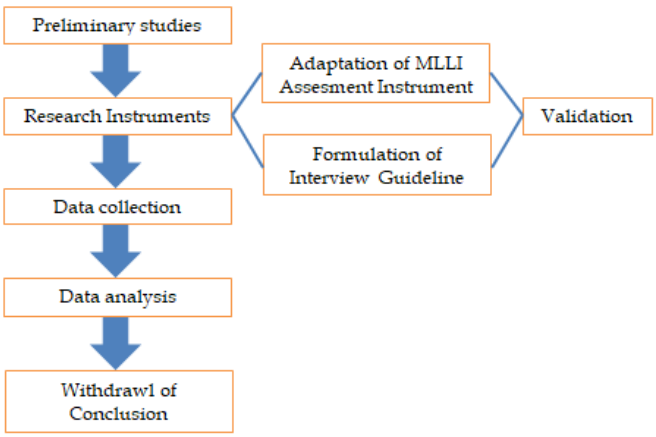

Figure 1. A research flow chart

Result and Discussion

The data obtained in this study are the results of the MLLI assessment instrument and interviews, the research information will be displayed in the description below:

Recapitulate Meaningful Learning in the Laboratory Instrument (MLLI)

From 51 students who filled out the MLLI assessment instrument, a distribution diagram of the average score distribution per aspect was obtained as presented in Figure 2. The data in Figure 2 is obtained from the calculation of students based on the answers to the statements that have been given, totaling 30 statements, including 1 for strongly disagree, 2 for disagree, 3 for neutral, 4 for agree and 5 for strongly agree. As for the 30 statements with a total maximum score of 150, it contains 8 affective aspect statements with a total maximum score of 40, 16 cognitive aspect statements with a total score of 80, and 6 affective-cognitive aspect statements with a total maximum score of 30. Each aspect is in the good category, then seen from figure 1 in the affective and affective-cognitive aspects get the same percentage of 67%. Where the affective aspect focuses on statements that contain attitudes or emotions from students. It can be concluded that the percentage of cognitive aspects that focus on knowledge is higher than affective and affective-cognitive aspects that focus on attitudes.

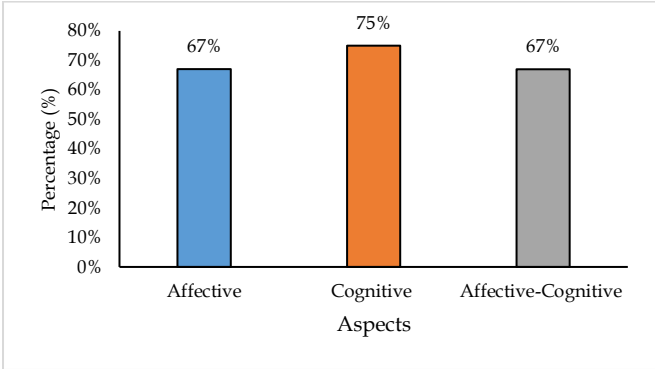

Figure 2. Data distribution diagram of MLLI results of basic chemistry practicum

The existence of new methods applied in practicum which aims to hone critical thinking (Purwaningsih et al., 2025) or student knowledge in solving problems is one of the factors that cause cognitive aspects to be higher than affective and affective-cognitive aspects. One of them is by using the Problem Based Learning (PBL) method. The results of the interview obtained information that this method was designed by the lecturer teaching the Basic Chemistry Practicum course itself, this can be described from the statement of the lecturer and laboratory assistant as follows: "we designed a new method that had never been done before during practicum, namely the PBL method in several experiments" and "we applied the PBL method to several existing experiments designed by the lecturer of the basic chemistry practicum course". According to Robiyanto (2021) PBL is very instrumental in sharpening critical thinking in students, the existence of this new method is what causes the cognitive or knowledge aspects of students to be superior to their affective aspects.

Students are still lacking in attitudinal or emotional aspects during practicum, where attitudes or emotions are the basis of their confidence or confidence when doing practicum. The results of the interview obtained information that students feel unsure of their abilities, this can be described from the statement of the respondent who is one of the 1st semester students with the final score of the practicum getting a medium

category as follows: "As far as I have done and the abilities I have, I have never been and feel unable to try to apply my abilities". It can be seen that students are indeed weak in affective aspects. What needs to be improved or events that must be carried out by lecturers or laboratory assistants to improve the affective aspects of students.

From the percentage of all aspects when combined, the average is 72% which is included in the good category, this has shown that meaningful learning in practicum in the Chemistry Education Study Program is sufficient, it just needs to be improved in the affective and affective-cognitive aspects. In line with research conducted by Asiyah et al. (2021) which states that there is an effect of problem-based learning models on students' cognitive abilities which causes too prominent an aspect, namely cognitive.

Comparison of Meaningful Learning in Both Classes (A1 and A2)

The data below are the results of the MLLI questionnaire comparison in the basic chemistry practicum of Chemistry Education students in classes A1 and A2 as presented in Table 2.

Table 2. MLLI Distribution Table of A1 and A2 Classes (N_{A1} = 26, N_{A2} = 25)

Aspects	Average Percentage (%)	
	A1	A2
Affective	68	67
Cognitive	75	75
Affective - Cognitive	67	68

Table 2 shows the average comparison of affective, cognitive, and affective-cognitive aspects between class A1 and class A2. The affective aspect of class A1 subjects is 1% greater than the affective aspect of class A2. For cognitive aspects, classes A1 and A2 have the same value, for affective-cognitive aspects, class A2 is 1% greater than class A1.

Table 2 shows that the percentage of A1 and A2 tends to be the same, although in the affective aspects and affective-cognitive aspects both classes get a percentage below 70% but both classes still get a good category from the affective and affective-cognitive aspects. In the cognitive aspect, it can be seen that both classes have the same percentage and have a high percentage among other aspects, this is due to the new method developed by the lecturer, namely PBL, with this PBL students become more critical (Robiyanto, 2021) it is very important that students develop their critical thinking skills as part of learning (Awaluddin et al., 2024; Anisah & Nasrudin, 2025).

Many causes cognitive aspects are superior to other aspects, namely the existence of structured assessments related to student knowledge during practicum. In this affective and affective-cognitive aspect which is related to attitude or self-confidence, there is no structured assessment or benchmark in the value of this which makes this affective aspect less considered in practicum. This is also obtained from the results of interviews with laboratory assistants who have a role in assessing everything students do during practicum, can be described from the statement of one of the laboratory assistants as follows: "attitude is also assessed but there is no rubric or benchmark in assessing this". From the statement of the laboratory assistant, they also participate in assessing or guiding students to be more confident and not hesitate in practicum but in this case there is no structured assessment carried out.

It is expected that this practicum not only pays attention to cognitive aspects but also can develop affective aspects. According to Bretz et al. (2013) affective aspects are often neglected in practicum activities. An overview of the laboratory head's statement regarding his expectations for affective aspects in the interview conducted as follows: "not only cognitive and psychomotor skills are educated or trained to practitioners but affective skills as well, the affective or attitude of students is something that can only be obtained in practicum. So later in practicum activities can see the nature and character of friends for that as practitioners and assistants to find the best solution in dealing with unfavorable nature or character". Based on the statement of the head of the laboratory, many must play a role in improving this affective aspect not only from the student himself but the role of those in the laboratory including laboratory assistants, laboratory heads, and practicum lecturers in order to improve good meaningful learning in practicum, especially in this basic chemistry practicum because this is the first practicum conducted by chemistry education students.

Meaningful Learning on Affective Aspects

The data below is the MLLI results data on student affective abilities presented in Table 3.

Table 3. Affective Aspect Distribution Table (N_{A1} = 26, N_{A2} = 25)

Range (%)	Number of Participants		Category
	A1	A2	
0-25	0	0	Not good
26-50	0	0	Enough
51-75	22	23	Good
76-100	4	2	Very good

Based on Table 3, it can be seen that the table presents data on the results of affective abilities of chemistry education students of FKIP Tanjungpura

University. It was found that both A1 and A2 were more dominant in the Good category, a little in the very good category, and none of them were in the poor or sufficient category. From what has been explained in Figure 2, this affective aspect needs to be considered in order to develop, especially in chemistry education study programs. Affective aspects in laboratory activities are often limited to teamwork and its relevance during practicum (Bretz et al., 2013).

In this affective aspect or attitude, to find out the ability of the students themselves, interviews were conducted with the results obtained that students felt worried about their performance or ability when carrying out practicum. This can be described from the statements of students who are in the minimum and maximum final scores in the practicum as follows: "to develop my own abilities I do not yet believe in my abilities" and "there are some situations that make me feel that the results of what I do are not right which makes me less brave during practicum". It can be seen from these statements, there is no difference between students who have minimum and maximum scores where both do not believe in the abilities they have or tend to have a less confident attitude in this basic chemistry practicum. According to Indriawati (2018) that self-confidence or attitude from within students towards their learning outcomes is one of the factors that influence learning outcomes in the learning process, it is hoped that those involved in basic chemistry practicum can design ways or methods that can be used to increase the confidence of chemistry education students.

Meaningful Learning on Cognitive Aspects

The data below is the MLLI results data on the cognitive aspects of students presented in Table 4.

Table 4. Distribution Table of Cognitive Aspects (N_{A1} = 26, N_{A2} = 25)

Range (%)	Number of Participants		Category
	A1	A2	
0-25	0	0	Not Good
26-50	0	0	Enough
51-75	16	15	Good
76-100	10	10	Very good

Based on Table 4, it can be seen that the table presents data on the results of cognitive abilities of chemistry education students FKIP Tanjungpura University. It is found that both A1 and A2 are more dominant in the Good category and the very good category and none of them are in the not good or sufficient category. With the number of participants in the excellent category, this is what makes the percentage of cognitive aspects higher than affective and affective-cognitive aspects as shown in Figure 2.

In this cognitive aspect, to find out the ability of the students themselves, interviews were conducted with the results obtained that students felt that their knowledge had become wider because of this basic chemistry practicum which helped them understand what had been learned in the theory class. This can be illustrated from the statements of students who are in the minimum and maximum final scores in the practicum as follows: "So far there are many concepts that I have begun to know, especially about the separation of mixtures". and "From this practicum I have become more aware of chemical concepts or theories that have been taught in class". This is in line with the statement from the laboratory assistant who explained about the purpose of the practicum itself, namely developing student knowledge that has been obtained when studying basic chemistry courses, which can be described as follows: "this practicum aims to train students in developing an understanding of the concepts they know in learning theory in basic chemistry courses". In addition, there is a new method applied to several experiments, namely PBL, which supports sharpening students' knowledge and critical thinking in solving problems (Robiyanto, 2021). With this PBL (Rizkiah et al., 2025) which applies the provision of problems that will be solved by students themselves, it directly hones students' thinking skills which support the improvement of learning outcomes. This is what makes the cognitive aspect get a high percentage.

Meaningful Learning on Affective-Cognitive Aspects

The data below is the MLLI result data on students' affective-cognitive abilities as presented in Table 5.

Table 5. Affective-Cognitive Aspect Distribution Table (N_{A1} = 26, N_{A2} = 25)

Range (%)	Number of Participants		Category
	A1	A2	
0-25	0	0	Not good
26-50	1	0	Enough
51-75	21	21	Good
76-100	4	4	Very good

Based on Table 5 above, it can be seen that the table presents data on the results of the cognitive abilities of chemistry education students of FKIP Tanjungpura University. It was found that both A1 and A2 were more dominant in the Good category, a few in the very good category and there was only 1 student who was in the sufficient category. The existence of participants who are in the sufficient category and at least in the excellent category makes the percentage of affective-cognitive aspects unable to be above 70% as shown in Figure 2.

In this affective-cognitive aspect, it can be seen that both classes tend to be in the 51%-75% range. The

percentage shows that the average affective-cognitive ability is 21 subjects, apart from the data above to find out the ability of students in this affective-cognitive aspect, interviews were conducted with students who were at the minimum and maximum scores. Each of the A1 and A2 classes at the minimum score stated that this basic chemistry practicum gives students the opportunity to connect what they know or learn in theory with what they practice in the real world. This can be described as follows: "basic chemistry practicum often provides opportunities for students to connect the concepts learned with real world situations" and "can directly practice what we get in theory and practicum" . It can be seen from the statements of representatives of students where both of them even though they have low scores but still feel that their knowledge has increased and their attitude is confident with the practicum. From several subjects who got a high percentage, interviews were conducted with subjects who got the maximum score from each class. With the following description: "in practicum we not only understand the theory, but also involve ourselves directly with experiments and apply the principles in real life" and "With practicum we can also observe and connect chemical phenomena that occur directly in everyday life" from the responses of both A1 and A2 it was found that both A1 and A2 felt that their affective-cognitive aspects could be developed because they could connect the concepts learned with situations in the real world.

Affective is interest, which is understood analytically as an emotional schema but in reality also includes a cognitive dimension. This means that interest can be changed and developed over time as new knowledge is acquired, allowing a shift from situational interest to individual interest (Hidi & Renneinger, 2006). The cognitive and affective components of attitude partly determine behavioral intention, which is the direct motivating factor for the behavior itself. Behavioral intention is thus seen as a direct result of these two dimensions of attitude (Svenningsson et al., 2022).

Conclusion

This study describes that Chemistry Education students in the first semester of class 2023 achieved meaningful learning with a good category in the Basic Chemistry practicum, with an affective aspect percentage of 67% with a good category, a cognitive aspect percentage of 75% with a good category, and an affective-cognitive aspect percentage of 67% with a good category. The overall percentage of aspects is 72% with a good category. These findings explain that meaningful learning in the laboratory can be achieved not only depending on cognitive abilities, but also how students' ability to respond emotionally. So, in the learning process in the laboratory, educators must pay more attention to the integration of cognitive and affective aspects to improve the quality of student learning experiences and create more meaningful learning.

Acknowledgments

The author would like to thank all validators who have validated the research instruments that will be used in this study. Next, the author would also like to thank all participants, namely chemistry education 1st semester students of FKIP Tanjungpura University and Basic Chemistry Course Lecturers who have been willing to become the subject of this research and fully participate in the data collection process.

Author Contributions

Creating the research instrument, carrying out research, and writing reviews of the research articles, author L. S.; guiding the research and article writing process, authors E. and L. I.; analyzing the writing and review, authors M. and U. M. All authors have read and agreed to the publish version of the manuscript.

Funding

This research received no external funding

Conflicts of Interest

The authors declare no conflict of interest.

References

Abadi, S. M. (2016). *Pengembangan Instrument Penilaian Aspek Psikomotor Siswa pada Praktikum Kimia Materi Termokimia*. Universitas Islam Negeri Syarif Hidayatullah.

Anisah, D. C., & Nasrudin, H. (2025). Profile of Critical Thinking Skills of Phase F Learning in Chemistry Subjects Acid-Base Material. *Jurnal Penelitian Pendidikan IPA*, *11*(1), 17-27. https://doi.org/10.29303/jppipa.v11i1.9842

Armalasari, T. R. (2017). *Pengaruh Strategi Scaffolding dalam Model Pembelajaran Simayang untuk Meningkatkan Kemampuan Literasi Kimia dan Motivasi Belajar pada Materi Asam Basa*. Universitas Lampung.

Asiyah, A., Topano, A., & Walid, A. (2021). Pengaruh Problem Based Learning (PBL) terhadap Kemampuan Pemecahan Masalah dan Hasil Belajar Kognitif Siswa SMA Negeri 10 Kota Bengkulu. *Edukatif: Jurnal Ilmu Pendidikan*, *3*(3), 717-727. https://doi.org/10.31004/edukatif.v3i3.263

Asni, A., Wildan, W., & Hadisaputra, S. (2020). Pengaruh Model Pembelajaran Inkuiri Terbimbing terhadap Hasil Belajar Kimia Siswa Materi Pokok

Hidrokarbon. *Chemistry Education Practice*, *3*(1), 17-22. https://doi.org/10.29303/cep.v3i1.1450

Ausubel, D. (1978). *Educational Psychology*: *A Cognitive View*. New York: Holt Rinehart & Winston.

Awaluddin, M. R. N., Hamdani, H., Hartoyo, A., Bistari, B., & Siregar, N. (2024). Pengaruh Kemampuan Awal terhadap Kemampuan Berpikir Kritis Siswa MTs dalam Pembelajaran Matematika. *JPMI: Jurnal Pembelajaran Matematika Inovatif*, *7*(1), 205-216. https://doi.org/10.22460/jpmi.v7i1.20189

Basir, M., Setiawan, A., & Chandra, D. T. (2024). Design and Construct of Magnetic Induction and Force Practicum Tools to Improve Science Process Skills. *Jurnal Penelitian Pendidikan IPA*, *10*(9), 6516-6524. https://doi.org/10.29303/jppipa.v10i9.7837

Burhanuddin, Wahyuni, N., & Esa. (2010). *Teori Belajar dan Pembelajaran*. Yogyakarta: Ar-Ruzz Media

Bretz, S. L., Fay, M., Bruck, L. B., & Towns, M. H. (2013). What Faculty Interviews Reveal About Meaningful Learning in The Undergraduate Chemistry Laboratory. *Journal of Chemical Education*, *90*(3), 281-288. https://doi.org/10.1021/ed300384r

Davis, B. G. (1993). *Tools for teaching*. San Fransisco: Jossey Bass Inc Publishers.

Diannisa, N. F., Erlina, E., Harun, A. I., Sahputra, R., & Ulfah, M. (2023). Deskripsi Pemahaman Konsep pada Materi Struktur Atom di Kelas X SMA Negeri 01 Ngabang. *Hydrogen: Jurnal Kependidikan Kimia, 11*(4), 497-512. https://doi.org/10.33394/hjkk.v11i4.8091

Djamarah, S. B. (2005). *Guru dan Anak Didik dalam Interaksi Edukatif Suatu Pendekatan Teoritis Psikologis*. Jakarta: PT Asdi Mahasatya.

Ericka, D., Yusnaeni, Ismirawati, N., & Ristanto, H. R. (2005). *Strategi Belajar Mengajar Biologi*. Magelang: Pustaka Rumah C1nta.

Galloway, K. R., & Bretz, S. L. (2015a). Development of an Assessment Tool to Measure Students' Meaningful Learning in the Undergraduate Chemistry Laboratory. *Journal of Chemical Education, 92*(7), 1149–1158. https://doi.org/10.1021/ed500881y

Galloway, K. R., & Bretz, S. L. (2015b). Measuring Meaningful Learning in The Undergraduate Chemistry laboratory: A National Cross-Sectional Study. *Journal of Chemical Education*, *92*(12), 2006-2018. https://doi.org/10.1021/acs.jchemed.5b00538

Gasong, D. (2017). *Belajar dan Pembelajaran*. Yogyakarta: CV Budi Utama.

Grove, N., & Bretz, S. L. (2007). CHEMX: An Instrument to Assess Student's Cognitive Expectations for Learning Chemistry. *Journal of Chemical Education*, *84*(9). https://doi.org/10.1021/ed084p1524

Hadiwangsa, D. H., Hairida, Rasmawan, R., Enawaty, E., & Junanto, T. (2024). Description of Students' Collaboration Skills Chemistry Education Department of FKIP UNTAN in Basic Chemistry Practicum. *Jurnal Penelitian Pendidikan IPA, 10*(1), 229-238. https://doi.org/10.29303/jppipa.v10i1.5224

Indriawati, P. (2018). Pengaruh Kepercayaan Diri dan Kecerdasan Emosional terhadap Hasil Belajar Mahasiswa FKIP Universitas Balikpapan. *Jurnal Pendidikan Edutama*, *5*(2), 59-77. http://dx.doi.org/10.30734/jpe.v5i2.183

Kurniasih, K., & Sani, B. (2015). *Ragam Pengembangan Model Pembelajaran: Untuk Profesionalitas Guru*. Jakarta: Kata Pena.

Kurniawati, Y. (2017). Analisis Kesulitan Penguasaan Konsep Teoritis Dan Praktikum Kimia Mahasiswa Calon Guru Kimia. *Jurnal Konfigurasi*, *1*(2), 146-153. http://dx.doi.org/10.24014/konfigurasi.v1i2.4537

Mamlok, N. R., & Barnea, N. (2012). Laboratory Activities in israel. *Eurasia Journal of Mathematics, Science, and Technology Education*, *13*(9), 49-57. https://doi.org/10.12973/eurasia.2012.816a

Mukti, D. P. (2018). *Pengaruh Pembelajaran Eksperimen Berbasis Inkuiri Terbimbing (Guided Inquiry) terhadap Kemampuan Kognitif dan Keterampilan Proses Sains Siswa pada Materi System Sirkulasi di Kelas XI MIPA SMAN 1 Air Putih Kabupaten Batu Bara T.P 2018/2019*. Universitas Negeri Medan

Nirmala, W., & Ramlawati, M. D. (2018). Pengembangan Perangkat Asesmen Praktikum Dasar-Dasar Kimia Analitik Berbasis Keterampilan Proses Sains Jurusan Kimia UIN Alauddin Makassar. *Chemistry*, *1*(2), 142-151. https://doi.org/10.26858/cer.v0i1.5617

Pratama, B. I., & Sukasih, S. (2024). The Effectiveness of Practicum Method Assisted with PHeT Media on Character and Learning Outcomes of IPA. *Jurnal Penelitian Pendidikan IPA*, *10*(9), 6271-6279. https://doi.org/10.29303/jppipa.v10i9.7444

Pratama, F. I., & Rohaeti, E. (2024). How Does "Chemistry Challenge" E-book Affect the Chemical Literacy Profile? A Study to Test Learning Media Effectiveness. *Jurnal Penelitian Pendidikan IPA, 10*(5), 2253-2260. https://doi.org/10.29303/jppipa.v10i5.7018

Purwaningsih, S., Falah, H. S., & Pujaningsih, F. B. (2025). The Use of E-Modules to Improve Critical Thinking Skills of Physics Education Students. *Jurnal Penelitian Pendidikan IPA*, *11*(1), 257-264. https://doi.org/10.29303/jppipa.v11i1.9553

Putra, R. A., Nurdiansyah, N., Futra, D., & Primahardani, I. (2021). Analisis Pembelajaran

Jarak Jauh (online) Mahasiswa Calon Guru IPA di Kota Pekanbaru pada Masa Pandemi Covid-19. *Journal of Natural Science and Integration*, *4*(1), 94-104. http://dx.doi.org/10.24014/jnsi.v4i1.12744

Rahmah, N. (2013). Belajar Bermakna Ausubel. *Al-Khwarizmi: Jurnal Pendidikan Matematika Dan Ilmu Pengetahuan Alam*, *1*(1), 43–48. https://doi.org/10.24256/jpmipa.v1i1.54

Rakhmalinda, F., Arifiani, R., Puspawati, W., & Simamora, A. M. (2024). Analysis of Students' Misconceptions on Acid-Base Topic Using the Two-Tier Diagnostic Test. *Journal of Computers for Science and Mathematics Learning, 1*(1), 27–43. https://doi.org/10.70232/9xp1nt17

Ridani, M., & Arianingrum, R. (2024). Development of Student Worksheets with Learning Cycle 5E Models on Solubility Product Constant Materials and Their Influence on Student Chemistry Literacy. *Jurnal Penelitian Pendidikan IPA*, *10*(12), 10215-10225. https://doi.org/10.29303/jppipa.v10i12.7522

Rizkiah, N., & Asih, S. S. (2025). Development of PBL-Based Smart Apps Creator Media to Improve Science Learning Outcomes for Grade IV Elementary School Students. *Jurnal Penelitian Pendidikan IPA*, *11*(1), 342-350. https://doi.org/10.29303/jppipa.v11i1.9889

Robiyanto, A. (2021). Pengaruh Model Problem Based Learning terhadap Hasil Belajar Siswa. *Mahaguru: Jurnal Pendidikan Guru Sekolah Dasar*, *2*(1), 114-121. https://doi.org/10.33487/mgr.v2i1.1752

Sapulete, H., Wenno, I. H., Tuhurima, D., & Dulhasyim, A. B. P. (2023). Analysis of creative thinking skills based on contextual teaching and learning in physics education students. *Jurnal Penelitian Pendidikan IPA*, 9(7), 5492–5497. https://doi.org/10.29303/jppipa.v9i7.369

Sukmadinata, N. H. (2006). *Pengembangan Kurikulum : Teori dan Praktek*. Bandung: Remaja Rosdakarya.

Sumiati & Asra. (2007). *Metode Pembelajaran*. Bandung: CV Wahana Prima.

Sutarno, S., Setiawan, A., Suhandi, A., Kaniawati, I., & Putri, D. H. (2017). Keterampilan Pemecahan Masalah Mahasiswa Dalam Pembelajaran Bandul Fisis Menggunakan Model Problem Solving Virtual Laboratory. *Jurnal Pendidikan Fisika Dan Teknologi*, *3*(2), 164-172. https://doi.org/10.29303/jpft.v3i2.396

Svenningsson, J., Host, G., Hulten, M., & Hallstrom. (2022). Student's Attitude Toward Technology: Exploring the Relationship Among Affective, Cognitive, and Behavioral Components of the Attitude Construct. *International Journal of Technology and Design Education*, *32*(3), 1531-1551. https://doi.org/10.1007/s10798-021-09657-7

Talino, I., Masriani, M., & Hadi, L. (2022). Pengembangan Penilaian Instrumen Otentik Pada Praktikum Pembuatan Larutan Untuk Mahasiswa Pendidikan Kimia. *Jurnal Ilmiah Wahana Pendidikan, 8*(11), 345–352. https://doi.org/10.5281/zenodo.6831833

Tommy, M., Hamidah, A., & Syahri, W. (2024). Analysis of Students' Science Process Skills in Practicum-Based Animal Physiology Learning. *Jurnal Penelitian Pendidikan IPA*, *10*(12), 10299-10307. https://doi.org/10.29303/jppipa.v10i12.7833

Wahyudiati, D. (2016). Analisis Efektivitas Kegiatan Praktikum Sebagai Upaya Peningkatan Hasil Belajar Mahasiswa. *Jurnal Tatsqif, 14*(2), 143-168. Retrieved from http://ejurnal.iainmataram.ac.id/index.php/tatsqif/article/view/1024

Wiratma, I. G. L., & Subagia, I. W. (2014). Pengelolaan Laboratorium Kimia pada SMA Negeri di Kota Singaraja (Acuan Pengembangan Model Panduan Pengelolaan Laboratorium Kimia Berbasis Kearifan Lokal Tri Sakti). *Jurnal Pendidikan Indonesia*, *3*(20), 425-236. https://doi.org/10.23887/jpi-undiksha.v3i2.4459

Yamin, M. (2007). *Kiat Membelajarkan Siswa*. Jakarta: Gaung Persada Students.

Yanti, I. E., & Sutrisno, H. (2024). Chemistry Teachers' Self-efficacy for Using Information and Communication Technology: A Survey Cross Sectional. *Jurnal Penelitian Pendidikan IPA*, *10*(9), 6669-6676. https://doi.org/10.29303/jppipa.v10i9.7419

Yekta, P., & Nasrabadi, N. (2004). Concept Mapping as An Educational Strategy to Promote Meaningful Learning. *Journal of Medical Education Summer*, *5*(2), 47-50. Retrieved from https://brieflands.com/articles/jme-105100.pdf