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Students' Learning Engagement in the Topic of Atomic Concepts and the Periodic Table

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Abstract
Learning engagement constitutes a critical component in the educational process, significantly influencing both the effectiveness of instruction and student academic achievement. This study aims to analyze the learning engagement of undergraduate students enrolled in a Chemistry Education program, specifically concerning their engagement with the subject matter of atomic concepts and the periodic system within the context of a general chemistry course. This research adopts a qualitative descriptive approach. Data were obtained through classroom observations, semi-structured interviews, and document analysis. Observational data were collected from a cohort of 31 students participating in lecture sessions. Based on the initial observational findings, 15 students were purposively selected for in-depth interviews, representing three distinct engagement profiles: highly engaged, moderately engaged, and minimally engaged. The results indicate that students' behavioral, emotional, and cognitive engagement levels vary across categories. Behavioral engagement was predominantly classified as "high," with students demonstrating active participation in learning activities. Emotional engagement was categorized as "moderate," reflecting students' interest in the subject matter, albeit with varying degrees of emotional involvement. Cognitive engagement was also categorized as "moderate," as most students exhibited cognitive involvement in line with the key indicators, although not consistently at an optimal level. In conclusion, while students generally demonstrated positive behavioral engagement, there remains room for improvement in fostering deeper emotional and cognitive engagement in learning about atomic concepts and the periodic system. These findings underscore the need for instructional strategies that holistically support all dimensions of student engagement to enhance learning outcomes in chemistry education.

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INTRODUCTION

Education is an essential component of human development. It is intended to cultivate a generation that is productive, creative, innovative, and effective through the integration of attitudes, abilities, and life skills knowledge (Mariyana et al., 2023). These elements reflect the ability to generate ideas, develop skills, and provide solutions to problems encountered in chemistry learning (Habibati,Hanum & Ahmad, 2025). Chemistry learning involves scientific process skills that are important to develop through appropriate training in both practical skills and theoretical knowledge (Fitri et al., 2022). Therefore, effective chemistry education must incorporate both theory and practical skills to achieve the desired learning outcomes (Hasanah et al., 2025).

Chemistry learning plays an important role in developing lessons that stimulate interest and foster critical thinking. Critical thinking involves active thinking that includes studying,

observing, and analyzing (Sari et al., 2022). It functions to enhance the ability to understand both existing knowledge and knowledge that is not yet known (Zakky, 2020).

One of the factors that significantly contributes to student learning achievement is their interest in chemistry learning, particularly in the General Chemistry course, which is a compulsory subject in the Chemistry Education program. General Chemistry explores fundamental principles and concepts in chemistry as well as their properties (Izasatifa, n.d.). (Haris et al., 2019) stated that the topic of atomic concepts and the periodic system is considered abstract. The abstract nature of chemical concepts requires educators to present a variety of learning media (Journal,Hanum, 2025). To help students grasp chemistry as a deep understanding that may appear simple on the surface (Cahyani et al., 2024). This concepts are not only academic in nature but also encourages students to think critically and solve problems systematically through processes such as observing, concluding, classifying, interpreting, predicting, and communicating issues that arise in chemistry learning (Rosid, 2019), as well as in implementing the knowledge (Ardyansyah et al., 2025).

In studying general chemistry, particularly the topic of atomic concepts and the periodic system, one contributing factor is learning engagement, which plays an active role in achieving effective and high-quality learning (Gu et al., 2022). Chemistry learning that takes learning engagement into account affects the level of learning outcomes. One aspect of learning engagement is the interaction built between lecturers and students during the learning process (Patmisari et al., 2021). Sa'adah & Ariati (2020) stated that chemistry learning shows significant improvement when educators implement learning engagement compared to those who do not. Learning engagement is one of the key factors that influences academic achievement in chemistry education.

Learning engagement plays a crucial role, as students who are not engaged will not listen, process, or pay attention to the learning process (Terrion & Aceti, 2012). It also benefits students by allowing them to reflect on what they have learned (El-Mansy et al., 2021). Learning engagement consists of several important factors: cognitive, emotional, and behavioral. Cognitive engagement is related to students' mental efforts, emotional engagement is associated with the interactions students have in the classroom, and behavioral engagement focuses on students' positive behavior during learning activities (Naibert et al., 2022). These factors vary depending on students' abilities, environments, attitudes, and experiences throughout the learning process. Encouraging learning engagement is essential so that chemistry education students develop critical, innovative, and systematic thinking skills to achieve learning outcomes (Pratiwi et al., 2023), improve educational quality especially in higher education and foster both academic success and positive student attitudes (Sunday, 2013).

Based on the problem description above, the objective of this study is to determine the level of student learning engagement in the topic of atomic concepts and the periodic system in the chemistry education study program during classroom teaching and learning activities.

METHOD

The research method employed in this study is qualitative descriptive, as the study aims to explore the process of learning engagement in a chemistry learning context, specifically within a general chemistry course covering the topics of atomic concepts and the periodic system**.** The participants consisted of 31 students from Class A1, cohort of 2024, enrolled in the 2024/2025 academic year. This study was conducted at the Faculty of Teacher Training and Education (FKIP), Department of Chemistry Education, Pontianak. This study involved 31 students from Class A1 as research subjects and was conducted in three stages: observation sheets, interviews, and documentation.

According to Bogdan, R., & Biklen, n.d. (1997), observation is a data-collection technique that requires the researcher to enter the field and watch the participants firsthand**.** In this study, direct observation was employed to examine the learning engagement of Chemistry Education students in Pontianak while they were studying atomic concepts and the periodic system**.** In this study, a semi-structured interview was employed as the method of data collection. This technique involves using a set of guiding questions or indicators while allowing flexibility in the interview process. The researcher adapted the interview approach based on the responses and characteristics of each participant, using appropriate techniques as needed. Interviews were conducted with 15 Chemistry Education students from Class A1, cohort of 2024. These participants were selected based on prior classroom observations and categorized into three groups according to their level of learning engagement: highly active**,** active**,** and less active.

The documentation used in this study involved collecting data in the form of notes, assignments given by the lecturer, photos of teaching and learning activities in the classroom, and video recordings of the learning process. This allowed for specific observation of the learning process that took place in Class A1, Faculty of Teacher Training and Education (FKIP), Universitas Tanjungpura, Pontianak. This study employed observation, interviews, and documentation techniques. Two research instruments were used: an observation sheet and an interview guide, both of which were valuable in examining the teaching and learning process, particularly students' learning engagement. These instruments were validated by two experts in the field. The observation sheet used in this study was adapted from the School Engagement Measure–MacArthur, obtained from a thesis related to student engagement, and then modified to suit the context of this research. The interview indicators were adapted from *Teacher and Student Engagement When Using Learning Materials Based on the Context of Cutting-Edge Chemistry Research* and were also adjusted to align with the objectives of this study.

The observation sheet in this study was used to monitor students' teaching and learning processes throughout the research, which was conducted using handout-based instruction. The sheet required the observer to select one of the provided statement**s** and then add a brief explanation or remark regarding the selected option. The observation sheet is presented in table 1.

Table 1. Observation indicators

No	Aspects	Indicator
1.	Behavioral Engagement	Student attendance Learning environment rules Student behavior Academic tasks
2.	Emotional Engagement	Student interest Student's feelings during learning
3.	Cognitive Engagement	Student learning strategies

(Zanira & Cahyadi, 2021)

Based on Table 1, the observation indicators used in this study cover several aspects. Behavioral engagement was assessed through student attendance, adherence to classroom rules, student behavior, and academic task completion. Emotional engagement was observed through students' interest and emotional responses during the learning process. Meanwhile, cognitive engagement was evaluated based on the learning strategies employed by the students.

The interview guide in this study was used to supplement the information obtained from the observation sheet. The interview guide is presented in table 2. Based on Table 2, the interview indicators involving students cover several aspects. For behavioral engagement, the indicators include students' understanding of the material, completion of assignments, participation in group discussions, and classroom discipline. Emotional engagement is assessed through

students' interest or enthusiasm in learning and their emotional responses to the learning experience. Cognitive engagement is evaluated based on the use of learning strategies and additional learning resources or literature.

Table 2. Indicators of interview guidelines

Aspects	Informant	Indicator
Behavioral Engagement	Student	Understanding of course material. Duties. Discussion. Class rules.
Emotional Engagement	Student	Interest/Enthusiasm. Feelings.
Cognitive Engagement	Student	Use of learning strategies. Use of additional literature.

(Tim H.H , 2022).

Data analysis is the process of systematically searching for and organizing data obtained from interviews, field notes, and documentation. This involves categorizing the data, breaking it down into units, organizing it into patterns, identifying what is important and worth studying, and drawing conclusions so that the findings are easily understood by both the researcher and others (Sugiyono, 2018).

The steps of data analysis used in this qualitative research follow the interactive model of data analysis proposed by Miles & Huberman (1994), as illustrated in figure 1.

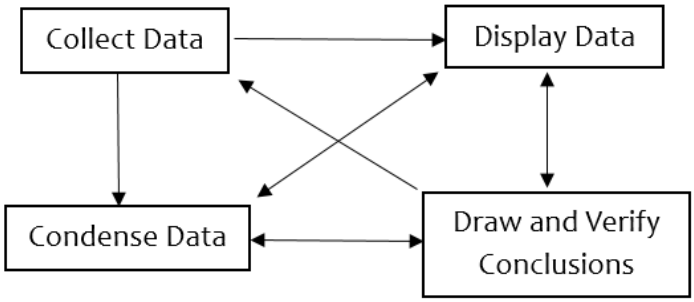

Figure 1. Components of data analysis with interactive model

Based on Figure 1, there are several stages in qualitative data analysis following data collection:

1. Data collection – Raw data obtained from the research is gathered.
2. Data reduction – This is the process of summarizing or simplifying raw data to make it more manageable.
3. Data display – The reduced data is organized and presented in a form that facilitates the drawing of conclusions.
4. Conclusion drawing – This stage involves interpreting the analyzed data to formulate conclusions based on the research findings.

The steps taken by the researcher using the interactive model of qualitative analysis are illustrated in Figure 2.

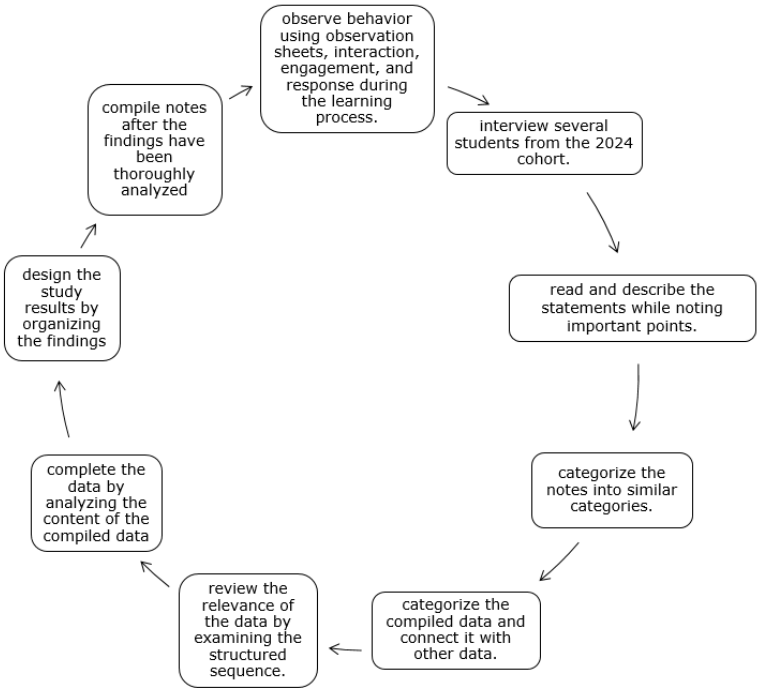

Figure 2. Steps taken by the researcher

This study employed two types of triangulation: source triangulation and technique triangulation (Wijaya, 2018). Source triangulation is used to test the credibility of data by cross-checking information obtained from various sources, such as observation results, interviews, and documentation. The analyzed data can lead to conclusions, which are then verified using these three data sources. In this study, source triangulation was employed by the researcher to verify data obtained through observations, interviews, and documentation of students in the Chemistry Education program at Tanjungpura University during the learning process. Technique triangulation is used to test the credibility of data by cross-checking information obtained from a single source using multiple techniques. For example, data gathered through observation is verified through interviews to gain deeper insights, as well as through documentation and relevant materials such as informants' notes and vice versa.

RESULTS AND DISCUSSION

Behavioral Engagement

The results of observations on the learning process of Chemistry Education students at Tanjungpura University, focusing on the topic of atomic concepts and the periodic system, revealed several indicators of behavioral engagement, as presented in table 3.

Table 3. Behavioral engagement observation results

Indicator	Observation result	Description
	Student Attendance	
Students attend class on time	The lesson was not on time because the lecturer was late entering the classroom so the lesson started at 15.45 which should have been 15.30.	Observed during lesson 1 and lesson 2 observations

Indicator	Observation result	Description
Students are late arriving on time to class	In this lesson, no students were late, all of them were present on time before 15.30	Observed during lesson 1 and lesson 2 observations
Learning Environment Rules		
Students are orderly in following the lesson	Students followed the lesson in an orderly manner, not chatting in class and not moving from place to place during the lesson.	Observed during lesson 1 and lesson 2 observations
Students use cell phones in learning without direction from lecturers	Overall, the use of cell phones was carried out according to the direction of the lecturer but there were still 15 people using cell phones by opening social media without direction from the lecturer.	Observed during lesson 1 and lesson 2 observations
Student Behavior		
Students pay attention to the explanation from the lecturer during learning	During the lesson, all students paid attention to the lectur's explanation	Observed during lesson 1 and lesson 2 observations
Students remain concentrated in following the lesson despite outside distractions	Overall, 16 students often feel distracted by outside distractions while others remain focused on following the lesson	Observed during lesson 1 and lesson 2 observations
Academic Tasks		
Students work on assignments given by the lecturer	Overall, students do the assignments given by the lecturer during the lesson	Observed during lesson 1 and lesson 2 observations
Students collect the assignments given by the lecturer	Assignments given by the lecturer are not collected but answered together during the lesson and done in their respective notebooks.	Observed during lesson 1 and lesson 2 observations
Students take notes on important things explained by the lecturer	Students record explanations from lecturers and materials displayed using whiteboard and ppt media	Observed during lesson 1 and lesson 2 observations
Participation in Learning		
Students are actively involved in discussions during learning	15 students actively discuss with lecturers and other students in answering questions given by lecturers	Observed during lesson 1 and lesson 2 observations
Students are active in responding to questions given by the lecturer	22 students respond to questions from lecturers during learning	Observed during lesson 1 and lesson 2 observations

Based on Table 3, the aspect of behavioral engagement**,** as observed and supported by interview results with students categorized as less active, active, and highly active, shows that students demonstrated discipline through punctual attendance, completing and submitting assignments, and active participation in class discussions. The orderly classroom environment is attributed to students' strong behavioral engagement, which positively influences learning outcomes.

However, some students reported being distracted by external conditions that reduced their concentration. As one student stated, *"I was disturbed by outside noises, such as people walking and laughing,"* which affected the learning process. This finding is supported by Putri et al., (2020), who stated that classroom conditions influence students' concentration when completing assignments and impact their academic performance.

Thus, students completed the assignments given by the lecturer on time, demonstrating a sense of discipline toward the learning process. In addition, they actively participated in group discussions and in question-and-answer sessions with the lecturer. This indicates the students' active involvement in the learning process. Hartika & Mariana (2019) state that active participation in the learning process enables students to develop their skills and practice critical thinking, which helps them solve problems presented by the lecturer.

Emotional Engagement

The results of observations on the learning process of Chemistry Education students at Tanjungpura University, specifically on the topic of atomic concepts and the periodic system, revealed several indicators of emotional engagement, as presented in table 4.

Table 4. Emotinal engagement observation results

Indicator	Observation results	Description
Student Interest		
Students feel interested in learning in	Students look very excited and active in participating it will add value to students when they are active in answering questions.	Observed during lesson 1 and lesson 2 observations
Student's Feelings During Learning		
Students feel happy with the material of atomic concepts and periodic systems	Students look enthusiastic, exciting and happy when the lecturer explains because they actively ask questions and use group learning.	Observed during lesson 1 and lesson 2 observations
Students are confident when presenting in class	9 students look confident when presenting the questions given from the lecturer and then written on the blackboard	Observed during lesson 1 and lesson 2 observations

Based on Table 4, in the aspect of emotional engagement, as observed and supported by interview results from students categorized as less active, active, and highly active, it was found that students felt enthusiastic about participating in the learning process. The observations showed that students were enthusiastic and highly engaged, as expressed during the interview: *"I'm excited, Sis, because if we answer correctly, we get points."* This high emotional engagement was driven by the opportunity to earn extra points when answering questions from the lecturer. Students also felt happier and more enthusiastic when given group assignments and expressed greater confidence when answering questions and providing explanations.

Therefore, fostering student enthusiasm and interest in learning plays a vital role in building strong emotional engagement. This is supported by (Yuliyani et al., 2017), who stated that a high level of learning interest among students should ideally result in high academic achievement, although this is not always the case. Learning interest and study habits are essential factors that positively influence learning outcomes. Additionally, Sudipa et al., (2022) stated that student activeness significantly impacts the achievement of optimal learning performance.

Cognitive Engagement

The results of observations on the learning process of Chemistry Education students at Tanjungpura University, specifically on the topic of atomic concepts and the periodic system, revealed several indicators of cognitive engagement, as presented in Table 5.

Table 5. Cognitive engagement observation results

Indicator	Observation results	Description
Student Strategies In Learning		
Students are motivated to follow the learning	All students seemed motivated in learning due to punctual attendance, enthusiasm in answering the lecturer's questions and easy to understans explanations.	Observed during lesson 1 and lesson 2 observations
Students hav additional literature to learn more about things that have been learned in class	25 students have additional literature before the learning begins so that it is easier to understans the explanation from the lecturer.	Observed during lesson 1 and lesson 2 observations
Students give critical opinions related to the problems given by the lecturer	19 students gave opinions related to the problems given from the lecturer in turn such as the history of atomic theory and what is the god particle.	Observed during lesson 1 and lesson 2 observations

Based on Table 5, in the aspect of cognitive engagement, as observed and supported by interviews with students categorized as less active, active, and highly active, it was found that students accessed additional literature prior to the learning process. This is supported by one interviewee who stated, *"I search through Google Scholar, look for journals, and mostly use online or internet-based media, because I find it easier to locate exactly what I need."* This is reinforced by Pramudibyanto, (2024), who noted that students feel more confident when they use additional references as reliable and useful sources of information.

Furthermore, in the indicator of actively interacting in response to critical problems posed by the lecturer, students demonstrated deeper understanding of the concepts of atoms and the periodic system. This is in line with (Anugraheni, 2020), who stated that responding to critical issues is an essential part of learning objectives, as it allows students to discern differences in the information they receive.

CONCLUSION

The learning engagement of students in class A1, in terms of behavioral engagement, showed very active results for the indicators of student attendance, academic assignments, and participation in learning activities. However, the indicators related to classroom rules and student behavior still reflected low active involvement, as supported by the observation and interview results. Meanwhile, in the aspect of emotional engagement, the results showed very active involvement in the indicator of student interest. In contrary, for the indicator related to students' feelings during the learning process was still considered to have low active involvement, as supported by the observation and interview results. In the aspect of cognitive engagement, the results showed very active involvement in the indicator of learning strategies, as observed and supported by interviews, as well as students' enthusiasm in responding critically to opinions.

Therefore, it can be concluded that among the three aspects of learning engagement, students showed the highest level of activity in cognitive engagement, while in behavioral and emotional engagement, there are still several indicators that need improvement.

RECOMMENDATIONS

This study has limitations, particularly in the interview process. The researcher acknowledges that every study inevitably has shortcomings. During the interview sessions, sometimes the responses given by the informants did not correspond to the questions asked. Additionally, the researcher occasionally posed questions that were similar but had different meanings, requiring the questions to be repeated and clarified. Future research could benefit from using questions that are easier for informants to understand.

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