

DESCRIPTION OF STUDENTS LEARNING DIFFICULTIES IN THE ATOMIC STRUCTURE

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Received: August 23, 2023. Accepted: August 31, 2023. Published: September 29, 2023

Abstract: Atomic structure material is studied by high school students in class X in odd semesters. In this material, as much as 66.81% of class X students of SMAN 13 Padang have yet to achieve the minimum criteria set. It indicates that students have learning difficulties. Learning difficulties are failures in achieving learning goals characterized by low learning outcomes. This study aims to determine the percentage of learning difficulties experienced by students in atomic structure material and determine the factors that cause students' learning difficulties in terms of learning methods. This research is a type of descriptive research. The sample for this research was 36 students in class X E3 of SMAN 13 Padang in the 2022/2023 academic year. The research instrument was a diagnostic test with two-tier multiple-choice questionnaires and interviews. The data analysis used is descriptive, namely analyzing and providing an understanding of the data in the form of numbers so that an overview can be given in an orderly, concise, and clear manner. The results of this study stated that students of SMAN 13 Padang experienced learning difficulties in atomic structure material with a high category. The highest difficulty level is found in the fourth indicator (Determining electron configurations and quantum numbers), which is 81.25%. Learning difficulties experienced by students are caused by ineffective learning methods, such as not making a study schedule and not carrying it out, not reading and not taking notes, not repeating material, not concentrating on learning, and not doing assignments.

Keywords: *Learning Difficulties, Atomic Structure, Diagnostic Tests, Two-Tier*

INTRODUCTION

Learning is defined as an effort made by someone to obtain new changes in behavior toward a better direction. Often, students fail to achieve learning goals or get changes in behavior for the better. It shows that students struggle to achieve learning goals [1].

Learning difficulties when students experience failure in achieving learning goals are characterized by low learning achievement, where the value obtained by students is less than the minimum standard of completeness criteria that have been set, causing students to be unable to achieve study goals [1].

Most students think chemistry is a difficult subject [2]. This is because chemistry lessons consist of abstract concepts that require mastery of mathematical operations and a strong memory [3]. Therefore, students are required to have the ability to understand concepts and apply understanding of mathematical operations. Understanding the concept is a very important aspect of learning because students can develop their abilities in each subject matter if they know it. Students' understanding of concepts influences their ability to solve problems.

Based on the results of distributing questionnaires and interviews with chemistry teachers at Padang 10 SMAN, Padang 5 SMAN, and Padang 13 SMAN, it can be seen that atomic structure material is quite difficult for students to understand. Of the three schools, SMAN 13 Padang has the highest percentage of students who receive

daily assessments under the KKM. It can be seen from the results of the daily evaluation of atomic structure material in the 2021/2022 academic year, which has an average score below the KKM that has been set, which is 80, as shown in Table 1.

Table 1. Average Student Exam Scores on Atomic Structure Material

Class	Average Test Results	% of Students under KKM
X MIPA 3	60.86	68.57
X MIPA 4	57.14	77.14
X MIPA 5	52.29	82.86
X MIPA 6	52.14	88.57
Average		79.29

Table 1 shows that at SMAN 13 Padang, 79.29% of students obtained daily assessments below the established Minimum Completeness Criteria (KKM) standard of 80 in the daily assessment of atomic structure. It indicates that students experience learning difficulties in atomic structure material, so student learning outcomes are low or below the KKM. However, it still needs to be made clear which indicators these students experience difficulties.

To be able to help students, a teacher needs to know the difficulties students experience in understanding the concept of the lesson [4]. One way to discover students' difficulties is by giving a

diagnostic test. The diagnostic test is one of the tests used to find out the weaknesses of students so that, based on these weaknesses, appropriate treatment can be carried out [5]. Meanwhile, to find out the factors that cause students' learning difficulties in terms of learning methods, namely by giving questionnaires and interviews.

The way of learning influences the achievement of student learning outcomes. Learning outcomes are a benchmark for achieving the learning objectives for students in following the learning series [6]. Mastery of effective learning methods is the secret to successful learning to obtain good learning outcomes [7].

Several studies on students' learning difficulties in chemistry learning, including research conducted by Neti, stated that students experienced learning difficulties on the subject of atomic structure because students only memorized and did not properly understand the concept. Students only focus on the teacher's explanation at school without looking for other sources [8]. Due to ineffective learning methods, Maryana's research stated that students needed help with acid-base subjects [9].

The learning difficulties experienced are revealed by students in class X MIPA at SMAN 13 Padang. It is necessary to research so that they can find the right solution to help students not experience learning difficulties. Therefore, researchers are interested in researching students who have learning difficulties for each indicator in atomic structure material and the causes of learning difficulties (in terms of learning methods) experienced by students.

RESEARCH METHODS

The type of research used is descriptive research. According to [10], descriptive research is a form of research that aims to describe or describe existing phenomena. The sample in this study was 36 students in class X E3 of SMAN 13 Padang. This research was conducted in the odd semester of the 2022/2023 academic year at SMAN 13 Padang.

The instrument used in this study was a diagnostic test sheet (two-tier multiple choice), questionnaire sheets, and interview sheets. Previous researchers validly prepared the diagnostic tests used in this study. Students are considered to understand a concept they are studying if the answer and the reason are also correct [11].

Students who experience misconceptions are students who have the right answers but give the wrong reasons or have the wrong answers but have the right reasons. Students needing help understanding the concept have wrong answers and reasons [12].

The diagnostic test given to students is in the form of two-level or multiple-choice questions with as many as 20 questions representing five learning indicators, namely indicator 1) explaining the

development of atomic theory according to Dalton, Thomson, Rutherford, Bohr, and wave mechanics; 2) Determining elementary particles (protons, electrons, and neutrons) and the discovery process; 3rd Determine the atomic number and mass number of an element; 4) Determine the electron configuration and quantum number; 5) Write down the electron configuration in the form of an orbital diagram. From the results of these tests, it can be grouped students' difficulties in each indicator.

The questionnaire sheet instrument was prepared based on external factors, namely student learning methods, consisting of 20 statements based on five indicators. Questionnaires are used to determine the factors that cause learning difficulties experienced by students. Interviews are used as supporting data to inquire further or clarify the results of the questionnaire answers (data not obtained from the questionnaire results will be supplemented by conducting interviews with students).

From the data from the diagnostic test results, it can be determined the percentage of students who have learning difficulties per learning indicator, namely by using the calculation of the percentage (%) to find out the number (%) of students who have learning difficulties in each indicator with the following formula.

$$\%K = \frac{\text{Students Answered Incorrectly}}{\text{All The Students}} \times 100\%$$

Information:

%K = Percentage of students with learning difficulties for each indicator question [13].

The interpretation of students' learning difficulties is based on the criteria put as in Table 2 below [14].

Table 2. Learning Difficulty Criteria

Criteria	Percentage (%)
Very high	81 – 100%
Hight	61 – 80%
High Enough	41 – 60%
Low	21 – 40%
Very low	0 – 20%

Then, grouping the results of students' answers from the level of understanding based on the diagnostic test questions. The answers given by students were categorized into four categories, as seen in Table 3.

The questionnaire was analyzed quantitatively by comparing the total score obtained by the respondents with a score of 100% so that the results will be expressed in percentage form using the percentage formula as follows:

$$P = \frac{\sum F}{\sum N} \times 100\% \tag{16}$$

The answers to each questionnaire item can be given a specific score [17], as in Table 4.

Table 3. Grouping categories of students' answer levels

Types of Student Answers	Explanation	Category
B-B (True-True)	Answer both levels of questions correctly	Understand
B-S (True-False)	Answer correctly on the first level and answer incorrectly on the second level.	Misconceptions
S-B (False-True)	Answer wrong on the first level and answer correctly on the second level	Misconceptions
S-S (False-False)	Answered incorrectly at both levels of the question	Do not understand

[15].

Table 4. Scores for each questionnaire item

Criteria	Statement Score (+)	Criteria	Statement Score (-)
Always	5	Always	1
Often	4	Often	2
Sometimes	3	Sometimes	3
Seldom	2	Seldom	4
Never	1	Never	5

[17].

RESULTS AND DISCUSSION

Description of Research

Research conducted at SMAN 13 Padang obtained data on learning difficulties based on the results of a diagnostic test given to 36 students in class X E3. Diagnostic test results of students are categorized into three groups, namely 1) Students who understand, 2) Students who experience misconceptions, and 3) Students who do not understand the test questions. Students who have misconceptions and do not understand are said to have learning difficulties [18].

In addition to using diagnostic tests, research data collection is also accompanied by filling out questionnaires and interviews with students. This questionnaire aims to discover the causes of learning difficulties experienced by students in terms of how students learn. The way students learn is measured by five indicators: making an implementation schedule, reading and making notes, repeating subject matter, concentrating, and doing assignments. Questionnaire data measurements use a Likert scale, including Always, Often, Sometimes, Rarely, and Never. Informants

choose answers by giving a marks *check-list* in one of the columns of the scale above. In contrast, the interview aims to inquire further or clarify the results of the questionnaire answers (data not obtained from the questionnaire results).

Student Diagnostic Test Results on Atomic Structure Material

The results of this study stated that, based on giving the most difficult indicator diagnostic test according to students, namely the fourth indicator, it was 81.25% in the very high category. The percentage of student diagnostic test answer categories is shown in Table 5.

Table 5. Student Diagnostic Test Results

Indicator	Category Answers Per-Indicator			
	PK (%)	TPK (%)	MK (%)	TPK+MK (%)
1	45.83	31.94	22.22	54.17
2	39.58	39.58	20.83	60.42
3	27.08	37.50	35.42	72.92
4	18.06	46.53	34.72	81.25
5	34.72	42.36	22.92	65.28
Average	33.05	39.58	27.22	66.81

Description: PK = Understand the Concept; MK = Misconceptions; TPK = Don't Understand the Concept

The average percentage of each category of answers per student indicator in Table 7 can be seen in the diagram in Figure 1.

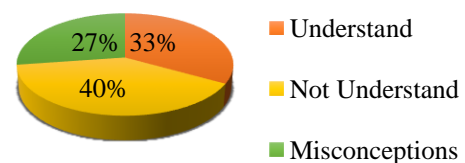


Figure 1. Categories of Student Answers

Figure 1 shows that the percentage of students who understand concepts, misconceptions, and do not understand concepts is 33%, 27%, and 40%. So, the percentage of students' learning difficulties is 67%.

The learning difficulties experienced by students in the 1st indicator were 54.17% in a fairly high category. It is because students need help understanding the theory of the atomic model, where students assume that electrons will decrease if they go around the nucleus and then fall into the atomic nucleus, as in question number 1. Some students also do not know that the JJ atom. Thomson

is positively charged, and electrons are scattered across its surface like raisins in a raisin bun. In addition, students also experienced difficulties with Rutherford's atomic theory because they assumed that the protons and neutrons in the nucleus would repel each other.

The second indicator, the learning difficulties experienced by students, amounted to 60.42% in a fairly high category. It is because students need help determining the basic particles that makeup atoms, where students assume that the atomic mass of an element is determined by the mass of protons and electrons, even though the mass of protons and neutrons determines it. Some students also need to learn how to calculate the number of neutrons from an element. In addition, students experience difficulties because they think that proving the existence of electrons is done by doing an alpha-ray experiment.

The third indicator is that students experience learning difficulties of 72.92% in the high category. It is because students need help determining an element's atomic number and mass number. Where students assume that the number of electrons equals the number of neutrons, the number of electrons should be the same as the number of protons. In addition, students experience an inverse concept between isotopes and isotones because they assume that isotopes have the same atomic number while isotopes have different atomic numbers.

The fourth indicator is that students experience learning difficulties of 81.25% in the very high category. It is because students have difficulty determining electron configurations and quantum numbers, and they still need to understand how to determine the electron configuration of an element with the Aufbau rule. They also need help in determining quantum numbers. In addition, students experience difficulties because they do not know the four quantum numbers, namely the principal quantum number, azimuth, magnetic, and spin.

The fifth indicator is that students have learning difficulties of 65.28% in the high category. Students need help writing electron configurations in the form of orbital diagrams. Students still need help determining electron configurations, so students also have difficulty writing in the form of orbitals and filling electrons in orbitals.

Based on the diagnostic test results, students have difficulty communicating the concepts they understand and analyzing questions because the atomic structure material is abstract. It is in line with Basri's research, namely abstract materials such as atomic structure and chemical bonds are difficult to observe with the naked eye [19]. Researchers assume that some students only memorize the concept of atomic structure but need help understanding it.

Mukhtar's statement supports this: difficulties in understanding chemical concepts

arise because concepts in chemistry are abstract and complex, so students are required to understand concepts in depth and correctly [20].

Results Causes of Student Learning Difficulties in terms of Learning Methods

In the questionnaire research, the results of the questionnaire data analysis showed that the factors causing students' learning difficulties in atomic structure material were caused by students rarely repeating subject matter and practice questions on atomic structure material that had been studied. The results of the questionnaire distribution analysis can be seen in Table 6.

Table 6. Questionnaire Results for Students' Learning Difficulties.

Indicator	Score (%)	Average	Criteria
Scheduling and implementation	58.24	3	Sometimes
	48.82	2	Seldom
Read and take notes	43.53	2	Seldom
	47.06	2	Seldom
	47.06	2	Seldom
	58.24	3	Sometimes
	57.06	3	Sometimes
	50.00	3	Sometimes
	68.82	3	Sometimes
	84.71	4	Often
Repeating course material	37.06	2	Seldom
	52.35	3	Sometimes
Concentration	40.59	2	Seldom
	59.41	3	Sometimes
	43.53	2	Seldom
Carry out a task	60.59	3	Sometimes
	54.71	3	Sometimes
	44.71	2	Seldom
	60.59	3	Sometimes
	85.29	4	Often

The 3rd indicator, namely repeating the subject matter, is the indicator that students do the least, affecting the learning process and causing their grades to be low.

The questionnaire results can be linked to interviews with several students. Students rarely repeat subject matter and practice questions that have been studied because students repeat subject matter when exams are to be held. It follows the results of the analysis of questions and questionnaires, where the most difficult learning indicator is the fourth indicator, namely, determining electron configuration and quantum numbers, and the highest causes of learning difficulties are students not repeating the subject matter.

The statement reinforces the results of this study [21], namely, repeating has a large effect on learning outcomes because repetition (review) on material that has yet to be mastered will remain embedded in one's brain. It is necessary to provide time to repeat and make the best use of the time to understand the material being repeated seriously.

Based on the results of diagnostic tests, questionnaires, and interviews, it was found that students were very influential on student learning outcomes. The results of this study align with the results of research conducted [22]; namely, there is a positive influence between learning methods on the learning outcomes of class X students of SMA Negeri 2 Bantul. The better the way of learning, the higher the learning achievement. Thus, students need to know how to learn effectively because the success of students can be achieved well if these students know how to learn effectively [23]. Based on this research, the way of learning has a major influence on learning outcomes, so the way of learning is very important to encourage and improve learning outcomes.

CONCLUSION

This study concludes that students of SMAN 13 Padang experience learning difficulties in atomic structure material, with a high category of 66.81%. The difficulty level of students in the 1st indicator, namely explaining the development of atomic theory according to Dalton, Thomson, Rutherford, Bohr, and wave mechanics, was 54.17% in a fairly high category; on the 2nd indicator, namely determining elementary particles (protons, electrons, and neutrons) and the discovery process of 60.42% in a fairly high category; on the 3rd indicator, namely determining the atomic number and mass number of an element of 72.92% in the high category; on the 4th indicator, namely determining the electron configuration and quantum number of 81.25% in the very high category; and on the 5th indicator, namely writing the electron configuration in the form of an orbital diagram of 65.28% in the high category. Learning difficulties experienced by students are caused because students need to implement effective learning methods, including not making study schedules and not carrying them out, not reading and not taking notes, not repeating material, not concentrating on learning, and not doing assignments.

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