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Needs Analysis of Student Perception Scale Instruments on Chemistry Learning Difficulties

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Abstract

The learning process is the mental activity of individuals in communicating with their environment which is invisible but can be proven through behavioral transformation in a positive direction. In reality, there are several difficulties faced by students such as students who have undergone a deep learning process but still have difficulty achieving learning achievements at school. Learning difficulties experienced by students must be diagnosed by the teacher which aims to determine the situation of student learning difficulties. However, there are obstacles in the unavailability of complete instruments to measure student learning difficulties and teachers have a lack of understanding of the use of measurement instruments. The questionnaire instrument will help teachers in diagnosing students' learning difficulties. Before its development, a needs analysis stage is needed to adjust the characteristics of the instrument design according to the data in the field. The needs analysis using a questionnaire consists of 3 aspects (17 questions) with 7 chemistry teacher participants in Yogyakarta. The needs analysis questionnaire has been validated by chemistry learning experts. The results of the data were analyzed using descriptive qualitative by presenting data or answers calculating frequencies and percentages. It was concluded that the development of a student perception scale instrument on chemistry learning difficulties has an urgency that is quite important because of the limitations or unavailability of these measurement instruments.

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INTRODUCTION

The learning process is the mental activity of individuals in communicating with their environment which is invisible but can be proven through behavioral transformation in a positive direction in terms of cognitive, affective, and psychomotor. The strength of individuals who are conscious in carrying out their activities because there is motivation to achieve goals or because of a habit (Emda, 2019). A positive learning process will have a positive impact too, this is what every educational institution hopes for. However, in reality there are several difficulties faced by students such as students who have undergone an in-depth learning process but still have difficulty achieving learning achievements at school. There are students who experience difficulties but know how to solve them, but there are students who are also confused about the problems they face so they cannot solve them (Ismail, 2016).

In Senior High School (SMA), one of the subjects is chemistry within the scope of Natural Sciences (IPA). The view of chemistry as a process is interpreted as a scientific activity in refining knowledge to find new knowledge or science. Chemistry as a product is interpreted as the result of a process of scientific activity that produces facts, concepts, principles, laws, and theories from scientists (Hemayanti et al., 2020). In reality, chemistry is interpreted as a difficult science for many students due to the characteristics of chemistry (Johnstone, 1991). Chemistry subjects in high school explore matters related to substances including composition, structure, properties, changes, and energy of substances that will link skills and reasoning (Astuti, 2020).

Learning difficulty is an event where students experience obstacles in their learning process to achieve learning goals. In this case, these obstacles come from within and outside so that students are less able to take the demands in the learning process (Utami, 2020). Learning difficulties encountered by students in studying chemistry are generally caused by students not knowing the system in learning, difficulty connecting between concepts, ability in language, mathematics, and logic (Zakiyah et al., 2018). Other research findings that identify problems faced by students in chemistry are numeracy, scientific reasoning, use of scientific language, and classroom situations (Woldeamanuel et al., 2014). Language can represent chemistry learning difficulties due to the variety of vocabulary used in chemistry, foreign vocabulary that is difficult to define (Crosson & Lesaux, 2013), and mathematical concepts used in chemical calculation activities and reaction processes (Scoot, 2012). This basic initial knowledge must be fulfilled sufficiently to be able to study chemistry which has its own scientific characteristics.

The characteristics of chemistry that are different from other branches of science are chemical concepts that have implications for the visualization of three stages (macroscopic, symbolic, and submicroscopic) that are interconnected. Visualization of the concept must be understood conceptually (Johnstone, 1991). Difficulties in this regard cause students to only receive information and memorize it. The memorization method makes students only receive information without understanding it for sure and not studying it again in depth (Yakina et al., 2017).

Learning difficulties experienced by students must be recognized and overcome by components of the role in learning such as educators or teachers. Teachers are required to carry out a diagnosis that aims to determine the situation of students' learning difficulties. Diagnosis of learning difficulties is an effort made by the teacher to find out learning difficulties, analyze the types and nature of student learning difficulties. The biggest obstacle when teachers face student learning difficulties is the absence of time to diagnose this because they are busy preparing for learning activities. Other obstacles are found in the unavailability of complete instruments to measure student learning difficulties and teachers have a lack of understanding of the use of measurement instruments (Ismail, 2016).

Research conducted by Utami (2020) on the role of teachers in overcoming student learning difficulties. Teachers identify and diagnose student learning difficulties by comparing individual achievement scores with the average overall score of students and comparing student scores with the minimum completeness criteria. Then the teacher develops a program to solve student problems by adjusting the required material, learning methods, and teaching and learning aids according to the material. The diagnosis carried out by the teacher in the study was not good enough because only the results of comparing student grades were obtained so that it was not specifically identified in student learning difficulties. Presumably teachers can pay more attention to student learning difficulties by conducting specific measurements using an instrument so as to obtain the types of student learning difficulties in terms of their perceptions of a subject.

In a study conducted by Allo & Azrun (2023) using a questionnaire instrument to determine the causes of chemistry learning difficulties expressed in 6 aspects, namely intelligence, motivation, talent, interest, school environment, and family environment. Based on this, it is concluded that there are two factors that cause chemistry learning difficulties, namely internal factors in the form of low student math skills, intelligence and low student learning motivation while external factors in the form of lack of facilities obtained and less conducive learning time. The research has not explained in detail about the aspects and indicators in the questionnaire instrument used. As well as concluded the causes of learning difficulties from the perspective of internal and external factors, but have not been specifically identified from students' perceptions of chemistry.

Based on this description, there are still problems such as teachers who do not diagnose student learning difficulties, the unavailability of measurement instruments, and learning difficulties that have not been identified from students' perceptions of chemistry. Difficulties arising from chemistry such as chemical concepts, language, mathematical calculations, concept visualization, and memorization have not been measured in depth. Thus, a measurement instrument is needed in order to assist teachers in diagnosing students' chemistry learning difficulties. This motivates researchers to explore the needs that are in accordance with the actual situation before the development of a valid and reliable student perception scale instrument on chemistry learning difficulties

METHODS

This research was to explore the need for a student perception scale instrument on chemistry learning difficulties. This research method will explain the type and design of research, participants, data collection techniques and instruments, and data analysis.

Research Type and Design

This research uses a qualitative type with an exploratory survey method. In this study, there was no experimental intervention to the participants in the study. The focus of this research is to explore the need for a student perception scale instrument on chemistry learning difficulties.

Participants and Research Context

A total of 7 teachers teaching in Yogyakarta City, Indonesia participated in this study. The research participants were selected using purposive sampling technique where the participants were determined based on a criteria. The criteria are teachers who teach chemistry subjects in public high schools in Yogyakarta City, have more than 2 years of teaching experience, and have encountered students who perceive chemistry as a difficult subject.

The purpose of the learning difficulty measurement instrument is to diagnose chemistry learning difficulties in terms of student perceptions. The results of the diagnosis will be used as a basis in overcoming students' chemistry learning difficulties. However, learning difficulty measurement instruments generally only look at internal factors and external factors. This has not been able to prove the types of learning difficulties in terms of students' perceptions themselves such as abstract chemical concepts, complex chemical terms, mathematical calculation skills, and visualization of chemical concepts.

Data Collection Technique and Instrument

The data collection technique used was in the form of a questionnaire or questionnaire analyzing the needs of the design of a student perception scale instrument on chemistry learning difficulties. The questionnaire consists of 3 themes, namely the teacher's experience of student learning difficulties, learning evaluation, and the urgency of instrument development. Based on the 3 themes, 16 closed-ended questions and 1 open-ended question with codes Q1 to Q17 will be formed. Before the teacher needs analysis questionnaire was used, the questionnaire was validated by 1 chemistry learning expert. The chemistry learning expert analyzed the accuracy between aspects, indicators, and questions, grammar, and answer choices. The correction results obtained must be revised and re-approved. The following Table 1. shows the lattice of the needs analysis questionnaire.

Table 1. Needs Analysis Questionnaire

Theme	Example Question	Total Items
Teacher experience of student learning difficulties	- How do you think students' chemistry learning difficulties impact on the chemistry learning process? - What do you know about diagnosing students' chemistry learning difficulties?	6
Learning evaluation	- How do you assess students' ability to understand chemistry concepts? - How do you assess students' ability to explain complex terms in chemistry?	7
Urgency of Instrument Development	- If you have the instrument, is it easy to use? - Do you feel any limitations in the student perception scale instrument on chemistry learning difficulties?	4

Data Analysis

Data analysis uses qualitative descriptive by presenting data or answers to calculate frequencies and percentages. Presentation of data to understand what happened and analyze the data so that participants are coded P1 to P7. Frequency calculation will provide an overview of the distribution of answers from respondents to each statement in the questionnaire. Thus, the frequency value will show the tendency of the data and clear patterns in the answers.

RESULTS AND DISCUSSION

Each finding from the research will be discussed in this section. Based on each questionnaire question, the data or participants' answer choices are shown. The results are presented in the form of frequencies and percentages for each answer.

Teacher Experience on Student Learning Difficulties

The first question (Q1) was What do you think is the level of difficulty faced by students in learning chemistry? The participants' answers varied from low, medium, and high. The frequency of answers for Q1 is presented in Table 2.

Table 1. Answer of Q1

Answer Result	Frequency	Percentage (%)
Medium	4	57
Moderately high	2	29
Low	1	14

Based on the frequency results in Table 2. most participants stated that the level of difficulty faced by students in learning chemistry is moderate. Findings from P1 and P2 as much as 29% stated that the level of difficulty of learning chemistry was quite high.

The second question (Q2) is how often do you find students who consider chemistry as a difficult lesson? The variety of participants' answers included sometimes and often. The frequency of answers for Q2 is presented in Table 3.

Table 2. Answer of Q2

Answer Result	Frequency	Percentage (%)
Sometimes	5	71
Often	2	29

Based on the frequency results in Table 3. five out of seven participants stated that they sometimes found students who considered chemistry as a difficult subject. Findings from P1 and P5 as much as 29% stated that they often encountered this. Chemistry subjects have two views, namely chemistry as a process and chemistry as a product. Chemistry as a process is interpreted as a scientific activity to produce a product in the form of facts, concepts, and theories. But in reality, chemistry is interpreted as a difficult science for students because of the characteristics of chemistry (Johnstone, 1991). Chemistry is interpreted as a difficult science for students due to its relationship with abstract material structures (Taber, 2002).

The third question (Q3) was how do you think students' chemistry learning difficulties impact on the chemistry learning process? The variety of participants' answers to Q3 is described in Table 4.

Table 3. Answer of Q3

Answer Result	Frequency	Percentage (%)
Students' chemistry learning difficulties can slow down the achievement of learning objectives but can be overcome by adjusting learning methods.	2	25
Students' chemistry learning difficulties do not have much impact on the learning process because students can overcome their own challenges.	2	25
Students' chemistry learning difficulties are an important concern because they can cause students to have difficulty in achieving satisfactory learning outcomes.	2	25
Students' chemistry learning difficulties occur due to ineffective communication in learning, which has an impact on students who are slow in understanding the material.	2	25

Based on the frequency results in Table 4. there are 4 answers chosen by participants with the same frequency. The findings from P3 state two answer choices, namely the impact of chemistry learning difficulties influenced by ineffective communication that can affect student learning outcomes. Learning difficulties faced by students such as difficulty in doing questions or assignments so that they can affect student learning outcomes (Ismail, 2016).

The fourth question (Q4) is what do you know about the diagnosis of students' chemistry learning difficulties? The variety of participants' answers to Q4 is described in Table 5.

Table 4. Answer of Q4

Answer Result	Frequency	Percentage (%)
Diagnosis of student learning difficulties is carried out to determine the types of student learning difficulties in chemistry.	3	43
Diagnosis of student learning difficulties can help students to overcome the learning difficulties they experience	2	29
Diagnosis of student learning difficulties is carried out as a form of attention to students who experience learning difficulties	1	14
Diagnosis of student learning difficulties is done not only through observation	1	14

Based on the frequency results in Table 5. the majority of participants stated that the diagnosis of student learning difficulties is used to determine the type of student's chemistry learning difficulties. Teachers are required to carry out a diagnosis that aims to determine the situation of students' learning difficulties. Diagnosis of learning difficulties is an effort made by the teacher to find out learning difficulties, analyze the types and nature of student learning difficulties (Ismail, 2016).

The fifth question (Q5) is what have you done to diagnose students' chemistry learning difficulties? In this question, participants answered with a variety of answer options for Q5 which are described in Table 6.

Table 5. Answer of Q5

Answer Result	Frequency	Percentage (%)
I compare students' scores with the maximum completeness score.	3	37
I observe each student and the results of the observation are used as material for analyzing the types of student learning difficulties	2	24
I conduct assessments or measurements using an instrument to analyze students' chemistry learning difficulties.	1	13
I never diagnose students' chemistry learning difficulties	1	13
I ask directly to students who have learning difficulties	1	13

Based on the frequency results in Table 6. there are 3 participants conducting diagnosis by comparing student scores with the maximum completeness value. P3 stated that she had never diagnosed students' chemistry learning difficulties and only made grade comparisons. The biggest obstacle when teachers face student learning difficulties is the absence of time to diagnose student learning difficulties because they are busy preparing for learning activities (Ismail, 2016). Teachers compare individual scores with the overall average to analyze student learning difficulties. However, this is not good enough because it does not specifically identify the types of student learning difficulties (Utami, 2020).

Table 6. Answer of Q6

Answer Result	Frequency	Percentage (%)
Visualization or depiction of chemical concepts and mathematical calculations	4	57
Chemical concepts, mathematical calculations, and visualization or depiction of chemical concepts	2	29
Use of scientific language and memorization skills	1	14

Based on the frequency results in Table 7. there are 4 participants stated that visualization or depiction of chemical concepts and chemical calculations as the cause of chemistry learning difficulties in high school students. Then followed by chemical concepts, mathematical calculations, and visualization of concepts as much as 2 frequencies stated by P1 and P5. Learning difficulties in learning chemistry are generally caused by students' difficulties in linking between concepts, ability in language, mathematics, and chemical logic (Zakiyah et al., 2018). Research by Woldemauel et al (2014) identified findings of learning difficulties faced by students in studying chemistry including numeracy, use of scientific language, scientific reasoning, and classroom situations.

Learning Evaluation

The seventh question (Q7) is how do you assess students' ability to understand chemical concepts? There is one answer option that has a high frequency value. The variety of participants' answers for Q7 is presented in Table 8.

Table 7. Answer of Q7

Answer Result	Frequency	Percentage (%)
Assessing based on their accuracy in doing written problems	6	67
Observing students in expressing their opinions in group discussions	2	22
Asking students verbally about the chemical concept	1	11

Based on the frequency results in Table 8. there are 6 participants who assess students' ability to understand chemical concepts based on their accuracy in doing written problems. P3 and P4 stated that they observed students in expressing their opinions in group discussions. The accuracy of students in working on problems as an initial benchmark for teachers to assess students' understanding of chemical concepts. Chemical concepts are abstract so that they cannot be explained without using analogies or models (Gabel, 1999).

The eighth question (Q8) is how do you assess students' ability to explain complex terms in chemistry? The variety of participants' answers to Q8 is presented in Table 9.

Table 8. Answer of Q8

Answer Result	Frequency	Percentage (%)
Provide essay questions to explain terms in chemistry	3	38
Assess student presentations in explaining chemical terms	2	25
Assessing students' ability to ask questions using terms in chemistry	2	25
Ask students orally about the definition of a term in chemistry	1	12

Based on the frequency results in Table 9. there are 3 participants who assess students' ability to explain complex terms by giving essay questions. P3 and P6 stated that they assessed students' presentation in explaining terms in chemistry. Language in chemistry learning has abstract and diverse meanings and students who do not improve their ability to use connective words. This supports teachers to assess through essay questions and student presentations so that the sentences used by students can be seen directly (Crosson & Lesaux, 2013).

The eighth question (Q9) is how do you assess students' ability in mathematical operations or calculations in chemistry? The variety of participants' answers to Q9 is presented in Table 10.

Table 9. Answer of Q9

Answer Result	Frequency	Percentage (%)
Asking students to explain step by step calculations on a problem	5	56
Assess based on their accuracy in solving written calculation problems	4	44

Based on the frequency results in Table 10. there are 5 participants who assess students' ability in mathematical calculations by asking students to explain step by step the calculation problem. P1, P3, P4, and P6 stated that they made assessments based on their accuracy in solving written problems. Students have difficulty learning chemistry because they cannot transfer their mathematical knowledge into chemistry. It takes good basic math for students to

experience ease in learning chemistry. There are mathematical calculations in chemistry that involve direct calculations and intermediate calculations to arrive at the right solution (Scoot, 2012).

The tenth question (Q10) is how do you assess students' ability to visualize chemistry concepts? The variety of participants' answers to Q10 is presented in Table 11.

Tabel 10. Answer of Q10

Answer Result	Frequency	Percentage (%)
Assess based on students' explanation of a picture, diagram, or an illustration of a chemical concept	5	56
Observe students in explaining visualization or example of a chemical concept	2	22
Assess based on visualization media used by students	2	22

Based on the frequency results in Table 11. there are 5 participants who assess students' ability to visualize chemical concepts based on students' explanations of pictures, diagrams, and illustrations. Chemistry is studied at three levels, namely macroscopic, symbolic, and sub-microscopic. These stages must be passed by students because otherwise students will experience difficulties at one level and affect other levels (Johnstone, 1991).

The eleventh question (Q11) was how do you assess students' ability to memorize chemistry? The variety of participants' answers to Q11 is presented in Table 12.

Table 11. Answer of Q11

Answer Result	Frequency	Percentage (%)
Using quizzes for students to mention chemical concepts in a limited time	5	72
Ask orally about chemical concepts that have been learned	1	14
Asking students to memorize a chemical concept and test it	1	14

Based on the frequency results in Table 12. there are 5 participants who assess students' memorization ability of chemistry using quizzes for students to mention the chemical concepts. Science understanding is difficult at three stages so students often use rote techniques to memorize algorithms without conceptual understanding so that students answer a question using rote memory (Lamba, 2008).

The twelfth question (Q12) is have you ever conducted a learning evaluation to diagnose students' chemistry learning difficulties? All teachers stated that yes, they have done this.

The thirteenth question (Q13) as a continuation of the previous question was how do you diagnose the problem? The variety of participants' answers to Q13 is presented in Table 13.

Table 12. Answer of Q13

Answer Result	Frequency	Percentage (%)
Written test with multiple choice questions	3	30
Direct observation during the student discussion process in class	3	30
Written test with essay questions	2	20
Inviting students to fill out a questionnaire regarding the types of chemistry learning difficulties they experience	2	20

Based on the frequency results in Table 13. there are 3 participants who diagnose students' learning difficulties using written tests with multiple choice questions. P1 and P2 have invited students to fill out questionnaires regarding this matter.

Urgency of Instrument Development

The fourteenth question (Q14) is whether you have ever encountered a non-test scale instrument to measure students' perceptions of chemistry learning difficulties? A total of 4 participants stated that yes, they had encountered this, while 3 participants stated that they had not.

The fifteenth question (Q15) as a continuation of the previous question is if you have the instrument, is it easy to use? All participants stated that yes, it was quite easy because the whole instrument was clear although some statement items were less relevant. This was slightly inconsistent with Q14 because 3 participants stated that they had never encountered a non-scale test instrument regarding this matter.

The sixteenth question (Q16) was do you feel limitations in non-scale test instruments to measure students' perceptions of chemistry learning difficulties? The variety of participants' answers to Q16 is presented in Table 14.

Table 13. Answer of Q16

Answer Result	Frequency	Percentage (%)
Yes, quite limited as there are often instruments that are not relevant enough	4	57
Yes, limited as there are often instruments that point to internal and external factors related to students' learning difficulties.	3	43

Based on the frequency results in Table 13, 4 participants stated that it was quite limited because they often encountered instruments that were less relevant. Less relevant instruments lead to internal and external factors related to student learning difficulties.

The seventeenth question (Q17) is to provide your suggestions and responses regarding the design of the student perception scale instrument on chemistry learning difficulties that the researcher will develop! Participants had varied answers such as the instrument raises relevant questions covering the 5 aspects and the instrument design should be with specific aspect identification. The coding results for Q17 are presented in Table 15.

Table 14. Answer of Q17

Answer Result	Frequency	Percentage (%)
Instrument design according to aspects	3	43
Never made	1	14
Instrument design refers to chemistry material	3	43

Based on the code results in Table 15. 3 participants stated that the design of the instrument to be developed is in accordance with the relevant aspects and questions. This is based on the participant's expression as follows.

“Instruments about student perceptions of learning difficulties include various things ranging from memorized concepts, calculations, practices, utilization of group discussions and peer tutors.” (P1)

“Instrument design should identify specific aspects that are often a challenge for students in learning chemistry, more specific questions.” (P2)

“The instrument that is developed may be able to raise questions that are relevant to the reality in the field.” (P4).

Based on the theme of the urgency of instrument development, the results of the analysis show that the development of a scale instrument for students' perceptions of chemistry learning difficulties is important. The majority of participants have encountered the scale instrument but found shortcomings in questions that are less relevant. In the research conducted by Allo & Azrun (2023) aims to analyze the causes of students' chemical learning difficulties in stoichiometry material. Based on this, it is concluded that there are two factors that cause chemistry learning difficulties, namely internal factors in the form of low student math skills, intelligence and low student learning motivation while external factors in the form of lack of facilities obtained and less conducive learning time. The research has not explained in detail about the aspects and indicators in the questionnaire instrument used. As well as concluded the causes of learning difficulties from the perspective of internal and external factors, but have not been specifically identified from students' perceptions of chemistry.

The limitations in this study are the small research sample so that the level of generalization is low. Participants came from Yogyakarta so that the research results were less relevant in other contexts. Overall, based on the data from the needs analysis, the development of the design of the student perception scale instrument on chemistry learning difficulties shows that the importance of developing the product. The instrument to be developed can be adjusted to the results of the needs analysis so that a valid and reliable instrument is obtained

CONCLUSION

Learning difficulty is an event where students experience obstacles in their learning process to achieve learning goals. In this case, these obstacles come from within and outside so that students are less able to take the demands in the learning process. Learning difficulties experienced by students must be recognized and overcome by components of the role in learning such as educators or teachers. Diagnosis of learning difficulties is an effort made by the teacher to find out learning difficulties, analyze the types and nature of student learning difficulties. The development of a student perception scale instrument on chemistry learning difficulties has a high urgency. This is due to the lack of time for teachers to carry out measurements and the unavailability of the right instrument to measure this. The instrument developed must be interrelated between the 5 aspects, indicators, and question items…

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