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REDUCTION OF STUDENT MISCONCEPTIONS ABOUT ELEMENTS, COMPOUNDS, AND MIXTURES THROUGH THE GUIDED INQUIRY LEARNING MODEL

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Abstract
This research aims to determine the effectiveness of the guided inquiry learning model in reducing student misconceptions about the material of elements, compounds, and mixtures. The research used a descriptive quantitative method using a pre-experimental research design and a one-group pretest-posttest design. The research sample is class VIII-D SMP Negeri 2 Saronggi, with purposive sampling as the sampling technique. The student's misconception was identified using a three-tier diagnostic test. Data collection techniques using tests, questionnaires, observation, and documentation. Based on the result of the research, it can be concluded that (1) The effectiveness of the guided inquiry learning model reduces student misconceptions about the material of elements, compounds, and mixtures by testing the hypothesis obtained Asymp. Sig < 0,05 (0,00 < 0,05), (2) the guided inquiry learning model can reduce student misconception from an average of 51,92 to 18,46, (3) the implementation of learning of the guided inquiry learning model obtained a percentage of 93% with a perfect category, (4) student responses to guided inquiry learning model is very good with a percentage 80%.

Keywords: element, compound, guided inquiry, misconceptions, mixtures, three-tier diagnostic test.

Abstrak
Penelitian dilakukan untuk mengetahui keefektifan model pembelajaran *guided inquiry* dalam mereduksi miskonsepsi siswa pada materi unsur, senyawa dan campuran. Penelitian menggunakan metode kuantitatif dengan desain penelitian pre-experimental dengan bentuk one-group pretest-posttest design Sampel yang digunakan yaitu kelas VIII-D SMP Negeri 2 Saronggi sebanyak 26 siswa dengan pemilihan sampel secara purposive sampling. Identifikasi miskonsepsi siswa menggunakan tes diagnostik three-tier. Teknik pengumpulan data menggunakan tes, lembar observasi keterlaksanaan pembelajaran, angket respons siswa dan dokumentasi. Berdasarkan hasil penelitian dapat disimpulkan bahwa (1) Model pembelajaran *guided inquiry* efektif dalam mereduksi miskonsepsi siswa pada materi unsur, senyawa dan campuran dengan uji hipotesis yang diperoleh yaitu nilai Asymp.sig 0,00 < 0,05, (2) Model pembelajaran *guided inquiry* mampu mereduksi miskonsepsi siswa dari rata-rata sebesar 51,92 menjadi 18,46, (3) Hasil keterlaksanaan pembelajaran dengan model pembelajaran *guided inquiry* sebesar 93% dengan kategori sangat baik, (4) Respons siswa terhadap model pembelajaran guided inquiry sangat baik dengan rata-rata nilai sebesar 80%.

Kata Kunci: campuran, miskonsepsi, *guided inquiry*, senyawa, tes diagnostik *three-tier*, unsur.

INTRODUCTION

Science is a science that has the benefit of knowing about events that occur in the natural environment. Science lessons cover all theories in the universe, which can explain the facts of natural events in everyday life. Science learning is not only about theoretical understanding but is also required to understand the concepts in science (Jufrida et al., 2020). Understanding concepts in science lessons is very important to apply to students because they contain phenomena in life. Understanding science concepts is students' understanding of the concepts and facts in science by expressing them using their language but without changing the actual meaning (Marlina, 2022).

Science learning is a learning that often has misconceptions. Misconceptions are errors in understanding a concept that contradict the concept experts have put forward (Suparwati, 2022). Misconceptions can occur in students, namely because one of them is the existence of preconceptions before the student receives the material being taught (Suparwati, 2022). Low interest in learning can also cause misconceptions (Adi & Oktaviani, 2019). Misconceptions are one of the big problems in learning because they can hinder the learning process (Mulya & Zulyusri, 2022).

Misconceptions need to be overcome because they can prevent students from accepting new material that the teacher will present. Apart from that, misconceptions can impact the difficulty of developing concepts that students already have with new concepts that students will learn (Puspitasari et al., 2019). Applying appropriate learning models can be done to reduce misconceptions experienced by students so that learning material can be understood easily. The use of the Guided Inquiry learning model is effective in increasing students' understanding because in this learning model, students will study the material more realistically and actively, and students will also be trained to find solutions to the problems they face and make decisions about these problems (Kurniawati, 2021).

Implementing an effective learning model is one method of reducing misconceptions (Wati & Novita, 2021). One such learning model is Guided Inquiry, which teachers use to train student activity in the classroom. The Guided Inquiry learning model involves students in the learning process, such as in research, where students gain knowledge through formulating problems, creating hypotheses, collecting data, presenting results, and finally drawing conclusions (Annafy et al., 2021).

The teacher's role in the Guided Inquiry learning model is as a facilitator, which means the teacher's job is to guide and direct students so that students are more actively involved in the learning process (Dinda et al., 2019). The teacher presents a problem so students can look for ways to solve it (Rachman & jauhariyah, 2020). The advantage of the Guided Inquiry learning model is that students can think critically and analytically in solving the problems they face and express opinions actively (Yudhanegara et al., 2018).

Students often need clarification about science materials, namely elements, compounds, and mixtures. Elements, compounds, and mixtures are the primary

materials in class VIII science subjects in the even semester. The application of elements, compounds, and mixtures is easy to find in everyday life. Simple examples of compound and mixture elements in everyday life are sugar, water, salt (NaCl), and oxygen (O). However, the level of misconceptions experienced by students regarding elements, compounds, and mixtures still needs to be lowered. It considers the high level of misconceptions students experience regarding elements, compounds, and mixtures. This shows a lack of effort in implementing effective learning models. Therefore, it is necessary to reduce misconceptions to reduce the level of misconceptions students experience. The learning model applied is the Guided inquiry learning model. Based on the problem description above, it is necessary to research "Reducing Student Misconceptions on Elements, Compounds, and Mixtures Through the Guided Inquiry Learning Model."

METHOD

This type of research was carried out using quantitative methods with a pre-experimental research design. Research with a pre-experimental design was carried out to test the influence of the independent variable on the dependent variable. The research was conducted at SMPN 2 Saronggi, whose address is Jalan Raya Tanjung, Saronggi District, Sumenep Regency, East Java. The research was conducted in the Even Semester Academic Year 2022/2023, with the sample being class VIII-D. The sample selection technique is purposive sampling, which is a sample selection technique that is carefully considered (Sugiyono, 2019). The research was carried out after students received the material taught by the teacher.

The instruments used in the research are learning implementation collection instruments and data collection instruments. The instrument for collecting learning implementation consists of Learning Objectives Flow (LOF), Teaching Modules, and Student Worksheets. The data collection instrument used was a test. The instrument used is a three-tier diagnostic test consisting of 10 questions. Before use, the test instrument was validated by Science Education Lecturers and Teachers at SMPN 2 Saronggi. The validity results obtained were then analyzed using Aiken's V formula (Damayanti et al., 2021) contained in formula 1. The validity level criteria can be seen in Table 1.

$$V = \frac{\sum s}{n\,(c-1)} \quad (1)$$

Note:
V = Index of respondent agreement regarding the validity of the instrument
s = number determined by the respondent minus the lowest score (r-1)
r = number given by the respondent
n = Number of respondents
c = highest rating number by the respondent

Table 1. Instrument Validity Criteria

Average Score	Validity Level
0.8 < V ≤ 1	Very Valid
0.6 < V ≤ 0.8	Valid
0.4 < V ≤ 0.6	Fairly Valid
0 < V ≤ 0.4	Less Valid

(Damayanti *et al.*, 2021)

Apart from calculating the level of validity, the reliability value of the instrument that will be used is also calculated using the Percentage of Agreement (PA), which is determined by the Borich equation, with the condition that if the PA value is ≥ 75%, then the data can be said to be reliable (Hasin et al., 2020) equation Borich can be seen in Formula 2.

$$PA = \left(1 - \frac{A-B}{A+B}\right) \times 100\% \quad (2)$$

The three-tier diagnostic test is given before learning and after learning to identify misconceptions experienced by students using a combination of three-level test answer categories, namely understanding the concept (UC), misconception (M), guessing (G), not understanding the concept (NUC) (Erna et al., 2021). The combination of three-tier diagnostic test answers and their conception levels can be seen in Table 2 (Erna et al., 2021).

Table 2. Combination of Three-tier Diagnostic Test Answers along with Conception Categories

No	Tier-1	Tier-2	Tier-3	Category
1	Correct	Correct	Certain	UC
2	Correct	Wrong	Certain	M
3	Wrong	Correct	Certain	M
4	Wrong	Wrong	Certain	M
5	Correct	Correct	Not Sure	G
6	Correct	Wrong	Not Sure	NUC
7	Wrong	Correct	Not Sure	NUC
8	Wrong	Wrong	Not Sure	NUC

Note:
UC: Understand the concept
M: Misconceptions
G: Guessing
NUC: Not understand the concept

The pre-test and post-test results were then analyzed and categorized into students who understood the concept, had misconceptions, did not understand the concept, and guessed using formula 3 (Edy et al., 2022).

$$P = \frac{f}{N} \times 100\% \quad (3)$$

Note:
P = Percentage value
f = frequency of each category
N = Number of students

Furthermore, students' misconceptions are categorized into three levels: high, medium, and low. To find out these categories, use standard deviation. Table 3 shows the percentage categories of misconceptions experienced by students.

Table 3. Misconceptions Level Categories

Criteria	Misconceptions Level
s ≥ (M + 1 SD)	High
(M - 1 SD) < S < (M + 1 SD)	Medium
s ≤ (M – 1 SD)	Low

(Andriani *et al.*, 2021)

Note:
S = Student's Score
M = Mean
DS = Deviation Standart

RESULTS AND DISCUSSION

Data on the percentage of misconceptions experienced by students before and after learning were processed using the SPSS version 22 application. The data were from descriptive statistical analysis tests.

Table 4. Descriptive Statistical Analysis of Student Misconceptions

Statistics Descriptive	Percentage of Misconceptions	
	Pre-test	*Post-test*
N	26	26
Mean	5.92	18.46
Std. error of the mean	3.680	2.462
Std. Deviation	18.766	12.551
Variance	352,154	157.538
Range	70	50
Minimum	10	0
Maximum	80	50

The data in Table 4 shows the percentage of misconceptions experienced by students before learning (pre-test), resulting in an average value (mean) of 51.92. In contrast, the results of the percentage of student misconceptions after learning (post-test) produced an average value- the average (mean) is 18.46. This shows that there has been a decrease in the average score before and after learning, so the guided inquiry learning model can reduce misconceptions among students.

Hypothesis testing can determine the influence of the guided inquiry learning model in reducing misconceptions experienced by students. Before carrying out a hypothesis test, a normality test is carried out first to determine whether the data is normally distributed or not. The data obtained in this research does not meet the requirements of a parametric test, so it is carried out. Hypothesis test with the non-parametric Wilcoxon test. The result of the normality test is in Table 5.

Table 5 Normality Test Results

	Kolmogorov-smirnof			Note
	Statistic	Df	Sig.	
Pre-test	0.167	26	0.062	Normal
Post-test	0.201	26	0.008	Not Normal

The hypothesis test result using the non-parametric Wilcoxon test is in Table 6.

Table 6. Hypothesis Test Results

	Posttest-pretest
Z	-4.421
Asymp. Sig. (2-tailed)	.000

Table 6 shows the significance results of 0.000. They are obtaining Asymp value. Sig < 0.05, namely 0.000 < 0.05, means H_1 is accepted and H_0 is rejected. So, the guided inquiry learning model can reduce misconceptions experienced by students regarding elements, compounds, and mixtures.

The guided inquiry learning model can increase students' understanding of concepts because the learning syntax is different from the conventional learning model; here, students are guided by the teacher to determine hypotheses and test the hypotheses that have been determined by discussing with their group through direct observation. One of the stages of the guided inquiry learning model that is able to make students develop their own understanding is the formulation stage (Erna et al., 2021) because, at the formulation stage, students carry out the investigation stage by looking for answers to the hypotheses that the students have determined. In the collection stage, students conclude from the investigations carried out with their groups and then present the results. In the presentation stage, the teacher provides material reinforcement to strengthen the understanding that students have gained through the guided inquiry learning model.

The guided inquiry learning model is by constructivist learning theory, namely that knowledge is built through activities connecting new knowledge to previously possessed knowledge (Yamin, 2015). Therefore, learning by applying the guided inquiry learning model provides the opportunity to find out students' understanding, namely at the formulation stage.

The data from the pre-test and post-test results were then analyzed and classified into students who understood, guessed, needed help understanding the concept, and had misconceptions. Table 7 shows the results of classifying students' conception levels before and after learning.

Table 7. Average Percentage of Students' Pre-test and Post-test Conceptions

Misconception Level	Pre-test (%)	Post-test (%)
UC	21.92	64.61
M	51.92	18.46
G	8.07	0.00
NUC	17.69	16.15

The percentage of misconceptions experienced by students before and after learning decreased. Before learning, the percentage of students' misconceptions was 51.92%; after learning, the percentage of misconceptions fell to 18.46%. This is in line

with research conducted by Uce & Ceyhan (2019) which states that students still have high levels of misconceptions regarding elements, compounds, and mixtures. The guided inquiry model is student-centered learning, where students play a more significant role in learning activities and can convey all their ideas (Damayanti et al., 2021).

The percentage of misconceptions is also analyzed based on each question item to see which questions have high misconceptions. The results of the percentage of misconceptions based on each question item can be seen in Table 8.

Table 8. Percentage of Misconceptions based on Question Items

No	Percentage of Misconceptions	
	Pre-Test	Post-Test
1	46%	23%
2	81%	47%
3	54%	12%
4	31%	15%
5	58%	27%
6	35%	12%
7	69%	0%
8	50%	4%
9	43%	23%
10	54%	23%

Based on the data in Table 8, the results show that before learning with the guided inquiry model, students who experienced the highest misconception were at number 2 at 81%, namely explaining the nature of metallic elements, while students who experienced the lowest misconception at number 4 were at 31%, namely analyzing examples—compounds in everyday life. After learning using the guided inquiry model, the highest percentage of students who experienced misconceptions were obtained at number 2, 47%, explaining the nature of metal elements, while students who experienced the lowest misconception at Number 7, 0%, namely identifying the type of mixture. Question number 7 is the question item with the most significant decrease in misconceptions, from 69% to 0%.

The highest misconception per question item occurred in question number 2; the misconception before learning was 81%; after learning, it fell to 47%. This is influenced by students who still need to understand the properties of metal elements. Some students understand the properties of metal elements but cannot give the correct reasons why metal elements are widely used. This is based on research by Astuti (2022), which stated that material about metallic elements took more work for students to understand. However, there was still a decrease in the percentage of misconceptions in question number 2 to 47%. The guided inquiry learning model effectively reduces misconceptions by allowing students to build and develop their knowledge (Oktaviani & Nugrahaningsih, 2021).

Apart from being based on each question item, the misconceptions experienced by students are also analyzed based on sub-concepts. The percentage of misconceptions based on sub-concepts can be seen in Table 9.

Table 9. Percentage of Misconceptions Based on Sub-Concepts

Sub Concept	Percentage of Misconceptions (%)	
	Pre-Tets	Post-Test
Unsure	60.3	27.3
Compound	34.5	21.0
Mixture	50.2	12.4

Based on Table 9, the learning material used consists of the sub-concepts of elements, compounds, and mixtures. These three sub-concepts experienced a decrease in the percentage of misconceptions. Before learning, in the sub-concept elements, students experienced misconceptions with a percentage of 60.3%; after learning with the guided inquiry model, it became 27.3%. Misconceptions about the sub-concept of elements often occur because metal elements are often used in industrial tools, the use of metal elements in life, and the classification of objects that are elements. Misconceptions experienced by students are corrected by applying the guided inquiry learning model. Namely, students are given pictures of various elements and analyze them with their group friends so that students can correct misconceptions experienced about the meaning of elements and the benefits of metallic and non-metallic elements.

The percentage of misconceptions in the compound sub-concept before learning was 34.5%; after learning with the guided inquiry model i, it became 21.0%. Misconceptions regarding the sub-concept of compounds often occur regarding the meaning and examples of compounds in everyday life. Misconceptions experienced by students regarding compound material were corrected by applying the guided inquiry learning model. Namely, students were given various kinds of pictures to be analyzed and categorized into compound categories with their group friends so that students could understand the meaning and examples of compounds in everyday life.

The percentage of misconceptions in mixed sub-concepts before learning was 50.2%; after learning with the guided inquiry model, it was 12.4%. Misconceptions regarding the sub-concept of mixtures often occur when classifying mixture types and mixture separation techniques. The reduction in misconceptions occurred significantly after implementing the guided inquiry learning model with the practicum method. Mixture material and mixture separation techniques are easily understood if you know the various mixtures and mixture separation techniques using practical activities. This is based on research conducted by Afifah et al. (2021), which states that the practicum method can help students understand concepts in science material.

The results of the percentage of students decreasing in the misconception value for each sub-concept obtained is by research conducted by Nurhidayah et al. (2020),

which states that the guided inquiry learning model is effective in reducing student misconceptions, both the misconceptions of each student and each sub-concept. The guided inquiry model provides opportunities for students to be more active in actual learning activities. More realistic learning activities, such as applying the guided inquiry model, can change the incorrect understanding of concepts (Nana, 2020).

The percentage of misconceptions experienced by students before and after learning was classified into three categories: high, medium, and low. The average pre-test result was 51.92, and the standard deviation was 18.76. The post-test obtained an average value of 18.46 and a standard deviation 12.55. The results of classifying misconceptions can be seen in Table 10.

Table 10. Percentage of Students' Misconceptions Level Before and After Learning

Before Learning			After Learning	
Misconception Level	N	Percentage of Misconceptions (%)	N	Percentage of Misconceptions (%)
Tinggi	3	12%	2	12%
Seeding	17	65%	19	73%
Rendah	6	23%	5	19%

Based on Table 10, the results can be obtained, namely that before learning was carried out using the guided inquiry learning model, the level of misconception in the high category was 12%; after learning, it became 8%. The level of misconception in the medium category was 65% after learning; it was 73%. The level of misconception in the low category was 23% after learning 19%.

CONCLUSION

The guided inquiry learning model is effective in reducing misconceptions experienced by students regarding elements, compounds, and mixtures. This can be seen from the hypothesis test results using the Wilcoxon non-parametric test, the Asymp. Sig value was obtained. $0.00 < 0.05$ so H_1 is accepted and H_0 is rejected. There was a reduction in the percentage of students' misconceptions before and after learning by implementing the guided inquiry learning model. This can be seen in the percentage value before learning of 51.92% to 18.46%. So that future researchers can apply the guided inquiry learning model to reduce students' misconceptions about other learning materials.

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