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Development of a Pictorial-Based Five-Tier Multiple Choice Diagnostic Test to Identify Misconceptions in the Material of Colligative Properties of Solutions

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ABSTRACT

Chemical concepts that are difficult for students to understand will lead to misconceptions or misunderstandings. There are still few chemistry teachers who develop multi-level diagnostic tests to identify misconceptions in students. This study aspires to create an innovative, pictorial-based, five-tier multiple-choice diagnostic test that will empower educators to uncover and address students' misconceptions about the colligative properties of solutions. This research uses the Research and Development (R&D) method with the Tessmer model. The subject of this study is high school/MA students. The instruments used are five-tier diagnostic tests and evaluation expert validation sheets. Through the content validity test using the Content Validity Ratio (CVR), 25 items emerged as strong and valid criteria. The reliability test showcased a remarkable Cronbach's Alpha value of 0.90, affirming that the developed test is a credible tool ready for impactful use. This can identify misunderstandings of high school students on the material of the colligative nature of the solution because the image in the question can provide a representation of the question asked.

INTRODUCTION

Chemistry starts with concepts, so students must understand them in order to learn practical chemistry (Arsyad & Sihaloho, 2016). Chemistry is complex for students to understand because its learning only focuses on the macroscopic and symbolic levels, ignoring the submicroscopic level (A'yun, 2018). Students' ability to connect the three levels of chemical representation (macroscopic, sub-microscopic, and symbolic) indicates their understanding of the topic of chemistry (Imaduddin, 2018). Chemistry lessons in high school involve interrelated topics. As a result, students' understanding of one field of chemistry will affect their knowledge of another (Siswaningsih, 2014). Chemistry learning must be based on reasonable, mature, and applicable concepts, as chemistry encompasses scientific innovations in addition to facts, ideas, and principles.

In science, mistakes and misunderstandings are often found, negatively impacting learning. Misunderstandings in science can hinder the understanding of new material because it is embedded in the cognitive framework of students (Van den Berg, 1991). Students' views of an idea different from those recognized by science are called misconceptions (Kirbulut & Geban, 2014). Misconceptions are ideas or cognitive structures in a student's brain that differ significantly from the accepted scientific understanding (Tayubi, 2005). Misconceptions can be reduced or eliminated by effectively connecting concepts into students' thinking frameworks

(Yosephine Louise et al., 2017). Misunderstandings in students' thinking are beliefs that are not based on scientific principles.

Personal knowledge that does not conform to accepted scientific theories is categorized as a misunderstanding (Putri & Subekti, 2021). Misunderstandings in science concern wrong ideas and the relationship between concepts and erroneous initial understandings (Yuliati, 2017). Misunderstandings in science can be a significant obstacle for students in understanding new concepts and advancing their learning (Wilantika et al., 2018). Misunderstandings can be caused by the circumstances of the student, the teacher, the literature, the environment, and the teaching strategy (Elvinawati et al., 2022). Diagnostic tests are powerful tools for uncovering student misconceptions and guiding the way to deeper understanding and growth.

Diagnostic exams are a valuable tool for teachers to help students reach their maximum learning potential and can provide more effective learning (Zaleha et al., 2017). Because the answer pattern of diagnostic test questions can be classified as understanding concepts, not understanding concepts, and misunderstandings, the design and quality of the questions are the main components of diagnostic tests (Susilaningsih, 2016). Diagnostic tests can be the basis for designing follow-up care tailored to the student's weaknesses and appropriate therapy (Hadi et al., 2015). A well-designed diagnostic exam can clearly show of a student's misconceptions based on their mistakes (Fariyani & Rusilowati, 2015). Multiple-choice questions to detect student misconceptions have undergone developments from One-Tier to Four-Tier Diagnostic Test (Wilantika et al., 2018). Diagnostic tests can be in the form of multiple choice or description.

The four-tier diagnostic test is one of the question instruments used in science education to identify students' misconceptions (Islami et al., 2019). Diagnostic tests have evolved from one-tier Simple to four-tier, which is more sophisticated to accurately identify studentd misconceptions (Rukmana et al., 2019). The student conception and misunderstandings level can be found using the four-level test question instrument. On the other hand, overcoming misunderstandings will work better if the underlying problem is identified. Studying the sources of students' misconceptions is an essential step in designing proper learning. This allows teachers to overcome these misconceptions effectively. The five-level diagnostic test is derived from the four-level multiple-choice diagnostic test, providing more in-depth information about the student's understanding (Fitri et al., 2023). The five-level diagnostic test is expanded by adding a questionnaire to identify the sources of information students use in answering questions (Inggit et al., 2021). The benefits of the five-tier multiple-choice diagnostic test include detailed misconception diagnosis, error source identification, identifying content that requires emphasis, and more efficient learning planning. In light of this, the author is eager to see how this examination is used to determine the reasons behind students' misunderstandings (Mardeni, 2023).

Diagnostic tests are generally presented in a narrative form, which can lead to student saturation and are less effective at explaining chemical phenomena at the level of invisible (submicroscopic particles) (Santi, 2022). Assessments that include images, representing physical and chemical events are pictorial tests (Siswaningsih et al., 2015). In contrast to the narrative test on the learning material of mole and computing, the majority of the tests *pictorial* help students better understand the questions asked (Rachmaniah, 2014). This study presents illustrations as a type of chemical representation, macroscopic, sub-microscopic, or symbolic. One of the materials that requires chemical representation is the colligative properties of solutions.

The colligative properties of solutions are one of the many abstract ideas found in chemicals, which often lead to conceptual errors. The force between particles, phase transitions, and vapor pressure conditions in a liquid are examples of abstract meanings in this material (Anugerah, 2017). The Number of solute particles in a solution determines the colligative

quality of the solution; the type of solute has nothing to do with these properties (Chang, 2006). Phenomena such as interparticle force and phase change are fundamental ideas in the material colligative properties of solutions that need to be displayed. Because interparticle forces involve many molecules, they are difficult to visualize with physical models. Animation is only appropriate to support learning if it reflects a process or system; therefore, it is also applicable to visualize the idea (Vavra et al., 2011). At the macroscopic level, directly observed properties, such as a decrease in vapor pressure, an increase in boiling point, a decrease in freezing point, and osmotic pressure, are the main focus. At the microscopic level, this phenomenon is described based on the interaction of particles, such as molecules or ions, where the Number of dissolved particles affects the properties of the solution. Meanwhile, at a symbolic level, these traits are represented using formulas and equations.

Based on the results of observations and interviews conducted in two high schools in Yogyakarta, none of the teachers created multilevel questions to find common misunderstandings. Among the two high schools, teachers have never used multilevel questions to find students' misunderstandings on the colligative properties of solutions. Based on the literature that the researcher has seen, the research conducted is using five-level multiple-choice questions based on images on the colligative properties of solutions. Research by (Rositasari et al., 2015), used a two-tier diagnostic test to identify students' misconceptions. The results showed that students experienced misconceptions on the material of pH calculation, the use of the Ka/Kb concept, and the application of pH in everyday life. (Santi, 2022), research used a pictorial-based four-tier diagnostic test to analyze students' misconceptions on electrolyte and non-electrolyte solutions. The test consisted of 22 questions with very high reliability (r = 0.879). The results showed misconceptions in all representations, especially macroscopic-submicroscopic (28.45%). Causal factors include low understanding, inappropriate learning styles, and ineffective distance learning.

METHODS

Research Design

The research is included in the Research and Development (R&D) category. This method aims to produce products by discovering potential problems and designing and developing a product as the best solution (Waruwu, 2024). The purpose of the research, which falls under the educational research and development category, is to create a diagnostic test instrument with five levels for use in chemistry classes that include the colligative characteristics of solutions. This study uses a procedural development model, especially a descriptive one describing the processes needed to produce a final product. This research uses Martin Tessmer's development model (1993). According to (Alfiatin & Oktiningrum, 2019), The stages in the Tessmer model include preliminary, self-evaluation, expert review, one-to-one, small group, and field test.

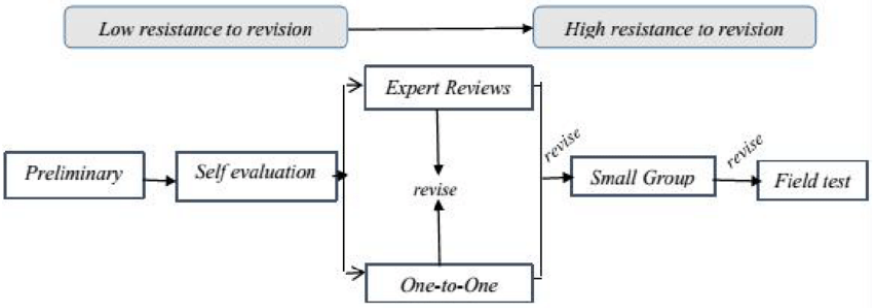


Figure 1. Stages of the Tessmer model

The need for developing five-tier multiple-choice diagnostic test questions was analyzed in the initial stage. Namely, the researcher collected several references related to developing test instruments with the characteristics of the five-tier multiple choice diagnostic test in students, namely articles and thesis. The second stage of self-evaluation is carried out

curriculum analysis, student analysis, and material analysis, as well as designing a structure of science literacy questions, including making a grid of questions. In the third stage of prototyping, which includes the expert review stage, product validation is carried out, the one-to-one stage is evaluated using three students, and the small group stage is evaluated using six students. Furthermore, the fourth stage of the field test questions was for the respondents, namely thirty-five students, and the reliability test. The last stage eliminates invalid and reliable questions, producing a five-tier multiple-choice diagnostic test question based on the colligative properties of valid and reliable solutions.

Research Target

This study involved two lecturers and three teachers to validate each question item. Sampling in this study used a purposive sampling technique on thirty-six grade XII MBS Yogyakarta students producing data used to determine the reliability of the questions.

Research Data

Data collection techniques include through interviews and tests. Student's test instruments for students are in the form of questions and non-tests are in the form of validation instruments used to find out the validation of questions from evaluation experts.

Research Instruments

The student test instrument is in the form of five-tier diagnostic test questions, while the non-test is in the form of a validation instrument used to determine the validity of the questions from evaluation experts.

Data Analysis

The types of data used are quantitative and qualitative. Quantitative data was obtained from product validation results from validators, evaluation experts, and chemistry teachers on the questions. Meanwhile, qualitative data comes from needs analysis data, input and suggestions for question validation from evaluation expert validators, and input and suggestions from peer reviewers. The data analysis techniques used are validation and reliability tests. To create a valid and reliable diagnostic test tool. The content validity ratio (CVR) is one of the methods to analyze the results of expert judgment. Using expert opinions, a content validity approach known as CVR assesses whether or not an item is appropriate for the domain under test (Lawshe, 1975).

$$\text{CVR} = \frac{Ne - \frac{N}{2}}{\frac{N}{2}}$$

Information:
CVR= Content validity ratio
Not = Number of validators who gave a "valid" rating
N = Number of validators

Furthermore, a comparison is made between the calculated CVR value and the lowest CVR value determined by the number of validators. The following table shows the minimum CVR score with a specific number of validators.

Table 1. Minimum Values of CVR

Number of Validators	Minimum Values
5	0,99
6	0,99
7	0,99
8	0,75
9	0,78
10	0,62

Once the CVR value is determined, the Content Validity Index (CVI) value is calculated to show that the validation of the content of the question items is generally good. The CVI formula is as follows:

$$\text{CVI} = \frac{\Sigma CVR}{k}$$

Information:
CVR = Content Validity Ratio of each item
k = Number of questions

Reliability test using the Rasch model. The analysis of the Rasch model was put forward by Georg Rasch in the 1960s and popularized by Ben Wirght. The raw data used is dichotomous data that shows the ability of students. In analyzing this Rasch model, the relationship between questions and students can be known in one model. To measure reliability, it is indicated by the value of person reliability and item reliability. The Rasch model analysis will provide the suitability level of the question items (item fit). The fit item will explain whether the item is functioning normally when taking the measurement. If a question is obtained that does not fit, this indicates a misconception in the question, so it is helpful for teachers to improve the quality of teaching (Sumintono, 2021). Items that are valid against the Rasch model are those that usually function. Item matching is essential to ensure the measurement instrument is valid and reliable (Ocy et al., 2023).

Table 2. Table of criteria for assessing reliability using Cronbach alpha

Reliability (Person/Item)	Interpretation
>0,94	Special
0,91 – 0,94	Very good
0,81 – 0,90	Good
0,67 – 0,80	Enough
<0,67	Weak

If the alpha value > 0.7, it means sufficient reliability, while the alpha > 0.80 suggests that all items are reliable and all tests are consistently reliable. Some interpret it as follows: If alpha > 0.90, then reliability is perfect. The reliability is high if alpha is between 0.70 – 0.90. If alpha is 0.50 – 0.70, then reliability is moderate. If the alpha < 0.50, then the reliability is low. If alpha is low, one or more items are likely unreliable (Sanaky et al., 2021).

RESULTS AND DISCUSSION

The product produced in this study is a Pictorial-Based Five-Tier Multiple Choice Diagnostic Test Instrument with the subject matter of Colligative Properties of Solution. The test instrument is multiple choice, with as many with as 25 questions and valid and reliable results. This study uses a Tessmer model, which includes self-evaluation, expert review, one-to-one, small group, and field test (field test).

1. **Preliminary**

In the preliminary stage, the results of interviews with chemistry teachers in two schools in Yogyakarta were obtained, and it was determined that the two schools had never developed a diagnostic test to identify misconceptions about the material of the colligative properties of solutions. In the results of the curriculum analysis, it was obtained that the curriculum used was the 2013 curriculum. The analysis of students who will be used as research subjects is 36 students of class XII MIPA who have studied the material of the colligative properties of solutions, and at the stage of material analysis, namely the material used in the development of this problem is the colligative sifitive of solutions.

2. **Self-evaluation**

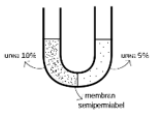
At this stage, students, curriculum, and material used in question development are analyzed. After analyzing, it is continued to design or design test instruments to identify students' misconceptions, which include test questions, answer keys and discussions, and scoring guidelines. The questions designed consist of 25 pictorial-based five-tier multiple choice questions. At the self-evaluation stage, a product called protoype I is produced.

3. **Prototyping**

In the third stage of prototyping, which includes the expert review stage, product validation, one to one stage, and small group stage are carried out.

1. Expert review

At this stage, the evaluation of the questions and the provision of suggestions by the validator will be used to improve the test questions, which will be called prototype II. Process Judgment Validation of the content of the test instrument to identify students' misconceptions about the material Colligative Properties of Solutions was carried out by five validators, including two lecturers of the Chemistry Education Study Program and three chemistry teachers. Assessment instruments need to pay attention to the characteristics of a good instrument, including valid, reliable, relevant, representative, and practical (Rohman, 2023). The priority in the preparation of instruments is validity and reliability (Hasibuan et al., 2024). A test instrument is valid if it can accurately measure what is being measured (Arikunto, 2010). Several question items were declared valid with revisions by the validators, so revisions are needed so that the question items can be declared valid.

		Perhatikan gambar di bawah ini!  Gambar 16. Proses tekanan osmosis pada larutan urea 10% dan 5% melewati membran semipermeabel Sumber: Dokumentasi pribadi Pada gambar diatas, larutan urea 5% dan larutan urea 10% dipisahkan oleh membran semipermeabel. Hal yang paling mungkin terjadi adalah.... A. Molekul-molekul air bergerak dari larutan urea 10% ke larutan urea 5% B. Molekul-molekul urea bergerak dari larutan urea 10% ke larutan urea 5% **C. Molekul-molekul air bergerak dari larutan urea 5% ke larutan urea 10%** D. Molekul-molekul urea bergerak dari larutan urea 5% ke larutan urea 10% E. Tidak terjadi perpindahan molekul antara kedua larutan Apakah anda yakin dengan jawaban anda? A. Yakin B. Tidak yakin	C-D	Pada gambar di soal, larutan urea 5% dan larutan urea 10% dipisahkan oleh membran semipermeabel. Membran semipermeabel adalah membran yang hanya dapat dilalui oleh molekul-molekul air, sedangkan molekul-molekul urea tidak dapat melewatinya. Osmosis adalah proses perpindahan molekul air dari larutan yang memiliki konsentrasi rendah (hipotonik) ke larutan yang memiliki konsentrasi tinggi (hipertonik). Hal ini terjadi akibat pergerakan molekul air yang konstan menuju kesetimbangan, dari daerah dengan konsentrasi rendah ke daerah dengan konsentrasi tinggi. Dalam soal ini **larutan urea 5% adalah larutan hipotonik, sedangkan larutan urea 10% adalah larutan hipertonik**. Oleh karena itu, **molekul-molekul air akan bergerak dari larutan urea 5% ke larutan urea 10% melalui membran semipermeabel**				

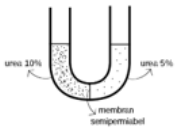
Apakah anda yakin dengan jawaban anda?
A. Yakin
B. Tidak yakin

Alasan dari jawaban anda?
A. Perpindahan molekul pelarut dari larutan yang konsentrasinya tinggi ke larutan yang konsentrasinya lebih rendah melalui penghalang semipermeabel, maka perpindahan molekul air dari larutan X ke larutan Y.

B. Perpindahan molekul pelarut dari larutan yang konsentrasinya rendah ke larutan yang konsentrasinya lebih besar melalui penghalang semipermeabel, maka perpindahan molekul air dari larutan Y ke larutan X.

Figure 2. Examples of question items that are declared valid with revisions

18. Perhatikan gambar berikut!



Gambar 16. Proses tekanan osmosis pada larutan urea 10% dan 5% melewati membran semipermeabel

Sumber: Dokumentasi pribadi

Pada gambar di atas, larutan urea 5% dan larutan urea 10% dipisahkan oleh membran semipermeabel. Hal yang paling mungkin terjadi adalah....
A. Molekul-molekul air bergerak dari larutan urea 10% ke larutan urea 5%
B. Molekul-molekul urea bergerak dari larutan urea 10% ke larutan urea 5%
C. Molekul-molekul air bergerak dari larutan urea 5% ke larutan urea 10%
D. Molekul-molekul urea bergerak dari larutan urea 5% ke larutan urea 10%
E. Tidak terjadi perpindahan molekul antara kedua larutan

Apakah anda yakin dengan jawaban anda?
A. Yakin B. Tidak Yakin

Apakah alasan dari jawaban anda?
A. Pergerakan molekul pelarut dari larutan dengan konsentrasi tinggi menuju larutan dengan konsentrasi lebih rendah melalui penghalang semipermeabel menyebabkan perpindahan molekul air dari larutan 5% ke larutan 10%.
B. Pergerakan molekul pelarut dari larutan dengan konsentrasi rendah menuju larutan dengan konsentrasi lebih tinggi melalui penghalang semipermeabel menyebabkan perpindahan molekul air dari larutan 10% ke larutan 5%.
C. Perpindahan molekul pelarut dari larutan yang konsentrasinya tinggi ke larutan yang konsentrasinya lebih rendah melalui penghalang semipermeabel, maka perpindahan molekul air dari larutan 10% ke larutan 5%.
D. Perpindahan molekul pelarut dari larutan yang konsentrasinya rendah ke larutan yang konsentrasinya lebih besar melalui penghalang semipermeabel, maka perpindahan molekul air dari larutan 5% ke larutan 10%.
E. Proses perpindahan molekul pelarut melalui membran semipermeabel dari larutan yg pekat ke larutan yg lebih encer, maka molekul urea bergerak dari larutan 10% ke larutan 5%.

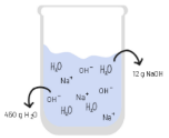
Apakah anda yakin dengan jawaban anda?
A. Yakin B. Tidak Yakin

Darimana sumber informasi jawaban anda?
1. Buku 2. Guru 3. Internet 4. Orang tua 5. Teman

Figure 3. Examples of revisions made to question items

The question item was declared valid with revision because there was a suggestion from the validator that the writing of the word "above" should be "above" and the writing of the letters X and Y was not included in the question. The revision was made by changing the writing "above" to "above", and changing the letters X and Y in the answer options to 5% and 10%. Because it incorporates abstract ideas like the flow of solvents via semipermeable membranes, which are hard to see, osmotic pressure frequently leads to misunderstandings. The question above focuses on the indication of measuring osmotic pressure. Students frequently make mistakes because they don't grasp the symbolic meaning of the osmotic pressure formula, misjudge the direction of particle movement, and mix up osmosis and diffusion.

3. Perhatikan ilustrasi larutan berikut!



Gambar 3. Ilustrasi larutan NaOH
Sumber: Dokumentasi pribadi

Dari ilustrasi diatas, tentukan fraksi mol zat pelarutnya! (Ar Na = 23, O = 16, H=1)
A. 1,066
B. 0,989
C. 0,988
D. 0,012
E. 0,011

Apakah anda yakin dengan jawaban anda?
A. Yakin B. Tidak Yakin

Apakah alasan dari jawaban anda?
A. Fraksi mol adalah ukuran konsentrasi dalam suatu campuran yang menyatakan perbandingan jumlah massa suatu komponen terhadap jumlah massa total semua komponen dalam campuran.
B. Fraksi mol adalah ukuran konsentrasi dalam suatu larutan yang menyatakan perbandingan jumlah mol pelarut terhadap jumlah mol terlarut.
C. Fraksi mol adalah ukuran konsentrasi dalam suatu campuran yang menyatakan perbandingan jumlah volume suatu komponen terhadap jumlah volume total semua komponen dalam campuran.
D. Fraksi mol adalah ukuran konsentrasi dalam suatu campuran yang menyatakan perbandingan jumlah mol suatu komponen terhadap jumlah massa total semua komponen dalam campuran.
E. Fraksi mol adalah ukuran konsentrasi dalam suatu campuran yang menyatakan perbandingan jumlah mol suatu komponen terhadap jumlah mol total semua komponen dalam campuran.

Apakah anda yakin dengan alasan jawaban anda?
A. Yakin B. Tidak Yakin

Darimana sumber informasi jawaban anda?
1. Buku 2. Guru 3. Internet 4. Orang Tua 5. Teman

Figure 4. Examples of questions that are declared valid

Link: https://bit.ly/4gNjxPc

The indicator contains the legitimate queries. Because the concept of comparing the number of moles of components in a mixture rather than mass or volume, which are frequently more recognizable to studentsis involved in determining the outcomes of mole fraction calculations, mole fraction material is prone to misconceptions. Even though the value of the mole fraction is always between 0 and 1, students frequently make mistakes when calculating the number of moles, dividing the amount in reverse (solvent moles vs. total moles), or presuming that the mole fraction can be greater than 1.

The validation analysis methods used are the Content Validity Ratio (CVR) and Content Validity Index (CVI). This CVR value is used to determine whether Each item is valid. The item can be considered valid if viewed from the validity of the content if it has a CVR value equal to or greater than 0.99 (CVR $\geq$ 0.99). In contrast, if the item has a CVR value of less than 0.99 (CVR < 0.99), then the item is said to be invalid in terms of the validity of the content (Rahmawan et al., 2021). A CVR value between 0 and 0.99 indicates that half of the validators say it is appropriate. In contrast, if the CVR value is 0, then less than half of the validators say it is appropriate (Siswaningsih, 2014). Based on the CVR and CVI test results, it shows that 25 questions have a CVR and CVI of 1.00, so the CVR value > 0.99 and based on the CVI criteria of the 25 questions are included in the very appropriate category.

2. One-to-one

At this stage, the product in the form of revised questions (prototype II) based on comments and suggestions from the validators will be tested in the one-to-one stage. 3 students with high, medium, and low abilities were asked to work on the five-tier diagnostic test questions. Students are also invited to comment on the questions that have been done. Some of the comments given by students such as: difficult to understand because too many questions are presented, images that are too small may be enlarged to make it clearer, and variations of answer options that are similar to each other. Based on the suggestions and comments from students at the one-to-one stage, 25 questions will be corrected and revised

so that they can be tested at the small group stage.

3. Small group

   The revised questions will be tested on six students with high, medium, and low abilities at this small group stage. Students are asked to work on the problem and give comments and suggestions. Students' comments at the small group stage are too many questions. Based on the results of the student's work, the questions can be continued to the field test stage.

4. Field test

   At field test, questions that have been validated and revised will be tested on 36 students of class XII MIPA in one of the schools in Yogyakarta. Students are asked to work on test questions consisting of 25 questions *five-tier multiple choice* with a time allocation of 2 x 35 minutes. The results of the trial to 36 students will be analyzed with a rasch model to find the reliability value using winstep software. Reliability using the rasch model can be used to analyze the stability of people and instrument items (Ocy et al., 2023). Based on the results obtained, namely assessments from validators and trials limited to 36 students, diagnostic test instruments *five-tier multiple choice* berbasis *pictorial* In the material of the colligative properties of the resulting solution reaches the criteria that have been set, namely valid and reliable. A research instrument is said to have a high reliability value if the test has consistent results in measuring what is to be measured (Hartono et al., 2022). The analysis results of the Cronbach alpha coefficient were 0.90 with the category of very good, the reliability of items 0.91, and the reliability of people 0.85. The results of this cronbach alpha analysis align with the research (Rahmawan et al., 2021) which obtained a Cronbach Alpha result of 0.827 with good information. This shows that this diagnostic test instrument is feasible to identify students' misconceptions about the colligative properties of solutions.

Table 3. Percentage of student understanding

Indicator	Understand the concept	Minsconception	Didn't understand the concept
Determine the results of the calculation of the molar fraction or molarity or molality	Question no 5 = 77%	Question no 4 = 41%	Question no 4 = 33%
Determining the boiling and freezing points based on the drawings	Question no 9 = 69%	Question no 10 = 33%	Question no 10 = 47%
Analyzing the vapor pressure from the attached chart	Question no 12 = 50%	Question no 12 = 41%	Question no 12 = 47%
Inferring through images about the boiling point of a solution	Question no 15 = 75%	Question no. 13 and 14 = 22%	Questions no 13 and 15 = 13%
Analyzing the drop in freezing point in a solution	Question no 17 = 77%	Soal no 16 = 44%	Question no 16 = 36%
Analyzing osmosis pressure from images	Question no 19 = 75%	Question no 18 = 41%	Question no 18 = 41%
Analyzing the freezing and boiling points of the attached P-T diagram	Question no 21 = 66%	Question no 20 = 22%	Question no. 20 and 21 = 13%
Determine the application of colligative traits in daily life	Question no 23 = 27%	Question No 23 = 55%	Question no 23 = 30%
Distinguishing between electrolyte and non-electrolyte solutions	Question no 24 = 75 %	Question no 25 = 38%	Question no 25 = 38%

In the test instrument testing, 47% of students had difficulty or did not understand the concept when working on questions with indicators of calculating boiling points based on data in the image and analyzing vapor pressure from data in the attached table. This can be seen from the results of the work on the test instrument of the students who got 0 points on the indicator. 44.4% of students experienced a misunderstanding of the concept in the indicator of analyzing the decrease in the freezing point in a solution through data in the table. The occurrence of this misconception is also in line with research (Agung et al., 2022), which states that the most common misconception is the decline in the freezing point. Misconception on this decrease in freezing point This can be calculated from the acquisition of point 1 in 16 students. 13% of students experienced a misconception in the indicator of the question determining the results of the calculation of the molar fraction or molarity or molality, this was shown by only 3 students who got point 1 on the indicator. 86.1% of students are considered to understand the concept because they are able to do problems with indicators to determine molality based on data in the figure. This can be seen from the number of students who got point 2 on the question.

Misconceptions about concepts in students when doing test questions can be caused by several factors, including teachers, students, and books (Suparno, 2013). Teachers often have misconceptions about methods, strategies, and ways of providing information. Students' conceptual errors, the phenomenon of interdependent algorithms, their skills, or lack of interest are the leading causes of misunderstandings generated by students. Instead, the misconception of this book is that some ideas require further explanation in the student's notebook (Rahmawan & Ashfarini, 2024). To prevent misconceptions, teachers can apply various innovative learning strategies and can use molecular models or demonstrations that can help students visualize the processes that occur at the particle level.

CONCLUSION AND RECOMMENDATIONS

A five-level multiple-choice diagnostic test instrument based on illustrations of the colliding properties of solutions was created for this investigation. Five experts two lecturers and three chemistry teachersvalidated this instrument, which demonstrated great reliability in 36 student trials and had CVR and CVI values of 1.00. It was determined that the 25 question test was appropriate for usage. According to the findings, 47 % of students found it difficult to calculate boiling points and analyze vapor pressure, with the freezing point depression indication having the largest misperception (44.4%) and the molality calculation indicator having the lowest (13%). Up to 86.1% of pupils were found to comprehend the idea of calculating molality. The researcher suggests that further research be supplemented with interviews to obtain more in-depth and accurate misconception identification results.

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