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Systematic Literature Review: Analysis of Misconception Problems and Diagnostic Instruments for Learning Chemistry

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Abstract: This research aims to analyze research trends in Chemical misconceptions in chemistry learning and diagnostic instruments used. The research method used in this research is a systematic literature review (SLR). The database obtained was 16 articles selected from the Scopus and Google Scholar databases with Publish or Perish (PoP). The results of the research found were the majority of students experienced misconceptions in learning chemistry caused by errors in preconceptions and abstract thinking concepts in the material, the method used to analyze the misconceptions found was a two-level, three-level, four-level diagnostic instrument, multiple choice, and semi-open tests and The misconceptions found in chemistry materials are acid-base, reaction rate, chemical equilibrium, chemical bonding, salt hydrolysis, and buffer solution.

Keywords: Diagnostic instruments; Misconceptions in chemistry; Systematic literature review

Introduction

Chemistry is a complex subject for learners. Not only do they have to understand symbols, terminology, and theories, but they also have to transform the material acquired during learning into meaningful representations (Keshavarz & Moshkbid, 2023). Chemistry is also a subject that is full of concepts, ranging from simple concepts to more complex concepts and from concrete concepts to abstract concepts. Therefore, it is necessary to have a correct understanding of the basic concepts to build these chemical concepts (Karini et al., 2022).

Difficulties in learning chemistry often make students experience an understanding of concepts that are different from the actual understanding. Misunderstanding of concepts is known as misconceptions. The misconception is a mistake in understanding the concept of learning material that can lead to a mismatch between the concepts that individuals have with scientific interpretations or according to scientists (Djarwo, 2018). Misconceptions are errors made by students in interpreting, connecting, or applying certain concepts (Treagust, 1998). Misconceptions arise due to several factors such as observational reasoning, observation of phenomena, textbook content, learning media, or activities during the learning process (Suprapto, 2020).

Misconceptions can hinder the process of constructing new knowledge into the cognitive structure that learners have built before if learners' knowledge is insufficient to process new information so learners tend to reject new knowledge obtained (Üce & Ceyhan, 2019). Misconceptions that often occur in students in learning chemistry are usually related to understanding the relationship between concepts. Because the concepts in chemistry are interrelated with one another, so that to learn advanced material requires an understanding of the right concepts in the previous material. The inability of students to understand concepts with high

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abstractness sometimes makes them make their interpretations to overcome the difficulties they face. This can cause chemical misconceptions in students (Jusniar & Syamsidah, 2021). Some previous studies have been conducted.

Some studies have been conducted previously, one of which is Ramdani (2017) the low academic achievement of students in general can be caused by various reasons, including, students' understanding of knowledge is not optimal, misunderstanding of basic concepts, interfering with understanding certain concepts. Not only that, Aini et al. (2022) found students' misconceptions of acid-base material through diagnostic tests. Through this study, it was found that 50% of students misunderstood acid-base theory, 59% of students misunderstood acid-base index, 58% of students misunderstood pH value, 55% of students misunderstood pH calculation, and 51.9% of students misunderstood pH value. Students have misconceptions about the calculation of pH. Regarding the application of pH in schools, environment.

The misconceptions experienced by students in chemistry material if not overcome will continue and repeat the same mistakes, so it is necessary to have an assessment tool that can identify students' concept misunderstandings (Suyono, 2020). A diagnostic test that can be used to find out exactly and show students' weaknesses and strengths when learning something so that these results can become the basis for further learning planning in the form of treatment based on the student's weaknesses and strengths. In line with the opinion expressed by Warsito et al. (2021) that the use of diagnostic tests is one of the solutions to detecting student misconceptions. The results of this diagnostic test can help in identifying students who understand, do not understand, and misconceptions.

Diagnostic tests can be carried out by means of interviews, multiple choice tests, for example Two Tier and Three Tier (Warsito et al., 2021). However, this method still has shortcomings such as the Two-tier diagnostic test has the disadvantage that it cannot distinguish the responses of students who are given whether they only guess or not. The weakness of this Three Tier diagnostic test instrument is that it only gives students the opportunity to choose one level of confidence in the answers and reasons for each item (Laksono, 2020). This single belief measure cannot detect whether students have different beliefs when choosing answers and reasons. In addition, this instrument is too low level to explain misconceptions and is therefore considered inaccurate in detecting misconceptions experienced by students. Therefore a more complex test instrument is needed, namely a four-level multiple choice test instrument to analyze student misconceptions.

Based on the analysis of all types of tests used in identifying student misconceptions are through interviews, multiple choice, essay tests, and tier diagnostic tests. However, the one test that is most widely used and considered effective is the diagnostic test (Soeharto et al., 2019). The existence of this diagnostic test can provide in-depth analysis, this test can detect students' lack of understanding through each stage at its level. Through student confidence in the answers given, this condition can help researchers get a more accurate percentage of student misconceptions. This is because each student needs a different treatment to correct their misconceptions.

Existing research is still individual and carried out by specific researchers. Therefore, further analysis is needed to obtain a more comprehensive picture of students' misconceptions in chemistry learning and the diagnostic tools used. Recommendations are given to researchers, educators, and prospective educators to apply diagnostic tools to detect student misconceptions more quickly. Based on this, a systematic review of research results is needed that reviews students' misconceptions in learning chemistry along with diagnostic tools.

Method

This research uses a systematic literature review (SLR) method to collect information related to diagnostic misconceptions in chemistry and diagnostic instruments in chemistry education. A systematic review is a rigorous procedure for combining, assessing, and synthesizing research results related to a topic with strategies to reduce bias (Kitchenham, 2004). Research subjects were taken from articles found through the Scopus and Google Scholar databases with the help of Publish or Perish (PoP) in the publication range from 2014 to 2023. The keywords used in searching for articles in Scopus were "Diagnostics of Chemical Misconceptions" and "Diagnostic instruments in chemistry education".

Search results using Publish or Perish show that there are 233 articles related to the research topic. After removing duplicates, the number of articles was reduced to 223. These articles were then filtered based on consideration of the title, abstract and inclusion requirements, resulting in 16 articles that met the predetermined inclusion criteria. The inclusion criteria used as a reference in searching for articles include: articles discussing misconceptions about learning chemistry, publications from 2014 to 2023, publication of articles on Scopus and Google Scholar, as well as the availability of full-text and open source in the articles. The process of searching and filtering articles can be seen in the flow diagram documented in Figure 1.

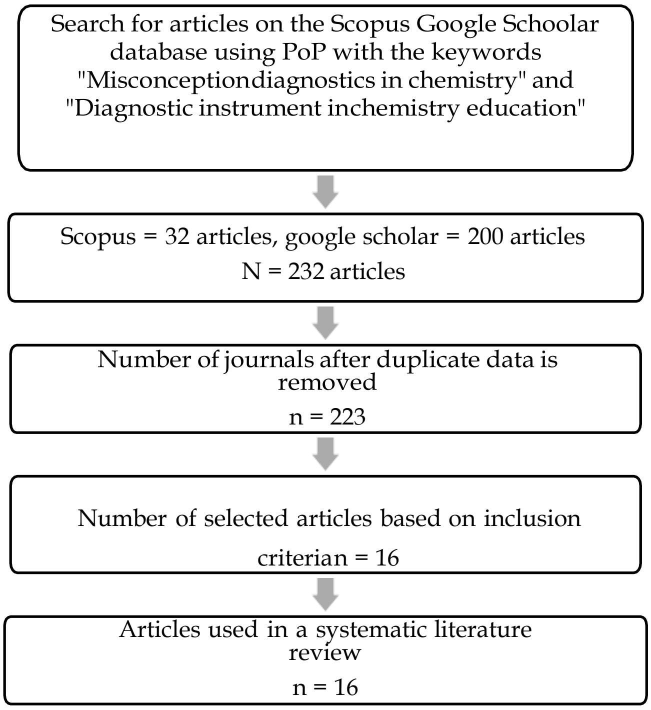

Figure 1. Stages journal search in the database

After identifying articles that met the inclusion criteria and were relevant, the articles were then coded and sorted to facilitate analysis (Vistara et al., 2022). The next step is to prepare a systematic and clear report. The researchers focused on several points grouped as follows: definitions of misconceptions from experts, instruments used to reduce chemical misconceptions, as well as findings of misconceptions in chemical materials (Rokhim et al., 2023).

Result and Discussion

Mapping of Chemical Misconceptions and Diagnostic Instruments in Chemical Materials

Misconception as a misinterpretation of a concept, has a big impact in the world of education. This is the difference between a person's personal understanding and the correct interpretation according to science (Maison et al., 2020). In the context of chemistry learning, misconceptions are still a significant challenge. The source of these misconceptions can come from students, teachers, or even the learning materials used. Table 1 shows the results of mapping misconceptions in chemistry learning as well as the diagnostic instruments used to analyze them. This helps identify areas where errors in understanding occur in the chemistry material.

Table 1. Results of Mapping Chemical Misconceptions and Diagnostic Instruments in Chemical Materials

Researcher	Title of Journal	Name of Journal	Diagnostic Instrument	Research Result
Monita & Suharto (2016)	Identification and Analysis ofStudents' Misconceptions Using a Three- Tier Multiple Choice Diagnostic Instrument on the Concept of Chemical Equilibrium	Journal of Science Education Innovation	Three-tierand interview	Research using three-tiermultiple choice instruments and interviews revealed severalcauses of misconceptions that commonly occur in chemistrylearning. The first cause is misconceptions in chemical equilibrium material. Studentscan have a wrong or less precise understanding of this concept, which leads to misconceptions.The second cause of misconceptions is errors made by students themselves. The third cause of misconceptions is the teaching method used by the teacher.
Erman (2017)	Factors contributing to students' misconceptionsin learning covalent bonds	Journal of Research inScience Teaching	Semi-opentest	Factors that causemisconceptions about covalent bond material are (1) textbooks that have incomplete information, (2) difficulty understanding the basic concept of covalent bonding, and (3) lack of effective communication between students and teachers.
Fahmi & Irhasyuarna (2017)	The Misconceptions of Senior High School Students in Banjarmasin on Chemical Bonding	Journal of Education and Practice	Multiple choice test	The results of the study found that students in the Banjarmasin area had misconception problems with the Closed-reasoned multiple choice test instrument which was 48.52% for SMA 2 Banjarmasin students, 46.29%

Researcher	Title of Journal	Name of Journal	Diagnostic Instrument	Research Result
				for SMA 3 Banjarmasin students, 43.33% for SMA 4 Banjarmasin students , 50.37% for SMA 5 Banjarmasin students, 48.15% for SMA 7 Banjarmasin students, 39.63% for SMA 8 Banjarmasin students and 48.51% for SMA 13 Banjarmasin students. The majority of students face misconceptions in understanding chemical bonding materials, especially on the concept of chemical bonding itself, crystal lattice, intermolecular forces, and electrical conductivity. These misconceptions occur due to errorsin students' preconceptions, their stage of cognitive development, and the explanation of the material by the teacher.
Fajri et al. (2020)	Use of a Two- Tier Diagnostic Instrument to Analyze Acid- Base Misconceptions of High School and MA Students	JINoP (Journal of Learning Innovation)	Two-tier	Two-tier diagnostic instruments can be used as an analysis of misconceptions in acid-base materials. As many as 36% of students who experience misconceptions about acid-base material are found with a two-tier instrument. Misconceptions that occur in acid-base material are caused by the lack of students understanding conceptual material and using an acid-base theory to determine the nature of acid-base reactions.
Karpudewan et al. (2015)	Investigating high school student's understanding of chemical equilibrium concepts	International Journal of Environmental and Science Education	Two-tier	Based on the results of research using two conceptual tests, it was found that there are limitations in students' understanding of the concept of chemical equilibrium. Especially on topics such as calculating chemical constants, understanding the reversibility of chemical reactions that contribute to the formation of an equilibrium state, and understanding the effect of catalysts or inert gases on equilibrium systems.
Kurniawan et al. (2020)	Effectiveness of Dual Situated Learning Model in Improving High School Students' Conceptions of Chemistry Equilibrium and Preventing Their Misconceptions	Journal of Science Learning	Two-tier	Based on the results of the study, it was found that the use of dual situated learning model (DLSM) proved effective in improving students' understanding of the concept of chemical equilibrium compared to conventional learning methods. This is shown through the use of two-tier multiple choice diagnostic instruments.
Maratusholihah et al. (2017)	Analysis of the Misconceptions of Senior High School Students on the Material of Salt Hydrolysis and Buffer	Journal of Education: Theory, Research, and Development	Two-tier	The research results obtained are the application of the dual situated learning model (DSLM) assisted by animation can overcome misconceptions more than the conventional approach with a two-

Researcher	Title of Journal	Name of Journal	Diagnostic Instrument	Research Result
	Solutions			tier multiple-choice diagnostic instrument. Findings of misconceptions on salt hydrolysis material on the topic of salt hydrolysis definition and the properties of salt hydrolysis and buffer solution materials found on the topic of manufacture and capacity of buffer solutions.
Milenković et al. (2016)	Development of a Three-Tier Test as a Valid Diagnostic Tool for the Identification of Misconceptions Related to Carbohydrates	Journal of Chemical Education	Three-tier	This study shows that the three- tier diagnostic instrument has a medium level of difficulty and has proven to be a valid and reliable instrument in identifying misconceptions about carbohydrates as well as the level of student understanding with a high level of certainty.
Mubarokah et al. (2018)	Identifying students' misconceptions of acid-base concepts using a three-tier diagnostic test: A case of Indonesia and Thailand	Journal of Turkish Science Education	Three-tier	The results showed that the use of a three-tier diagnostic instrument in analyzing the misconceptions of acid-base concepts in students in Thailand and Indonesia resulted in the percentage of students who had misconceptions. In the topic of electrolytic and nonelectrolytic acid-base properties, it was found that 30.56% of Thai students and 42.71% of Indonesian students had misconceptions. On the topic of acid-base strength, the percentage was 30.25% of Thai students and 42.53% of Indonesian students who had misconceptions. Meanwhile, on the topic of acid-base theory, the percentage of students who had misconceptions was 26.67% of Thai students and 23.75% of Indonesian students. On the topic of pH concept, a percentage of 19.91% of Thai students and 14.06% of Indonesian students were found to have misconceptions.
Mutlu & Sesen (2015)	Development of a Two-tier Diagnostic Test to Assess Undergraduates' Understanding of Some Chemistry Concepts	Procedia - Social and Behavioral Sciences	Two-tier	The two-tier diagnostic instrument is valid in identifying students' understanding of general chemistry subjects such as thermochemistry, chemical kinetics, equilibrium chemistry, acid-base, and electrochemistry.
Ningrum et al. (2022)	Effectiveness of Cognitive Conflict-Based Chemistry Learning in Reducing Students' Misconceptions of Acid-Base Materials	Journal of Science Education Research	multiple- choice reasoned test method	Misconceptions found in acid- base material include several topics including Arrhenius acid- base theory (by 32.05%), Arrhenius acid-base classification (by 56.40%), Bronsted-Lowry theory (by 43.59%), acid-base reaction equations according to Bronsted-Lowry theory (by 59.00%), differences in Arrhenius acid-base theory, Bronsted- Lowry, and Lewis (by 49.00%), properties of acid-base

Researcher	Title of Journal	Name of Journal	Diagnostic Instrument	Research Result
				solutions (by 47.00%), degree of acidity / pH (by 79.00%), determination of strong acids (by 79.00%), determination of strong bases (by 46.00%), degree of ionization in acid-base determination (by 46.00%), application of the concept of pH to pollution (by 66.00%). To overcome students' misconceptions on acid-base materials, cognitive conflict- based chemistry learning strategies proved effective. This approach involves the use of strategies that trigger cognitive conflict in students, where they are encouraged to question and rejuvenate their incorrect understanding with the correct concept.
Prodjosantoso et al. (2019)	The misconception diagnosis on ionic and covalent bonds concepts with three-tier diagnostic test	International Journal of Instruction	Three-tier	The results of the study found that the use of a three-tier diagnostic instrument in analyzing students' misconceptions about ionic and covalent bonding concepts found that students experienced misconceptions in the high category of 19.05%, the medium category of 42.86%, and the low category of 9.52%.
Rositasari et al. (2015)	Development of a Two-Tier Diagnostic Test to Detect High School Students' Misconceptions on Acid-Base Topic	Edusains	Two-tier	The research results found are the use of instruments two-tier diagnostic in analyzing misconceptions in students found a percentage of 40.87% on the topic of acid-base concepts, 21.62% on the topic of acid-base indicator concepts, 59.46% on the topic of pH concepts, 15.54 on the topic of acid balance base (Ka/Kb), 15.54% on the topic of pH calculation, and on the topic of implementing the concept of PH in the environment by 37.83%.
Amry et al. (2017)	Analysis of Acid-Base Misconceptions in Conventional Learning and Dual Situated Learning Model (DSLM)	Journal of Chemistry Education	Two-tier	The results showed that there were more misconceptions that occurred in conventional learning compared to learning using dual situated learning model (DSLM) on acid-base material. This study used a two-tier diagnostic test as an instrument to identify students misconceptions.
Yan & Subramaniam (2018)	Using a multi-tier diagnostic test to explore the nature of students' alternative conceptions on reaction kinetics	Chemistry Education Research and Practice	Four-tier	The results showed that about 70% of students had misconceptions in understanding reaction kinetics. These misconceptions were identified through the use of a four-tier diagnostic instrument involving questions featuring graphs related to reaction kinetics.

Researcher	Title of Journal	Name of Journal	Diagnostic Instrument	Research Result
Ni'mah et al. (2020)	The effectiveness of POGIL learning with cognitive conflict strategies to reduce misconceptions about reaction rates in class XI SMA	Journal of Education: Theory, Research, and Development	Two-tier	Misconceptions found on the topic of reaction rates are the basic concept of reaction rates with a percentage of 50%, the topic of the reaction rate equation is 59%, and the effect of the surface area is 75%. And to reduce it can using the POGIL learning model with a conflict strategy is considered effective in reducing misconceptions about reaction rates in class XI.
Warsito et al. (2021)	Identification of students' misconceptions on the topic of chemical bonds and their improvement by learning the ECIRR model (elicit, confront, identify, resolve, reinforce)	Journal of Education: Theory, Research, and Development	Three-tier	Found as many as 41 types of misconceptions about chemical bonds in students with a percentage of 61.5%. After applying remedian learning with the ECIRR model it is quite effective in reducing students' misconceptions about chemical bonds with a percentage of 22.4%.

Analysis of Misconceptions and Their Causes

The causes of misconceptions in chemistry learning can be detected with diagnostic instruments, the cause of misconceptions by the students themselves because there are errors in the preconceptions of the material and misconceptions caused by the teaching teacher (Monita & Suharto, 2016). One of the causes of misconceptions in learning is textbooks that do not provide complete information. The guidebook used has incomplete material, causing students to lack understanding of a concept (Noprianti & Utami, 2017). This can make it difficult for students to understand basic concepts, such as covalent bonds. In addition, the lack of effective communication between students and teachers can also be a factor that exacerbates misconceptions (Erman, 2017) and according to Orgill et al. (2008).

The teacher's way of teaching which is more focused on solving calculation problems in these two materials is also another factor that can trigger misconceptions and the causes of chemistry misconceptions among students are the misalignment of students' preconceptions with the concepts taught by experts and the use of ineffective learning strategies in overcoming students' chemistry misconceptions (Damsi & Suyanto, 2023) overcome the problem of misconceptions can be done by strengthening the preconceptions of the material being studied and can use learning strategies, learning models, learning methods and complete textbooks. the application of remedial learning with the ECIRR model is quite effective in reducing student misconceptions of chemical bonds with a percentage of 22.4 from 61.5% (Warsito et al., 2021) and in addition, the use of the POGIL learning model with conflict strategies has also proven effective in reducing misconceptions in reaction rate material in class XI (Ni'mah et al., 2020).

Based on the description above, misconceptions in chemistry learning are caused by students' misconceptions, lack of information in textbooks, and lack of effective communication between students and teachers. The solution is to strengthen students' prejudices against the material, use appropriate learning strategies, and pay attention to complete textbooks. Remedial learning with the ECIRR model. The ECIRR (Elicit, Confront, Identification, Resolve, Reinforce) learning model is a popular method and has proven effective in overcoming students' errors in understanding chemistry material. Through this approach, students are encouraged to recognize the misconceptions they have, understand the correct concepts, and ultimately reduce these understandings (Khomaria & Nasrudin, 2016), and POGIL learning model with conflict strategies is effective in reducing students' misconceptions about chemical bonds and reaction rates. The POGIL model combines guided inquiry and cooperative learning, allowing for active student involvement in the learning process. This is based on guided inquiry which emphasizes the role of students as the center of learning (Manampiring, 2019; Aulia et al., 2017). Application of the POGIL model reduces misconceptions and improves student learning outcomes (Sulalah, 2014; Putri & Gazali, 2021).

Apart from using learning models, various other learning methods have been proven effective in reducing or even eliminating misconceptions in students' chemistry material, including the use of laboratory experiments and connected multiple representation approaches (Sihaloho et al., 2021).

Diagnostic Instruments to Analyze Misconceptions

Diagnostic tests are a tool to identify differences between the knowledge a person should have and the knowledge they have about the material being studied, especially in students (Gurel et al., 2015). According to Warsito et al. (2021), diagnostic tests are one solution to clarify student misconceptions. The results of this diagnostic test help identify students who understand, do not understand, and misunderstand. Diagnostic instruments can examine students' understanding more carefully and reveal the causes of misconceptions (Dirman et al., 2022). The chemistry misconception instrument developed can provide categories of student misconceptions. There are five diagnostic instruments used in analyzing chemical misconceptions, namely; five analytic instruments were used to test students' misconceptions, namely; multiple choice, semi-open choice, and tests of two, three, and four sets. A two-level multiple choice diagnostic test and reasons for analyzing misconceptions is a product of a two-level diagnostic instrument (Rositasari et al., 2015), but a three-level diagnostic test is needed because a two-level test cannot fully identify student misconceptions.

To make the harder of the two layers, students' overall understanding, reasoning abilities, and students' level of self-confidence can be assessed using three sets of diagnostic tests. The three-level diagnostic test can also be used as a student self-assessment to identify and overcome weaknesses in students' understanding of concepts (Prodjosantoso et al., 2019). Besides the three-tier, there is a diagnostic instrument that is more effective in identifying misconceptions, namely a four-tier instrument to identify alternative concepts as well as in ensuring student understanding of a topic. The four-level diagnostic test is one of the tools used to analyze student conceptions (Kartimi et al., 2021) and the four-level multiple choice instrument has several advantages. This allows teachers to discern students' level of confidence in their answers and opinions, enables diagnosis of misconceptions, as well as analyzing aspects of the material that need attention. In this way, teachers can design more appropriate learning to increase students' understanding of concepts (Fariyani et al., 2017). The good number of alternative conceptions obtained from the use of the instrument as well as the confidence measures associated with this has enabled a more nuanced and more robust classification of alternative conceptions in separating true misconceptions from incorrect responses (Yan & Subramaniam, 2018).

Misconceptions on Chemistry Acid and Base

Rositasari et al. (2015), utilization of two-tier diagnostics instruments in analysing misconceptions in students found a percentage of 40.87% regarding acid-base concepts, 21.62% regarding acid-base concepts indicator concepts, 59.46% on pH concepts and 15.54 % on acid-base equilibrium (Ka/Kb), 15.54% on the topic of pH calculation, and on the topic of applying the concept of PH in the environment by 37.83% and according to Ningrum et al. (2022) that the misconceptions found in acid-base material are the topics of arrhenius acid-base theory (32.05%), Arrhenius acid-base classification (56.40%), Bronsted Lowry theory (43.59%), acid-base reaction equations based on Bronsted Lowry theory (59.00%), properties acid base solution (47.00%). Degree of acidity/pH (79.00%), determination of strong acid (79.00%), determination of strong base (46.00%), degree of ionization in the determination. Some of the above studies can be concluded that there are several significant levels of misconceptions in various acid-base concept materials. This can indicate the need for more effective learning approaches and appropriate interventions to overcome student misconceptions in understanding acid-base materials.

Reaction Rate

Based on the findings of Ni'mah et al. (2020) that the misconceptions found in the topic of reaction rate material are the basic concept of reaction rate with a percentage of 50%, the issue of the equation of reaction rates of 59%, and the effect of the surface area of 75%. And to reduce it, using the POGIL learning model with conflict strategies is effective in reducing misconceptions in reaction rate material in class XI.

The conclusion of the study is reducing these misconceptions, the study used the POGIL (Process Oriented Guided Inquiry Learning) learning model with an effective conflict strategy. The application of this learning model aims to reduce students' misconceptions on reaction rate material in class XI. Misconceptions on reaction rate material are found in the basic concept, reaction rate equation, and the effect of surface area. The use of POGIL learning model with effective conflict strategy can help reduce students' misconceptions on reaction rate material.

Chemical Equilibrium

One of the chemistry topics that contains a lot of abstract ideas is chemical equilibrium. Examples include the idea of dynamic equilibrium, the distinction between equilibrium and non-equilibrium, the Le Chatelier equilibrium shift principle, and the energy involved in chemical equilibrium reactions. MAN Banjarmasin students in the 2015–2016 academic year had misconceptions about the concept of chemical equilibrium, specifically the concepts of dynamic equilibrium with low criteria, homogeneous and heterogeneous equilibrium with moderate criteria.

Equilibrium constant with moderate criteria, and the concept of quantitative relationship, according to research by Monita et al. (2016) using a three-tier multiple choice instrument. The Dual-Situated Learning Model (DSLM) can be used to overcome these misconceptions because it is more effective at improving students' understanding of balance concepts than conventional learning methods are. Both the concept of equilibrium shift and the concept of chemical equilibrium in industrial processes have moderate criteria. Apart from that, the application of the Dual Location Learning Model (DSLM) is a learning innovation that marks a paradigm shift from teacher focus to student focus. This model emphasizes the importance of combining concepts that students believe in with concepts that are recognized in science (Amry et al., 2017). DSLM is superior to traditional learning in preventing misunderstandings about chemical equilibrium (Kurniawan et al., 2020).

Chemical Bonds

Students had misconceptions in the high category of 19.05%, the medium category of 42.86%, and the low category of 9.52%, according to a three-tier diagnostic tool used to analyze student misconceptions in the concept material for ionic and covalent bonding (Prodjosantoso et al., 2019). According to Warsito et al. (2021), using a four-tier instrument, 41 different forms of misconceptions about chemical bonding was discovered in students with a proportion of 61.5%.

Salt Hydrolysis and Buffer Solutions

In this study, misunderstandings regarding the definition and nature of salt hydrolysis, as well as the preparation and capacity of buffer solutions, were identified through the use of a two-level diagnostic multiple choice instrument (Maratusholihah et al., 2017). In addition, it was found that students often experience misconceptions in calculating the pH and pOH of buffer solutions, especially in understanding how the pH and pOH values change when acid or base is added (Jannah et al., 2017; Kustiarini et al., 2019; Mapada et al., 2022; Nurhidayatulah & Prodjosantoso, 2018). This misconception is in line with research by Kurniawan et al. (2013) because students often use the pH calculation formula for buffer solutions when solving buffer capacity problems. As a step to overcome misconceptions in this material, a multiple situation learning model (DSLM) supported by animation was used, proving its effectiveness in reducing understanding, especially in the concept of salt hydrolysis and buffer solutions.

Conclusion

The conclusion of this research is that between 2014 and 2023, a literature review confirms that students experience misconceptions in chemistry lessons due to wrong assumptions, but the teacher's role in delivering the material also contributes to these misconceptions. Diagnostic test instruments, such as two-level, three-level, four-level, multiple choice, and semi-open tests, are effective in identifying misconceptions on various chemical concepts, such as acid-base, reaction rate, chemical equilibrium, chemical bonding, salt hydrolysis, and buffer solutions. This highlights the need for a better understanding of these misconceptions in order to promote more effective learning methods in improving students' understanding of complex chemistry material.

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Conflicts of Interest

The authors declare no conflict of interest.

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