

A systematic review of diagnostic tools for identifying chemistry misconceptions among undergraduate students

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ABSTRACT

The purpose of writing this paper is to identify the most diagnostic methods used in the literature to address chemistry misconceptions, the pros and cons of each diagnostic test, and the topics of chemistry that were studied for misconception. The research discussed (35) articles published in peer-reviewed journals between 2001-2021. This paper analyzed the studies to achieve the goals of the study. The articles were obtained from Google Scholar, ERIC, Elsevier, and Tylor and Francis. The results showed that the diagnostic methods to address chemistry misconceptions were used are multiple-choice questions which are the most popular, and tier-questions, interviews, open-ended questions, and combined diagnostic tests. According to the study, each diagnostic evaluation method has its own set of strengths and limitations. As a result, it is assumed that a mixture of various techniques is superior to a single method; MCQs with an interview, MCQs with CRI, or other combined tests. The findings showed that several chemistry topics were investigated for misconceptions; general and inorganic chemistry has the highest percentage of misconceptions, followed by physical chemistry, and the least percentage of misconceptions found in organic and analytical chemistry.

Keywords: misconceptions, diagnostic tests, chemistry concepts, systematic review

INTRODUCTION

Chemistry is the scientific discipline focused on the composition, structure, properties, and transformations of matter, tracing its origins to the Egyptian word "kme" (chem), meaning "earth." Modern chemistry emerged from alchemy following the chemical revolution in 1773. As a branch of physical science, chemistry investigates atoms, molecules, crystals, and other aggregates of matter—either individually or in combination. It examines chemical reactions through the concepts of energy and entropy to understand spontaneity. Chemistry is typically categorized according to the type of matter studied or the research approach, with main fields including inorganic, organic, physical, and analytical chemistry. In recent years, numerous specialized subfields have also developed (Brown et al., 2000).

Like all academic disciplines, chemistry employs a specialized vocabulary with precise meanings. A key challenge in teaching and learning chemistry is helping students develop a clear understanding of these chemical concepts. Research indicates that difficulties often arise because instructors may lack familiarity with the specific terminology and the obstacles it presents to beginners. This can lead to misunderstandings of fundamental concepts among students (Kind, 2004).

A solid understanding of chemistry concepts is essential for success in chemistry education. However, students often struggle to grasp many fundamental principles, and misconceptions can significantly hinder their learning outcomes. This challenge is especially evident among high school students, many of whom find chemistry difficult and consequently fail to achieve mastery in the subject (Nazar et al., 2010). Misconceptions—also referred to as misunderstandings—can prevent students from progressing to higher-level concepts or from effectively connecting related ideas. While some misconceptions can be corrected, many are deeply rooted in students' thinking and often persist despite regular classroom instruction, as they stem from personal beliefs and prior knowledge. If these misconceptions are not addressed, acquiring new concepts becomes increasingly difficult (Gonen & Kocakaya, 2010).

A variety of factors contribute to student misconceptions, including everyday experiences, textbooks, teachers, and the language used in instruction. Misconceptions are defined as students' interpretations or beliefs that lead to incorrect understandings, often formed from personal experiences or events (Martin et al., 2001). Misconceptions—also referred to as alternative conceptions or alternative frameworks—are a widespread challenge in chemistry education. These misunderstandings often arise from individual knowledge shaped by informal experiences or prior instruction that may not align with scientific principles, leading to persistent errors in understanding key topics (Allen & Coole, 2012). In summation, a scientific misconception

can be defined as a student's ideas from life experience or informal education that are not effectively structured, resulting in the inaccurate interpretation of a scientific topic. Misconceptions can be classified into five different types: preconceived notions, nonscientific beliefs, conceptual misunderstandings, vernacular misconceptions, factual misconceptions (Davis, 1997).

Over the past four decades, research into students' scientific concepts and reasoning has grown substantially. The primary aim of these studies is to identify and understand the incorrect or inaccurate conceptions that hinder learning, while also uncovering productive elements within these misconceptions that can be leveraged in other educational contexts (Kaltakci Gurel et al., 2015). Addressing misconceptions is important in the learning process. The recognition of student conceptions, also known as "misconceptions," validly and reliably is an important first step in addressing them. Diagnostic tests are evaluation instruments that are associated with learning challenges that are persistent or recurring and are the causes of learning problems. Diagnostic tests that are mentioned based on the literature are open-ended questions, interviews, MCQs tier questions, mapping, drawings, word assessment.

The main aim of the review of the assessment of chemistry misconceptions is to achieve the following goals:

- 1- Presenting quantitative data for which instrument was used in chemistry education to discover student misconceptions
- 2- Identifying chemistry topics that students typically have misconceptions about
- 3- Addressing the benefits and drawbacks of each method as described in the literature

Significance of Study

- The importance of this research rests in its contribution to the literature by providing a critical overview of the most often used diagnostic instruments in chemistry education for assessing students' misconceptions.
- This research will aid academics and teachers in identifying the appropriate tool to use in evaluating student misconceptions and examining the most prevalent science themes that lead to misconceptions.
- Presenting an overview of chemistry topics in education that is generally researched, as well as getting an education on common misconceptions.

METHODOLOGY

The studies on students' misconceptions in chemistry education were examined, analyzed, and described using a systematic and meta-analysis, structured review (**Figure 1**). The review article is to review studies on the diagnosis methods used to evaluate the understanding of chemical concepts. To obtain the most recent data, only research published between 2001 and 2021 was chosen.

Articles were obtained from a variety of databases; Google scholar, Elsevier, ERIC, Taylor & Francis.

Eligibility Criteria

Studies were eligible for inclusion if they met the following criteria:

1. Published in peer-reviewed journals
2. Available in full-text format
3. Focused on undergraduate or higher education populations
4. Addressed diagnostic instruments or models used to identify misconceptions in chemistry concepts

Publications that did not meet these criteria, such as non-journal publications, studies focused on school-level education, or articles unrelated to diagnostic assessment of misconceptions, were excluded.

Search Strategy

A comprehensive literature search was conducted to identify relevant studies examining diagnostic tools for identifying misconceptions in chemistry among undergraduate students. The search targeted peer-reviewed journal articles published within the selected publication period and available in full text. Key search terms included *undergraduates/higher education*, *diagnostic tests*, *misconceptions*, and *chemistry concepts*. Database searches yielded an initial pool of more than 4,000 records.

Study Selection

Duplicate records were first removed according to the PRISMA screening process. The remaining articles were then evaluated for relevance to the review objectives by examining their titles, abstracts, and keywords. Studies that significantly advanced the understanding of diagnostic models for chemistry misconceptions were selected. In total, 35 publications were included in the final review, each reporting on diagnostic instruments or models used to identify misconceptions in undergraduate chemistry concepts.

Data Analysis

A descriptive statistical method was used to analyze the selected studies. The distribution of diagnostic instruments in the reviewed publications was determined by calculating their frequencies and percentages.

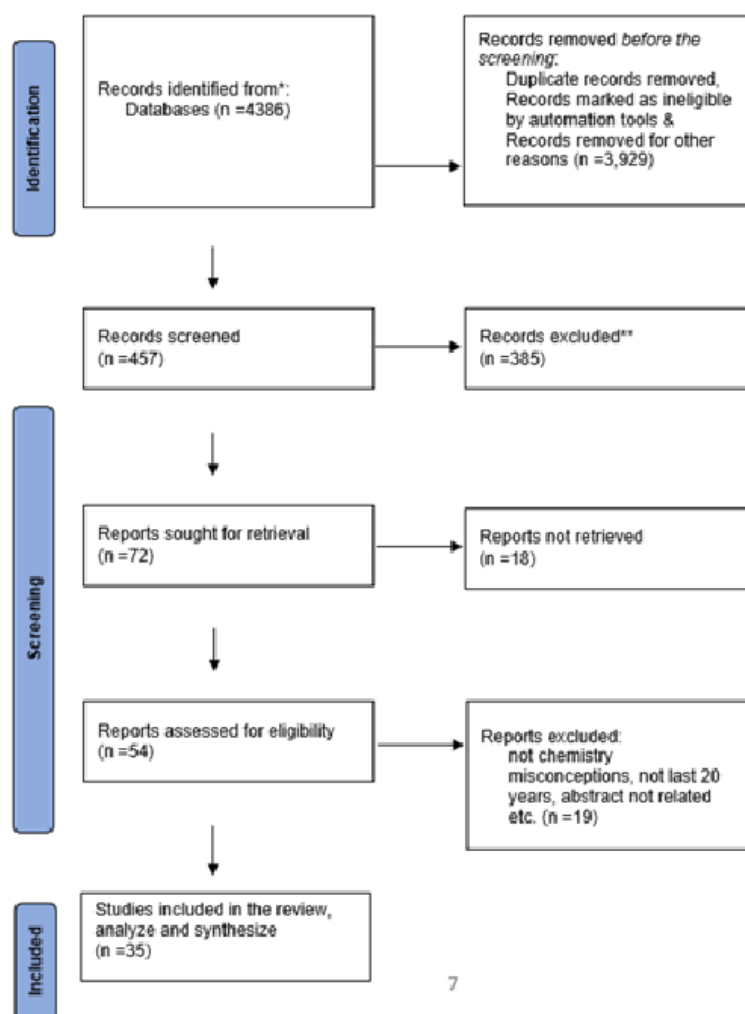


Figure 1. The flow of studies for inclusion in the review (Adapted from Page et al., 2021, PRISMA 2020 statement)

RESULTS AND DISCUSSION

Presenting Quantitative Data for Which Instrument was Used in Chemistry Education to Discover Students' Misconceptions

The majority of the research for this study was published in peer-reviewed journals starting in 2001-2021. Among 35 studies various diagnostic tests have been devised and used to detect and identify students' misconceptions in a variety of chemistry issues. The following diagnostic methods were used: interviews (6 articles) (Basuki, 2019; Gultepe et al., 2013; Mubarak & Yahdi, 2020; Nicoll, 2001; Pabuçcu & Geban, 2012; Wang & Barrow, 2013), open-ended questions (8 articles), multiple-choice question (14 articles), MCQs and CRI (after each question, ask the student how confident they are in their response to see if they are just guessing, confidently correct, or highly confident in their incorrect information) (4 articles), multiple-tier test (9 articles), and other diagnostic methods (9 articles), see **Table 1**. Based on the articles chosen, the percentage of frequently used diagnostic tests is shown in **Figure 2**.

Table 1. Descriptive review of the studies on diagnostic teste used in chemistry misconceptions from 2001-2021

Authors/year	Place of the study	Method to identify the misconception	Topics of misconception	Sample	Journal
Nicoll (2001)	USA	interviews	Electronegativity bonding, geometry, & microscopic representations	-	International J. of Science Education
Azizoğlu et al. (2006)	Türkiye	Phase-equilibrium concept written test	Melting, freezing, sublimation, etc., solutions, vapor pressure,	59	Journal of chemical education
Canpolat (2006)	A State University in Türkiye	Open-ended questions	Evaporation, evaporation rate, vapor pressure	107	International Journal of Science Education
Banerjee (2007)	India	Written test	Chemical equilibrium	162	International Journal of Science Education
Topal et al. (2007)	Dicle University	MCQs	Aromatic concepts	140	International Journal of Environmental and Science Education

Table 1 (Continued). Descriptive review of the studies on diagnostic tests used in chemistry misconceptions from 2001-2021

Authors/year	Place of the study	Method to identify the misconception	Topics of misconception	Sample	Journal
Pinarbasi et al. (2009)	Ataturk University, Türkiye	4-open ended questions	Colligative properties	78	Chemistry education research and practice
Nottis et al. (2008)	Türkiye	Open-ended & MCQs	Atomic orbitals & hybridization	167	Chemistry education research and practice
Aydeniz (2011)	Türkiye	Pre and post-tests MCQs, Blank	Compounds, reactions, solutions, the periodic table, atoms properties, liquids, solids, intermolecular forces/	96	dergipark.org.tr Necatibey Faculty of Education Electronic Journal of Science and Mathematics Education
Kolomuç and Tekin (2011)	Türkiye	Open-ended questions	Chemical reaction rate	70	Euroasian J. of physics and chemistry education
Kind and Kind (2011)	UK	Questionnaire likert scale	particle theory, change of state, conservation of mass, chemical bonding, mole calculations, and combustion reactions/	150	International Journal of Science Education
Pabuçcu and Geban (2012)	Türkiye	Pre & post-test/ 2tier MCQS semi-structured interview	Chemical bonding	41	International. online J of educational sciences
Wang and Barrow (2013)	Midwest research-extensive institute in the United States	Interviews diagnostic instrument on electronegativity (2) a two-tier MCQs diagnostic instrument on chemical bonding and (3) a diagnostic instrument on molecular geometry and polarity	atomic structure and periodic variations, chemical bonding, and molecular shape and polarity	159	Royal society of chemistry
Gultepe et al. (2013)	Türkiye	MPC, MCQS test & interview	Pure substances, mixtures, gas laws, solutions, chemical calculations, mole concept	554	Australian J. of teacher education
Danielson and Tanner (2015)	San Francisco	Novel written assessment	Greenhouse gases, climate change, Ocean acidification	25000	International online J. Of educational sciences
Akkuzu and Uyulgan (2016)	Türkiye	Functional group worksheet & concept maps	Organic compounds within fictional groups	60	Chemistry education research and practice
Pérez García et al. (2016)	USA	MCQs	Physical chemistry	56	J of Chem. Edu.
Milenković et al. (2016)	Serb Republic	3tierMCQs	Carbohydrates	42	J of Chem. Edu.
Romine and Todd (2016)	United States	Rasch rating scale model	Acid base	----	Science education
Sadhu et al. (2017)	Mataram	3 Tier MCQS with CRI	Acid base	148	International conference on science and applied science
Ramon et al. (2017)	Valencia	MCQs	Properties of substances; color, boiling points, solubility & conductivity, intra & intermolecular forces, h-bonding, covalent & molecular network, polarity & geometry	79 high school & 99 Undergraduate Valencia University	Asian J of education & e-learning
Widarti et al. (2017)	Indonesia	MCQs with open end	Acid-base & argentometric titration	30	International J of Education
Eggen et al. (2017)	Norwegian University of Science and Technology (NTNU)	chemistry concept inventory pre-post test MCQs	general chemistry	-----	International Journal on Math, Science and Technology Education
Basuki (2019)	Indonesia	MCQs & interview	Oxidation number	34	Indonesian J. of chemistry
Hanson (2019)	Ghana	2 tier MCQs	Acid, base, hybridization, chemistry principles, transformation	313	International j. of infonomics
Durmaz (2018)	Anatolian University	Stereochemistry concept inventory MCQs	stereochemistry concept	28	Journal of education and training studies
Manneh et al. (2018)	Sweden	analytical tool of practical epistemology analysis	oxidation states of atoms	--	INTERNATIONAL JOURNAL OF SCIENCE EDUCATION
Waluyo et al. (2019)	Nigeria	MCQs & CRI	Tangent circle	48	Tadris: Jurnal Keguruan Dan Ilmu Tarbiyah
Jenkins and Shoopman (2019)	Eastern Kentucky University	acombination of think-aloud activities and written probes	Molecular orbital diagrams	13	Science Education International
Mustari et al. (2020)	Pesisir Salatan Nigiri	4 level objective test MCQs with CRI	Work and energy material	30	J. of Physics:conference series
Mubarak and Yahdi (2020)	Islamic state University Of Mataram	3tier MCQs Interview survey	Acid, base	33	Jurnal Pedidikan APK Indonesia
Türkoguz (2020)	State of University in Aegean Türkiye	3-tier MCQs	Acid-base, electrochemistry, thermodynamic, kinetic and equilibrium	115	International education studies
Watson et al. (2020)	Southeast United States	Pre post test MCQs & survey	PH concepts	59	Chemistry education research & practice
Khandagale and Shinde (2021)	Std Sivaji University, Kolhapur	2-tier MCQs	Valency & chemical bonding	52	International j. of innovate research in technology
Putri et al. (2021)	Indonesia	Pre-post-tests MCQs CRI	Adsorption, mathematical chemistry	Case study	Indonesian J. of Multidisciplinary research
Karonen et al. (2021)	Fennish University	MCQs pre-post-test	Lewis structure	200	Education sciences

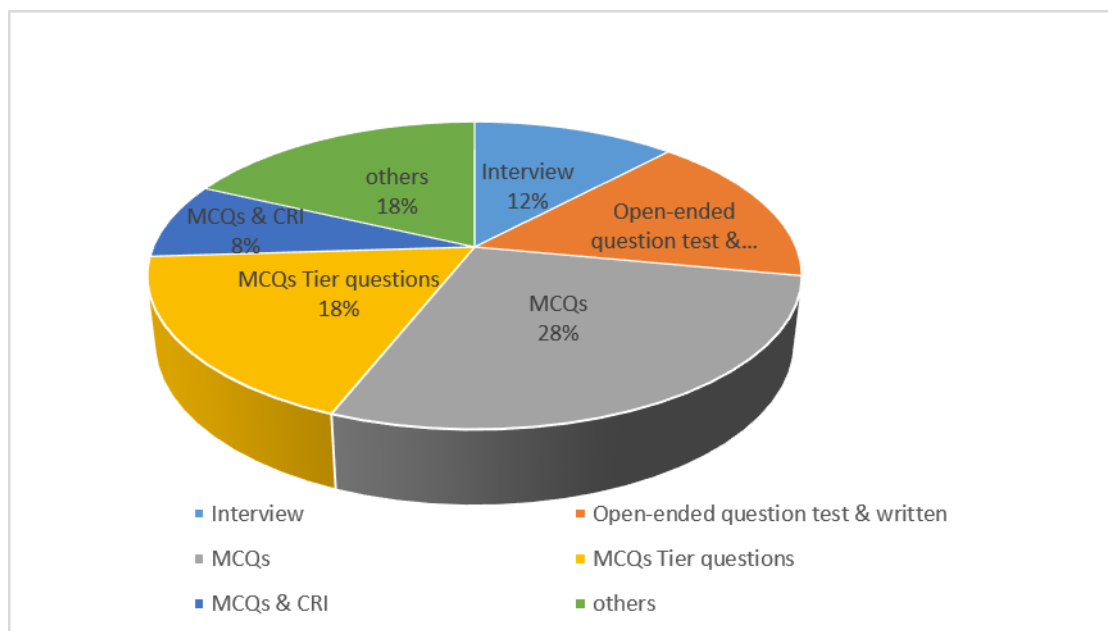


Figure 2. Percentage of frequently used diagnostic tests (Source: Authors' own elaboration)

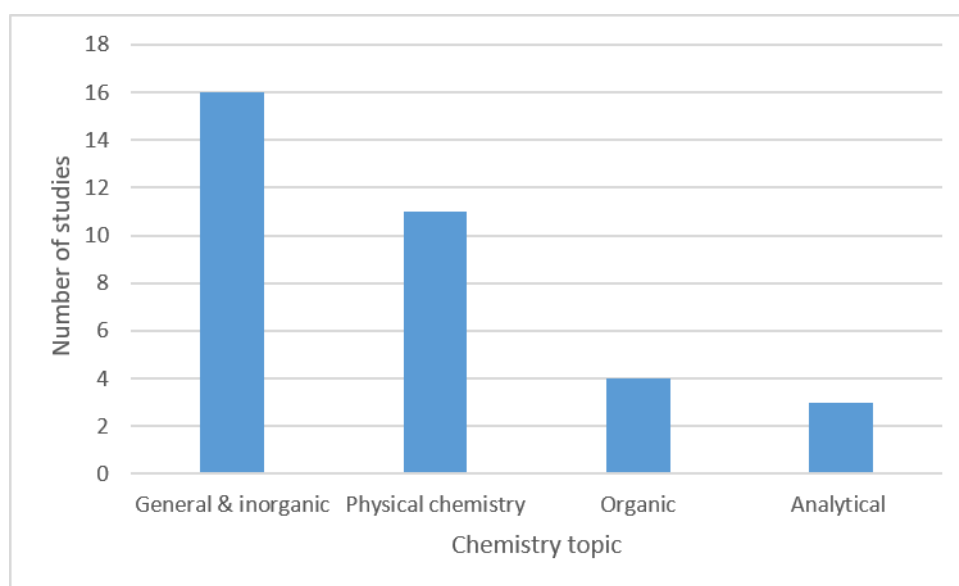


Figure 3. Distribution of chemistry topics in reviewed articles (Source: Authors' own elaboration)

Different common methods of diagnostic tests have been used, and their percentages are presented in **Figure 2**. The most commonly utilized diagnostic test, according to the 35 research included in this review, was MCQs 27 (54%). In addition, multi-diagnostic tests in 14 articles (28%) were detected in the studies, meaning that they do not use a particular tool but rather two or three different diagnostic instruments to achieve a better study outcome. We have reported that researchers frequently use interviews as a second tool to uncover chemistry misconceptions in particular (Basuki, 2019; Gultepe et al., 2013; Mubarak & Yahdi, 2020; Nicoll, 2001; Pabuçcu & Geban, 2012; Wang et al., 2013). While others used MCQs with CRI for instance in Mustari et al. (2020), Putri et al. (2021), Sadhu et al. (2017), Waluyo et al. (2019). In addition to open-ended questions used as a single tool or combined with other diagnostic tools such as in Canpolat (2006), Kolomuç and Tekin (2011), Nottis et al. (2008), Pinarbasi et al. (2009), Widarti et al., 2017).

Identify Chemistry Topics that Students Typically have Misconceptions About

The subjects that commonly lead to student misconceptions are listed in **Table 1**.

Table 1 provides references for the most popular chemistry misconceptions tests on many topics. After analyzing the topics, all misconceptions have been categorized into four major chemistry disciplines; general and inorganic chemistry, physical chemistry, organic chemistry, and analytical chemistry. **Figure 3** shows the distribution of chemistry topics that students have misconceptions about.

Figure 3 indicates that misconceptions are most frequently reported in general and inorganic chemistry (47.06%), followed by physical chemistry (32.35%), whereas misconceptions related to organic chemistry (11.76%) and analytical chemistry (8.82%) are comparatively less prevalent. These findings can be effectively interpreted through constructivist learning theory, conceptual change theory, and mental model theory, thereby enhancing the theoretical depth of the study.

From a constructivist perspective, learners actively construct knowledge based on prior experiences and existing cognitive structures. General and inorganic chemistry concepts are introduced early and repeatedly throughout students' educational trajectories—from elementary school to university level. At lower educational levels, instruction often emphasizes memorization of rules, trends, and exceptions rather than conceptual understanding. As a result, students develop fragmented or naïve conceptions that persist into higher education. These pre-existing conceptions become resistant to change, particularly when instruction at later stages assumes foundational understanding that students do not actually possess.

This issue is especially pronounced in inorganic chemistry, where students exhibit underdeveloped conceptual frameworks and profound difficulty in shifting between macroscopic, microscopic, and symbolic representations of chemical phenomena. According to mental model theory, students rely on internally constructed representations to explain phenomena. When these mental models are incomplete or incorrect—such as viewing chemical processes only at the symbolic level—students are unable to reason conceptually or apply knowledge flexibly. Consequently, they rely heavily on rote memorization, which limits meaningful learning and transfer.

Furthermore, conceptual change theory explains why these misconceptions persist. Conceptual change requires dissatisfaction with existing conceptions and the availability of intelligible, plausible, and fruitful alternatives. However, in inorganic chemistry, students are often not encouraged to confront their misconceptions explicitly. Instead, educators may resort to rationalization or algorithmic explanations due to the abstract and mathematically intensive nature of the subject, limiting opportunities for deep conceptual restructuring (Derkach, 2021) supports this interpretation, reporting that students' inorganic chemistry knowledge is characterized by insufficient understanding of microscopic processes, difficulty working with multiple models, and limited mathematical competence—all of which hinder conceptual change.

Similar theoretical explanations apply to physical chemistry, where misconceptions arise largely from students' inability to mentally integrate abstract mathematical formulations with chemical meaning. Physical chemistry demands coordination across multiple representational levels, yet many students fail to construct coherent mental links between them. According to mental model theory, this failure results in surface-level understanding, where formulas are memorized without comprehension of the underlying phenomena. Derkach (2021) further notes that students often misunderstand the purpose and limitations of models used in physical chemistry, reinforcing persistent misconceptions.

Language also plays a critical role in the construction of misconceptions. From a constructivist viewpoint, learners interpret scientific terminology through the lens of everyday language. Deshmukh and Gadre (2009) notes that chemical terms frequently carry meanings in daily discourse that differ from their scientific definitions, leading to misinterpretation and reinforcement of alternative conceptions. When conceptual understanding is weak, students increasingly depend on rote learning, which further limits conceptual change and negatively impacts academic achievement (Omwirhiren & Ubanwa, 2016).

Misconceptions related to solutions and colligative properties further illustrate students' difficulties with mental model construction. Many learners struggle to visualize microscopic processes such as solvation and particle interactions, relying instead on memorized equations without understanding their conceptual basis. This inability to transition between micro- and macro-level explanations reflects poorly developed mental models and aligns with constructivist explanations of learning failure.

In contrast, organic chemistry exhibits fewer misconceptions, possibly because its concepts are more internally coherent, relational, and limited in scope. Although organic chemistry also requires memorization, students often perceive it as more engaging and manageable, particularly when instruction emphasizes structural patterns and reaction mechanisms. Omwirhiren and Ubanwa (2016) reported that a majority of students found organic chemistry interesting and preferred it over other chemistry disciplines, suggesting that affective factors and instructional style also influence conceptual understanding. Nevertheless, misconceptions remain in areas such as isomer recognition, reaction classification, and nomenclature, often due to insufficient foundational knowledge and time constraints in instruction (Bryan, 2007).

Regarding analytical chemistry, misconceptions tend to stem from students' epistemological beliefs about scientific instrumentation. Carbó et al. (2010) describe a prevalent "black-box" perception, where instruments are viewed as autonomous, error-free entities producing unquestionable results. This pseudo-empiricist view reflects poorly structured mental models and weak conceptual understanding of analytical procedures, calibrations, and data interpretation. Such misconceptions highlight the need for instruction that explicitly addresses the conceptual and theoretical underpinnings of analytical methods.

Finally, the abstract nature and inherent complexity of chemistry concepts, particularly bonding, acids and bases, and matter structure, constitute a fundamental source of misconceptions. Studies consistently show that students rely on sensory-based reasoning, struggling to accept particulate models of matter because particles and interparticle spaces cannot be directly observed (Griffiths et al., 1992; Kind, 2004). These intermediate conceptions reflect partial conceptual change rather than full scientific understanding.

In summary, the dominance of misconceptions in general, inorganic, and physical chemistry can be explained by the interaction of prior knowledge construction (constructivism), resistance to replacing entrenched alternative conceptions (conceptual change theory), and inadequate or incorrect internal representations (mental model theory). Explicitly addressing these theoretical dimensions in instruction and diagnostic design is essential for meaningful misconception remediation and conceptual development in chemistry education.

Addressing the Benefits and Drawbacks of Each Method as Described in the Literature

After analyzing the articles, the benefits and drawbacks of diagnostic tools were identified as follows.

Open-ended tests

The advantages are: understanding students' ideas and misconceptions in-depth, analyzing wrong responses to open-ended questions that require students to illustrate their thought processes might provide greater insight into the nature and origins of student mistakes (Marx, 1998), easy to prepare. While the drawbacks analysis requires a skilled person, takes time to analyze, bias can be identified.

MCQs and tier questions

Tests were described as diagnostic tools comprising the first layer of multiple-choice subject questions and a second tier of multiple-choice reasons for the first tier's answer. To summarize, two-tier tests offer benefits above traditional multiple-choice assessments. The most crucial is that these examinations reveal the explanation or explanation behind the pupils' chosen response. These assessments, however, have considerable limits when it comes to distinguishing knowledge deficit from misconceptions, errors, or scientific understanding (*A Review and Comparison of Diagnostic Instruments to Identify Students' Misconceptions in Science*, n.d.). Several authors have explored the advantages of using multiple-choice tests over other techniques. MCQs combined with tier-questions (Marx, 1998). Effective in assessing students' misconceptions in a short period, a vast range of topics are covered, suitable for a large number of students, different levels of learning are measured, reliable, scoring is simple and quick/safe time, useful for pupils who have a hard time writing, appropriate for item analysis (*A Review and Comparison of Diagnostic Instruments to Identify Students' Misconceptions in Science*, n.d.). On the contrary, preparation takes time, urges people to make guesses and to overcome these problems 2/3/4-tier questions are recommended or MCQs combined with CRI, writing good items is difficult. Students' answers to multiple-choice questions can be confirmed by asking them to explain their choices. Furthermore, two-tier multiple-choice items based on student reasoning, including known misconceptions, appear to be a viable technique for assessing students' comprehension and detecting commonly held misunderstandings.

Furthermore, the results of diagnostic multiple-choice tests have been often published in the literature on misconceptions. This format has a lot of valid evidence (*A Review and Comparison of Diagnostic Instruments to Identify Students' Misconceptions in Science*, n.d.). It may be concluded that employing the three-tier or modified certainty of answer index is more effective in determining the percentage of students who grasp the concept well, those who do not comprehend the concept well, and those who have a misconception about the topic. Three-tier examinations are more successful than traditional multiple-choice tests in assessing students' understanding because they distinguish alternate ideas from a lack of knowledge by evaluating the tiers (Sadhu et al., 2017). To compensate for the limits of typical multiple-choice tests used in diagnosing students' conceptions, they enlarged multiple-choice tests into examinations with two, three, or four levels (Kaltakci Gurel et al., 2015).

Interviews

Interviewing, according to Kaltakci Gurel et al. (2015), is the most effective technique to uncover student misconceptions when done correctly, in-depth information collected. The interview method is flexible, clears the doubts, they also advise that combining interviews with additional assessments such as multiple-choice questions will improve the study instrument. While it is time-consuming, less reliable, very costly, the shyness of the interviewee, requires dedication. Interview studies provide less anonymity, which is a big concern for many respondents because many interviewers lack collaborative and conversational skills, they are unable to obtain correct data. Moreover, because data analysis is difficult and complicated, interview bias may be identified in the study (Bolderston, 2012).

CONCLUSION

In summary, a variety of diagnostic tests reveal misconceptions in chemistry. Several approaches and instruments have been reported in the literature, such as concept mapping, interview about instances and events, interview about concepts, prediction-observation-explanation, drawings, word association, pencil-and-paper diagnostic instruments based on multiple-choice items, two-tier multiple-choice tests. However, the majority of academics are split on the optimum strategy for detecting misunderstandings. It depends on the topic of the issue under investigation, the qualities of the targeted subjects under investigation, and the researcher's or teacher's ability and resources (Widarti et al., 2017). Kaltakci Gurel et al. (2015) asserted that it is commonly recognized, however, that a mix of several procedures is superior to a single one. All diagnostic assessment approaches were shown to have their strengths and limitations, according to the study. As a result, a combination of several procedures is thought to be superior to a single method. Chemistry topics deal with abstract and difficult concepts such as determining sample concentrations, acids and bases, and ions in titration, chemical bonding; ionic and covalent bonds..etc. (Nicoll, 2001) mentioned that from reactivity in organic chemistry to spectroscopy in analytical chemistry, the ideas of the electron, ionization energy, electronegativity, bonding, geometry, molecular structure, and stability are important to most of the chemistry (general and inorganic chemistry). Furthermore, students must master these concepts in order to comprehend why and how chemical bonds form. As a result, many students continue to struggle with the Fundamentals Chemistry courses, which may cause misconceptions. Teachers face a huge task in producing a higher, chemically precise knowledge of the basic concepts that make up chemistry. Chemistry will remain mysterious for many if this is not carefully considered.

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