Literature Study: The Phenomenon Of Chemical Bonding's Misconceptions And Opportunities For Remediation

Nur Alawiyah¹, Resi Pratiwi²

¹, ² Study Program of Chemistry Education, The Faculty of Science and Technology, Universitas Islam Negeri Walisongo Semarang, Jl. Walisongo No.3-5, Tambakaji, Kec. Ngaliyan, Kota Semarang, Jawa Tengah 50185
alawiyah@walisongo.ac.id

Abstract
This research aims to analyze the misconceptions that occur in chemical bonding materials and offer remediation processes. This type of research was library research with data taken from library materials or information. There were 32 scientific journals related to the research topic, then grouped within the last five years, and four scientific journals were produced that discussed misconceptions in chemical bonding material and four scientific journals that discussed the process of remediation of misconceptions in chemical bonding material. Based on the results of the review, misconceptions about chemistry occur in almost every sub-topic. The offer to remediate misconceptions that occur in this material is the ECIRR learning model, cognitive conflict strategy, and conceptual change strategy.

Keywords: Learning Media, Intrinsic Elements, Poetry

INTRODUCTION

Conceptual errors or misconceptions can be defined as discrepancies between scientific understanding by scientists and students' conceptual understanding in a particular field (Chi, 2017; Taş et al., 2015; Ibrahim, 2012; Dhindsa & Treagust, 2009;). Understanding concepts has an important role in the learning process. If, during this process, there is a misunderstanding of the material being communicated, it will have a fatal impact on the continued suitability of existing theories in chemistry. As is known, in chemistry learning, there are not only abstract theories with quite high complexity, but they are also based on facts, concepts, principles, and scientific innovations (Erza & Nasrudin, 2017; Redhana, 2019; Zulkarnain et al., 2019), resulting in opportunities for misconceptions when the delivery of material is not based on mature concepts.

There are several factors that influence the occurrence of misconceptions, according to Suparno (2013). He stated that there are six things that can influence the occurrence of conceptual errors or what are also called misconceptions, namely 1) Preconceptions or students' initial concepts. The initial
construction of a concept owned by students has quite an important role in instilling the concept; 2) Students' associative thinking. Differences in the meaning of educators and students in translating terms used in the learning process; 3) Humanistic thinking; 4) Incomplete or incorrect reasoning; 5) Wrong intuition; and 6) Stage of cognitive development of students, adapting the theory provided to the level of cognitive development of students can prevent misconceptions.

Based on a literature review search using the keyword misconception, chemical bonding is the material most widely discussed in scientific articles. This is also the basis for researchers to find out more about why this material has many misconceptions among students. Chemical bonding material has a fairly high level of abstractivity, so students must imagine the bonds that occur at the microscopic level (Mezia et al., 2018). Chemical bonding concepts such as covalent bonds, ionic bonds, and metallic bonds, as well as the octet rule, Lewis structure, and molecular polarity, are often difficult for students to understand. This is due to the abstract nature of the topic, which requires good imagination and visualization to understand how small particles interact. This difficulty in visualization and abstraction often causes students to build incorrect or incomplete understandings, which then develop into misconceptions.

Remediation, or what can also be called an improvement process which, has the aim of making something better (Widiastuti & Purwanto, 2019). In this context, it means improvement to reduce conceptual errors in chemistry subjects. Remediation or improvements that can be carried out in the learning process certainly involve various aspects according to the causes of misconceptions. This misconception remediation process can be carried out by recognizing and analyzing students' initial knowledge, especially incorrect preconceptions, so that ongoing misconceptions do not occur (Yulianti, 2017). Apart from that, teachers must also have the ability to overcome misconceptions that occur in students by providing more challenging learning to construct students' knowledge directly and independently.

Before carrying out corrections or remediation of misconceptions, an important thing that teachers must do is to be able to identify the misconceptions experienced by students. Misconceptions can occur because students experience a condition of not knowing or not knowing the concept. So, in carrying out the diagnosis, you must be able to differentiate between students who do not understand the concept and students who experience misconceptions because when students experience misconceptions, they believe that what they understand is scientifically correct, so treatment is appropriate to straighten out their understanding.

According to Taufiq (2012), there are three options that can be used to find out preconceptions and misconceptions in students, namely: (1) through diagnostic tests, (2) clinical interviews, and (3) presentation of concept maps. Based on the results of the answers and arguments put forward by students on the test sheet, participants' initial knowledge and misconceptions and their backgrounds can be traced. If the process of diagnosing misconceptions has been carried out and the teacher is able
to distinguish whether there really is a misconception or whether the students really don't understand, then the teacher can take remediation action that is appropriate to the cause.

**METHOD**

This type of research is library research, where the data collection method is carried out by collecting data from library materials or information (books, encyclopedias, scientific journals, newspapers, magazines, and documents) (Syaodih, 2009). This research uses secondary data, where the data is obtained not from direct observation but is obtained by collecting the results of previous research written in books, articles, and scientific journals (Azwar, 2009).

Data collection was carried out using the documentation method, namely collecting data by searching or digging up data from literature related to what is intended in the problem formulation. The data analysis technique in this research is content analysis, namely by collecting related data from library materials. The data analysis was carried out, and conclusions were drawn (Afifudin, 2012). In general, the steps in this research are designing a review, choosing a topic, formulating the problem and formulating the objectives that will be discussed in the review, conducting reviews, data analysis, and writing reviews (Synder, 2019).

**RESULT AND DISCUSSION**

The results of the literature review were produced through a process of filtering the data obtained, namely 32 scientific articles obtained, which were then categorized into smaller groups with a period of the last five years that discussed this topic. There were five scientific articles regarding misconceptions regarding chemical bonding and four scientific articles discussing opportunities for remediation. This can be seen in Table 1.1 and Table 1.2.

Table 1. The Result of Scientific Articles Review with The Topic Misconception of Chemical Bonding

<table>
<thead>
<tr>
<th>No</th>
<th>Judul Artikel</th>
<th>Penulis</th>
<th>Hasil Review</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Identifikasi Miskonsepsi Siswa pada Topik Ikatan Kimia Serta Perbaikannya dengan Pembelajaran Model ECIRR (Elicit, Confront, Identify, Resolve, Reinforce)</td>
<td>Warsito, et. al., 2020</td>
<td>As many as 41 types of misconceptions were found in seven sub-topics in the material of chemical bonds, namely the octet rule and Lewis structure, covalent bonds, ionic bonds, molecular polarity, metallic bonds, molecular shape, and intermolecular forces. The research results also show that misconceptions among students are in the high category, with a percentage of 61.5%.</td>
</tr>
<tr>
<td>2</td>
<td>Identifikasi Miskonsepsi Peserta Didik Pada Materi Ikatan Kimia : Sebuah Studi Literatur</td>
<td>Rahayu, et. al., 2021</td>
<td>Misconceptions were found among students in the Lewis structure sub-material, Stability of Elements and the Octet Rule, Exceptions and Failures of the Octet Rule, ionic bonds, covalent bonds, metallic bonds, molecular shape, molecular polarity, and intermolecular forces.</td>
</tr>
</tbody>
</table>
Identifikasi miskonsepsi materi ikatan kovalen pada mahasiswa kimia tahun pertama universitas negeri malang menggunakan tes diagnostik two-tier

Istiqomah, *et. al.*, 2021

Misconceptions were found in 10 concepts of covalent bond material, namely 23% on the concept of the elements that form covalent compounds, 69% on the Lewis structure concept, 54% on the concept of double bonds, 35% on the concept of coordinating covalent bonds, 54% on the concept of polar covalent bonds and molecular polarity, 27% on the formal charge concept, on the concept of the octet rule and the stability of covalent compounds, 27% of stable Lewis structures do not have Free Electron Pairs (PEB) and fulfill the octet rule; 62% of chlorine gas will form Cl2 molecules because it fulfills the octet rule; and 54% of covalent bonds store chemical energy, 42% on the concept of molecular shape, on the concept of intermolecular forces and the properties of covalent compounds, 38% of the energy needed to boil table salt is greater because table salt is an ionic bond; and 81% of the strongest attractive interactions are hydrogen bonds and in the concept of valence bond theory, 23% of the most important particles in the formation of covalent bonds are valence electrons; and 27% electron sharing means sharing 1 (one) electron by two atoms, as in the case of sharing an apple for two people.

Identifikasi Miskonsepsi Ikatan Kimia Menggunakan Diagnostic Test Multiple Choice Berbantuan Certainty of Response Index

Karim, *et. al.*, 2022

It was found that the overall average indicator of students who understand the concept is 12.55%, students who experience error one misconception are 3.22%, students who experience error two misconceptions are 8.55%, error three misconceptions are 19.34%, and the average of students who do not understand the concept as much as 56.32%. The overall average misconception is 31.13%.

<table>
<thead>
<tr>
<th>No</th>
<th>Judul Artikel</th>
<th>Penulis</th>
<th>Hasil Review</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Identifikasi Miskonsepsi Siswa pada Topik Ikatan Kimia Serta Perbaikannya dengan Pembelajaran Model ECIRR (Elicit, Confront, Identify, Resolve, Reinforce)</td>
<td>Warsito, <em>et. al.</em>, 2020</td>
<td>The ECIRR model is effective in correcting student misconceptions.</td>
</tr>
<tr>
<td>2</td>
<td>Strategi Konflik Kognitif Dapat Mereduksi Beban Miskonsepsi Mahasiswa Calon Guru Kimia Pada</td>
<td>Palisoa, 2020</td>
<td>Cognitive conflict strategies in the research conducted can reduce misconceptions.</td>
</tr>
</tbody>
</table>

Table 2. The Result of Scientific Articles Review about The Opportunity of Misconception's Remediation on Chemical Bonding
### Literature Study: The Phenomenon Of Chemical Bonding’s Misconceptions And Opportunities For Remediation, Nur Alawiyah, Resi Pratiwi 21399

<table>
<thead>
<tr>
<th>Konsep Ikatan Kimia</th>
<th>3</th>
<th>Kemudahan Eliminasi Miskonsepsi Ikatan Kimia pada Siswa dengan Efikasi diri yang Berbeda</th>
<th>Aryunga, et. al., 2020</th>
<th>Eliminating misconceptions is easier for students who have reached the formal operational level compared to students with a concrete level.</th>
</tr>
</thead>
<tbody>
<tr>
<td>4</td>
<td>Software Development to Reduce Misconceptions Using Conceptual Change Text Strategy on Chemical Bonding</td>
<td>Putri, et. al., 2020</td>
<td>Software developed by valid researchers can be used to detect and reduce misconceptions about chemical bonding material with the conceptual Change strategy.</td>
<td></td>
</tr>
</tbody>
</table>

### Misconception on Chemical Bonding

Based on the data found by researchers, misconceptions about chemical bonding material occur in various sub-topics, such as the octet rule, Lewis structure, covalent bonds, ionic bonds, molecular polarity, metallic bonds, molecular shape, and intermolecular forces. Common misconceptions include the belief that the octet rule has no exceptions, confusion between covalent and ionic bonds, and misconceptions regarding molecular polarity that do not take into account molecular geometry. In addition, students often misidentify the nature of metallic bonds and the role of electron seas and have difficulty applying VSEPR theory to predict molecular shapes.

In the research of Warsito et al., (2020), it was seen that there were 41 types of misconceptions in seven sub-topics of chemical bonding material. Misunderstandings include the belief that the octet rule has no exceptions, confusion between covalent and ionic bonds, and misperceptions of molecular polarity that do not take into account molecular geometry. This is also in line with research conducted by Rahayu et al. (2021), who found misconceptions in almost every sub-chapter of chemical bonding material. In other research, Istiqomah et al. (2021) stated that the prevalence of misconceptions among students ranges from 23% to 81% on various concepts in chemical bonds.

### The Opportunities of Misconception's Remediation on Chemical Bonding

Remediation of misconceptions regarding chemical bonding requires a structured approach and focuses on identifying and correcting misconceptions. Teachers can use interactive learning methods to clarify complex concepts. The use of visual models and concrete analogies can also help students better understand Lewis structures, covalent bonds, ionic bonds, and other concepts. Additionally, providing constructive feedback through formative tests can help identify specific areas of misconception in individual students.

Various remediation strategies offered by researchers, such as the ECIRR model and cognitive conflict strategies, have proven effective in overcoming and reducing misconceptions among students. The application of the ECIRR learning model by Warsito et al. (2020) to overcome student misconceptions was carried out through group learning. This is based on Piaget's view of how peer interaction in group learning can influence the development of students' thinking. Although the results of this research show that the application of this model has not been able to eliminate misconceptions completely, the application of this model is quite significant in reducing students' misconceptions.
Regarding chemical bonding material.

Remediation with cognitive conflict strategies is also offered by Palisoa (2020). Cognitive conflict is defined as a conflict between a person's cognitive structure and the information they have just received (Damon & Killen, 1982; Kwon & Lee, 2003; Moody, 2008). Palisoa's research results show that this strategy can reduce the occurrence of misconceptions about chemical bonding material. The success of implementing this strategy in reducing misconceptions is due to conceptual changes in the research subject so that concepts that experience errors can be straightened out by providing new information. This is in line with research conducted by Putri et. al. (2020). In his research, he developed software with the Conceptual Change Text strategy to detect and reduce misunderstandings related to chemical bonds. The results show that the software developed is quite significant in reducing misconceptions that occur among students.

CONCLUSION

Based on the literature study carried out, misconceptions regarding chemical bonding material occur in almost all sub-themes of this material. There are several remediations offered to reduce students' misconceptions regarding chemical bonding material, namely the ECIRR (Elicit, Confront, Identify, Resolve, Reinforce) learning model, cognitive conflict strategy, and Conceptual Change Text strategy.

REFERENCES


