INVESTIGATE THE UTILITY OF A MISCONCEPTION DETECTION APPLICATION AS AN EARLY DETECTION TOOL BASED ON FIVE-TIER DIAGNOSTICS TEST

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Abstract. *Research into misconceptions is crucial in the field of education, particularly in subjects like chemistry, which are complex and prone to misunderstandings. Misconceptions—ideas held by individuals that deviate from established scientific understanding—can arise from various sources, including students, teachers, textbooks, and instructional methods. These inaccuracies can hinder effective learning and need to be addressed to enhance educational outcomes. Identifying and remediating misconceptions is challenging, requiring specialized tools and methods. Therefore, research into misconceptions aims to uncover and correct these misunderstandings to improve teaching strategies and student comprehension. Therefore, the research in this article is concerned with the practicality of the application of chemical representation diagnostic tests to identify chemical misconceptions, particularly on chemical equilibrium and chemical bonding materials. This research was carried out at Surabaya State University participated by 24 students from the Chemistry Education Study Program. In this research, the practicality of the chemical misconception diagnostic test application was obtained at 98.6% which indicates that the application is practical to use. In addition, obtained data on student diagnostic results, namely: 88.3% did not understand the concept; 10.4% had misconceptions; and 1.3% understood the concept on the topic of chemical bonding.*

Keywords: *misconceptions, five-tier diagnostic test, chemical bonding, online application*

INTRODUCTION

A concept is an abstraction of human thought based on experiences that share similar characteristics, allowing it to be distinguished from other concepts. An individual's comprehension of a concept is referred to as a conception. Conception serves as the foundation for advanced cognitive processes and problem solving abilities [1]. Consequently, it is imperative that individuals possess the appropriate conceptions and refrain from experiencing misconceptions. It is imperative that individuals do not experience misconceptions.

The results of several studies [2][3][4] indicate that misconceptions continue to evolve. The aforementioned misconceptions remain unresolved. Despite the implementation of measures designed to rectify these erroneous beliefs, the resulting outcomes indicate that the misconceptions have not been entirely eliminated. Some students exhibit inconsistent behavior, reverting to their initial erroneous conception after a period of time. The aforementioned misconception change also occurs in the context of chemical bonding [5][6].

From the aforementioned discussion, it can be posited that misconceptions are deemed appropriate when they are challenging to eradicate. This serves to illustrate the necessity for the prevention of such misconceptions. The persistence of misconceptions is a significant challenge in the field of science education.

A further hypothesis was formulated. To avoid any potential misunderstanding, it is essential for an individual to. It is recommended that individuals engage in self-identification to ascertain whether they have misconceptions. These are obtained by

diagnostic tests that still have various shortcomings [7][8].

To identify conceptions, it is necessary to have an accurate detection instrument. The process of conception must be completed in a timely and accurate manner. One potential method for achieving this is the Conception Detection Application.

The Chemistry Conception Detection Application is an online application that was developed to detect conception with precision and speed. The accuracy of the conception detection application is based on a five-tier diagnostic test that has been developed and validated for the accurate detection of a person's chemical conception. The application is capable of detecting a person's chemical conception.

The five-tier diagnostic test is a diagnostic tool that comprises five stages. Stage 1 presents a question regarding the concept, while stages 2 and 4 assess the level of belief. Stage 3 comprises a follow-up question regarding the concept, while stage 5 is concerned with identifying conceptions based on an individual's chemical representation picture.

The objective is to express phenomena, abstract concepts, ideas, and mechanism processes in a way that facilitates the identification of conceptions with greater precision and accuracy. It is anticipated that the identification of conceptions will be more precise and appropriate.

The speed of identification is a crucial factor, as it enables the swift progression from the initial accuracy of conception to the subsequent stage. The educator requires the rapid identification of conceptions in order to expeditiously execute the aforementioned process. The speed of identification is also a requisite of the necessary conceptual remediation process. Furthermore, identification speed is a necessity for the individual. In order to ascertain the conception without undue delay, it is necessary to determine whether remediation is required. In some cases, the individual may opt to undergo the remediation process.

An accurate conceptualization is one that can link a concept with other concepts, as well as new concepts with existing concepts within the minds of learners between new and existing concepts in learners' minds, in alignment with experts' conceptions. In accordance with the conceptions of experts, the aforementioned relationships must be identified in order to ensure the correctness of one's conception and the rectification of misconceptions. It is possible to ensure that a person's conception is correct and that misconceptions are prevented from occurring in the first place.

From the aforementioned prepositions, a provisional conclusion can be drawn that in order to prevent misconceptions, it is essential to identify the underlying conceptions that individuals hold in order to facilitate self-monitoring and evaluation of their existing knowledge (or lack thereof) in this area. Furthermore, it is essential to evaluate the existing knowledge base and identify any gaps in understanding, which can then be incorporated into a comprehensive model for misconception prevention. A fundamental model of misconception prevention is presented herewith.

The objective of this study is twofold: firstly, to describe the conceptions held by students, prospective teachers and sample teachers; and secondly, the data will be described at the level of mastery of conceptions and the speed of acquisition of conceptions use the Conception Detection Application

METHOD

This research employs a mixed-methods approach, which entails the integration of both qualitative and quantitative methods. The selected combined model is the concurrent embedded strategy is a combination of qualitative and quantitative methods. One of the methods is the primary method, which is of greater significance. The secondary method will be integrated into the primary method.

This study employs a qualitative methodology as the primary method for data collection on cognitive processes. This is achieved through the mapping of students',. The data was processed in the form of a conceptual map, which was created based on the responses of students.

Secondary methods include: The quantitative method is employed to obtain data on the level of mastery of conceptions and the

rate of acquisition. At the data collection stage, both qualitative and quantitative methods are employed. The subsequent stages of the process are data analysis and data interpretation.

The testing phase was initiated following the completion of the development and validation processes for the application. The trial phase yielded a corpus of data in both qualitative and quantitative forms, which were used to assess the utilization of the application. These data were obtained from 24 student respondents.

Moreover, at the data analysis stage, a qualitative analysis was conducted on the conceptual process experienced by respondents when using the application. A quantitative analysis was also carried out on the measurement of conceptions held by respondents on each concept. This approach enabled the generation of results regarding student misconceptions, the level of student conception, and the speed of the application in identifying student misconceptions on chemical bonding material.

RESULT AND DISCUSSION

The research was conducted through the implementation of trials pertaining to the detection of misconceptions associated with the application of the chemical sub-materials, specifically chemical bonds. The Chemistry Conception Detection Application is an online application that was developed to detect conception with precision and speed.

This application is compatible with the Microsoft Windows 8/8.1, 10, and 11 operating systems. It can be accessed via the web browsers Google Chrome or Microsoft Edge. Prior to using the application, users must first register an account.

This application comprises a series of question packages that can be accessed by students. The question package is divided into a number of materials, including but not limited to ion bonds, metal bonds, covalent bonds, and coordination and polar covalent bonds, which are incorporated into one overarching material, namely chemical bonds. Each material is comprised of five questions, which are representative of the types of questions typically found in a five-tier diagnostic test. At the initial level, questions are posed that pertain to fundamental concepts. At the second and fourth levels, questions are presented that assess the level of confidence in the answer to the preceding question. At the third level, follow-up questions are posed regarding the concepts presented. Finally, at the fifth level, a question is posed that assesses the ability to identify conceptions based on an individual's chemical representation picture.

Figure 1 The Chemistry Conception Detection Application

Upon completion of the assessment, the resulting score will be immediately available, allowing for the prompt identification of any misconceptions. The earlier these are identified, the more rapidly they can be addressed through the implementation of appropriate remediation strategies. Remediation, defined as a systematic improvement process, aims to enhance understanding and mitigate conceptual errors in chemistry education. In this context, remediation seeks to rectify misconceptions by addressing the underlying causes of these misunderstandings. Effective remediation involves the assessment and analysis of students' prior knowledge, particularly identifying incorrect preconceptions, to prevent the persistence of misconceptions. Additionally, educators must possess the skills necessary to address these misconceptions by delivering more rigorous and engaging learning experiences, thereby facilitating the independent and direct construction of knowledge by students [6][9][10].

Each set of questions is designed to be completed in 10 minutes. At the end of the course, students are invited to complete a questionnaire designed to assess their perceptions of the efficacy of the chemical misconception detection applications. The questionnaire comprises a series of questions inviting respondents to share their impressions, suggestions and criticisms following their use

of the applications. Each respondent is invited to provide a brief response to each question.

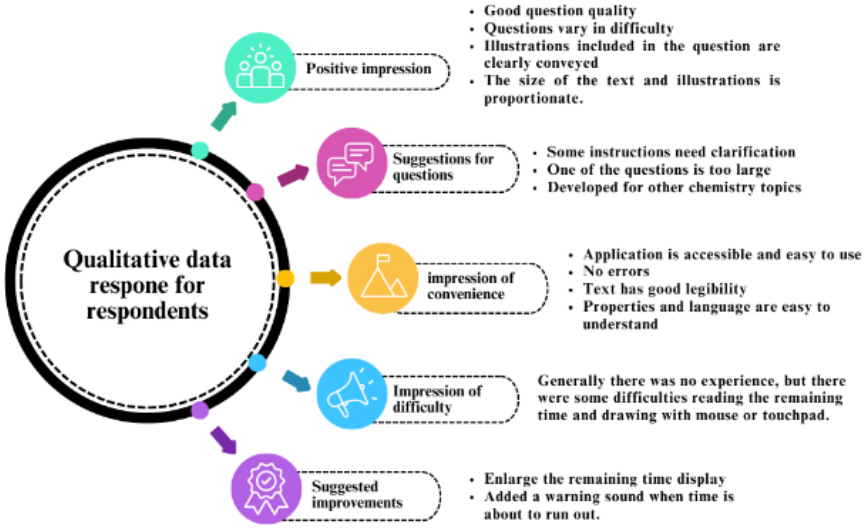

Figure 2 The Map of Qualitative Data Respon

The data obtained from the questionnaires is presented in the form of qualitative data, as illustrated in Figure 2. Respondents provided generally positive feedback after using the application to detect misconceptions in chemical bonding. They highlighted the good quality of the questions, noting a range of difficulty levels that helped enhance students' understanding. The illustrations were praised for offering clarity, and the text and illustrations were presented in a proportional size. However, some suggestions were made for improvement, such as clarifying certain instructions and resizing one of the larger questions. Additionally, respondents recommended developing the app for other chemistry topics. The application was found to be user-friendly, with no technical errors, and both the features and language supported comprehension. A few challenges were mentioned, particularly in reading the remaining time display and in drawing with a mouse or touchpad. To address these issues, respondents suggested enlarging the time display and adding a warning sound as the time runs out.

In light of evidence presented, it can be posited that the application has proven effective in swiftly and accurately discerning students' erroneous beliefs. The illustration of misconceptions through a five-tier diagnostic assessment is effectively conveyed by the application's design, which has been developed through modeling. This assertion is further substantiated by prior research indicating that application design can offer a more efficacious alternative to conventional methods, increasing practicality due to the incorporation of features that cannot be delivered by conventional methods [11].

The online platform facilitates the practicality of the application process. The accessibility of the platform at any given time allows for the prompt identification of misconceptions, which can then be addressed and rectified in a timely manner, thus preventing the further proliferation of these misconceptions [12]. The prevalence of misconceptions also presents a significant challenge to the objective of stabilizing students' understanding of the material, particularly in the context of this study, which focuses on chemical bonding [13].

The qualitative data obtained is also supported by quantitative data on student test results. The results demonstrate three stages of conceptualization among students: a lack of understanding, the presence of misconceptions, and an understanding of the concept. With this data, it will be possible to ascertain how the application can identify student conceptions. In this case, it is necessary to determine whether the student in question is exhibiting a lack of understanding, the presence of misconceptions, or an understanding of the concept.

The results of the analysis will then be presented, indicating whether the student in question has demonstrated any misunderstandings or misconceptions. The data can be found in Table 1.

Table 1 Diagnostic Test Result Data

Topic	Percentage (%)		
	Not Understanding Concept	Misconceptions	Understand Concept
Ionic Bonding	88.3	11.7	0.0
Metallic Bonding	87.5	9.2	3.3
Covaent Bonding	90.8	8.3	0.8
Covalent Coordination and Polar Bonding	86.7	12.5	0.8
Total	88.3	10.4	1.3

As evidenced in Table 1, the majority of students indicated a lack of comprehension regarding the concept under examination. Among the four topics pertaining to chemical bonds, the average level of understanding is 88.3%. Conceptual comprehension is crucial in the learning process, as a solid understanding of core concepts enables students to effectively store, assimilate, and recall the material. While memorization of chemical formulas and facts may aid in long-term retention, it does not guarantee a robust conceptual understanding. Students must grasp the fundamental elements of the content to construct coherent chemical concepts, which can significantly influence their interest in learning chemistry [14].

Students develop conceptual understanding through their learning experiences, which can be assessed by their ability to articulate the material in their own words. Those with a strong grasp of the concepts can convey the information without reliance on the textbook. It is essential for students to thoroughly understand basic concepts prior to tackling more complex topics; failure to do so can lead to perceptions of difficulty and hinder their learning progress. Therefore, conceptual understanding plays a vital role in shaping students' academic outcomes in chemistry [15].

The results of student misconceptions yielded an average percentage of 10.4%, with 1.3% of students demonstrating comprehension of the concept. Based on these findings, the chemical misconception detection application can be utilized to identify student misconceptions regarding chemical bonds. However, this study revealed that a greater number of students lacked understanding of the concept than exhibited misconceptions. This highlights a potential avenue for further research.

The results demonstrate that the application is capable of rapidly identifying students' conceptions, as evidenced by the immediate display of student work outcomes. Table 2 provides a comprehensive illustration of the specific conceptions exhibited by students.

Table 2 Details of Student Answer in Misconceptions

Topic	Percentage (%)				
	Question 1	Question 2	Question 3	Question 4	Question 5
Ionic Bonding	4.2	4.2	16.7	16.7	16.7
Metallic Bonding	8.3	8.3	12.5	8.3	8.3
Covaent Bonding	0.0	8.3	16.7	8.3	8.3
Covalent Coordination and Polar Bonding	8.3	4.2	20.8	8.3	20.8

The results indicate that a significant number of students hold erroneous beliefs regarding the sub-topic of coordination and polar covalent bonds. The chemical misconception detection application is capable of identifying the specific location of these

misconceptions with precision. Additionally, it provides a comprehensive and transparent representation of the erroneous responses pertaining to each topic and level.

It can be stated that the developed chemical conception detection application is an effective tool for identifying students' conceptions with accuracy and speed. This application can serve as an alternative for the early detection of conceptions that can be linked to more effective chemistry learning strategies. The implementation of appropriate remediation at the level of students' conceptions has been shown to have a positive correlation with students' understanding of chemistry topics.

CONCLUSIONS AND SUGGESTIONS

In accordance with the findings of the research project and the results of the data analysis, it can be concluded that:

1. The conception detection application employs a five-tier diagnostic test to ascertain whether a person has a fundamental understanding of a given concept. The test categorizes an individual's comprehension into three levels: lack of understanding, misconception, and comprehension.
2. The study revealed that 88.3% of respondents demonstrated a lack of understanding of the concept, 10.4% exhibited misconceptions, and only 1.3% exhibited comprehension. The identification of concept mastery is expedited by the application developed, which provides immediate feedback on the results of the test.

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