9 (2)(2024)70-75

International Journal of Active Learning

http://journal.unnes.ac.id/nju/index.php/ijh

Analysis of The Level of Understanding of Class X Students' Concepts on The Periodic Table of Elements Material Assisted by The Three-Tier Multiple Choice Test Instrument

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Keywords

Understanding, Concept, TTMCT, SPU, Rasch

Abstract

Chemistry is one of the subjects that is abstract and emphasizes concepts. This is often the cause of low levels of student understanding (misconceptions). Not only because of inappropriate learning methods or models, but less in-depth question instruments also increase students' misconceptions. This study was conducted with the aim of analyzing the level of conceptual understanding of grade X students on the Periodic System of Elements (SPU) material which is basic material before other complex chemical materials. Misconception analysis was carried out using Rasch analysis from the results of the Three-Tier Multiple Choice Test (TTMCT) instrument. The method used is a quantitative method and expert validation was carried out by eight experts. The study was conducted in 5 schools (public-private). The results of the study showed that students' conceptual understanding was low and several misconceptions were found.

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p-ISSN 2528-505X
e-ISSN 2615-6377

INTRODUCTION

Chemistry is one of the subjects that emphasizes concepts. The implementation of chemistry learning can be said to be good and effective if the teacher as an educator can find out the level of students' understanding of concepts as material for subsequent learning evaluation (Rahmawati et al., 2019). The evaluation of the level of student understanding is carried out to determine whether there are any misconceptions. Misconceptions and the level of student understanding are better done starting from basic material so that teachers can improve the quality of learning and prepare students' understanding of more complex material (Lahinda & Tuerah, 2022).

The level of students' understanding of basic chemistry material for class X can have a significant influence on the level of students' understanding of advanced chemistry material because there is relevance and connection between the two materials (Lahinda & Tuerah, 2022). Chemistry material for class X becomes introductory and introduction material and provides students with a more comprehensive and broader conceptual understanding of the scope of chemical science. Therefore, the level of students' understanding of chemistry material for class X greatly influences the level of students' understanding of chemistry material at higher grade levels (A'yun & Nuswowati, 2018).

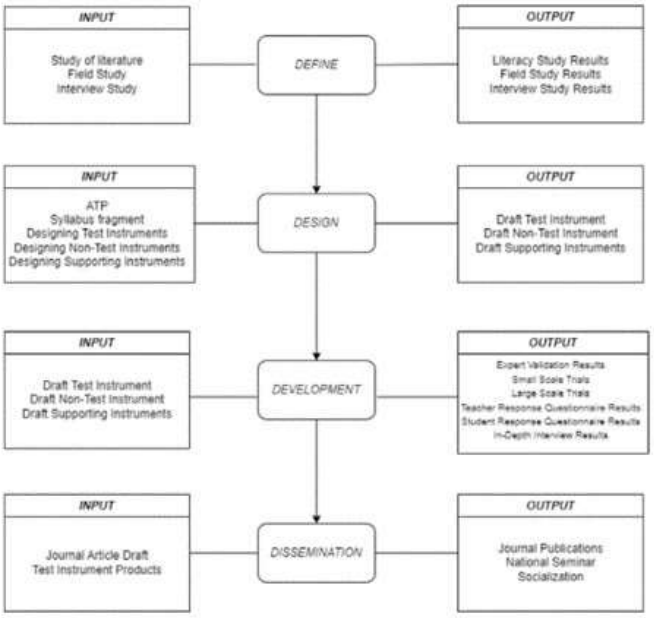
One of the basic chemistry materials for class X which is a basic concept in recognizing and understanding the characteristics and properties of elements is the Periodic Table of Elements. Analysis of students' level of understanding and minimizing student misconceptions on the Periodic Table of Elements material is very important, considering that a number of concepts in advanced chemistry materials are related to the diversity of elements (Djarwo, 2020). The Periodic Table of Elements can be a prerequisite material in some advanced chemistry materials, such as molecular shapes and chemical bonds. If the level of student understanding of the Periodic Table of Elements material is low or even not analyzed properly, it will cause ongoing student misconceptions.

The level of student understanding can be measured using a graded multiple choice test instrument (Okpatrioka Okpatrioka, 2023). The instrument can not only be an indication of the level of student understanding, but can also help teachers in identifying misconceptions in students. Data obtained from the results of the test instrument work by students can be analyzed and used as a reference for Action during learning in advanced chemistry material, so that student understanding can increase (Monita & Suharto, 2016).

This study aims to determine the level of understanding of class X students from 5 different schools, both public and private schools, with the help of the Three-Tier Multiple Choice Test instrument consisting of 25 questions. The Three-Tier Multiple Choice Test (TTMCT) instrument is a type of multiple-choice test instrument consisting of three levels (Alfa, 2023). The first level or layer consists of questions and answer choices like multiple choice questions in general (one-tier) (Antari & Sumarni, 2020). The second level or layer is the question items and answer choices which are the reasons for choosing that answer at the first level (Rustamana et al., 2024). The third level or layer contains questions about the level of student confidence in answering each question item. The third level or layer in TTMCT is also called the Certainty of Response Index (CRI). CRI consists of five categories that can be an indication of the level of student confidence (Siregar & Rosmaini, 2021). The five categories are just guessing (total guess the answer), more guessing (almost guest), not sure (not sure), sure (sure), almost certain without a doubt (almost certain), and very certain (certain) (Jusriana et al., 2022). This complexity makes the TTMCT instrument effective in measuring students' level of understanding (Kefi et al., 2021). The three levels in the TTMCT instrument produce data that can be an indication of the level of student understanding and the profile of student misconceptions regarding the concept of the Periodic Table of Elements (Lestari et al., 2021).

METHODS

The method used in this research is the Research and Development (R&D) method. R&D research is research used in developing and perfecting products that have been created or developed previously (Nurjannati et al., 2017). The approach used in this study is a quantitative approach that involves various processes such as making hypotheses, going directly to research and collecting data in the field, and conducting data analysis by paying attention to aspects of calculation, formulas, measurements, and data that are numerical in nature. The research design used is 4D (*Define, Design, Development,* dan *Disseminate*).



The data from the TTMCT instrument work were analyzed using Rasch modeling (Winstep). The features in the Rasch model in the Winstep software are divided into at least 3 parts, namely Item Analysis Feature, Person Analysis Feature, and Additional Analysis Feature (Susilawati, 2021). Item Analysis Feature consists of several parts, including item column fit order which is used to sort items based on statistical fit so that it can help in determining items that cannot function properly in the test instrument, item entry which is used to enter item data into the analysis, item alphabetical to sort items alphabetically, item displacement which is used to measure changes in item rankings from model to data, item correlation which is used to measure the correlation between item scores and total scores so that it can be used as an identification of inconsistent items, item responses which is used to display the responses given by each item, item outfit plot which is used to show a graph as a measure of inappropriate bias based on the difference in squares, item infit plot which is used to show a graph as a more sensitive measure of inappropriate responses based on student ability levels, and item subtotals which is used to provide subtotals of item groups for further analysis (Lestari et al., 2021). Rasch analysis in this study is not only to review and analyze the level of student understanding, but also the quality of the TTMCT instrument used in the study (Waruwu, 2024). Research data was obtained from the results of working on the TTMCT instrument through small-scale trials, large-scale trials, and implementation tests.

RESULTS AND DISCUSSION

Small Scale Trial

A small-scale trial was conducted to determine the level of feasibility and readability of the TTMCT instrument so that it can be used to measure what should be measured. The subjects of this small-scale trial consisted of 25 students. This stage requires expert validation, namely two chemistry lecturers and six high school chemistry teachers (two chemistry teachers from SMA Negeri 1 Cawas, one chemistry teacher from SMA Muhammadiyah 1 Klaten, one chemistry teacher from SMA Negeri 3 Semarang, one chemistry teacher from SMA Negeri 12 Semarang, and one chemistry teacher from SMA Karangturi Semarang.). The validation results showed very valid values and the developed TTMCT instrument could be used in data collection. The practicality of the instrument in the small-scale trial was reviewed through a student response questionnaire. The student response questionnaire obtained a result of 92% in the language aspect and 84% for the suitability of timeliness. Based on this, it can be said that the TTMCT instrument is practical. The results of the student response questionnaire also showed that 96% of students gained benefits and deeper understanding from the TTMCT instrument. Not only through questionnaires, the quality of the TTMCT instrument was analyzed using Rash modeling and obtained a Person Reliability value of 0.83, Item Reliability of 0.75, and Cronbach Alpha of 0.88 which shows that the TTMCT instrument is in the "Good" category.

Large Scale Trial

Large-scale trials were conducted to determine the effectiveness of the TTMCT instrument in detecting students' level of understanding of SPU material. Large-scale trials in development research are conducted on students with a larger quantity than small-scale trials. The subjects of the large-scale trial in this study were 75 students from students. The TTMCT instrument in the large-scale trial was analyzed using Rash modeling and obtained a Person Reliability value of 0.80, Item Reliability of 0.90, and Cronbach Alpha of 0.86 which showed that the TTMCT instrument was in the "Very Good" category. The validity analysis of the TTMCT instrument in the large-scale trial was carried out by considering Item Dimensionality and Item Fit Order. The output or result of this analysis is that it can be seen which items or questions can measure what should be measured in this study. Raw Variance Explained by Measures in this study based on the results of the large-scale trial is 32.8%. Unexplened Variance in 1st Contrast in the large-scale trial in this study has Eigenvalue and Observed which have values of 2.1 and 12.8% respectively. The Eigenvalue must be less than 3 to indicate that there are no problematic items and the Observed value must be less than 15% to indicate that each item developed is fit. Based on the Item Dimensionality data, it can be concluded that the developed TTMCT instrument can be used and there are no problematic items. The Item Fit Order analysis produces data that is in line with the Item Dimensionality analysis, that each item developed can be maintained and is fit. The analysis is continued with the analysis of the level of difficulty of the items. The results of the analysis and data processing show that 18 out of 25 items are in the moderate to very difficult category.

Implementation Test

Implementation Test was conducted with 150 students as subjects. The TTMCT instrument that has been developed and tested in the implementation scale trial has a good level of reliability with a Person Reliability value of 0.80, Item Reliability of 0.95, and Cronbach Alpha of 0.86. Based on the existing results, it can be said that the effectiveness of the TTMCT instrument for analyzing the level of student understanding is in the "Special" category. The validity analysis of the TTMCT instrument for the implementation scale trial was also carried out by considering Item Dimensionality and Item Fit Order. The output or result of this analysis is that it can be seen which items or questions can measure what should be measured in this study. Raw Variance Explained by Measures in this study based on the results of the implementation scale trial is 36.7%. Unexplened Variance in 1st Contrast in the implementation scale trial in this study has Eigenvalue and Observed which have values of 1.9 and 12% respectively. Based on the Item Dimensionality data, it can be concluded that the TTMCT instrument developed can be used and there are no problematic questions.

Student Understanding Level

The results of the analysis of a number of existing tests found seven profiles of student misconceptions. The criteria for students based on the misconception profile along with the percentages include students who understand the concept (PK) 22%, understand the concept less confident (PKKPD) 15%, understand the concept less (KPK) 5%, do not understand the concept (TPK) 34%, Positive misconception (M+) 13%, Negative misconception (M-) 16%, and Full misconception (MP) 20%. The data from the analysis shows that the level of student understanding is still low (smaller in percentage when compared to the percentage of misconceptions). Therefore, additional activities are needed, namely In-Depth Interviews to be able to find out the causes of student misconceptions in more depth.The results of the analysis of a number of existing tests found seven profiles of student misconceptions. The criteria for students based on the misconception profile along with the percentages include students who understand the concept (PK) 22%, understand the concept less confident (PKKPD) 15%, understand the concept less (KPK) 5%, do not understand the concept (TPK) 34%, Positive misconception (M+) 13%, Negative misconception (M-) 16%, and Full misconception (MP) 20%. The data from the analysis shows that the level of student understanding is still low (smaller in percentage when compared to the percentage of misconceptions). Therefore, additional activities are needed, namely In-Depth Interviews to be able to find out the causes of student misconceptions in more depth.

CONCLUSION

The level of students' conceptual understanding analyzed from the Three-Tier Multiple Choice Test Instrument data using the Rasch Model analysis shows that there are still many students with low levels of understanding. Students with a good level of understanding are only 37% of students (Understand the Concept and Understand the Concept Less Confident). The results of this analysis can be used by teachers as learning evaluation material in the next material.

ACKNOWLEDGEMENT

Gratitude is addressed to all parties involved in the research activities, including students, chemistry teachers, and principals of SMA Negeri 1 Cawas, SMA Muhammadiyah 1 Klaten, SMA Karangturi Semarang, SMA Negeri 3 Semarang, and SMA Negeri 12 Semarang.

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