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Marzano Taxonomy-Based Assessment Instrument to Measure Analytical and Creative Thinking Skills

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ABSTRAK

Penilaian merupakan salah satu aspek penting dalam proses pembelajaran. Penilaian yang didesain dengan baik akan dapat mengukur kemampuan siswa sesuai tujuan pembelajaran yang telah ditetapkan. Kemampuan berpikir analitis dan kreatif merupakan kemampuan esensial yang harus dikuasai oleh siswa. Instrumen tes yang digunakan oleh guru dalam penilaian hasil belajar siswa pada pembelajaran jarak jauh masih mengukur kemampuan berpikir rendah Tujuan penelitian ini yaitu mengembangkan instrumen penilaian berbasis Taksonomi Marzano untuk mengukur kemampuan berpikir analitis dan kreatif. Penelitian ini merupakan penelitian pengembangan. Model yang digunakan adalah 4D sampai tahap development. Instrumen yang telah didesain kemudian divalidasi oleh 3 pakar dan dinyatakan valid. Instrumen kemudian diuji cobakan kepada 450 siswa kelas XI. Data hasil ujicoba kemudian dianalisis menggunakan SPSS. Berdasarkan hasil analisi data diketahui bahwa 17 butir soal yang dikembangkan valid, reliabel, memiliki tingkat kesukaran dan daya pembeda yang memadai. Instrumen penilaian ini dapat membantu guru mengukur kemampuan berpikir analitis dan kreatif dibarengi dengan proses pembelajaran di kelas menggunakan metode pembelajaran yang merangsang siswa berpikir tingkat tinggi.

ABSTRACT

Assessment is one of the essential aspects of the learning process. A well-designed assessment will be able to measure students' abilities according to the learning objectives that have been set. The ability to think analytically and creatively is essential for students to master. The test instrument used by teachers in assessing student learning outcomes in distance learning still measures low thinking skills. This study aims to develop an assessment instrument based on Marzano's Taxonomy to measure analytical and creative thinking skills. This research is development research. The model used is 4D until the development stage. The designed instrument was then validated by three experts and declared valid. The instrument was then tested on 450 students of class XI. The experimental data were then analyzed using SPSS. Based on the results of data analysis, it is known that the 17 items developed are valid, reliable, and have an adequate level of difficulty and distinguishing power. This assessment instrument can help teachers measure the ability to think analytically and creatively coupled with the learning process in the classroom using learning methods that stimulate students to think at higher levels.

1. INTRODUCTION

Distance Learning is a learning method that has existed for a long time in Indonesia. Distance Learning is not well known by the wider community. Only a few level education providers implement it (Prawiyogi et al., 2020; Prehanto et al., 2021). Distance Learning is a learning process in which students are separated from the teacher and learn using various learning resources online (Robandi & Mudjiran, 2020; Saifulloh & Darwis, 2020; Shodiq & Zainiyati, 2020). The Covid-19 pandemic has changed the implementation of education in Indonesia. Through the Circular of the Ministry of Education and Culture Number 04 of 2020, the government has established a policy that during the handling of Covid 19, education is held from home or known as Learning From Home (Maulana & Hamidi, 2020; Shodiq & Zainiyati, 2020; Yulia, 2020). They are organizing Learning From Home using the Distance Learning

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method. Distance Learning is quite effective during the Covid-19 pandemic (Abidin et al., 2020; Dhawan, 2020). The distance learning process changes theory learning from face-to-face directly outside the network to online learning within the network (Nunez & Leeuwner, 2020; Ramachandran & Rodriguez, 2020). Online learning is a challenge for educators and students. Changes in the learning system that are carried out suddenly and quickly make preparations for implementing online learning not optimal (Dewantara & Nurgiansah, 2020; Djamdjuri et al., 2020). In addition, there are many obstacles experienced when implementing online learning, including students having difficulty following the learning process, incomplete material being delivered, learning management, assessment, and supervision (Napitupulu, 2020; Putria et al., 2020; Rigianti, 2020). Even though it is done online, learning must still pay attention to aspects of the implementation of learning. Implementation of learning includes planning, implementation, and assessment of student learning outcomes that are interrelated (Alghafri & Ismail, 2014; Setiawan & Aden, 2020). Implementing learning without planning will result in ambiguous learning, while the implementation of learning without an assessment of learning outcomes will be in vain (Rahayu et al., 2020; Vlachopoulos, 2020). Assessment of student learning outcomes is very important to determine the effectiveness of the learning process in the classroom. Assessment can determine the curriculum, weaknesses, and strengths of learning methods and know the effectiveness of the learning strategies used (Kusaeri & Suprananto, 2012). Today, there is a change in the assessment paradigm. Offline assessment turns into online assessment (Hartati & Zulminiati, 2020; Sudirman et al., 2020). In addition, the assessment was carried out only to determine the level of understanding of students' concepts after participating in the learning process. Now the focus of the assessment shifts to determine the level of thinking and application of the knowledge that has been learned (Irawana & Taufina, 2020; Utami & Wardani, 2020). Assessment should be used to measure students' thinking level and ability to analyze and solve problems in life, not just to measure students' memorization and counting ability (Astiwi et al., 2020; Hidayat & Andriani, 2020; Lestari et al., 2020). Students as agents of change are requito understand concepts and play a role in solving problems by demonstrating higher-order thinking skills.

Based on the results of observations and interviews with several high school teachers in Semarang City, the test instrument used by teachers in assessing student learning outcomes in distance learning still measures low thinking skills. Students only receive information or knowledge passively and then remember it during exams or tests. The test used by the teacher is generally a multiple-choice test, so students thinking processes in answering test questions have not been measured properly. Multiple-choice tests are less precise in measuring high-level abilities because students only choose one of the alternative answers presented in multiple-choice, so analytical and creative thinking skills cannot be measured properly. A suitable test used to measure higher order thinking skills in the form of a description test because, with the description test, the teacher can measure students' analytical skills in answering questions so that students' ability to represent the results of the answers can be measured (Amalia & Susilaningsih, 2014; Juditya et al., 2020). Higher order thinking skills can be measured using the Marzano taxonomy developed by Marzano & Kendall. A new taxonomic model combines cognitive, metacognitive, and self-system aspects that influence how students think (Marzano & Kendall, 2007). These three aspects are interrelated in determining student success in the learning process. Cognitive aspects are the basic aspects of students' understanding levels (Pratiwi & Ismaniati, 2017; Ratna & Utami, 2018). The cognitive system has four levels: retrieval, comprehension, analysis, and knowledge utilization. The four levels in the cognitive system can be used to measure higher order thinking skills (Saraswati & Agustika, 2020; Sugianti et al., 2018). Based on the problems that have been described, researchers will conduct research to develop an assessment instrument based on Marzano's Taxonomy to measure analytical and creative thinking skills.

Analytical thinking is the ability of students to think about describing, detailing, and analyzing the information used to understand the relationship from all aspects by using reason and a logical mind (Chonkaew et al., 2016; Sitthipon, 2012). Analytical thinking is the ability of students to think about describing, detailing, and analyzing the information used to understand the relationship from all aspects by using reason and a logical mind (Chonkaew et al., 2016; Sitthipon, 2012). In chemistry learning, improving students' ability to analyze, criticize, assess, compare, and evaluate must be discussed to improve analytical thinking skills. Creative thinking is the ability to create new ideas and generate new and original thinking experiences as new patterns in solving problems. Students are expected to develop creative thinking skills to keep pace with the fast global changes (Prawitaningrum & Endarini, 2019; Ritter et al., 2020; Suparmi, 2018). The creative thinking domain has three important aspects to focus on: First, generating various ideas: and focusing on students' ability to think flexibly across domains. Second, Generating creative ideas: focuses on students' ability to search for appropriate and original ideas across different domains. Third, Evaluating and improving ideas: focuses on students' ability to evaluate the

shortcomings of the given ideas and find ways to improve them. The findings of previous research also stated that students need the ability to think analytically to understand learning materials (Chonkaew et al., 2016; Irwanto et al., 2017; Sitthipon, 2012). Other research findings also state that creative thinking skills are also needed by students in learning (Al-Idrus et al., 2021; Prawitaningrum & Endarini, 2019; Suparmi, 2018). Other studies also state that research instruments are needed to assess students' abilities (Imania & Bariah, 2019; Sukmasari & Rosana, 2017; Tiara & Sari, 2019). There is no study on the Marzono taxonomy-based assessment instrument to measure analytical and creative thinking skills. This study aims to develop an assessment instrument based on Marzono's taxonomy to measure analytical and creative thinking skills. It is hoped that this instrument can help teachers in assessing students.

2. METHODS

This research is development research using the 4D by Tiagarajan method until the development stage. This stage includes define, design, develop, and disseminate. The assessment instrument that has been prepared is then tested for validation on three lecturers to determine the validity of the content 3. The indicators for validating the assessment instrument developed to include the depth of the material, the construction of questions, and the use of language, pictures, and tables. The assessment instrument was tested on 450 eleventh grade students of SMA N and MAN in the city of Semarang. Research subjects were determined using the purposive sampling technique. Before testing the questions on students, learning about the teacher's reaction rate material has implemented a learning model that stimulates students to develop analytical and creative thinking skills. The data from the student trials were then analyzed statistically using SPSS. This test was conducted to determine the construct validity, reliability, level of difficulty, and differentiating power of analytical and creative thinking assessment instruments based on Marzano's Taxonomy.

3. RESULTS AND DICCUSSION

Results

The define stage produces initial data as an analysis of product development needs. This stage includes five things, namely: preliminary and final analysis is carried out to determine the assessment process carried out by the teacher, student characteristics analysis aims to determine students' abilities and tendencies in working on questions, and the objective instructional analysis aims to synchronize learning objectives to develop instruments, task analysis is carried out to identify indicators of Marzano's Taxonomy, analytical thinking, and creative thinking that students and concept analysis will achieve aims to determine the material to be used in research. Based on the analysis stages, it was obtained data that the assessment instruments that teachers had used had not measured higher order thinking skills. Teachers tend to use multiple-choice questions and short essays. The material reaction rate will be developed based on the assessment instrument's concept analysis. The next stage is to design the assessment instrument used in the research. This stage includes an analysis of the 2013 curriculum to determine core competencies, basic competencies, and material indicators of reaction rates to prepare questions. Next is to describe the indicators of Marzano's Taxonomy, analytical thinking, and creative thinking, which were developed into a grid of questions and scoring rubrics. The scoring rubric in this study consisted of two types, namely, the scoring rubric for analytical and creative thinking skills. The instrument developed consists of 29 questions containing analytical, creative thinking skills indicators and aspects of Marzano's Taxonomy, presented in Table 1.

Table 1. Indicators of analytical, creative thinking skills and aspects of Marzanos Taxonomy

Question Number	Analytical Thinking Ability Indicator	Indicator of Creative Thinking Ability	Aspects of Marzano's Taxonomy
1	Organize	*Fluency*	Comprehension: Integrating
2	Organize	*Fluency*	Comprehension: Integrating
3	Organize	*Fluency*	Comprehension: Integrating
4	Organize	*Fluency*	Analysis: Generalizing
5	Conclude	*Elaboration*	Analysis: Specifying
6	Conclude	*Elaboration*	Analysis: Generalizing
7	Conclude	*Elaboration*	Knowledge Utilization: Problem Solving
8	Conclude	*Fluency*	Knowledge Utilization: Decision Making
9	Conclude	*Elaboration*	Comprehension: Integrating

Question Number	Analytical Thinking Ability Indicator	Indicator of Creative Thinking Ability	Aspects of Marzano's Taxonomy
10	Attribute	*Fluency*	Analysis: Generalizing
11	Conclude	*Originality*	Comprehension: Integrating
12	Organize	*Elaboration*	Analysis: Classifying
13	Organize	*Elaboration*	Knowledge Utilization: Problem Solving
14	Organize	*Elaboration*	Knowledge Utilization: Problem Solving
15	Differentiate	*Flexibility*	Knowledge Utilization: Investigating
16	Attribute	*Elaboration*	Comprehension: Integrating
17	Organize	*Fluency*	Analysis: Generalizing
18	Conclude	*Elaboration*	Knowledge Utilization: Experimenting
19	Organize	*Elaboration*	Comprehension: Integrating
20	Conclude	*Fluency*	Analysis: Generalizing
21	Conclude	*Elaboration*	Comprehension: Integrating
22	Organize	*Fluency*	Analysis: Specifying
23	Organize	*Fluency*	Knowledge Utilization: Experimenting
24	Conclude	*Elaboration*	Analysis: Generalizing
25	Organize	*Elaboration*	Analysis: Specifying
26	Conclude	*Flexibility*	Analysis: Generalizing
27	Organize	*Originality*	Knowledge Utilization: Experimenting
28	Conclude	*Elaboration*	Knowledge Utilization: Decision Making
29	Organize	*Elaboration*	Knowledge Utilization: Investigating

The design stage resulted in an initial draft of an instrument measuring analytical and creative thinking skills for reaction rate materials based on Marzano's Taxonomy, as shown in Table 2.

Table 2. Examples of the developed questions

Question Formula	Aspects of Marzano's Taxonomy	Analytical Thinking Indicator	Creative Thinking Indicator
Presented a problem, students can explain the factors that affect the reaction rate related to the surface area.	Analysis: Generalizing	Organize	*Fluency*
Porridge Sum-Sum is a traditional food served with liquid brown sugar. A Sum-Sum porridge trader was ready to go to sell, but apparently, he forgot to make liquid brown sugar. The trader had to melt 1 kg of brown sugar, but the merchant didn't have much time so he could sell on time. Explain how to melt sugar quickly. Relate your answer to the concept of the rate factor for the reaction.			

The development stage aims to obtain data from expert validation, reliability data, level of difficulty, and discriminating power of questions. Each stage can be explained as follows—the validity of the questions in terms of content validity and construct validity. Content validity assessed by experts aims to prove the indicators' suitability and the concept's correctness. Experts in this study are one material expert and two learning evaluation experts. Material experts are chemistry lecturers, while learning evaluation experts are chemistry education lecturers and research and educational evaluation lecturers. The results of expert judgment were then analyzed using V-Aiken's. The results of the agreement of 3 experts are known that the average Aiken's Index for the items developed is 0.97, with the smallest index of 0.85 and the largest index of 1. The index obtained is greater than 0.8 in the high category. Based on the analysis results, it can be concluded that the experts agree that the questions developed in the test instrument are appropriate. Meanwhile, the results of expert agreement regarding the correctness of the reaction rate concept developed in the test instrument obtained an average index of 0.97, with the smallest index of 0.85 and the largest index of 1. The index obtained was greater than 0.8 in the high category. The analysis results show that the expert agrees that the concept of reaction rate developed in the test instrument is correct or appropriate. The validity of the content of an assessment instrument can be viewed from the suitability and accuracy of the competencies that students must master. Based on the results of the expert agreement in Table 3, it can be concluded that the contents of the test instrument, both aspects of conformity between indicators and the truth of the concept, obtained an Aiken index

greater than 0.8. The index results show that the content validity of the test instrument is in the high category. Valid assessment instruments can measure certain learning objectives according to basic competency indicators. There are several suggestions and input from experts aimed at improving product quality. Empirical or construct validity was analyzed to determine the accuracy of the measuring instrument in measuring the level of psychological intelligence and the characteristics of the test instrument. Construct validation was carried out by analyzing the test scores of 450 students using the SPSS test. The test results from 29 items obtained 17 valid items. The statement instrument is valid if the r-count value is greater than the r-table and the significance value is less than 0.05. r-count for sample 450 is 0.098.

Based on the results of data analysis, 29 items developed obtained 17 valid items. The assessment instrument meets the criteria for measuring higher order thinking skills if the instrument is valid. It is important to calculate the reliability of the assessment instrument to determine the level of consistency of the questions when tested at different times. The reliability of the developed instrument was obtained by analyzing the test scores of 450 students using the SPSS test. Based on the results of data analysis, the questions developed were declared reliable because the Cronbach's Alpha value was more than 0.600. Cronbach's Alpha implies that the instrument has a good level of consistency and reliability when used for surveys. Analysis of the level of difficulty of the items is carried out to determine whether the items have the specified criteria. Statistical analysis was used to calculate the level of difficulty of the questions based on the level of the questions. The category of difficulty levels used includes the types of easy, medium, and difficult questions. Discriminatory analysis was conducted to determine whether the items were able to measure students' ability to understand concepts or not. The differentiating power levels are very good, good, fair, bad, and very bad. The statistical analysis results are used to calculate the discriminatory power of questions based on the level of the questions. Based on the results of data analysis, it is known that 17 items are in a good category to be used for further research. Items that have not been included in the good category can be revised to be used for testing.

Discussion

Items that have adequate discriminatory power indicate that the items have good quality and can be used to distinguish students with high abilities and students with low abilities (Rofiah et al., 2013). Based on the results of data analysis on validity, reliability, level of difficulty, and discriminating power, it was obtained data that 17 of the 29 items developed met the criteria of validity, reliability, level of difficulty, and adequate distinguishing power. So it can be concluded that the 17 items meet the criteria for a good assessment instrument. An assessment instrument that is valid, reliable, and categorized as a good test will be effectively and efficiently used to measure thinking skills (Astiwi et al., 2020; Diawati et al., 2017; Irwanto et al., 2017). All items developed are included in the difficult category. This is because the purpose of developing this assessment instrument is to measure higher-order thinking skills, namely the ability to think analytically and creatively, so the questions must be included in the category of higher-order thinking abilities. Based on the analysis results, it is known that the 17 questions developed to meet the criteria for questions that are suitable for use, namely valid, reliable, and have a good level of difficulty and discrimination.

The instrument for assessing higher order thinking skills is very important for teachers (Kuantum et al., 2018; Kurnia et al., 2022; Toledo & Dubas, 2016). The instrument developed is suitable for use by the teacher because all questions are valid. The developed instrument can also assess the ability to think analytically, creatively, and collaborate to solve these problems. Higher level thinking skills are important for students to master to analyze, evaluate and solve problems in everyday life (Magelo et al., 2019; Pratama & Retnawati, 2018). Higher order thinking skills can be seen in the ability of students to think analytically and think creatively when solving problems. Higher-order thinking skills include thinking analytically, evaluating, creating, and thinking creatively, which are very important to be developed in the 21st century (Laura, 2021; Petrovska & Veselinovska, 2013). In addition, the developed instrument is also reliable. A reliable assessment instrument can measure thinking skills such as critical thinking and chemical literacy (Candra et al., 2018; Sadhu & Wijayanti, 2018). The assessment instrument is declared a good quality instrument if its validity and reliability are high. This is in line with the results of Liliasari's research, where the reliability value of the questions developed is 0.899 and is declared reliable (Diawati et al., 2017). A reliable assessment instrument can measure thinking skills such as critical thinking and chemical literacy (Sadhu & Wijayanti, 2018). The development of this instrument also contains four indicators, namely 1) interpreting information and ideas, 2) identifying similarities and differences in the reality of the information presented, 3) developing hypotheses, and 4) describing sentence relationships or parts of a concept to make decisions. It makes the developed instrument feasible to use. Previous research also states that a valid instrument is suitable for learning (Nugraha, 2016; Umami et al., 2021).

Other research findings also state that the instrument can assess students' abilities if it is reliable (Dessiane & Kristin, 2021; Khaerunnnisa & Pamungkas, 2018). It was concluded that the teacher could use the instrument if it were valid and reliable. This research implies that the instrument developed in the form of an assessment instrument based on Marzano's taxonomy can be used by teachers to measure analytical and creative thinking skills. Further research is needed to determine the effectiveness of the Marzano Taxonomy-based assessment instrument, which was developed to measure analytical and creative thinking skills.

4. CONCLUSION

Based on the analysis results, it is known that the 17 questions developed to meet the criteria for questions that are suitable for use, namely valid, reliable, and have a good level of difficulty and discrimination. Items that meet the criteria will measure the ability to think analytically and creatively. This assessment instrument can help teachers measure the ability to think analytically and creatively coupled with the learning process in the classroom using learning methods that stimulate students to think at higher levels.

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