

DIAGNOSTIC ASSESSMENT BASED ON QUIZIZZ ON THE TOPIC OF ENVIRONMENTAL CHANGE

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ABSTRACT

Diagnostic assessments are divided into non-cognitive and cognitive. Cognitive diagnostic assessment is important to know how to analyze the basic abilities of students in the topic of a subject and in order to serve as a reference for teachers in designing learning according to the needs of students. The purpose of the research is to facilitate teachers in designing learning that is aligned with the needs of students, especially on the material of environmental change. The method used in this study is research and development using the ADDIE approach. The development of interactive web-based cognitive diagnostic assessment instruments such as Quizizz on class X environmental change material is effective based on the results of validity (34/35 valid questions), reliability (0,884) and expert testing (86%; very feasible). This cognitive diagnostic assessment test can be developed within a certain period of time to be able to adjust to the needs of students periodically.

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Introduction

Assessment and learning should not be separated. The learning process achieves competence when both teachers and students reach the intended competencies. One type of assessment is diagnostic assessment, which serves to diagnose the cognitive, psychomotor, and affective aspects of students. Diagnostic assessment consists of cognitive and non-cognitive components. The purpose of cognitive diagnostic assessment is to determine students' initial understanding of specific subject matter and to serve as a reference for teachers to adjust learning based on students' needs (Sugianto et al., 2023; Zhang & Li, 2019). Cognitive diagnostic assessment plays a role in informing learning, providing feedback, and guiding improvements for future instruction by teachers (Min & He, 2022; Chen et al., 2017). Cognitive diagnostic assessment is conducted periodically, specifically at the beginning of a new learning topic, at the end after the teacher has completed a topic, and at various intervals throughout the semester. Diagnostic assessment can encompass one or more subjects.

The development of cognitive diagnostic assessment has been widely implemented, one of which follows the ADDIE approach (Branch, 2009). Robert Maribe Branch, a co-author of ADDIE, emphasizes student-centered learning and project management. The ADDIE system design approach consists of input, process, and output. Input involves analysis, the process includes development and evaluation, and the output occurs during the implementation stage. Activities such as guiding, setting methods and procedures, developing strategies, goal orientation, being active, and using various approaches are part of the learning design process (Mesra et al., 2023; Nugroho & Wicaksono, 2022). The general paradigm of instructional design is described by Analysis, Design, Development, Implementation, and Evaluation (ADDIE) (Setyosari & Sugianto, 2020). Branch states that during the design stage, learning objectives, content, assessment tools, learning design, and media need to be prioritized (Masyithah & Pathoni, 2017; Syahputra et al., 2019).

Samatowa (2015) and Rezaei et al. (2013) argue that to help students solve everyday problems based on science concepts and to foster scientific attitudes, biology learning must be conducted in an engaging and interactive manner. In this study, the Quizizz application serves as an example of interactive learning media with the Strike & Defense feature, allowing students to earn points from their peers while protecting their own points. This makes the Quizizz features used in this research more interactive, stimulating visual, verbal, and competitive components (Erawati & Widiana, 2023). The development of Quizizz functions assists teachers in assessing classroom learning (Wijayanti, 2021). The Quizizz application helps students achieve learning objectives by fostering a more active atmosphere (Erawati & Widiana, 2023). Previous research by Juniarthi et al. (2023) demonstrated that using Quizizz with the Lesson Study method significantly improved students' biology learning outcomes. The application of Quizizz in biotechnology material for tenth-grade high school students showed higher cognitive learning outcomes compared to written tests (Nurlatifah et al., 2024). Based on the above descriptions, the use of Quizizz media is considered a viable alternative for developing assessments, including the cognitive diagnostic assessment to be tested. The aim of this research is to develop evaluation media and improve the learning process conducted periodically to achieve better quality and learning outcomes. Thus, the development of cognitive diagnostic assessments facilitates teachers in designing learning that aligns with students' needs.

Method

The research was conducted at Yuppentek 1 High School in Tangerang in April 2024. The target of the study was tenth-grade students, totaling 76 participants. Samples from each class were taken, with 20 students selected using simple random sampling. The test instrument consisted of 35 items that had been validated by experts. The research method used was Research and Development (RnD) with the ADDIE approach, which consists of five stages: analysis, design, development, implementation, and evaluation.

The development of the instrument was followed by a feasibility test, where the score obtained was divided by the maximum score and then multiplied by one hundred percent, based on the formula by Arikunto (2020). The scores used in the feasibility test were obtained from experts who provided their assessments. The percentage of scores obtained for the instrument was then interpreted according to the score feasibility criteria set by Riduwan (2015), which are: a range of 0% to 20% = Not Valid; about 21% to 40% = Less Valid; a range of 41% to 60% = Moderately Valid; a range of 61% to 80% = Valid; and about 81% to 100% = Highly Valid.

The validity of the test items was examined using SPSS version 25 by calculating the r calculated value, where if r calculated exceeds the r table value, the test item is considered valid (Slamet & Wahyuningsih, 2022). The reliability of the test items was assessed using SPSS version 25 with Cronbach's Alpha, where the instrument is considered reliable if the Cronbach's Alpha value is greater than 0.70. Subsequently, the difficulty level test was calculated using formula (2) with the assistance of Google Spreadsheets.

$$\text{Proposition} = (\text{Number of samples answering correctly} / \text{Total number of samples}) \quad (2)$$

The results of the Proposition (P) calculation are interpreted using the score interpretation criteria by Bagiyono (2017), which are: 1 = Very Easy; $(0,7 < P < 1)$ = Easy; $(0,3 < P \leq 0,7)$ = Moderate; $(0 < P \leq 0,3)$ = Difficult; and 0 = Very Difficult. Subsequently, the discriminative power test is calculated using formula (3) with the assistance of Google Spreadsheets.

$$\text{Discrimination} = (\text{Difficulty level of the upper group} - \text{Difficulty level of the lower group}) \quad (3)$$

The results of the Discrimination (D) calculation are interpreted using the score interpretation criteria by Bagiyono (2017), which are: $(0,7 < D \leq 1)$ = Very High; $(0,4 < D \leq 0,7)$ = High; $(0,2 < D \leq 0,4)$ = Moderate; $(0 < D \leq 0,2)$ = Low; and $(D \leq 0)$ = Very Low.

Result and Discussion Analysis

The assessment analysis was conducted by tracking the characteristics of students to develop cognitive diagnostic assessment instruments. In addition to the characteristics of students, it is also important to analyze the learning modules. Based on the analysis of the teaching module, it was found that at SMA X, teachers still use Google Forms to conduct cognitive diagnostic assessments, which requires more time to review students' answers individually. Therefore, the researcher intends to develop this cognitive diagnostic assessment instrument through an interactive website such as Quizizz.

Development

At this stage, the researcher created a cognitive diagnostic assessment consisting of 35 multiple-choice questions. The item specifications for the research instrument are presented in Table 1, which includes learning achievements, learning objectives, cognitive process dimensions, and question numbers.

Learning Outcomes	Learning Objectives	Dimensions of Cognitive Processes	Question Number
At the end of phase E, students are expected to be responsive to global issues and actively participate in problem-solving. These abilities include observing, questioning and predicting, planning and conducting research, processing and analyzing data and information, evaluating and reflecting, as well as communicating in the form of simple projects or visual simulations using available technology applications related to alternative energy, global warming, environmental changes, nanotechnology, biotechnology, chemistry in everyday life, waste and natural resource utilization, and pandemics caused by viral infections. All these efforts are directed towards achieving sustainable development goals (SDGs). Through process skills, a scientific attitude and the Pancasila student profile are also developed	Understand the concept of environmental degradation.	C1, C2	1, 2, 23, 28, 32
	Differentiate between types of environmental changes, including changes in water, soil, air, and noise.	C2	7, 13, 14, 19, 20, 24, 25, 29, 30, 31
	Identify facts about environmental changes as a result of global warming	C3	18, 33, 35
	Analyze environmental changes as a result of global warming	C4	6, 12, 21
	Identify human activities that cause environmental changes as a result of global warming	C3	5, 8, 9, 10, 11
	Analyze efforts needed to maintain environmental balance.	C4	3, 4, 16, 22, 26, 34
	Create solutions to address environmental changes as a result of global warming	C3	15, 17, 27

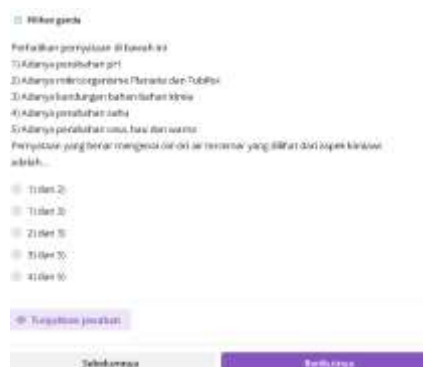


Figure 3. Question Number 7



Figure 4. Question Number 32

The instrument's feasibility test was then conducted with experts, specifically Biology Education lecturers at STKIP Arrahmaniyah, regarding the topic of environmental changes. Below is Table 2, which presents the results of the feasibility test by the experts, namely the Biology Education lecturers at STKIP Arrahmaniyah.

Aspect	Indicator	Result	Percentages
Language Aspect	Accuracy of sentence structure	4	87%
	Effectiveness of sentences	4	
	Use of appropriate Indonesian language rules	5	
Material aspect	Alignment of questions with learning objectives	5	85%
	Consistency of question items with answers	4	
	Clear formulation of the main question	4	
	Homogeneous and logical answer choices	4	
Konstruction aspect	Constructive and meaningful	5	90%
	Context relevant to the real world (realistic)	4	
Another aspect	Clarity of instructions on the instrument display	4	80%
Average			86%

A score of 86% was obtained, indicating that the developed instrument is considered very feasible. After conducting the expert feasibility test, data collection from the samples was followed by validity and reliability testing using SPSS version 25. The validity results for each item of the instrument were obtained using SPSS version 25, as shown in Table 3.

Table 3. Results of the Validity of the Diagnostic Cognitive Assessment Instrument

Question Number	r calculated	r table	Result	Question Number	r calculated	r table	Result
1	0,666	0,3120	Valid	21	0,566	0,3120	Valid
2	0,450	0,3120	Valid	22	0,450	0,3120	Valid
3	0,666	0,3120	Valid	23	0,257	0,3120	Tidak Valid
4	0,436	0,3120	Valid	24	0,487	0,3120	Valid
5	0,601	0,3120	Valid	25	0,558	0,3120	Valid
6	0,521	0,3120	Valid	26	0,340	0,3120	Valid
7	0,630	0,3120	Valid	27	0,487	0,3120	Valid
8	0,511	0,3120	Valid	28	0,511	0,3120	Valid
9	0,643	0,3120	Valid	29	0,462	0,3120	Valid
10	0,499	0,3120	Valid	30	0,357	0,3120	Valid
11	0,548	0,3120	Valid	31	0,505	0,3120	Valid
12	0,518	0,3120	Valid	32	0,427	0,3120	Valid
13	0,500	0,3120	Valid	33	0,536	0,3120	Valid
14	0,370	0,3120	Valid	34	0,456	0,3120	Valid
15	0,506	0,3120	Valid	35	0,546	0,3120	Valid
16	0,524	0,3120	Valid				
17	0,554	0,3120	Valid				
18	0,433	0,3120	Valid				
19	0,501	0,3120	Valid				
20	0,536	0,3120	Valid				

Based on the results from Table 1, it can be concluded that out of 34 items, there is 1 item that is not valid, which is item number 23. This is due to the fact that for item number 23, (r calculated $<$ r table) with ($0.257 < 0.3120$). Therefore, a total of 34 valid questions were obtained. The next test conducted was the reliability test, with results presented in Table 4.

Table 4. Results of Reliability Test

<i>Spearman Brown</i>	Total Questions
0,884	34

Based on Table 4, the reliability calculation using SPSS version 25 with the Spearman-Brown formula shows a value of 0.884. It can be concluded that all 34 items created are considered reliable and dependable.

After the reliability test, the next step was to measure the difficulty level, with results presented in Table 5. The difficulty test results indicate that 21% of the questions are categorized as difficult, 65% as moderate, and 15% as easy. This is due to the higher number of educators who were able to answer questions 2, 5, 6, 7, 9, 10, 11, 12, 13, 14, 15, 16, 17, 20, 21, 22, 24, 26, 27, 28, 31, and 35 compared to those categorized as easy or difficult.

Table 5. Results of Difficulty Level Test

No	Questions Criteria	Question Number	Total Questions	Percentage
1	Sangat Sukar	-	0	0%
2	Sukar	3, 8, 18, 30, 32, 33, 34 2, 5, 6, 7, 9, 10, 11, 12, 13,	7	21%
3	Sedang	14, 15, 16, 17, 20, 21, 22, 24, 26, 27, 28, 31, 35	22	65%
4	Mudah	1, 4, 19, 25, 29	5	15%
5	Sangat Mudah	-	0	0%

The difficulty level test was followed by measuring the discriminative power of each question. The results of the discriminative power for each item of the instrument are presented in Table 6. The discriminative power test results indicate that 12% of the questions have moderate discriminative power, while 88% have high discriminative power.

Table 6. Results of Discrimination Test

No	Questions Criteria	Question Number	Total Questions	Percentage
1	Rendah Sekali	-	0	0%
2	Rendah	-	0	0%
3	Sedang	25, 28, 29, 34, 1, 2, 3, 4, 5, 6, 7, 8, 9, 10,	4	12%
4	4 Tinggi	11, 12, 14, 15, 16, 17, 18, 19, 20, 21, 22, 24, 26, 27, 30, 31, 32, 33	28	88%
5	Tinggi Sekali	-	0	0

Next, the items that passed the validity and reliability tests were trialed with respondents. Table 7 shows the results of the respondents' pre-test scores. This pre-test was conducted at the beginning of the learning process.

Table 7. Results of Respondents' Pre-test Scores

Respondent Number	Pre-test Score	Respondent Number	Pre-test Score	Respondent Number	Pre-test Score	Respondent Number	Pre-test Score
25	39	28	57	35	69	13	85
5	40	1	58	33	70	8	88
16	42	23	59	4	71	18	88
9	44	31	60	27	71	17	89
14	44	10	61	2	73	6	94
29	44	21	62	15	74		
12	46	3	65	30	76		
22	50	32	65	34	77		
7	53	11	67	26	79		
20	57	19	68	24	82		

The analysis stage is a crucial initial phase in the development of cognitive diagnostic assessments. This stage involves identifying the characteristics of students and the learning modules used. Based on the research results at SMA X, it was found that teachers still use Google Forms to conduct cognitive diagnostic assessments. This method requires more time to review students' answers individually, creating a need for more efficient and interactive instruments like Quizizz.

The use of interactive platforms such as Quizizz in cognitive diagnostic assessments can provide solutions to the challenges faced by teachers. In the design stage, the initial step taken is to create an account on Quizizz or use an existing Google account. This assessment instrument is then developed with multiple-choice questions based on previously designed item specifications. This aligns with previous research indicating that interactive platforms can enhance student engagement and motivation in the learning process (Liu et al., 2021; Sari & Pratama, 2020).

After the question creation was completed, the researcher proceeded to the development stage by creating 35 multiple-choice questions. The feasibility test of the instrument was conducted by Biology Education lecturers at STKIP Arrahmaniyah, who provided a feasibility score of 86%, indicating that the instrument is very suitable for use. The validity and reliability of the instrument were then tested using SPSS version 25. According to Permata et al. (2020), validity is a characteristic that a research instrument must possess to ensure measurement accuracy.

The validity test showed that out of 35 items, only one item was invalid. This item was deemed invalid because ($r_{\text{calculated}} < r_{\text{table}}$) ($0.257 < 0.3120$). This highlights the importance of thorough evaluation in the development of assessment instruments, as also found in previous studies (Fraenkel, Wallen, & Hyun, 2012; Creswell & Guetterman, 2019). The reliability test using the Spearman-Brown formula showed a value of 0.884, indicating that the instrument has very good reliability (Johnson & Christensen, 2019).

In addition to testing validity and reliability, measurements were also made on difficulty levels and discriminative power. The results showed that 21% of the questions were at a difficult level, 65% at a moderate level, and 15% at an easy level. This variation in difficulty is important to ensure that the instrument can accurately assess students' abilities (Brown & Abeywickrama, 2019; Nitko & Brookhart, 2016). Discriminative power was also measured, with 12% of the questions showing moderate discriminative power and 88% showing high discriminative power, indicating that the instrument effectively distinguishes between students who understand the material and those who do not (Muijs, 2020; Rodriguez, 2018).

The next step was to pilot the instrument with respondents, where the pre-test results indicated that the instrument could be effectively used to measure students' understanding. This trial is crucial to ensure that the instrument is not only valid and reliable but also practical and beneficial in real-world contexts. According to research, piloting with a representative sample is an important step in validating assessment instruments (Creswell & Guetterman, 2019; Fraenkel et al., 2012).

The integration of questions using Quizizz showed that in Figure 3, question number 7 received a medium difficulty level, while in Figure 4, question number 32 was assessed as difficult. Well-designed questions typically fall within the medium difficulty range, as overly difficult questions can lead to student frustration and disengagement from learning (Arikunto, 2013). Question number 32 is categorized as difficult because it contains distractors, which is beneficial for multiple-choice questions. This aligns with Zainal's (2017) assertion that multiple-choice items should include alternative answers or distractors.

The use of Quizizz-based cognitive diagnostic assessment instruments offers numerous advantages, including ease of data management and analysis, as well as increased student motivation. This study on the use of Quizizz-based cognitive diagnostic assessment instruments is expected to contribute to the development of more effective and efficient assessment tools, while also supporting the integration of technology in education. Previous research has also indicated that technology can play a crucial role in enhancing the quality of assessment and learning (Wang et al., 2016; Sari & Pratama, 2020).

Moreover, the importance of developing technology-based assessments is also supported by the growing need for education that is adaptive and responsive to changing times. By using interactive platforms like Quizizz, teachers can more easily tailor content and teaching methods to meet the needs and characteristics of their students, making the learning process more effective and personalized (Johnson et al., 2016; Liu et al., 2021).

The development and implementation of Quizizz-based cognitive diagnostic assessment instruments are expected to have a positive impact on the learning process. This instrument not only facilitates teachers in managing assessments but also enhances student engagement and understanding. The use of technology in assessments continues to evolve, and this study serves as an example of how innovation can be applied to improve educational quality. The cognitive diagnostic assessment developed through interactive platforms like Quizizz not only contributes to increased efficiency in the assessment process but also provides a more enjoyable and challenging learning experience for students.

Conclusion

The development of web-based interactive cognitive diagnostic assessment instruments, such as Quizizz, for the environmental changes material in grade X has been deemed effective. This is supported by the results of validity, reliability, and expert evaluations. The cognitive assessment instrument comprises 35 items, with one item (number 23) identified as invalid and subsequently removed. The reliability score obtained is 0.884, indicating that the developed instrument is reliable. Based on the trial results, 34 items yielded scores ranging from 39 to 94. The expert evaluation score was 86%, categorized as very feasible for testing. However, the cognitive diagnostic assessment still needs to be further developed over time to consistently align with the evolving needs of students.

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