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INTEGRATION OF HOTS-BASED QUIZIZZ APPLICATION TO IMPROVE MATHEMATICAL LITERACY ABILITIES OF VOCATIONAL SCHOOL STUDENTS

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ABSTRACT

This study was motivated by the need for contextual, interactive assessments aligned with the characteristics of the Merdeka Curriculum in developing students' mathematical literacy skills. The purpose of this research was to develop a Merdeka Belajar assessment based on ethnomathematics and Higher Order Thinking Skills (HOTS) integrated with the digital application Quizizz to enhance students' mathematical literacy. The study was conducted at Dharma Pancasila Private Vocational School (SMK Swasta Dharma Pancasila) in Medan during the odd semester of the 2025/2026 academic year, employing a Research and Development (R&D) approach using a modified Dick & Carrey model through several stages: needs analysis, design, development, validation, limited trial, and field testing. The research subjects were ninth-grade students selected through total sampling. The research instruments included expert validation sheets, mathematical literacy tests, questionnaires, interviews, and observations. The expert validation results indicated that the developed assessment was categorized as very valid, with an average score of 4.52. The limited trial results showed that 93% of students stated that the questions were easy to understand, and 100% found the Quizizz application easy to use. The effectiveness test demonstrated an increase in the average score from 62.3 to 84.1 with an N-Gain value of 0.58 (moderate–high category). The independent t-test result showed a significance value of $p = 0.003 < 0.05$, indicating a significant difference between pretest and posttest results. The study concluded that the assessment based on ethnomathematics, HOTS, and Quizizz was proven to be valid, practical, effective, and well-received by both students and teachers. The implication of this research is that this assessment model can serve as an innovative alternative to strengthen mathematical literacy, integrate local cultural values, and support the digital and sustainable implementation of the Merdeka Curriculum.

INTRODUCTION

The Merdeka Belajar (Freedom to Learn) policy launched by the Ministry of Education and Culture has become an important milestone in the transformation of national education. This concept emphasizes freedom of thought and innovation,

particularly among educators, because without a shift in teachers' paradigms, it is difficult to expect learning practices that truly liberate students (Kemendikbud, 2019). In line with this, Rahmadayanti and Hartoyo (2022) assert that the implementation of Merdeka Belajar in both primary and secondary schools opens meaningful spaces for students to think freely and actively explore their potential through contextual learning experiences.

The concept of Merdeka Belajar also plays a crucial role in shaping character and fostering independent thinking. Ainia (2020) explains that the idea of Merdeka Belajar in Ki Hadjar Dewantara's perspective aligns with character education because it cultivates care, self-confidence, and adaptability to social dynamics. Similarly, Daga (2021) emphasizes that Merdeka Belajar strengthens the role of teachers as democratic facilitators who support learners' autonomy rather than functioning merely as sources of knowledge.

However, factual conditions indicate that Indonesian students' scientific thinking skills and mathematical literacy remain relatively low. PISA survey results highlight that low student performance is driven by limited practice in solving contextual problems that demand reasoning, argumentation, and creativity. Moreover, teachers' limited ability to design assessment instruments based on ethnomathematics, HOTS, and digital applications weakens the quality of assessment. As a result, assessments tend to focus on memorization and fail to nurture higher-order thinking skills.

Another major challenge in education is the impact of globalization and technological advancement, which can erode local cultural values. Agustin (2017) notes the growing tendency among younger generations to drift away from cultural traditions, leading to a diminishing sense of nationalism. Therefore, modern education must be designed not only to be adaptive to technology but also rooted in local wisdom. In this context, ethnomathematics becomes a strategic approach for integrating cultural values into learning. Sulfayanti, Aziz, and Hakim (2022) assert that ethnomathematics plays an important role in preserving tradition and shaping student character, while Gazanofa and Wahidin (2023) view ethnomathematics as a multicultural approach that fosters tolerance and diverse perspectives within education.

Assessment also holds a central role in supporting the quality of learning. Kumalasari, Rambe, Julia, and Asriati (2022) explain that assessment functions not only as a measurement tool but also as a means of providing constructive feedback for teachers and students. Julia (2019) found that the type of assessment influences students' learning behavior, as they tend to adjust their learning strategies based on the assessment format used. Setiawan and Sa'dijah (2017) further emphasize that authentic assessment is

essential for comprehensively measuring skills competencies. This is reinforced by the Ministry of Education and Culture Regulation Number 4 of 2018, which states that assessment instruments play a strategic role in educational decision-making at schools.

Within the Merdeka Belajar framework, teachers are expected to become professional facilitators who master pedagogical, social, and personal competencies. Houtman (2020) states that these competencies are essential for helping teachers face the challenges of Society 5.0 and realize independent and innovative learning. Meanwhile, Higher Order Thinking Skills (HOTS) have become an urgent requirement in modern mathematics education. Saputra (2016) explains that HOTS encompasses analytical, evaluative, and creative abilities, while Mustahdi (2019) highlights that developing HOTS-based questions effectively trains students' critical and reflective thinking skills.

In addition, mathematical literacy is a key 21st-century competency that involves an individual's ability to formulate, apply, and interpret mathematical concepts to solve real-world problems. Rahmasari and Setyaningsih (2023) found that mathematical literacy significantly contributes to students' ability to solve word problems using Polya's steps. Elenna and Setiani (2023) further note that cognitive style also influences mathematical literacy performance in the Merdeka Belajar context. According to OECD (2019), indicators of mathematical literacy include formulating problems, applying concepts, and interpreting results, demonstrating that mathematical literacy is not merely about mastering formulas but also about engaging in critical reflection on contextual phenomena.

Several previous studies have examined HOTS-based or ethnomathematics-based assessments; however, they generally remain in manual formats and rarely integrate digital technology. The research gap lies in the limited development of assessment models that simultaneously incorporate three essential components: cultural context (ethnomathematics), higher-order thinking skills (HOTS), and interactive digital platforms such as Quizizz. This study introduces scientific novelty by developing a Merdeka Belajar assessment model that integrates ethnomathematics and HOTS within the Quizizz digital platform to enhance students' mathematical literacy in a contextual and engaging manner.

Thus, this research is expected to contribute theoretically by offering an innovative assessment model rooted in culture and technology, and practically by providing teachers and schools with tools to support the implementation of the Merdeka Curriculum in a digital, contextual, and sustainable manner.

Research Problem

Based on the background, the research problem in this study is: How effective is the Merdeka Belajar assessment based on ethnomathematics and HOTS, integrated with the Quizizz application, in improving students' mathematical literacy skills?

Research Objective

The objective of this study is to measure the effectiveness of the Merdeka Belajar assessment based on ethnomathematics and HOTS, integrated with the Quizizz application, in enhancing students' mathematical literacy skills.

Research Urgency

The urgency of this research arises from the reality that the assessments commonly used in schools—particularly at SMK Swasta Dharma Pancasila Kota Medan—are still dominated by cognitive instruments that primarily measure basic knowledge. Such instruments are insufficient to support the development of higher-order thinking skills, mathematical literacy, and character formation rooted in local culture. In fact, innovative assessment is essential to support the implementation of the Merdeka Curriculum, which demands contextual, reflective, and technologically adaptive learning.

Several previous studies have made important contributions to the development of HOTS-based and literacy-based assessments. For instance, the study conducted by Setyaningsih & Mukodimah (2022) shows that HOTS-based mathematical literacy assessment instruments on the topic of systems of linear equations in two variables (SPLDV) significantly contribute to connecting mathematical concepts with real-life contexts. Their findings indicate that assessments grounded in literacy and higher-order thinking skills can help students think more critically and analytically.

In addition, Randy et al. (2024) developed a numeracy literacy–based mathematics test instrument for the topic of integers at the elementary school level. The study concluded that the numeracy literacy–based instrument is feasible to use because it effectively measures students' numeracy abilities. This confirms that numeracy-based literacy assessments can be applied across various educational levels with positive outcomes.

However, the literature review shows that studies specifically integrating ethnomathematics-based assessments, HOTS, and interactive digital applications such as Quizizz are still very limited. In fact, the use of ethnomathematics can strengthen cultural

identity while making learning more contextual, whereas the integration of Quizizz offers technical convenience, interactivity, and greater learning motivation. The combination of these three components is expected to produce an assessment instrument that is not only valid and practical but also effective in improving students' mathematical literacy skills.

RESEARCH METHOD

Type of Research

This study is a Research and Development (R&D) project that adopts a modified version of the Dick & Carey development model, adjusted to the context of digital assessment based on ethnomathematics and HOTS. This model was selected because it provides a systematic sequence of stages, starting from needs analysis, design, development, validation, limited trials, to evaluation and product revision. The main goal of this study is to produce a Merdeka Belajar assessment instrument based on ethnomathematics and Higher Order Thinking Skills (HOTS), integrated into the Quizizz application, to enhance students' mathematical literacy in a contextual and interactive manner.

Research Location and Subjects

The research was conducted at SMK Swasta Dharma Pancasila, Medan, during the first semester of the 2025/2026 academic year, involving all eleventh-grade students. The school was selected through purposive sampling based on an initial analysis showing that it had not yet implemented ethnomathematics-based assessment, HOTS-oriented test instruments, nor interactive digital platforms. Data collection used total sampling, meaning that all eleventh-grade students were included as respondents to ensure that the data obtained were comprehensive, representative, and reliable.

Research Procedure

The development procedure follows the modified Dick & Carey model, consisting of six main stages, as illustrated in Figure 1.

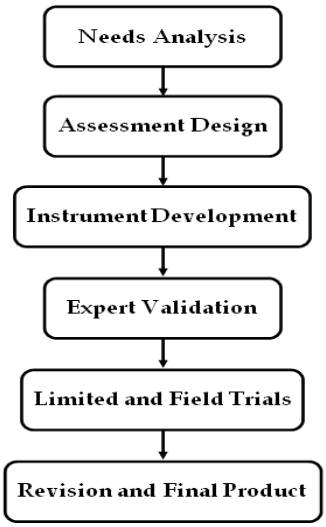

Figure 1. Flowchart of the Modified Dick & Carey Development Model

The implementation stages are described as follows:

1. Needs Analysis: Conducted through observations, teacher interviews, and document studies to identify students' difficulties and limitations of the assessments currently used in the school.
2. Assessment Design: Includes formulating assessment objectives, developing indicators of mathematical literacy based on ethnomathematics, and preparing HOTS item blueprints aligned with the curriculum.
3. Instrument Development: Constructing assessment items based on local cultural contexts with cognitive levels C4–C6 (analysis, evaluation, creation), then integrating them into the Quizizz application to support interactive digital learning.
4. Expert Validation: Involving content experts, assessment experts, and media experts to evaluate the content validity, construct validity, and overall usability of the product.
5. Field Testing: Administered to all eleventh-grade students to examine the effectiveness of the assessment in improving mathematical literacy skills.
6. Product Revision: Conducted based on feedback from validators and field test results until a valid, practical, and effective assessment instrument is produced.

Research Instruments

The instruments used in this study include:

1. Mathematical Literacy Test, consisting of HOTS-based ethnomathematics questions integrated into the Quizizz application.

2. Student Response Questionnaire, used to measure acceptability, motivation, and learning experience during the digital assessment process.
3. Teacher and Student Interviews, to strengthen qualitative data on the practicality and effectiveness of the assessment tool.
4. Observation Sheet, to record activities, engagement, and interactions of students throughout the assessment process.
5.

Validity and Reliability of the Instruments

Content validity of the assessment was measured using Aiken's V formula with a 1–5 rating scale by expert validators. A V value ≥ 0.80 is categorized as highly valid (Azwar, 2019).

$$V = \frac{\sum s}{n(c-1)}$$

Description:

V	:	Aiken's V content validity coefficient
∑s	:	Total score given by experts for each item. The value of s is calculated by multiplying the score assigned by an expert with its numerical value. For example, if an expert gives a score of 3 (Very Relevant), then the value of s is 3.
N	:	Total number of raters or experts
c		Highest score on the rating scale used. For example, if the scale consists of Very Relevant (4), Relevant (3), Fairly Relevant (2), and Less Relevant (1), then c = 4.

Reliability of the Test

The reliability of the test was analyzed using Cronbach's Alpha (α) with the assistance of SPSS software. A value of α ≥ 0.70 indicates a high level of reliability. In addition, item analysis included the difficulty index (p) and discrimination index (D) to ensure that each item possessed good quality and was capable of differentiating students' ability levels effectively.

Research Ethics

This study was conducted by adhering to ethical principles of educational research, which included the following:

1. Obtaining official permission from the school principal and subject teachers to conduct the research within the school environment.
2. Ensuring the confidentiality of student data by omitting personal identifiers in all forms of publication.

3. Avoiding conflicts of interest and maintaining a strong orientation toward improving the quality of learning.

Data Collection Techniques

Data were gathered through several stages:

1. Development and validation of instruments (tests, questionnaires, observation sheets, interviews).
2. Administration of pretest and posttest to measure improvements in mathematical literacy.
3. Collection of qualitative data through questionnaires and interviews to capture students' responses and motivation.
4. Observation of the implementation of digital assessment using a structured observation instrument.

Data Analysis Techniques

The analysis employed both quantitative and qualitative approaches.

a. Quantitative Analysis

1. **Validity and Reliability Analysis:** Instrument validity was examined using Aiken's V, while reliability was determined using Cronbach's Alpha.
2. **Effectiveness Analysis:** Effectiveness was measured by comparing pretest and posttest results using an independent t-test, following the fulfillment of the normality assumption (Shapiro–Wilk test) and homogeneity of variance (Levene's test).
3. **N-Gain Calculation:** Learning improvement was assessed using the N-Gain formula:

$$\mathrm{N-Gain} = \frac{(\mathrm{Spost} - \mathrm{Spre})}{(\mathrm{Smax} - \mathrm{Spre})}$$

   Improvement categories were defined as high (>0.70), medium (0.30–0.70), and low (<0.30).
4. **Effect Size:** Cohen's d was calculated to determine the strength of the treatment effect on mathematical literacy, categorized as small (0.2), medium (0.5), and large (≥0.8).

b. Qualitative Analysis

Data obtained from questionnaires, interviews, and observations were analyzed through data reduction, data display, and conclusion drawing. Triangulation of sources and methods was employed to enhance the credibility, validity, and depth of qualitative interpretations.

RESULTS AND DISCUSSION

Expert Validation and Instrument Reliability

Prior to field testing, the assessment was validated by three experts (content, media, and educational evaluation). The evaluation used a 1–5 rating scale based on criteria such as content alignment, item construction, linguistic clarity, integration of ethnomathematics, and alignment with HOTS principles.

Table 1. Expert Validation Results of the Assessment

Evaluation Aspect	Average Score	Category
Alignment with assessment objectives	4.60	Very Valid
Item construction and clarity of instructions	4.50	Very Valid
Integration of ethnomathematics elements	4.45	Very Valid
Integration of HOTS components	4.55	Very Valid
Language clarity and contextual readability	4.50	Very Valid
Compatibility with Quizizz application	4.50	Very Valid
Overall Mean	4.52	Very Valid

Content validity was also analyzed using Aiken's V, resulting in V = 0.91, indicating a high level of content validity (Aiken, 1985; Azwar, 2019). Meanwhile, the reliability analysis using Cronbach's Alpha produced $\alpha = 0.87$, demonstrating excellent internal consistency (Cronbach, 1951).

1. Limited Trial Test

To ensure that the developed assessment was feasible for broader implementation, a limited trial test was conducted involving 15 students. This stage aimed to evaluate the readability, clarity of instructions, item relevance, and ease of using Quizizz as a digital assessment platform. The trial results are presented in Table 2 below.

Table 2. Results of Limited Trial Assessment (N = 15)

Assessment Aspect	Percentage (%)
Items are easy to understand (readability)	93
Instructions are clear	87
Items are relevant to daily life	87
Items contain elements of local culture	80
Items promote critical thinking (HOTS)	87
Quizizz is easy to access	100
Assessment is enjoyable and not monotonous	93

Based on the limited trial involving 15 students, the ethnomathematics- and HOTS-based assessment integrated with Quizizz demonstrated highly positive results. A total of 93% of students reported that the items were easy to understand, 87% agreed that the items were relevant to real-life contexts, and 80% recognized cultural elements embedded in the items. Moreover, 87% felt the items promoted critical thinking, 100% confirmed that

Quizizz was easily accessible, and 93% stated the assessment was enjoyable. These findings indicate that the assessment met the criteria of readability, relevance, and practicality, making it suitable for implementation in the field test.

2. Assessment Effectiveness (Field Test)

The effectiveness test was conducted with 30 eleventh-grade students through pretest and posttest administration. The average pretest score of 62.3 increased to 84.1 in the posttest. The average N-Gain score of 0.58 indicates an improvement categorized as medium–high.

Table 3. Mean Scores of Pretest, Posttest, and N-Gain

Test Stage	Mean Score	Standard Deviation
Pretest	62.3	5.7
Posttest	84.1	6.3
N-Gain	0.58 (medium–high)	—

The independent t-test yielded a significance value of $p = 0.003 < 0.05$, indicating a significant difference between pretest and posttest scores. These results confirm that the assessment integrating ethnomathematics, HOTS, and Quizizz is effective in improving students' mathematical literacy.

A comparative bar chart illustrating the improvement in mathematical literacy scores before and after the implementation of the assessment is presented in Figure 2.

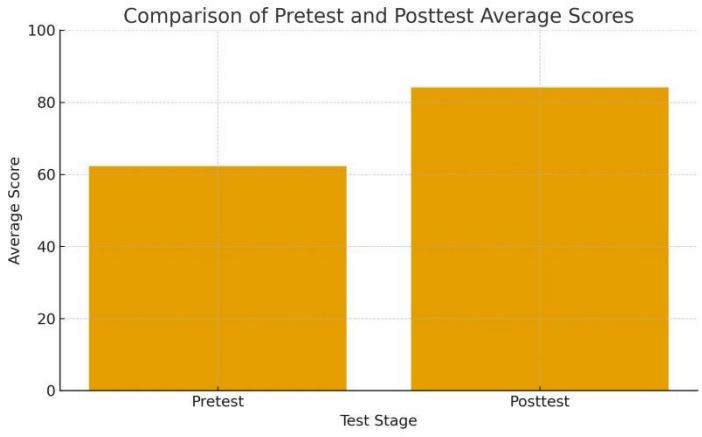

Figure 2. Graph of Increase in Pretest and Posttest Scores

3. Analysis of Mathematical Literacy Indicators

Based on the PISA framework, students' mathematical literacy abilities were analyzed using three main indicators: problem formulation, concept utilization, and interpretation and reflection.

Table 4. Average Mathematical Literacy Scores by Indicator (N = 30)

Indicator	Average
Problem Formulation	83.2
Concept Utilization	84.5
Interpretation & Reflection	85.1

The highest score was recorded for the interpretation and reflection indicator (85.1), showing that students had become more capable of understanding mathematical results within real-life contexts. This strengthens the role of ethnomathematics in connecting abstract mathematical concepts with local cultural realities (Sulfayanti et al., 2022; Gazanofa & Wahidin, 2023).

Practicality was also evaluated based on teacher responses. The average score was 4.65 on a 5-point scale, with the highest rating (4.8) given to student engagement. Teachers stated that Quizizz greatly supported efficiency, accessibility, and curriculum alignment.

Student questionnaire results also showed strong positive responses. A total of 94% of students felt that Quizizz made learning more enjoyable, 89% found the items relevant to local culture, and 93% expressed interest in having similar assessments in the future.

Discussion

The findings indicate that the ethnomathematics-, HOTS-, and Quizizz-based assessment is valid, practical, and effective. The high validity results show strong alignment with the principles of the Merdeka Belajar curriculum, which emphasizes contextual learning and higher-order thinking skills. The practicality of Quizizz supports efficient digital assessment, aligning with Kumalasari et al. (2022), who emphasized the importance of assessment as constructive feedback.

The significant improvement in students' mathematical literacy after the intervention supports Saputra's (2016) assertion that HOTS plays a crucial role in developing students' analytical and reflective abilities. Additionally, these findings reinforce Elenna & Setiani (2023), who emphasized that mathematical literacy is influenced by cognitive styles and the assessment methods applied.

Thus, the assessment model not only enhances cognitive achievement but also fosters appreciation for local culture, develops 21st-century skills, and supports the goals of the Merdeka Belajar Curriculum.

CONCLUSION AND RECOMMENDATIONS

Conclusion

Based on the research findings and data analysis, the following conclusions are drawn:

1. **Practicality and Readability**

   The ethnomathematics- and HOTS-based assessment integrated with Quizizz is highly practical and easy to use. Students understood the instructions well and were enthusiastic during the assessment process. Teachers also reported that the assessment was efficient, interactive, and aligned with the characteristics of the Merdeka Belajar Curriculum.

2. **Effectiveness of the Assessment**

   The developed assessment was proven effective in improving students' mathematical literacy. The increase in learning outcomes indicates that combining local cultural contexts with digital technology enhances critical thinking and strengthens the connection between mathematical concepts and real-life situations.

3. **Acceptability and Positive Impact**

   Students showed very positive responses toward the digital Quizizz-based assessment. The learning activity became more enjoyable, challenging, and meaningful. Moreover, the assessment helped cultivate appreciation for local culture while enhancing learning motivation.

4. Research Limitations

   This study is limited by a relatively small sample size (30 students) and data collection conducted only in one school, restricting the generalizability of the findings. Future research with broader samples and diverse school contexts is recommended to strengthen the validity of the results.

Overall, the Merdeka Belajar assessment integrating ethnomathematics, HOTS, and Quizizz is proven to be valid, practical, effective, and well-received by both teachers and students. This assessment product contributes significantly to the development of innovative evaluation models aligned with the demands of the Merdeka Curriculum and 21st-century learning needs.

Recommendations

1. **For Teachers**

   Teachers are encouraged to integrate digital applications such as Quizizz into assessment practices. Besides providing variation in evaluation, digital assessment can

enhance student motivation and support the development of higher-order thinking skills.

2. **For Schools**

   Schools are expected to provide full support in the form of training on the development of ethnomathematics-based questions and the use of educational technology. Improving technological infrastructure is also essential to ensure the sustainability of digital assessment implementation.

3. **For Students**

   Students are encouraged to actively participate in HOTS- and ethnomathematics-based assessments. Active engagement will enrich learning experiences, improve mathematical literacy, and foster pride in local culture.

4. **For Future Researchers**

   Further research can be conducted at different educational levels or on alternative mathematical topics. Researchers may also integrate other innovative learning approaches, such as project-based learning or problem-based learning, to explore their combined effects on students' literacy skills.

5. **For Government and Curriculum Developers**

   The findings may serve as a reference for designing digital assessment policies rooted in cultural values and emphasizing higher-order thinking skills. Such efforts will strengthen the goals of the Merdeka Belajar Curriculum and support national cultural identity.

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