Journal of General Education and Humanities
Vol. 5, No. 1, February 2026, pp. 851 – 861, https://doi.org/10.58421/gehu.v5i1.1024
ISSN 2963-7147

Culturally Responsive Teaching: Improving Middle School Numeracy in Linear Functions

Brigita Wanda Pangestika[1], Nurcholif Diah Sri Lestari[2], Antonius Cahya Prihandoko[3], Dian Kurniati[4], Abi Suwito[5]
[1,2,3,4,5]Magister Pendidikan Matematika, Universitas Jember, Indonesia

Article Info

Article history:

Received 2025-12-29
Revised 2026-01-15
Accepted 2026-01-16

Keywords:

Culturally Responsive Teaching
Linear function
Mathematics learning
Numeracy skills

ABSTRACT

The low level of numeracy skills among junior high school students in linear function topics indicates the need for more contextual and meaningful mathematics instruction. This study explores the integration of *Culturally Responsive Teaching* (CRT) through the incorporation of local Banyuwangi culture as an instructional context to enhance students' numeracy skills. Local cultural elements such as the *Petik Laut* tradition, Kawah Ijen tourism, Osing traditional house architecture, and Banyuwangi community economic activities were embedded in learning modules, student worksheets, and numeracy assessment tasks related to linear functions. Employing a research and development approach with a modified 4D model, this study involved eighth-grade students from a junior high school in Banyuwangi. The results indicate that the CRT-based learning materials grounded in Banyuwangi culture met the criteria of validity, practicality, and effectiveness. Furthermore, the implementation resulted in significant improvements in students' numeracy skills, as indicated by complete learning mastery and moderate to high *n-gain* scores. These results suggest that positioning local culture as a source of mathematical contexts within a CRT framework not only enhances students' understanding of linear functions but also fosters more relevant, meaningful, and culturally connected mathematics learning.

Corresponding Author:

Brigita Wanda Pangestika
Universitas Jember, Indonesia
Email: brigitawanda77@gmail.com

1. INTRODUCTION

Mathematical literacy (numeracy) is the mathematical ability required for learning in the 21st century. This skill enables individuals to understand and calculate numbers, measure time, determine prices, and analyze data, which are competencies crucial in daily life. Mathematical literacy is an individual's ability to apply mathematical knowledge to solve everyday problems [1]. Numeracy is the ability to manage data and numbers to estimate solutions to questions within specific contexts [2]. State that numeracy can be defined in multiple ways and is often referred to as mathematical literacy [3]. In line with this, the OECD defines numeracy as an individual's capacity to formulate, use, and interpret mathematics in various contexts [4].

Additionally, numeracy can enhance reasoning skills, data interpretation, and information identification [5]. Although Indonesia's numeracy results have improved in ranking, they remain below the OECD average. Indonesia ranked 69th out of 81 countries in the PISA assessment with a score of 366 [6].

The global emphasis on numeracy as a core skill prompted the Indonesian government to implement the Minimum Competency Assessment (Asesmen Kompetensi Minimum, AKM). In 2021, Indonesia replaced the National Examination (Ujian Nasional, UN) with the AKM [7]. This shift, carried out by the Ministry of Education and Culture (Kemendikbud), aims to improve the quality of education in Indonesia [8]. According to The AKM, it strives to set minimum standards for the educational objectives to be achieved [9]. Kemendikbud explains that the AKM is conducted to obtain information on students' attainment of expected competencies [10]. Moreover, the AKM is considered the best method to meet students' learning needs [11]. The AKM measures two competencies: reading literacy and mathematical literacy (numeracy). It is designed to assess students' competencies in depth, not merely mastery of content. Therefore, the AKM presents problems in various contexts that students are expected to solve using their reading and numeracy skills [10].

The 2023 Indonesian education report shows that students' numeracy skills at elementary, junior high, and senior high school levels are categorized as moderate, with scores around 40%. Specifically, numeracy achievement at the elementary level (SD/MI/equivalent) is 46.67%, at the junior high level (SMP/MTs/equivalent) is 40.63%, and at the senior high level (SMA/SMK/MA/equivalent) is 41.14%. The lowest achievement is observed at the junior high level (SMP/MTs/equivalent) [11]. Therefore, this study aims to improve numeracy skills at the junior high school level using AKM-based questions as a reference.

One way to enhance students' numeracy skills is through mastery of Linear Functions (Cao et al., 2022). Linear Functions are a core topic in mathematics and an essential subject in junior high school [12]. Students' success in Linear Functions significantly affects their understanding of subsequent topics. However, students' proficiency in this material remains relatively low, as shown by TIMSS results in 2007 and 2011. Pramesti & Retnawati reported that students' achievement in Linear Functions was 58.63% in 2014/2015, 56.79% in 2015/2016, 57.02% in 2016/2017, and 57.54% in 2017/2018 [13]. These figures indicate that students' abilities in Linear Functions are still relatively low, despite their applications in daily life, such as in economics, tourism, and development planning, which require numeracy skills to solve related problems. Numeracy enables students to analyze problems, formulate appropriate equations, and find correct solutions. Other studies indicate that eighth-grade students still face difficulties solving problems involving Linear Function operations [14]. Therefore, attention to students' mastery of Linear Functions is crucial, as it helps them solve real-life problems similar to those in numeracy questions.

Aprilia et al. and Muliana et al. state that learning with high-quality instructional materials can improve numeracy skills. Similarly, mathematics learning materials incorporating local culture can enhance students' numeracy abilities [15]. The integration of mathematics and culture is important because it strengthens understanding of mathematical content [16]. Gay refers to this approach as "culturally responsive teaching" (CRT), combining culture to make learning more relevant and effective for students [17]. According to Gay, CRT is defined as the use of students' cultural characteristics, experiences, and perspectives from diverse ethnic backgrounds to facilitate more effective teaching [17].

Furthermore, CRT leverages students' cultural knowledge, values, and personal experiences to create meaningful and relevant learning experiences [18]. Halim emphasizes that culturally responsive curricula are necessary to preserve national culture [19]. Most CRT research has been conducted in Western contexts, but recent studies have also taken place in Africa, Europe, and Asia [20]. Buchori & Harun designed a CRT-based e-module that was valid but impractical and ineffective [21]. Riva'i developed a CRT-based teaching module for junior high students on integer material, but the module was not tested for validity, practicality, or effectiveness, and its problems were not linked to numeracy skills, which are essential for students today [22]. Therefore, this study is essential to develop CRT-based learning materials to improve students' numeracy skills. Additionally, CRT-based learning is relevant to Linear Functions, such as modeling annual increases or decreases in museum or cultural site visitors, modeling the relationship between product prices and sales of traditional art products, or modeling the relationship between investment in tourism infrastructure and annual tourist arrivals.

2. METHOD

This study aims to develop a set of instructional materials comprising learning modules, student worksheets (Lembar Kerja Peserta Didik), a numeracy test, and a guidebook, all of which meet the criteria of validity, practicality, and effectiveness. Accordingly, this study is classified as a *research and development* (R&D) study employing a modified 4D development model.

The field trial was conducted at SMP Al Azhar Muncar. The readability test involved five eighth-grade students, while the main trial included 18 students from class VIII A. Students' numeracy development was measured through pretest and posttest assessments administered before and after the implementation of CRT-based instructional materials. Multiple data sources were employed, including expert validation forms, observations of instructional implementation and classroom learning processes, student response surveys, and numeracy assessment.

Data analysis in this study focused on evaluating the validity, practicality, and effectiveness of the developed instructional materials. Validation data were analyzed by calculating the mean validation score from all validators for each indicator (I_i), followed by determining the mean score for each aspect (A_i), and finally calculating the overall

 https://doi.org/10.58421/gehu.v5i1.1024

validity score (V_a). The instructional materials were considered valid if they achieved a minimum score of $3 \leq V_a < 4$, with a maximum score of 4 [23]. Materials that met the validity criteria were subsequently tested for readability with five students and then implemented in the main trial with 18 students, during which instructional implementation was continuously observed.

Practicality was assessed using data from instructional implementation observation sheets. The analysis involved calculating the mean observation score for each indicator (I_i), determining the mean score for each aspect (A_i), and computing the overall mean score across all aspects (IO). The instructional materials were categorized as practical if they achieved a minimum IO score of $3 \leq IO < 4$, with a maximum score of [24].

The effectiveness of the instructional materials was evaluated based on learning outcome tests, improvements in students' numeracy skills, and statistical analysis. The materials were considered effective if classical learning mastery was achieved, students' numeracy improvement reached at least a moderate category based on the *n-gain* classification, and statistical testing using a paired-sample t-test indicated significant improvement.

Statistically, the research hypotheses were formulated as follows:

$$H_0 : \mu_1 \leq \mu_2$$

$$H_1 : \mu_1 > \mu_2$$

where:
H_0 indicates that there is no significant effect of implementing CRT-based mathematics instructional materials on improving students' numeracy skills, while H_1 indicates that there is a significant effect of implementing CRT-based mathematics instructional materials on improving students' numeracy skills.

3. RESULTS AND DISCUSSION

CRT-based mathematics instructional materials were systematically developed through a modified 4D model, including the stages of defining, designing, developing, and disseminating, to support the improvement of students' numeracy skills.

3.1. Define Stage

Initial observations indicated that students' interest in learning linear functions at SMP Al Azhar Muncar has declined over the years compared to other mathematics topics. A key need in addressing this recurring issue is the development of contextual instructional materials that reduce the abstract nature of linear function concepts. One effective approach to contextual learning is integrating cultural elements into the instructional process. The implementation of *Culturally Responsive Teaching* (CRT) has been shown to improve students' learning outcomes [25]. Therefore, this study aims to develop instructional materials that more fully integrate students' environmental and cultural contexts, such as Mount Ijen, the *Petik Laut* tradition, and traditional Banyuwangi cuisine into the teaching of linear functions.

3.2. Design Stage

At this stage, the researcher developed the initial design of four instructional materials grounded in *Culturally Responsive Teaching* (CRT). The design of these materials was informed by the needs analysis conducted during the define stage, the characteristics of students at SMP Al Azhar Muncar, and the local cultural context of Banyuwangi.

The guidebook includes an overview of the rationale for applying the CRT approach in mathematics instruction, the objectives of using the instructional materials, guidelines for implementing the learning modules and CRT-based student worksheets, as well as the use of numeracy test items and scoring rubrics that teachers are required to understand when administering, scoring, and evaluating the numeracy assessments. An example of the guidebook design is presented in Figure 1.

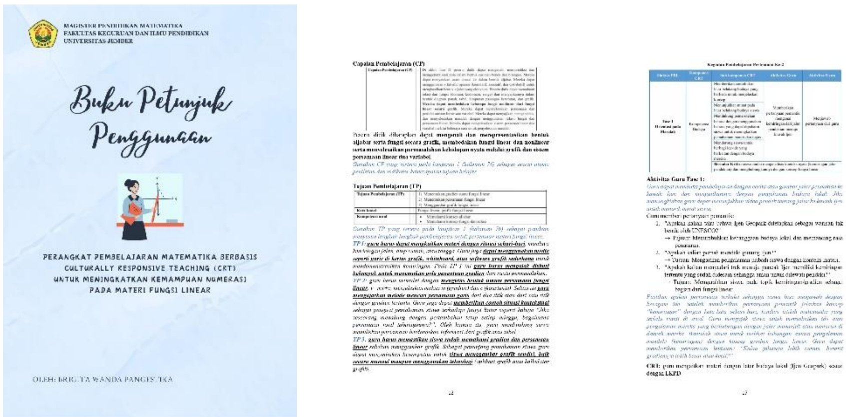

Figure 1. Instructional Materials Guidebook

The CRT-based learning module was designed as the core instructional material that structures the learning sequence across six class meetings, addressing three learning objectives on linear functions while integrating Banyuwangi cultural contexts. The design principles of this module emphasize cultural contextualization to enhance students' sense of relevance and familiarity with the content, while also incorporating collaborative learning activities such as group work, cultural discussions, and mini projects. An example of the learning module design is presented in Figure 2.

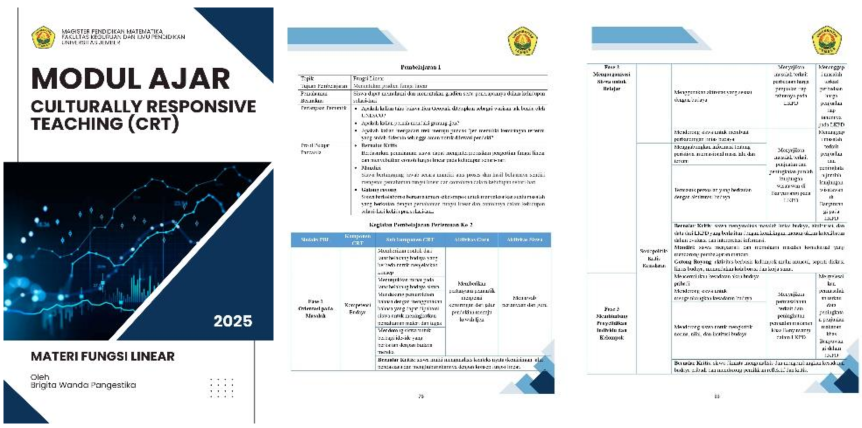

Figure 2. Linear Function Learning Module Using the CRT Approach

The student worksheets were designed to actively engage students in constructing knowledge through exploratory activities that are relevant to their everyday lives. The worksheets incorporate cultural illustrations to support CRT-based learning and integrate numeracy by presenting multiple representations, including tables and graphs, within contextual problem situations. An example of the worksheet design is presented in Figure 3.

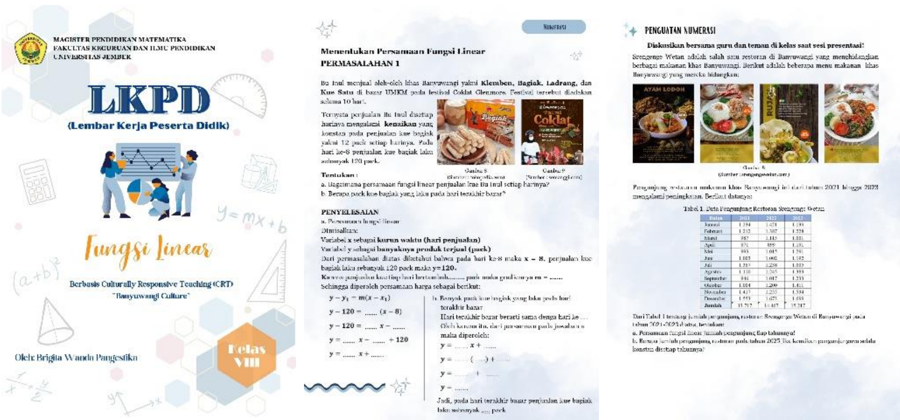

Figure 3. Student Worksheets Using the CRT Approach

The numeracy test was designed to assess students' numeracy skills before and after the learning intervention. The test package consists of two problem contexts, each comprising three items, for a total of six numeracy questions aligned with the cognitive levels of the *Asesmen Kompetensi Minimum* (AKM). Problem Context 1 focuses on data on tourist visits to Banyuwangi from 2020 to 2023, while Problem Context 2 addresses data and graphical representations of sardine sales in 2023. An example of the numeracy test design is presented in Figure 4.

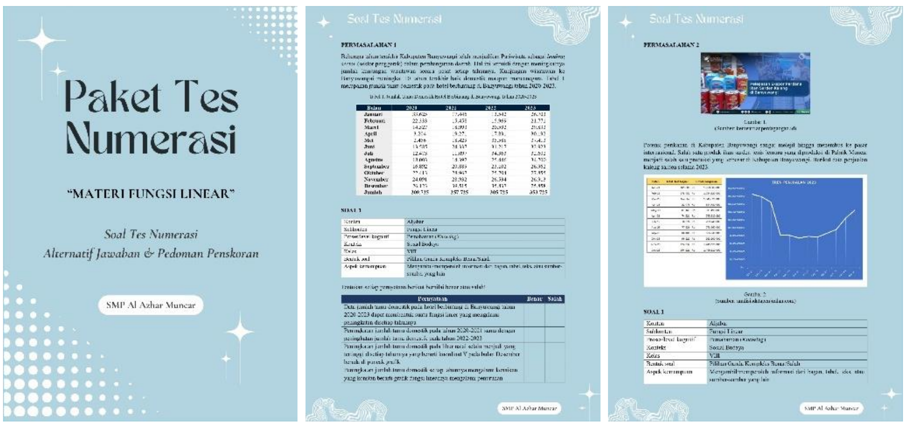

Figure 4. Numeracy Test for Linear Function

3.2. Develop Stage

The designs of the instructional materials user guide, learning module, student worksheets, and numeracy test were subsequently evaluated by experts through a validation process. The experts provided assessments and revision suggestions to improve the quality of the materials prior to field testing. The validation results are presented in Table 1.

Table 1. Validation Results of the Instructional Materials

Instructional Materials	V_a	Category
Guidebook	3.77	Valid
Learning module	3.84	Valid
Student worksheets	3.85	Valid
Numeracy test	3.83	Valid

Based on Table 1, the validation scores for the guidebook, learning module, student worksheets, and numeracy test were 3.77, 3.84, 3.85, and 3.83, respectively. These results indicate that all instructional materials met the validity criteria.

At the development stage, the focus shifted to analyzing the practicality and effectiveness of the instructional materials. The validated numeracy test and student worksheets were first subjected to a readability test with five eighth-grade students to ensure clarity and comprehensibility. The results indicated that no revisions were required to the wording or sentence structure. Subsequently, the instructional materials were implemented in class VIII A over six instructional meetings. Students completed the numeracy pretest at the beginning of the intervention and the posttest at the end of the final meeting.

Practicality analysis was conducted by observing the implementation of the instructional materials during classroom instruction. The results of the practicality evaluation are presented in Table 2.

Table 2. Practicality of Instructional Materials by Meeting

Meeting	Mean score	Practicality level
Meeting 1	3.69	High
Meeting 2	3.81	High
Meeting 3	3.75	High
Meeting 4	3.81	High
Meeting 5	3.86	High
Meeting 6	4	High
Average	3.82	High

Based on the analysis of instructional implementation data, the overall mean score was 3.82, which falls within the range of $3 \leq IO < 4$, indicating a high level of practicality. Therefore, the instructional materials were categorized as practical.

In addition, a student response questionnaire was administered at the final meeting after the posttest. A summary of the student responses is presented in Table 3.

Table 3. Summary of Student Questionnaire Responses

Response category	Percentage
Positive responses (Agree)	95.8%
Negative responses (Disagree)	4.2%

As shown in Table 3, 95.8 percent of student responses were positive, indicating that the instructional materials met the practicality criteria from students' perspectives.

Instructional effectiveness was evaluated based on learning mastery, n-gain categories, and statistical analysis. All students achieved numeracy posttest scores above the minimum mastery criterion of 70, indicating 100 percent classical mastery and confirming the effectiveness of the instructional materials in terms of learning outcomes. Furthermore, pretest and posttest scores were analyzed using the n-gain formula to measure improvements in students' numeracy skills. The distribution of n-gain categories is presented in Table 4.

Table 5. Distribution of n Gain Categories

Category	Number of students	Percentage
Low	0	0%
Moderate	7	39%
High	11	61%
Moderate and High	18	100%

Based on Table 5, the average n-gain category was high, with 100 percent of students achieving at least a moderate level of improvement. These results indicate that the instructional materials met the effectiveness criteria based on n-gain analysis.

Statistical analysis was conducted to test the research hypothesis regarding the effectiveness of CRT-based instructional materials in improving students' numeracy skills. Prior to hypothesis testing, prerequisite analyses were performed, including tests of normality and homogeneity of variance. The normality test was conducted using the Shapiro-Wilk method, with the following decision criteria:

(a) If the significance (Sig.) > 0.05, the data were considered normally distributed;

(b) If the significance (Sig.) > 0.05, the data were considered not normally distributed.

Table 6. Normality Test Results

Tests of Normality

	Kolmogorov-Smirnov[a]			Shapiro-Wilk		
	Statistic	df	Sig.	Statistic	df	Sig.
min_postest_pretest	.139	18	.200*	.955	18	.512

*. This is a lower bound of the true significance.

a. Lilliefors Significance Correction

The Shapiro-Wilk normality test showed a p-value of 0.512 ($p > 0.05$). This indicates that the difference between posttest and pretest scores was normally distributed, thus meeting the normality assumption.

Given that the normality assumption was met, a parametric test using the paired-samples t-test was conducted. The statistical hypotheses were formulated as follows:

(a) H_0: There is no significant difference in students' numeracy improvement between pretest and posttest scores.

(b) H_1: There is a significant difference in students' numeracy improvement between pretest and posttest scores.

The decision rule was based on the significance value (Sig. 2-tailed): if Sig. < 0.05, H_0 was rejected and H_1 was accepted; if Sig. > 0.05, H_0 was accepted and H_1 was rejected.

Table 7. The results of the paired sample t-test

Paired Samples Test

		Paired Differences					t	df	Sig. (2-tailed)
		Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference				
					Lower	Upper			
Pair 1	Pretest – Postest	-26.94444	2.81743	.66407	-28.34552	-25.54337	-40.574	17	.000

The results of the paired sample t-test showed a significance value (Sig. 2 tailed) of 0.000, which is lower than the significance level of 0.05. Therefore, H_0 was rejected, and H_1 was accepted. This result indicates that the implementation of CRT-based mathematics instructional materials had a statistically significant effect on students' numeracy skills.

3.4. Dissaminate Stage

At the dissemination stage, the instructional materials were distributed in hard file format at SMP Al Azhar Muncar and introduced to all teachers to support the implementation of CRT-based learning across subjects. The materials were formally adopted by the school principal and curriculum vice principal as instructional resources that can be used and adapted for other topics.

The materials were also disseminated through a Deep Learning Training program organized by BBGTK East Java in Banyuwangi Regency from August to October 2025, involving teachers from nine junior high schools. The dissemination concluded with a best-practice exhibition attended by representatives from 29 public and private junior high schools and lecturers from several universities, during which the CRT-based Banyuwangi cultural instructional materials for linear functions were showcased.

4. CONCLUSION

This study developed Culturally Responsive Teaching (CRT) based mathematics instructional materials using a modified 4D development model. The development process resulted in a comprehensive set of materials, including learning modules, student worksheets, a numeracy test package, and a user guide. Expert validation confirmed that all components met the validity criteria. Field implementation demonstrated that the instructional materials were practical, as indicated by high implementation scores and positive student responses. Furthermore, the materials proved effective in enhancing students' numeracy skills, as evidenced by mastery of the material, high average N-gain scores, and statistically significant improvements between pretest and posttest scores. Overall, these findings indicate that CRT-based mathematics instructional materials integrating local cultural contexts constitute a valid, practical, and effective approach to improving students' numeracy skills at the junior secondary level.

ACKNOWLEDGEMENTS

The authors gratefully acknowledge the academic support of the Master's Program in Mathematics Education at the University of Jember. Appreciation is also extended to the peer reviewers and the editorial board of the *Journal of General Education and Humanities* for their valuable comments and constructive suggestions during the review process. In addition, the authors recognize the contributions of the scholars cited in this paper, whose work has significantly informed and supported the present study. This study was conducted without any specific financial support from public, commercial, or not-for-profit funding sources.

REFERENCES

[1] Lestari, N. D. S., Juniati, D., & Suwarsono, S. (2017). Preliminary Study : Mathematics ' Teacher Conception in Suporting the Integration of Mathematics ' Literacy and Mathematics Teaching and Learning . International Conference on Mathematics: Education, Theory, and Application (ICMETA), 1, 76–83. https://jurnal.uns.ac.id/math/article/view/12026.

[2] McNally, S. (2015). Numeracy And Mathematics. In Making a Difference in Education (pp. 123–133). Routledge. https://doi.org/10.4324/9781315712352-8.

[3] Goos, M., & O'Sullivan, K. (2023). The Evolution and Uptake of Numeracy and Mathematical Literacy as Drivers for Curriculum Reform. In New ICMI Study Series: Vol. Part F776 (pp. 345–357). https://doi.org/10.1007/978-3-031-13548-4_21

[4] OECD. (2012). PISA 2012 Results in Focus.

[5] Via, Y., Tatag, S., & Abadi, A. (2021). The effect of mathematics self-efficacy on numeracy skills of prospective elementary school teachers. Cypriot Journal of Educational Sciences, 16(6), 3405–3417. https://doi.org/10.18844/cjes.v16i6.6590.

[6] OECD. (2022). Comparing countries' and economies' performance in mathematics. https://doi.org/10.1787/ad5d244c-en.

[7] Putri, M. A. K., Pambudi, D. S., & Kurniati, D. (2022). Pengembangan Perangkat Pembelajaran Berbasis Lesson Study For Learning Community Bernilai Budaya Using Untuk Meningkatkan Numerasi. Aksioma: Jurnal Program Studi Pendidikan Matematika, 11(4), 2567. https://doi.org/10.24127/ajpm.v11i4.6164.

[8] Schirmer, B., & Lockman, A. (2022). Culturally Responsive Teaching in an Undergraduate Online General Education Course. Online Learning, 26(3). https://doi.org/10.24059/olj.v26i3.2805.

[9] Coates, R. D., & Wilson-Sadberry, K. R. (1994). Minimum Competency Testing: Assessing the Effects of Assessment. Sociological Focus. https://doi.org/10.1080/00380237.1994.10571018.

[10] Kemendikbud. (2020). AKM dan implikasinya pada pembelajaran. Pusat Asesmen Dan Pembelajaran Badan Penelitian Dan Pengembangan Dan Perbukuan Kementerian Pendidikan Dan KebudayaanPembelajaran Badan Penelitian Dan Pengembangan Dan Perbukuan Kementerian Pendidikan Dan Kebudayaan, 1–37.

[11] Grisf, P., Bfattik, S., Algozzink, B. (1982). Assessment of Minimum Competency in Fifth Grade Learning Disabled Students: Test Modifications Make a Difference. The Journal of Educational Research, 76(1), 35–40. https://doi.org/https://doi.org/10.1080/00220671.1982.10885420.

[12] Kemdikbud. (2023). Rapor Pendidikan Indonesia tahun 2023. 2023. https://raporpendidikan.kemdikbud.go.id/login.

[13] Jupri, A., Drijvers, P., & van den Heuvel-Panhuizen, M. (2014). Difficulties in initial algebra learning in Indonesia. Mathematics Education Research Journal, 26(4). https://doi.org/10.1007/s13394-013-0097-0.

[14] Pramesti, T. I., & Retnawati, H. (2019). Difficulties in learning algebra: An analysis of students' errors. Journal of Physics: Conference Series, 1320(1). https://doi.org/10.1088/1742-6596/1320/1/012061.

[15] Winata, R., & Friantini, R. N. (2019). Pengaruh motivasi belajar terhadap prestasi belajar matematika siswa kelas VIII SMP negeri 1 Kuala Behe. Jurnal Math Educator Nusantara: Wahana Publikasi Karya Tulis Ilmiah Di Bidang Pendidikan Matematika, 5(01). https://doi.org/10.29407/jmen.v5i01.12810.

[16] Aprilia, G. M., Nabila, H., Karomah, R. M., Hs, E. I., Permadani, S. N., & Nursyahidah, F. (2023). Development of Probability Learning Media PjBL-STEM Based Using E-comic to Improve Students' Literacy Numeracy Skills. Kreano: Jurnal Matematika Kreatif-Inovatif, 14(1).

[17] Bonner, E. P. (2014). Investigating practices of highly successful mathematics teachers of traditionally underserved students. Educational Studies in Mathematics, 86(3), 377–399. https://doi.org/10.1007/s10649-014-9533-7.

[18] Gay, G. (2000). Genevagay_Th2000.Pdf.
[19] Cao, T. H., Nguyen, H. C., Dang, X. C., Chu, C. T., Le, T. A., & Le, T. T. H. (2022). Exploring Numeracy Skills of Lower Secondary School Students in Mountainous Areas of Northern Vietnam. International Journal of Learning, Teaching and Educational Research, 21(10), 309–324. https://doi.org/10.26803/ijlter.21.10.17.
[20] Halim, A. (2021). The Indonesian Curriculum: Does It Retain Culturally Responsive Teaching? Journal of English Language and Culture, 11(1). https://doi.org/10.30813/jelc.v11i1.2399.
[21] Civitillo, S., Juang, L. P., Badra, M., & Schachner, M. K. (2019). The interplay between culturally responsive teaching, cultural diversity beliefs, and self-reflection: A multiple case study. Teaching and Teacher Education, 77, 341–351. https://doi.org/10.1016/j.tate.2018.11.002.
[22] Buchori, A., & Harun, L. (2020). Desain E-Modul Flipbook Berbasis Culturally Responsive Teaching (CRT) Pada Materi Transformasi Geometri Di Sekolah Menengah Kejuruan. Lebesgue : Jurnal Ilmiah Pendidikan Matematika, Matematika Dan Statistika, 1(1), 63–73. https://doi.org/10.46306/lb.v1i1.
[23] Riva'i, C. (2022). Modul Ajar Culturally Responsive Teaching (CRT).
[24] Hobri. (2021). Metodologi Penelitian Pengembangan (Aplikasi Pada Penelitian Pendidikan Matematika). PENA Salsabila.
[25] Hobri. (2021). Metodologi Penelitian Pengembangan (Aplikasi Pada Penelitian Pendidikan Matematika). PENA Salsabila.