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DEVELOPMENT OF AN ACEHNESE CULTURE-BASED TEACHING MODULE TO ENHANCE ELEMENTARY STUDENTS' UNDERSTANDING OF MATHEMATICAL CONCEPTS IN ACEH BESAR

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Abstract

Mathematics learning in elementary schools is often considered abstract and difficult for students to understand due to the lack of connection with cultural contexts and everyday life. Studies show that most students in Aceh Besar experience difficulties in understanding mathematical concepts, particularly in abstract topics such as fractions and geometry. This is caused by conventional teaching methods, the limited availability of contextual teaching materials, and the lack of integration of local culture as a learning medium. This study aims to develop an Acehnese culture-based teaching module that is valid, practical, and effective in improving elementary school students' conceptual understanding of mathematics in Aceh Besar. The research employed a Research and Development (R&D) method using the ADDIE model (Analysis, Design, Development, Implementation, Evaluation). The research subjects were 118 fourth-grade students from three schools (SDN 1 Peukan Bada, SDN 2 Peukan Bada, and SDN Lamteh) along with three classroom teachers. The instruments used included validation sheets from subject matter, media, and cultural experts, interview guidelines for the module practicality test, and conceptual understanding tests. Data were analyzed using a mixed-methods approach with an Explanatory Sequential design, in which quantitative analysis was followed by qualitative analysis. The results showed that the

Acehnese culture-based teaching module was judged valid by experts, practical for teachers to use, and effective in improving students' mathematical conceptual understanding. This was indicated by the significant increase in average pretest to posttest scores, N-gain values in the high category, paired t-test and Wilcoxon results with $p < 0.001$, as well as a very large effect size. Therefore, the Acehnese culture-based teaching module is feasible to be used as an alternative teaching material in elementary school mathematics learning.

Keywords: Teaching module development, Acehnese culture, Conceptual understanding, Mathematics, Elementary school

Abstrak

Pembelajaran matematika di sekolah dasar sering dianggap abstrak dan sulit dipahami oleh siswa karena kurangnya keterkaitan dengan konteks budaya dan kehidupan sehari-hari. Hasil studi menunjukkan bahwa sebagian besar siswa di Aceh Besar mengalami kesulitan memahami konsep matematika, khususnya pada materi abstrak seperti pecahan dan geometri. Hal ini disebabkan oleh pembelajaran yang masih bersifat konvensional, minimnya bahan ajar kontekstual, serta kurangnya pemanfaatan budaya lokal sebagai media pembelajaran. Penelitian ini bertujuan untuk mengembangkan modul ajar berbasis budaya Aceh yang valid, praktis, dan efektif dalam meningkatkan pemahaman konsep matematika siswa sekolah dasar di Aceh Besar. Jenis penelitian yang digunakan adalah Research and Development (R&D) dengan model ADDIE (Analysis, Design, Development, Implementation, Evaluation). Subjek penelitian adalah 118 siswa kelas IV dari tiga sekolah (SDN 1 Peukan Bada, SDN 2 Peukan Bada, dan SDN Lamteh) serta tiga guru kelas. Instrumen penelitian meliputi lembar validasi ahli materi, media, dan budaya, pedoman wawancara uji praktis modul ajar, serta tes pemahaman konsep matematika. Data dianalisis dengan pendekatan mixed method tipe Explanatory Sequential, yaitu analisis kuantitatif dilanjutkan dengan kualitatif. Hasil penelitian menunjukkan bahwa modul ajar berbasis budaya Aceh dinyatakan valid oleh para ahli, praktis digunakan guru, dan efektif meningkatkan pemahaman konsep matematika siswa. Hal ini ditunjukkan dengan peningkatan rata-rata skor pretest ke posttest, nilai N-gain dalam kategori tinggi, hasil uji-t dan Wilcoxon dengan $p < 0{,}001$, serta effect size yang sangat besar. Dengan demikian, modul ajar berbasis budaya Aceh layak digunakan sebagai bahan ajar alternatif dalam pembelajaran matematika di sekolah dasar.

Kata Kunci: Pengembangan modul ajar, Budaya Aceh, Pemahaman konsep, Matematika, Sekolah dasar

INTRODUCTION

Mathematics learning aims to develop students' abilities to calculate, measure, infer, and apply mathematical formulas needed in daily life. Thus, students can develop skills in inquiry, testing, and generalization during the process of learning mathematics (Jarmita, 2015). Mathematics also serves as a tool for solving problems encountered in everyday life. Despite its significant impact on human life, mathematics is still often perceived as an abstract and difficult subject to understand (Jehadus et al., 2024).

Mathematics learning in elementary schools plays a vital role in building students' foundational conceptual understanding (Zagoto, 2018). However, many students in Aceh Besar still struggle to grasp abstract mathematical concepts due to the lack of connection between learning materials and cultural or real-life contexts. Studies have shown that 65% of fourth- to sixth-grade students have difficulty understanding abstract mathematical concepts such as geometry and fractions (Dinas Pendidikan Aceh Besar, n.d.).

This issue may arise from several factors: (1) learning is still conducted conventionally through lectures, (2) instructional materials lack relevance to students' real-life experiences, and (3) limited utilization of local culture as a learning medium. Conventional and less innovative mathematics instruction has also been identified as a factor that hinders the improvement of students' learning outcomes (Fadlullah & Setyawan, 2020).

Mathematics should be taught in an engaging way, using real-life examples that incorporate local cultural values. Mathematics learning is considered highly relevant when connected to local cultural values, as it can enhance students' mastery of concepts, understanding of the subject, and personality development (Harahap, 2021). Through such learning approaches, students become more interested and motivated to study mathematics (Ajmain et al., 2020).

Innovation in mathematics learning should integrate cultural elements as effective instructional media (Muhammad & Novitasari, 2020). One possible approach is to relate mathematical concepts to local cultural elements, such as geometric patterns in traditional carvings or measurement systems used in handicrafts. The development of culture-based learning materials not only aims to improve students' mathematical competence but also contributes to the development of holistic intelligence, critical thinking skills, and character formation rooted in local wisdom (Farhatin et al., 2020). Local culture-based learning can thus serve as a means to instill local wisdom values in students while enhancing their conceptual understanding (Nafis et al., 2021).

Acehnese culture, rich in philosophical values, geometric patterns in carvings, and traditional numerical systems, can serve as an effective medium to facilitate the understanding of mathematical concepts. Integrating local culture into teaching modules not only enhances learning relevance but also preserves cultural heritage and fosters students' appreciation for mathematics (Azmi et al., 2021).

Despite the growing body of research on culture-based mathematics learning in Indonesia, most existing studies primarily focus on integrating local culture as contextual examples in classroom instruction rather than systematically developing and testing structured

teaching modules. In the context of Aceh, previous studies have largely emphasized ethnomathematics concepts or cultural integration at the secondary education level, with limited attention given to the development and empirical evaluation of Acehnese culture-based teaching modules for elementary school students. Moreover, few studies comprehensively examine the validity, practicality, and effectiveness of such modules in improving elementary students' conceptual understanding of mathematics. This gap indicates the need for a well-designed and empirically tested Acehnese culture-based teaching module specifically tailored to the elementary school level, particularly in Aceh Besar.

This study aims to develop and validate an Acehnese culture-based teaching module that distinctively integrates local cultural elements into mathematics learning, addressing the lack of culturally responsive instructional materials to improve elementary students' understanding of mathematical concepts in Aceh Besar. Through a contextual approach, it is expected that students will find it easier to relate mathematical content to real-life experiences, making the learning process more meaningful.

Based on the background above, the research problems are formulated as follows: (1) How can a valid and practical Acehnese culture-based teaching module be developed to improve elementary students' understanding of mathematical concepts in Aceh Besar? (2) How effective is the Acehnese culture-based teaching module in enhancing elementary students' understanding of mathematical concepts in Aceh Besar?

This research is important because: (1) Many students struggle to understand mathematics due to a lack of contextual teaching approaches. (2) Integrating Acehnese culture into learning can introduce local values while facilitating the understanding of abstract concepts. (3) Developing culture-based teaching modules can be a creative solution to increase students' interest and achievement in mathematics.

METHODS

This study employed a Research and Development (R&D) design using the ADDIE development model, which consists of five stages: Analysis, Design, Development, Implementation, and Evaluation (Branch, 2009). The ADDIE model was chosen due to its systematic and flexible characteristics in developing instructional materials, making it well-suited for developing teaching modules.

In general, this research includes the following steps: (1) conducting a needs analysis, both theoretically and of existing similar products, to produce an improved new product; (2) developing a prototype or new product along with defining its intended goals; (3) testing the developed product with experts and users; (4) revising the product based on trial results; (5) conducting further trials on the revised product; and (6) finalizing and disseminating the final product to users to maximize its benefits.

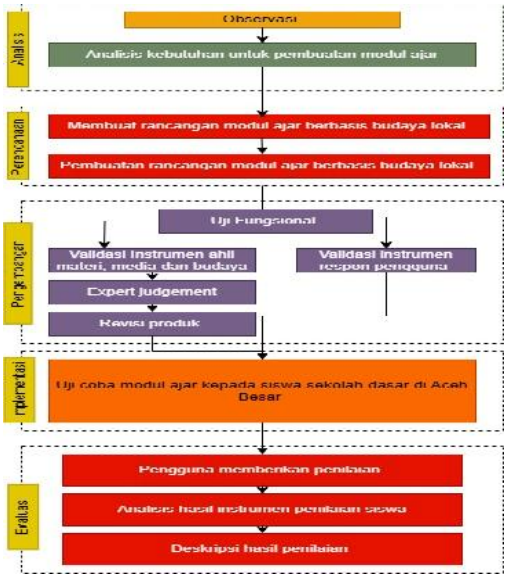

Figure 1. Research Flow

Referring to this model, the Analysis stage involves identifying user needs, defining problems, conducting detailed task analysis, mapping concepts, analyzing constraints, and conducting assessments. The Design stage focuses on creating a draft of the teaching module based on the needs analysis, ensuring the design is specific, measurable, applicable, and realistic. The Development stage transforms the design into an actual product—a culture-based teaching module incorporating Acehnese culture aimed at enhancing elementary students' understanding of mathematical concepts in Aceh Besar.

The Implementation stage involves small-scale trials to test the validity of the developed product, involving elementary school teachers and students. During the Evaluation stage, a mixed-methods approach is applied, combining quantitative and qualitative data. The mixed-methods model used is the Explanatory Sequential Model, in which data collection and analysis are conducted sequentially, beginning with quantitative data followed by qualitative data.

The research subjects consisted of 118 fourth-grade elementary school students from three schools in Aceh Besar District SD Negeri 1 Peukan Bada, SD Negeri 2 Peukan Bada, and SD Negeri Lamteh along with three fourth-grade teachers involved in the module practicality testing. The object of the research was the Acehnese culture-based teaching module developed for mathematics learning in fourth-grade elementary classes.

The research instruments included: Expert validation sheets (content, media, and cultural aspects) to assess the module's validity, Teacher interview guides to evaluate practicality, and Concept understanding tests (pretest and posttest) to measure the module's effectiveness in improving students' conceptual understanding.

Examples of research instruments are provided to clarify how data were collected and measured in this study:

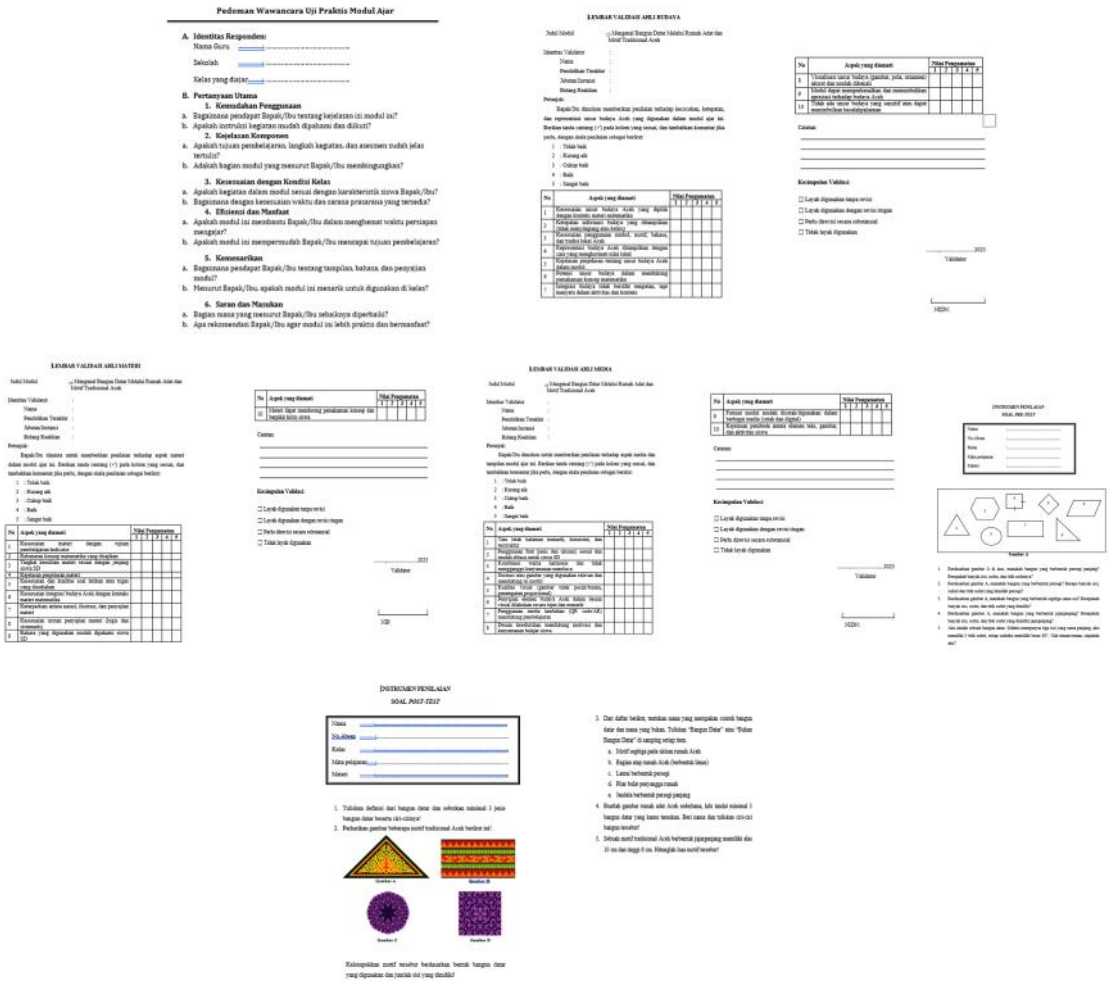

Figure 1. Research Instruments

The determination of subjects, objects, and instruments aligns with (Sugiyono, 2013) who stated that research subjects serve as data sources, while research objects are the main focus being studied. Moreover, research instruments must be adapted to the research objectives and the type of data collected.

Data collection techniques included expert validation, teacher interviews, and students' concept understanding tests. Data analysis employed a mixed-method approach, integrating both quantitative and qualitative analyses (Creswell & Creswell, 2017). Quantitative analysis was used to assess the validity and effectiveness of the module. Module validity was analyzed through experts' mean ratings on material, media, and cultural aspects (Sugiyono, 2013). Module effectiveness was analyzed using students' concept understanding test results, calculated through the N-gain to determine improvement levels (Hake, 1999), and a paired sample t-test to identify significant differences between pretest and posttest scores (Santoso, 2019).

Meanwhile, qualitative analysis was employed to evaluate the practicality of the teaching module through teacher interviews during the module's practical trials. The interview results were analyzed descriptively to illustrate the ease of use, clarity, and usefulness of the module when implemented in the classroom. Thus, the combination of quantitative and qualitative analyses provides a more comprehensive overview of the quality of the developed teaching module.

RESULT AND DISCUSSION

This study produced an Acehnese culture-based teaching module developed through the ADDIE model, which consists of five stages: Analysis, Design, Development, Implementation, and Evaluation. Each stage was systematically carried out to ensure that the resulting module possesses high quality in terms of validity, practicality, and effectiveness. The following section presents the research results according to the ADDIE development stages.

1. Presentation of the Develop Product

a. Analysis Stage

At this stage, the learning needs of fourth-grade students in Aceh Besar were identified through observations and teacher interviews, revealing that mathematics instruction relied heavily on textbooks and lacked integration with local culture. As a result, students experienced difficulties in understanding abstract concepts, particularly in plane geometry, measurement, and fractions. Therefore, an Acehnese culture-based teaching module was needed to contextualize geometry and measurement learning through local wisdom and support students' conceptual understanding.

b. Design Stage

Based on the analysis, the Acehnese culture-based teaching module was designed by integrating local contexts, such as Acehnese traditional cloth motifs to introduce plane geometry concepts (rectangles, triangles, and symmetry) and traditional houses (*Rumoh Aceh*) to support learning on measurement, area, and perimeter. The module includes learning objectives, materials, activities, exercises, and evaluations, with language and visuals adapted to students' developmental levels.

c. Development Stage

During the development stage, the Acehnese culture-based module was designed using Canva with a simple, age-appropriate layout and enriched with QR Codes and Augmented Reality (AR) features. Grounded in Multimedia Learning Theory (Mayer, 2009), AR was used to help elementary students visualize abstract mathematical concepts—such as geometric shapes and spatial relationships—through interactive representations of Acehnese cultural objects, thereby enhancing conceptual understanding through integrated visual and verbal learning.

d. Implementation Stage

Following the design and development stages, the module was implemented after validation by content, media, and cultural experts. The validated Acehnese culture-based

teaching module was then tested with fourth-grade students from three elementary schools in Aceh Besar, with data collected through geometry and measurement concept tests and teacher interviews to examine its practicality and impact on students' mathematical understanding.

e. Tahap *Evaluation*

The evaluation stage employed a mixed-method Explanatory Sequential design, beginning with quantitative analysis of students' pretest and posttest scores on plane geometry and measurement using N-Gain and paired samples *t*-tests, followed by qualitative analysis through teacher interviews. This evaluation assessed the module's validity, practicality, and effectiveness, and the results informed final revisions to ensure its suitability for mathematics learning.

2. Presentation of Trial Data

Trial data for the Acehnese culture-based teaching module were obtained from expert evaluations (material, media, and culture), teacher feedback, and student trials. Collected after the module was declared feasible, the data addressed three main aspects validity, practicality, and effectiveness serving as the basis for product evaluation and refinement.

a. Expert Validation Results

1) Media Expert Validation

Media expert validation evaluated the module's visual design, appearance, and readability, yielding a score of 48 out of 50 (96%), categorized as very valid. The module was deemed feasible for use, with minor revisions suggested to improve the cover design's visual appeal and consistency.

Before Revision

After Revision

2) Material Expert Validation

Material expert validation assessed the module's alignment with basic competencies, conceptual clarity, content completeness, and integration of Acehnese cultural context. The validation yielded a perfect score of 50 out of 50 (100%), categorized as very valid, indicating that the module is highly feasible and can be used in learning without revision.

3) Cultural Expert Validation

Cultural expert validation assessed the accuracy and integration of Acehnese cultural elements in the module, yielding a score of 49 out of 50 (98%), categorized as very valid and feasible without revision. Overall expert validation results confirmed the module's high validity across all aspects: media experts rated it 96% with minor suggestions for improving cover design, material experts rated it 100% and deemed it usable without revision, and cultural experts rated it 98%, affirming accurate and well-integrated cultural representation. Thus, the Acehnese culture-based teaching module was declared valid and ready for implementation, requiring only minor visual improvements.

b. Limited Trial and Module Evalution Results

1) Small Group Trial

A limited trial was conducted with 29 fourth-grade students at SD Negeri 01 Peukan Bada to examine the initial effectiveness of the Acehnese culture-based teaching module. Students used the module during mathematics learning, and a descriptive analysis of pretest and posttest scores was performed to assess learning outcomes, as presented in the following table.

Table 1. Descriptive Statistics of Students' Pretest and Posttest Results

Descriptive Statistics

	Pre-Test	Post-test
Valid	29	29
Missing	0	0
Mean	46.03	76.72
Std. Deviation	14.42	10.55
Minimum	20.00	55.00
Maximum	75.00	100.0

Table 1 shows that students' average score increased from 46.03 (SD = 14.42) in the pretest to 76.72 (SD = 10.55) in the posttest after using the Acehnese culture-based teaching module. Although score variability remained, the descriptive results indicate an overall improvement in students' mathematical conceptual understanding. To further examine the module's effectiveness, an N-Gain analysis was conducted based on the pretest and posttest scores, as summarized in the following table.

Table 2. Students' N-Gain Results

No.	Student Code	Pre-test	Post-test	Post-pre	Ideal Score	N-Gain score	N-Gain score (%)
1	S1	40	80	40	60	0,666667	66,66667

No.	Student Code	Pre-test	Post-test	Post-pre	Ideal Score	N-Gain score	N-Gain score (%)
2	S2	50	80	30	50	0,6	60
3	S3	40	80	40	60	0,666667	66,66667
4	S4	20	70	50	80	0,625	62,5
5	S5	35	70	35	65	0,538462	53,84615
6	S6	40	70	30	60	0,5	50
7	S7	75	90	15	25	0,6	60
8	S8	40	80	40	60	0,666667	66,66667
9	S9	20	70	50	80	0,625	62,5
10	S10	50	90	40	50	0,8	80
11	S11	70	70	0	30	0	0
12	S12	50	80	30	50	0,6	60
13	S13	50	80	30	50	0,6	60
14	S14	70	100	30	30	1	100
15	S15	40	65	25	60	0,416667	41,66667
16	S16	50	90	40	50	0,8	80
17	S17	40	60	20	60	0,333333	33,33333
18	S18	40	80	40	60	0,666667	66,66667
19	S19	50	65	15	50	0,3	30
20	S20	50	60	10	50	0,2	20
21	S21	20	70	50	80	0,625	62,5
22	S22	35	55	20	65	0,307692	30,76923
23	S23	40	75	35	60	0,583333	58,33333
24	S24	45	75	30	55	0,545455	54,54545
25	S25	65	90	25	35	0,714286	71,42857
26	S26	65	80	15	35	0,428571	42,85714
27	S27	40	80	40	60	0,666667	66,66667
28	S28	40	80	40	60	0,666667	66,66667
29	S29	65	90	25	35	0,714286	71,42857
	Average	**46,03448**	**76,72414**	**30,68965517**	**53,96552**	**0,567486**	**56,74857**

The N-Gain analysis showed an increase in average scores from 46.03 (pretest) to 76.72 (posttest), with an N-Gain of 0.56 (56.75%), categorized as moderate, indicating that the teaching module was reasonably effective in improving students' conceptual understanding. After confirming data normality, a paired samples *t*-test was conducted to examine the statistical significance of this improvement, as presented in the following table.

Table 3. Normality Test Results

Test of Normality (Shapiro-Wilk)

			W	p
Pre -Test	-	Pos t-test	0 .948	. 165

Note. Significant results suggest a deviation from normality.

Normality testing using the Shapiro–Wilk test showed that the posttest data were normally distributed (p = 0.165 > 0.05). Therefore, the analysis proceeded with a Paired Samples t-test to examine the difference between pretest and posttest scores. The hypotheses tested were H_0 (no significant difference) and H_a (a significant difference indicating the effectiveness of the Acehnese culture-based teaching module). The results of the Paired Samples t-test are presented below.

Table 4. Results of the Paired Samples T-Test

Paired Samples T-Test Table 5. Results of the Paired Samples T-Test

Measure 1	Measure 2	t	df	p
Pre-Test	Post-test	13.36	28	< .001

Note. Student's t-test.

The Paired Samples *t*-test showed a significant improvement between pretest and posttest scores ($t = –13.36$, $p < 0.001$), indicating that the Acehnese culture-based teaching module was effective in improving students' learning outcomes. To assess the magnitude of this improvement, an effect size analysis was conducted to determine the practical impact of the module on students' mathematical conceptual understanding.

Table 6. Effect Size Test Results

Paired Samples T-Test

Measure 1		Measure 2	z	df	p	*Rank-Biserial Correlation*	*SE Rank-Biserial Correlation*
Pre-Test	-	Post-test	-4.623		< .001	-1.000	0.213

The test results showed a highly significant difference between pretest and posttest scores ($Z = –4.623$, $p < 0.001$), with a very strong effect (Rank-Biserial Correlation = –1.000), indicating the high effectiveness of the Acehnese culture-based teaching module. At SD Negeri 01 Peukan Bada, students' average scores increased from 46.03 to 76.72, with an N-

Gain of 56.7% (moderate), supported by $p < 0.001$ and a large effect size. These findings confirm that the module effectively improves fourth-grade students' mathematical conceptual understanding.

Future evaluations involving more schools and students are recommended to further examine the module's effectiveness and support its broader implementation in elementary mathematics learning.

2) Evaluation of the Module Using a Mixed-Method Approach

The evaluation of the Acehnese culture-based teaching module employed a mixed-method Explanatory Sequential design, beginning with quantitative analysis of students' pretest and posttest scores, followed by qualitative analysis through teacher interviews. The evaluation was conducted in three schools—SDN 1 Peukan Bada, SDN 2 Peukan Bada, and SDN Lamteh—involving 89 fourth-grade students, and aimed to assess both the module's effectiveness in improving mathematical conceptual understanding and its practicality in classroom implementation.

To provide an initial overview of students' learning outcomes, a descriptive analysis of the pretest and posttest scores from the three schools was conducted, as presented in the following table.

Table 7. Results of Descriptive Data Analysis

Descriptive Statistics	Pre-test SD Negeri 1 Peukan Bada	Post-test SD Negeri 1 Peukan Bada	Pre-test SD Negeri 2 Peukan Bada	Post-test SD Negeri 2 Peukan Bada	Pre-test SD Negeri Lamteh	Post-test SD Negeri Lamteh
Valid	29	29	30	30	30	30
Missing	1	1	0	0	0	0
Mean	45.31	87.41	40.83	86.33	40.50	89.83
Std. Deviation	13.94	7.149	14.09	9.994	14.28	7.711
Minimum	20.00	80.00	20.00	60.00	20.00	80.00
Maximum	70.00	100.0	70.00	100.0	70.00	100.0

Descriptive analysis using JASP showed a clear increase in students' scores across all three schools. At SD Negeri 1 Peukan Bada (n = 29), the mean score increased from 45.31 (SD = 13.94) in the pretest to 87.41 (SD = 7.15) in the posttest. At SD Negeri 2 Peukan Bada (n = 30), the average score rose from 40.83 (SD = 14.09) to 86.33 (SD = 9.99), while at SD Negeri Lamteh (n = 30), it increased from 40.50 (SD = 14.28) to 89.83 (SD = 7.71). Across all schools, posttest scores were substantially higher and clustered near the maximum score of 100.

These descriptive results indicate a significant improvement in students' mathematical conceptual understanding after using the Acehnese culture-based teaching module. To further examine the magnitude of this improvement, an N-Gain analysis was conducted, as

summarized in the following table.

Table 8. Students' N-Gain Results

School	N	Average Pretest	Average Posttest	Average N-Gain (%)	Category
SDN 1 Peukan Bada	29	45.31	87.41	77.16	High
SDN 2 Peukan Bada	0	40.83	86.33	77.84	High
SDN Lamteh	0	40.50	89.83	84.51	High
Total	**9**	**81,33**	**263,57**	**239,51**	
Average		**40,66**	**87,85**	**79,83**	**High**

The N-Gain analysis showed a high improvement in students' conceptual understanding across all three schools. At SDN 1 Peukan Bada, the average score increased from 45.31 to 87.41 (N-Gain = 77.16%), while at SDN 2 Peukan Bada it rose from 40.83 to 86.33 (N-Gain = 77.84%). The highest improvement was observed at SDN Lamteh, where scores increased from 40.50 to 89.83 (N-Gain = 84.51%).

Overall, the combined average pretest score of 40.66 increased to 87.85 in the posttest, with an average N-Gain of 79.83% (high category), indicating that the Acehnese culture-based teaching module was effective in improving elementary students' mathematical conceptual understanding. Following this analysis, a normality test was conducted as a prerequisite for the paired samples *t*-test.

Table 9. Normality Test Results

Test of Normality (Kalmogorov-Smirnov)

	Statistic	p		Statistic	p
Pre-test SD Negeri 1 Peukan Bada	0.100	.935	Post-test SD Negeri 1 Peukan Bada	0.199	.200
Pre-test SD Negeri 2 Peukan Bada	0.257	.038	Post-test SD Negeri 2 Peukan Bada	0.193	.214
Pre-test SD Negeri Lamteh	0.181	.280	Post-test SD Negeri Lamteh	0.203	.170

Note. Significant results suggest a deviation from normality.

Data normality was tested using the Kolmogorov–Smirnov test, as the sample size exceeded 50, with a significance level of 0.05. The results showed that pretest and posttest data from SD Negeri 1 Peukan Bada and SD Negeri Lamteh were normally distributed ($p > 0.05$). At SD Negeri 2 Peukan Bada, the pretest data were not normally distributed ($p = 0.038$), while the posttest data met the normality assumption ($p > 0.05$).

Based on these results, parametric paired samples *t*-tests were applied to normally

distributed data, while the Wilcoxon Signed Rank Test was used for non-normal data. The hypothesis testing criteria were set at $p \leq 0.05$, where H_0 (no significant difference between pretest and posttest scores) was rejected in favor of H_a (a significant difference indicating module effectiveness).

The following presents the results of the Paired Samples T-Test for SD Negeri 1 Peukan Bada and SD Negeri Lamteh:

Table 10. Paired Samples T-Test Results

Paired Samples T-Test

Measure 1		Measure 2	t	df	p
Pre-test SD Negeri 1 Peukan Bada	-	Post-test SD Negeri 1 Peukan Bada	-17.68	28	< .001
Pre-test SD Negeri Lamteh	-	Post-test SD Negeri Lamteh	-27.56	29	< .001

Note. Student's t-test.

The paired samples *t*-test showed a significant improvement in students' mathematical conceptual understanding after using the Aceh culture-based teaching module at SD Negeri 1 Peukan Bada ($t = –17.68$, $df = 28$, $p < 0.001$) and SD Negeri Lamteh ($t = –27.56$, $df = 29$, $p < 0.001$). These results indicate a significant difference between pretest and posttest scores in both schools.

For SD Negeri 2 Peukan Bada, where the data were not normally distributed, the Wilcoxon Signed Rank Test was applied to examine the difference between pretest and posttest scores using the same effectiveness criteria ($p \leq 0.05$).

Table 11. Results of the Wilcoxon Signed Rank Test

Measure 1		Measure 2	Test	Statistic	z	df	p
Pre-test SDN 2 Peukan Bada	-	Post-test SDN 2 Peukan Bada	Student	-18.946		29	< .001
			Wilcoxon	0.000	-4.782		< .001

At SD Negeri 2 Peukan Bada, the paired samples *t*-test revealed a highly significant difference between pretest and posttest scores ($t = –18.946$, $df = 29$, $p < 0.001$), indicating that the Aceh culture-based teaching module effectively improved students' understanding of

mathematical concepts. This result was confirmed by the Wilcoxon Signed Rank Test ($z = -4.782$, $p < 0.001$), conducted due to non-normal pretest data. The consistency of both parametric and nonparametric analyses demonstrates the robustness of the module's effectiveness, which was further supported by a very large effect size, indicating a strong practical impact on students' learning outcomes.

Table 12. Effect Size Test Results

Paired Samples T-Test

Measure 1		Measure 2	t	df	p	Cohen's d	SE Cohen's d
Pre-test SD Negeri 1 Peukan Bada	-	Post-test SD Negeri 1 Peukan Bada	-17.68	28	< .001	-3.284	0.512
Pre-test SD Negeri Lamteh	-	Post-test SD Negeri Lamteh	-27.56	29	< .001	-5.033	0.468

Note. Student's t-test.

The paired samples *t*-test results at SD Negeri 1 Peukan Bada showed a highly significant improvement in students' conceptual understanding ($t = -17.68$, $df = 28$, $p < 0.001$), with a very large effect size (Cohen's $d = -3.284$). Similarly, at SD Negeri Lamteh, the analysis revealed a highly significant difference between pretest and posttest scores ($t = -27.56$, $df = 29$, $p < 0.001$), accompanied by an extremely large effect size (Cohen's $d = -5.033$). These results confirm the very high effectiveness of the Aceh culture-based teaching module in improving elementary students' mathematical conceptual understanding.

Table 13. Effect Size Test Results

Measure 1	Measure 2	Test	Statistic		df	p	Effect Size	SE Effect Size
Pre-test SD Negeri 2 Peukan Bada	Post-test SD Negeri 2 Peukan Bada	Student	-18.946		29	< .001	-3.459	0.508
		Wilcoxon	0.000	-4.782		< .001	-1.000	0.206

The paired samples *t*-test results at SD Negeri 2 Peukan Bada howed a highly significant difference between pretest and posttest scores ($t = -18.946$, $df = 29$, $p < 0.001$), with a very large effect size (Cohen's $d = -3.459$), indicating a strong impact of the Aceh culture-based

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teaching module on students' conceptual understanding. This finding was reinforced by the Wilcoxon Signed Rank Test ($z = –4.782$, $p < 0.001$) and a perfect Rank-Biserial Correlation (–1.000), confirming the module's very high effectiveness. Overall, both parametric and nonparametric analyses consistently demonstrate that the module is valid and highly effective for elementary mathematics learning in Aceh Besar.

To complement the quantitative results, qualitative data were collected through interviews with three teachers from SD Negeri 1 Peukan Bada, SD Negeri 2 Peukan Bada, and SD Negeri Lamteh. The interview findings revealed that the module is practical, easy to use, and supportive of classroom instruction, with only minor revisions suggested. A summary of these interview results is presented in the following table.

A summary of the interview findings is presented in the following table:

Table 14. Summary of Interview Analysis on the Practicality Test of the Aceh Culture-Based Teaching Module

Aspect of Practicality	Teacher 1 (SDN 1 Peukan Bada)	Teacher 2 (SDN 2 Peukan Bada)	Teacher 3 (SDN Lamteh)	Conclusion
Ease of Use	Instructions are easy to understand; objectives are clear.	The module is very helpful; steps are ready to use.	Instructions are clear, but some academic terms need simplification.	The module is easy for teachers to use, requiring only slight language simplification.
Clarity of Components	Objectives and activities are clearly stated.	Components are complete (introduction–core–closing).	The guide is comprehensive, from objectives to assessment.	Module components are clear and well-structured.
Suitability to Classroom Conditions	Suitable for diverse students, though additional media may be needed.	Activities are appropriate, but the language is too formal.	Applicable, but should be simplified for students from different backgrounds.	The module fits classroom contexts but needs language and local example adaptations.

Efficiency & Usefulness	Saves preparation time, though activities are somewhat lengthy.	Very helpful and efficient for teachers.	Builds confidence when teaching.	The module is practical and efficient, helping teachers be ready to teach.
Attractiveness	Needs more varied exercises.	Requires more engaging illustrations/pictures.	Neat layout, but should have more vibrant colors/design.	The module is fairly engaging, but adding visuals and varied exercises is recommended.
Suggestions for Improvement	Add more varied exercises.	Use more contextual language and add illustrations.	Simplify language and include more local examples.	Minor revisions needed: language, visuals, and exercise variety.

Teacher interviews indicated that the Acehnese culture-based teaching module is generally easy to use, with clear instructions, a systematic learning flow, and complete components ranging from objectives and activities to assessment. All teachers agreed that the module supports classroom implementation and reduces lesson preparation time, thereby increasing teachers' confidence in teaching. However, they also noted that some terms were too academic and the language slightly formal, suggesting the need for simplification to better suit elementary students' characteristics. In addition, teachers recommended enhancing visual elements and increasing the variety of practice exercises to improve student engagement.

Quantitatively, the module demonstrated strong effectiveness in improving students' conceptual understanding of mathematics. The average pretest scores, which initially ranged from 40 to 45, increased significantly to 86–90 in the posttest, with N-gain values classified as high. The results of the t-test and Wilcoxon test showed $p < 0.001$, and the effect size far exceeded the large-category threshold, indicating a very strong influence of the module on students' learning outcomes.

Qualitatively, the teachers' suggestions were systematically accommodated in the final product revision. These revisions included simplifying the language to be more contextual,

enriching the module with additional visual illustrations and Acehnese cultural examples—such as traditional cloth motifs and *Rumoh Aceh* structures—and expanding the variety of practice exercises in each subtopic. These improvements were implemented during the evaluation stage, ensuring that the final module reflects user feedback and demonstrates a complete and coherent Research and Development (R&D) cycle.

Discussion

This study employed the ADDIE development model (Analysis, Design, Development, Implementation, and Evaluation). The analysis stage identified teachers' and students' needs for contextual mathematics learning materials based on local culture, revealing that students struggled to understand abstract mathematical concepts when learning relied solely on textbooks. This finding aligns with constructivist theory, which emphasizes the importance of real-life contexts in supporting conceptual understanding (Upu & Bustang, 2021).

During the design and development stages, an Acehnese culture-based mathematics teaching module was developed using Canva and integrated with QR Codes and Augmented Reality (AR) to enhance interactivity. The integration of visual and digital technology is consistent with instructional design and multimedia learning theories, which state that visual elements can increase engagement and learning retention (Mayer, 2024). Expert validation in content, media, and cultural aspects indicated that the module met validity criteria with only minor revisions to visual design, supporting previous findings that culturally based modules with engaging visuals enhance students' mathematical literacy (Fitriyanti et al., 2019).

The implementation stage involved a limited trial with Grade IVB students at SDN 1 Peukan Bada, followed by wider trials in three elementary schools with 118 students. Results showed that the module was easy to use and significantly improved students' conceptual understanding of mathematics. These findings are consistent with ethnomathematics theory, which emphasizes that integrating local culture into mathematics learning makes instruction more contextual, relevant, and meaningful (Masruroh & Amir, 2024).

The evaluation stage employed a mixed-method Explanatory Sequential Design. Quantitative results showed significant increases in pretest–posttest scores, high N-gain values, $p < 0.001$ in both *t*-test and Wilcoxon analyses, and a very large effect size, indicating strong effectiveness of the module. Qualitative data from teacher interviews confirmed the module's practicality, clarity, and usefulness in supporting lesson preparation, while suggesting minor improvements such as simplifying language and adding illustrations.

Overall, the Acehnese culture-based mathematics module met the three essential quality criteria of teaching materials—validity, practicality, and effectiveness—and was positively received by teachers. The findings reinforce previous studies showing that ethnomathematics-based learning improves students' conceptual understanding, particularly in geometry, by bridging abstract concepts with real-life experiences (Masruroh & Amir, 2024) (Parmiyanti, 2023). In addition, integrating local culture into mathematics learning supports character development and local wisdom values, fostering cooperation, honesty, and responsibility (Suzana et al., 2021), while also enhancing motivation, learning satisfaction, and 21st-century

skills (Wulandari et al., 2024).

Furthermore, the development of this module contributes to cultural preservation and the strengthening of regional identity, enabling students to learn mathematics while appreciating their cultural heritage (Fatmi & Fauzan, 2022). In conclusion, the Acehnese culture-based mathematics module effectively improves elementary students' conceptual understanding and can serve as a model for developing contextual mathematics learning materials in other regions with rich local cultural resources.

CONCLUSION

The Acehnese culture-based mathematics teaching module developed through the ADDIE model is valid, practical, and effective for improving elementary students' conceptual understanding. Significant improvements were observed in learning outcomes, supported by high N-gain values, $p < 0.001$, and very large effect sizes.

Although this study was limited to three schools and fourth-grade students, the findings demonstrate that culturally responsive mathematics modules can serve as effective learning resources. Future research should expand implementation to other grade levels, regions, and integrate more advanced digital technologies.

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REFEFRENCES

Ajmain, A., Herna, H., & Masrura, S. I. (2020). Implementasi pendekatan etnomatematika dalam pembelajaran matematika. *Sigma: Jurnal Pendidikan Matematika*, *12*(1), 45–54.

Azmi, N., Nurhaliza, S., Ula, D., Syifa, D., & Aprillia, R. (2021). Eksplorasi Etnomatematika Dan Geometri Pada "Rumoh Aceh." *Ar-Riyadhiyyat: Journal of Mathematics Education*, *2*(1), 38–47.

Branch, R. M. (2009). *Instructional Design: The ADDIE Approach*. Springer US. https://doi.org/10.1007/978-0-387-09506-6

Creswell, J. W., & Creswell, J. D. (2017). *Research design: Qualitative, quantitative, and mixed methods approaches*. Sage publications. https://books.google.com/books?hl=id&lr=&id=335ZDwAAQBAJ&oi=fnd&pg=PT16&dq=Research+Design:+Qualitative,+Quantitative,+and+Mixed+Methods+Approaches

+&ots=YExXLNtumG&sig=B0XQW2FtQ9BieASaBiIgBGpCIXA

Dinas Pendidikan Aceh Besar. (n.d.). *Laporan Hasil Belajar Matematika Siswa SD*. Dinas Pendidikan.

Fadlullah, D., & Setyawan, A. (2020). Identifikasi Hasil Belajar Matematika Materi Bangun Datar Siswa Kelas I SD Negeri Socah 2 Bangkalan. *Prosiding Nasional Pendidikan: LPPM IKIP PGRI Bojonegoro*, *1*(1).

Farhatin, N., Pujiastuti, H., & Mutaqin, A. (2020). Pengembangan bahan ajar matematika berbasis kearifan lokal untuk siswa SMP Kelas VIII. *Prima: Jurnal Pendidikan Matematika*, *4*(1), 33–45.

Fatmi, N., & Fauzan, F. (2022). Kajian pendekatan etnopedagogi dalam pendidikan melalui kearifan lokal Aceh. *Al-Madaris Jurnal Pendidikan Dan Studi Keislaman*, *3*(2), 31–41.

Fitriyanti, N. L., Sukestiyarno, Y. L., & Dwidayati, N. K. (2019). The Development of Module Containing Local Culture with Realistic Approach for Mathematical Literation of Elementary School Students. *Journal of Primary Education*, *8*(8), 181–191.

Hake, R. R. (1999). Analyzing change/gain scores Unpubl. URL http. *Www Physics Indiana Edu/\backslash∼ Sdi/AnalyzingChange-Gain Pdf*, *16*(7), 1073–1080.

Harahap, R. (2021). Pengembangan Bahan Ajar Matematika SMP Berbasis Kearifan Lokal di Sekolah Menengah Pertama. *Jurnal Basicedu*, *5*(3), 1259–1270.

Jarmita, N. (2015). Kesulitan pemahaman konsep matematis siswa dalam pembelajaran matematika di kelas awal Sekolah Dasar. *PIONIR: Jurnal Pendidikan*, *4*(2). https://core.ac.uk/download/pdf/228447897.pdf

Jehadus, E., Sugiarti, L., & Jelimun, Y. (2024). Pengaruh Pendekatan Pembelajaran Matematika Realistik (PMR) terhadap Kemampuan Pemecahan Masalah Matematika ditinjau dari Kecemasan Matematis Siswa. *Didaktika: Jurnal Kependidikan*, *13*(2), 1457–1468.

Masruroh, M., & Amir, M. F. (2024). Innovative learning media: Ethnomathematics-based modules for third-grade of elementary school students. *Journal for Lesson and Learning Studies*, *7*(1), 81–93.

Mayer, R. E. (2024). The Past, Present, and Future of the Cognitive Theory of Multimedia Learning. *Educational Psychology Review*, *36*(1), 8. https://doi.org/10.1007/s10648-023-09842-1

Muhammad, A. F. N., & Novitasari, N. I. (2020). Pengembangan bahan ajar matematika berbasis etnomatematika untuk meningkatkan pemahaman matematik siswa kelas III sekolah dasar. *Jurnal Bidang Pendidikan Dasar*, *4*(1), 80–93.

Muliana, M., Nufus, H., Nuraina, N., Mahyuni, N., & Husna, A. (2023). Developing numeracy module based on local culture in Indonesia. *Jurnal Elemen*, *9*(1), 168–182.

Nafis, B., Nurfariha, M., Aisyah, S., & Marvida, T. (2021). Pengembangan Bahan Ajar Tema 7 Indahnya Keberagaman Negeriku Subtema 2 Berbasis Lokal di Sekolah Dasar. *Edukatif: Jurnal Ilmu Pendidikan*, *3*(5), 3189–3195.

Parmiyanti, A. (2023). Effectiveness of Ethnomathematics Application in Geometry Mathematics Learning. *Jurnal Pendidikan Rafflesia*, *2*(1), 1–8.

Santoso, S. (2019). *Menguasai statistik parametrik; konsep dan aplikasi dengan SPSS*.

Sugiyono, D. (2013). *Metode penelitian pendidikan pendekatan kuantitatif, kualitatif dan R&D*. https://digilib.unigres.ac.id/index.php?p=show_detail&id=43

Suzana, Y., Sabaruddin, S., Maharani, S., & Abidin, Z. (2021). Mathematics Learning Through Character Education Based On Integrated Thematic Learning: A Development Of Learning Materials. *Infinity Journal*, *10*(2), 301–318.

Upu, H., & Bustang. (2021). *Constructivism versus Cognitive Load Theory: In Search for an Effective Mathematics Teaching* (No. arXiv:2108.04796). arXiv. https://doi.org/10.48550/arXiv.2108.04796

Wulandari, D. U., Mariana, N., Wiryanto, W., & Amien, M. S. (2024). Integration of ethnomathematics teaching materials in mathematics learning in elementary school. *IJORER: International Journal of Recent Educational Research*, *5*(1), 204–218.

Zagoto, M. M. (2018). Pengembangan perangkat pembelajaran matematika berbasis realistic mathematic educations untuk siswa kelas V sekolah dasar. *Jurnal Education And Development*, *3*(1), 53–53.