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Numeracy skills students profile of Riau Province: content and construct instrument-based Riau culture and evaluation results

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ABSTRACT

Numeracy is an important ability of students and a foundation for future success. This research aimed to develop instruments, evaluate, and compare students' numeracy skills of 12 regencies of Riau Province, Indonesia. The research population was every junior high school student in Riau Province with 260,787 students. The research sample is made up of some students who were taken by multiple random sampling of 1,193 students. The data collection technique of this research was the survey approach, with the main instrument being a multiple-choice test. Eight analysis data were used in this research: content validity, Cronbach alpha reliability, confirmatory factor analysis (CFA), reliability construct, descriptive, and one-way ANOVA. The content validity analysis showed that 4 items have to be revised because of the ambiguous sentences. Cronbach alpha reliability was acquired at 0.872 with the accepted category. CFA analysis showed 19 indicators as constructs were valid categories. Overall, the numeracy skills of 12 regency students of Riau Province were not a good category. One-way ANOVA analysis showed there was a significant difference in students' numeracy skills between 12 districts in Riau Province, with a significant value of 0.000.

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1. INTRODUCTION

In the contemporary world, where technology and data reign supreme, the importance of numeracy skills for students cannot be overstated. Numeracy, the ability to understand and work with numbers, is fundamental for academic success and navigating the complexities of everyday life [1]. From solving equations in math class to interpreting statistics in science, from budgeting personal finances to making informed decisions in a data-driven society, numeracy skills permeate every aspect of modern existence [2]. This article delves into the significance of numeracy for students, exploring its impact on academic performance, real-life applications, and long-term career prospects. Numeracy skills form the backbone of a student's education. Mathematics, often considered the core subject associated with numeracy, is integral to the curriculum from early childhood through high school and beyond [3]. Proficiency in numeracy enables students to tackle mathematical problems with confidence, fostering a deeper understanding of more complex concepts as they progress through their education [4]. This foundational skill not only enhances performance in math but also in subjects such as science, economics, and technology, where quantitative analysis and logical reasoning are crucial. In the realm of science, for instance, numeracy skills are indispensable for conducting experiments, analyzing data, and drawing conclusions [5]. Students who excel in numeracy can interpret graphs, understand scientific measurements, and apply mathematical formulas to real-world phenomena [6]. Similarly, in economics, numeracy skills are essential for understanding market trends, calculating economic indicators, and making data-driven decisions. Without a solid grasp of numeracy, students may struggle to comprehend these subjects fully, limiting their academic potential.

Beyond the classroom, numeracy skills are vital for managing everyday tasks and challenges. Consider the act of shopping, where consumers constantly make decisions based on prices, discounts, and budget constraints [7]. A strong foundation in numeracy allows individuals to calculate totals, compare prices, and make financially sound choices. Similarly, when managing personal finances, numeracy skills enable individuals to budget effectively, track expenses, and plan for the future [8]. Moreover, numeracy is crucial in interpreting and understanding the vast amounts of data encountered daily. In a world inundated with information, the ability to critically evaluate statistical claims, understand percentages, and interpret graphs is paramount [9]. This skill is particularly relevant in today's society, where data-driven decision-making is prevalent in both personal and professional contexts. For instance, understanding the statistics behind health risks, election results, or economic reports empowers individuals to make informed decisions that impact their lives and communities.

Numeracy skills are also a key determinant of career success. In many professions, mathematical competence is a prerequisite. Engineers, scientists, financial analysts, and software developers, to name a few, rely heavily on numeracy to perform their jobs effectively [10]. Even in careers not traditionally associated with mathematics, numeracy skills can provide a competitive edge. For example, in marketing, professionals use data analytics to gauge campaign effectiveness, while in healthcare, practitioners use numerical data to diagnose conditions and develop treatment plans [11]. Furthermore, the rise of technology and data analytics has amplified the demand for numerate professionals. Employers increasingly seek individuals who can interpret data, solve quantitative problems, and apply mathematical reasoning to complex challenges [12]. By developing strong numeracy skills, students can enhance their employability and open doors to a wide range of career opportunities. In this context, numeracy is not just an academic requirement but a valuable asset in the job market.

In addition to immediate academic and career benefits, numeracy skills foster lifelong learning and adaptability. The rapid pace of technological advancement and the evolving nature of work mean that individuals must continually update their skills and knowledge [13]. Numeracy, with its emphasis on logical thinking and problem-solving, cultivates a mindset that is conducive to lifelong learning. Students who are proficient in numeracy are better equipped to adapt to new technologies, understand emerging trends, and engage in continuous professional development [14]. Moreover, numeracy skills contribute to the development of critical thinking and analytical abilities. These skills are not confined to mathematics alone but are transferable to a wide range of disciplines and contexts. The ability to approach problems methodically, analyze information critically, and draw reasoned conclusions is invaluable in both academic and professional settings. By nurturing these skills, education systems can prepare students to navigate the uncertainties and complexities of the modern world.

Recognizing the importance of numeracy, educators and policymakers are increasingly focused on strategies to enhance these skills among students. Effective numeracy education involves a combination of rigorous curriculum, innovative teaching methods, and real-world application. Interactive learning experiences, such as hands-on activities, games, and technology integration, can make numeracy more engaging and accessible [15]. Personalized learning approaches, tailored to individual student needs, can address gaps in understanding and build confidence [16]. Furthermore, fostering a positive attitude towards mathematics is crucial. Many students develop math anxiety, a fear of math that can hinder their performance and interest [17]. Educators can help students overcome these barriers and develop a growth mindset by creating a supportive and encouraging learning environment [18]. Celebrating small victories, emphasizing effort over innate ability, and providing constructive feedback can build students' confidence and motivation in numeracy.

Students in Indonesia have serious problems with numeracy skills. The consistently low numeracy skills among students in Indonesia can be attributed to a multifaceted array of factors that span across the educational system, socio-economic conditions, and cultural attitudes towards learning [19]. One of the primary issues is the quality of education, particularly in rural and underdeveloped areas. Many schools in these regions need more resources, including insufficient textbooks, inadequate teaching materials, and poorly maintained facilities [20]. This scarcity of resources often leads to an environment where students are not given the proper tools to grasp mathematical concepts fully, ultimately hindering their ability to perform well in numeracy. Moreover, the training and qualifications of teachers play a crucial role in shaping students' numeracy skills. In Indonesia, many teachers, especially in remote areas, may not have the adequate training or educational background necessary to teach mathematics effectively [21]. Teacher professional development opportunities are limited, and there is often a significant gap between the curriculum and the teacher's ability to deliver it effectively [22]. This results in a lack of innovative teaching methods that could make learning mathematics more engaging and comprehensible for students. Socio-economic factors also significantly impact students' numeracy skills [13]. Poverty is a pervasive issue in Indonesia, with many families struggling to meet basic needs. In such conditions, education often becomes a secondary priority [23]. Students from low-income families may have to work to support their households, leading to absenteeism and a lack of focus on their studies. Additionally, these students might not have access to supplementary educational resources, such as private tutoring or additional learning materials, which can be critical for mastering numeracy skills.

The curriculum itself can also be a contributing factor to low numeracy skills [24]. The Indonesian educational system has been criticized for its rote learning approach, where students are encouraged to memorize facts and procedures rather than understand underlying mathematical concepts [25]. This teaching method can limit students' ability to apply mathematical knowledge to real-world situations, which is a crucial aspect of numeracy [26]. Additionally, the curriculum is often not aligned with international standards, making it challenging for students to compete globally. The school assessment methods may not adequately reflect students' true understanding and abilities in mathematics [27]. Standardized tests often emphasize procedural knowledge over conceptual understanding, which can lead to a superficial grasp of numeracy skills [28]. Without proper assessment techniques that highlight areas of improvement, it is difficult for educators to address the specific needs of their students.

Cultural attitudes towards education and learning also contribute to the problem [29]. In some communities, there is a prevalent belief that education, particularly for girls, is not as important as other responsibilities [30], [31]. This cultural perspective can discourage students from investing time and effort into their studies, including mathematics. Furthermore, there is often a societal perception that mathematics is inherently difficult and inaccessible to everyone, which can demotivate students and create a self-fulfilling prophecy of poor performance [32]. Based on the problem, evaluating the numeracy skills of Riau Province students is basic to finding the quality of numeracy skills. The evaluation results can be basic to improve students through the best policy. The government and every stakeholder can follow up and define budgeting to improve the numeracy skills of students. The novelty of this study lies in its unique approach to assessing students' numeracy skills in Riau Province by integrating content and construct instruments based on Riau's cultural context. Unlike previous studies that focus solely on general mathematical proficiency, this research emphasizes the development of a culturally relevant numeracy assessment tool. Through a rigorous content and construct validation process, the study ensures the reliability and accuracy of the instrument, making it a pioneering effort in contextualized numeracy evaluation. By incorporating local cultural elements into the assessment framework, this study provides new insights into students' mathematical abilities while highlighting the importance of culturally responsive education in improving numeracy skills.

Furthermore, the research provides an in-depth analysis of students' performance across different cognitive levels (C3–C6), offering new insights into their problem-solving abilities. The findings highlight critical disparities in numeracy skills across 12 districts, shedding light on regional educational inequalities. This study contributes to educational policy by advocating for curriculum reforms that incorporate local cultural elements, ultimately enhancing students' engagement and comprehension. The results serve as a foundation for future research on culturally responsive mathematics education in Indonesia. This research answered the research question:

- How is the quality of the instrument based on content validity and reliability?
- How is the quality of the instrument based on construct validity and reliability?
- How are the evaluation results of students' numeracy skills in junior high schools in Riau Province?
- How are the evaluation results of students' numeracy skills based on indicators at the Bloom taxonomy level (C4-C6)?
- Is there a significant difference in the numeracy skills of junior high school students based on 12 districts in Riau Province?

2. METHOD

This research was quantitative research with a survey approach. The population of this research is all junior high schools in Riau Province, Indonesia with 260,787 students. The research samples were some junior high school students in Riau Province with 1,193 students. The sampling technique in this study used multiple random sampling, where the sampling process was carried out by randomizing the subdistrict and schools in each subdistrict. In each school, the sampling process is continued by randomizing the classes of schools, so this research surveyed 72 classes of 1,193 students. The data collection technique was a survey using a numeracy test instrument with four levels: cognitive C3 (application), C4 (analysis), C5 (evaluation), and C6 (created). The six data analysis techniques were proposed in this research: validity and reliability of content, validity, and reliability of construct, descriptive analysis, and one-way ANOVA analysis. There were four stages or procedures to complete this research. The research procedure started with developing instrument tests. The instrument test consisted of multiple-choice items to determine the numeracy skills of Riau Province students. A total of 10 packages of multiple-choice items were developed to get information on students' numeracy skills in Indonesia, with 40 items for every package. Before 10 packages, multiple-choice items were shared with students. Experts validated multiple-choice items to ensure these items had a high validation level or valid category. The six experts were validated instruments in content. After items were validated by an expert with high quality or validation, items were shared with 150 students to get empirical validation from three districts: Kuantan Singing, Pekanbaru, and Pelalawan. This stage was called a small-scale trial. Small-scale testing showed the quality of difficulty items, discriminant power, and empirical validity. The large-scale trial was conducted with a shared instrument of 40 items to 200 students and analyzed with second-order confirmatory factor analysis (CFA) and construct reliability. These steps get information on the quality of construct validity and construct reliability. The next step was to share the multiple-choice items with 1,193 items in 72 classes and analyze them with descriptive statistics and one-way ANOVA.

3. RESULTS AND DISCUSSION

This section reports the results of validity testing, small-scale and large-scale trials, and the evaluation of students' numeracy performance. The findings confirm the validity, practicality, and effectiveness of the developed system in enhancing students' numeracy skills through culturally grounded learning based on local wisdom, providing empirical support for its educational relevance and implementation potential [33], [34].

3.1. Validation results

The six experts assessed the content quality of the developed instrument. The instrument's alignment with indicators and coverage of all aspects of the measured topic were evaluated. The content must be representative of the concept being measured. The instrument should be usable with available resources, such as time, effort, and funds. It must also be user-friendly for both researchers and participants, requiring no complex interpretation. The language should be appropriate for the respondent group, ensuring it is easily understood and free from ambiguity. The validation results can be seen in Table 1.

Out of the 40 developed items, 4 were identified as needing revision. According to the experts, these 4 items could pose difficulties for students due to ambiguous wording and overly long sentences. After completing the content validity process, the next step is to revise the items and conduct a trial with 150 students.

3.1.1. Small-scale trial

The trial results were conducted to describe the empirical validity of the developed instrument. The trial was carried out in two districts: Kampar and Pekanbaru, with a total sample of 150 students. The trial results were analyzed for item difficulty levels, discrimination index, item validity, and instrument reliability. The analysis results can be seen in Tables 2 and 3.

Table 1. Assessment results from expert assessment [35]

Items	Sum s	Aiken' index	Conclusion	Item	Sum s	Aiken' index	Conclusion
1	13	0.867	High	21	11	0.733	Middle
2	12	0.800	Middle	22	5	0.333	Low
3	12	0.800	Middle	23	13	0.867	High
4	12	0.800	Middle	24	13	0.867	High
5	5	0.333	Low	25	13	0.867	High
6	13	0.867	High	26	13	0.867	High
7	12	0.800	Middle	27	12	0.800	Middle
8	12	0.800	Middle	28	4	0.267	Low
9	12	0.800	Middle	29	12	0.800	Middle
10	14	0.933	High	30	11	0.733	Middle
11	13	0.867	High	31	15	1	High
12	13	0.867	High	32	13	0.867	High
13	14	0.933	High	33	13	0.867	High
14	12	0.800	Middle	34	13	0.867	High
15	14	0.933	High	35	14	0.933	High
16	11	0.733	Middle	36	13	0.867	High
17	13	0.867	High	37	4	0.267	Low
18	13	0.867	High	38	12	0.800	Middle
19	13	0.867	High	39	12	0.800	Middle
20	13	0.867	High	40	13	0.867	High

Table 2. Analysis results of item difficulty levels and discrimination index [36]

Item	Difficulty level	Different power	Conclusion	Item	Difficulty level	Different power	Conclusion
1	0.73	0.33	Accepted	21	0.72	0.41	Accepted
2	0.59	0.30	Accepted	22	0.41	0.33	Accepted
3	0.81	0.27	Accepted	23	0.51	0.78	Accepted
4	0.72	0.25	Accepted	24	0.34	0.87	Accepted
5	0.41	0.22	Accepted	25	0.23	0.67	Accepted
6	0.61	0.59	Accepted	26	0.72	0.87	Accepted
7	0.79	0.43	Accepted	27	0.41	0.80	Accepted
8	0.77	0.52	Accepted	28	0.51	0.27	Accepted
9	0.50	0.55	Accepted	29	0.44	0.80	Accepted
10	0.37	0.13	Revision	30	0.33	-0.21	Replace/discard
11	0.59	0.41	Accepted	31	0.49	1	Accepted
12	0.43	0.38	Accepted	32	0.51	0.83	Accepted
13	0.52	0.36	Accepted	33	0.52	0.87	Accepted
14	0.55	0.33	Accepted	34	0.53	0.87	Accepted
15	0.58	0.30	Accepted	35	0.55	0.93	Accepted
16	0.61	0.27	Accepted	36	0.56	0.87	Accepted
17	0.44	0.25	Accepted	37	0.57	0.27	Accepted
18	0.67	0.22	Accepted	38	0.59	0.80	Accepted
19	0.49	0.19	Accepted	39	0.60	0.80	Accepted
20	0.64	0.17	Accepted	40	0.61	0.87	Accepted

Table 3. Empirical validity based on CFA [37]

Items	Loading factor	Conclusion	Item	Loading factor	Conclusion
1	0.31	Not good	21	0.52	Good
2	0.44	Good	22	0.43	Good
3	0.51	Good	23	0.47	Good
4	0.61	Good	24	0.44	Good
5	0.41	Good	25	0.26	Not good
6	0.52	Good	26	0.72	Good
7	0.55	Good	27	0.41	Good
8	0.57	Good	28	0.51	Good
9	0.61	Good	29	0.41	Good
10	0.44	Good	30	0.51	Good
11	0.41	Good	31	0.49	Good
12	0.51	Good	32	0.62	Good
13	0.44	Good	33	0.52	Good
14	0.33	Not good	34	0.63	Good
15	0.46	Good	35	0.46	Good
16	0.51	Good	36	0.54	Good
17	0.55	Good	37	0.41	Good
18	0.67	Good	38	0.40	Good
19	0.49	Good	39	0.49	Good
20	0.64	Good	40	0.43	Good

Based on the analysis of item difficulty levels and discrimination index, 2 items from the instrument were identified as needing revision or removal. This is due to their poor difficulty levels and discrimination indices. The next step is determining the empirical validity using first order CFA, as seen in Table 3.

Based on the analysis in Table 3, 3 items need to be replaced to improve the quality of the ethnomathematics-based instrument. The three revised items will be tested on a larger scale to obtain the data's construct validity and construct reliability. The new step is determining the reliability of 40 items. It shows the reliability analysis with Cronbach's alpha being 0.882. This result shows that the instrument 40 item has fulfilled the good criteria of a good instrument [38].

3.1.2. Large-scale trial

The large-scale trial was conducted to gather information about the construct validity and reliability of the data collected in the field. The instrument was tested on 200 Pelalawan, Dumai, and Kepulauan Meranti students. The analysis results can be seen in Tables 4 and 5. Based on Table 4, it can be concluded that all constructs tested in the development of the ethnomathematics-based numeracy instrument are valid and can be used to evaluate students' numeracy skills in Riau Province. The next analysis is the construct reliability analysis. The results of this analysis can be seen in Table 5.

From the results of the construct reliability analysis in Table 5, a reliability coefficient of 0.912 was obtained. This result indicates that the instrument, with 20 constructs or indicators, has an acceptable construct reliability coefficient. The ethnomathematics-based numeracy instrument can be used to evaluate students' numeracy skills in middle schools in Riau Province.

Table 4. Construct validity results used first-order CFA [39]

No	Construct	Loading factor	Conclusion
1	Whole numbers	0.58	Valid
2	Plane shapes	0.4	Valid
3	Statistics	0.59	Valid
4	Number patterns	0.67	Valid
5	Ratios	0.56	Valid
6	Lines and Angles	0.46	Valid
7	Social arithmetic	0.65	Valid
8	Probability	0.69	Valid
9	Linear equations	0.47	Valid
10	Data presentation	0.54	Valid
11	Algebra	0.68	Valid
12	Sets	0.53	Valid
13	Pythagoras	0.5	Valid
14	Relations and functions	0.67	Valid
15	Circles	0.67	Valid
16	System of 2-variable equations	0.44	Valid
17	Flat-sided solid shapes	0.47	Valid
18	Curved-sided solid shapes	0.61	Valid
19	Transformation	0.54	Valid
20	Similarity and congruence	0.52	Valid

Table 5. Construct reliability analysis [40]

No	Construct/indicators	Loading factor	Errors	CR	Conclusion
1	Whole numbers	0.58	0.67	0.912	Reliable
2	Plane shapes	0.4	0.84		
3	Statistics	0.59	0.65		
4	Number patterns	0.67	0.54		
5	Ratios	0.56	0.69		
6	Lines and angles	0.46	0.79		
7	Social arithmetic	0.65	0.58		
8	Probability	0.69	0.52		
9	Linear equations	0.47	0.78		
10	Data presentation	0.54	0.72		
11	Algebra	0.68	0.25		
12	Sets	0.53	0.72		
13	Pythagoras	0.5	0.75		
14	Relations and functions	0.67	0.55		
15	Circles	0.67	0.56		
16	System of 2-variable equations	0.44	0.51		
17	Flat-sided solid shapes	0.47	0.63		
18	Curved-sided solid shapes	0.61	0.42		
19	Transformation	0.54	0.53		
20	Similarity and congruence	0.52	0.51		

3.2. Evaluation results

Students' numeracy skills were evaluated in 12 districts/cities in Riau Province, Indonesia. This evaluation determines what percentage of students can answer numeracy questions based on the level of application, analysis, evaluation, and creation. This evaluation involved a total sample of 1,193 students who completed the questions. The analysis results can be seen in Table 6.

From the analysis results, the average percentage of students who were able to answer questions at the C3 level (application) was 17.5%. The average percentage of students who could answer C4 level (analysis) questions was 11.25%. The average percentage of students who could answer C5 level (evaluation) questions was 4.25%. The average percentage of students who could answer C6 level (creating) questions was 1.083%. Overall, the percentage of students in Riau Province who were able to answer the questions correctly was 34.08%. These results indicate that students' numeracy skills still need improvement. The evaluation results for each of the 20 indicators studied can be seen in Table 7.

Table 7 shows the percentage of each indicator that students can answer. The 17.5% of students can answer indicators of whole numbers and plane shapes. The 11.25% of students can answer number patterns, ratios, lines and angles, social arithmetic, probability, linear equations, data presentation, and algebra. The 4.25% students can answer sets, Pythagoras, relation and function, circles, system of two variable equations, and transformation. The 0.16% of students can answer flat-sided solid shapes, curved-sided solid shapes, and similarity and congruence indicators.

Table 6. Evaluation results per district according to cognitive level [41]

No	Regency	C3 (%)	C4 (%)	C5 (%)	C6 (%)	Truth answer (%)	Conclusion
1	Inhil	15	13	3	0	31	Not good
2	Rohil	18	15	3	0	36	Not good
3	Kuansing	15	8	4	1	28	Not good
4	Inhu	18	9	5	0	32	Not good
5	Bengkalis	15	11	4	2	32	Not good
6	Siak	20	9	3	1	33	Not good
7	Dumai	16	12	5	2	35	Not good
8	Pekanbaru	22	14	6	3	45	Not good
9	Pelalawan	19	11	3	1	34	Not good
10	Meranti	16	14	4	1	35	Not good
11	Kampar	17	8	7	2	34	Not good
12	Rohul	19	11	4	0	34	Not good
Average		17.5	11.25	4.25	1.083	34.08	

Table 7. Indicator evaluation results of 20 indicators [42]

No	Construct	C3	C4	C5	C6
1	Whole numbers	9.8			
2	Plane shapes	7.7			
3	Statistics		2.41		
4	Number patterns		1.53		
5	Ratios		1.34		
6	Lines and angles		1.11		
7	Social arithmetic		0.83		
8	Probability		0.8		
9	Linear equations		1.71		
10	Data presentation		0.33		
11	Algebra		0.61		
12	Sets			1.31	
13	Pythagoras			0.94	
14	Relations and functions			0.16	
15	Circles			1.17	
16	System of 2-variable equations			0.48	
17	Flat-sided solid shapes				0.61
18	Curved-sided solid shapes				0.12
19	Transformation			0.19	
20	Similarity and congruence				0.16

3.3. Comparison of students' numeracy 12 district of Riau Province

The comparison of numeracy across 12 districts was analyzed to determine whether there were significant differences in students' numeracy skills among these districts. This comparison will provide a complete picture of the difference between one district and the other 11 and which district has the highest numeracy ability. The analysis results can be seen in Table 8.

Table 8. The numeracy students' comparison of 12 regency of Riau Province [43]

Score	Sum of squares	df	Mean square	F	Sig.
Between groups	206.677.909.151	11	18.788.900.832	3.845	0.000
Within groups	6.196.873.995.649	1,268	4.887.124.602		
Total	6.403.551.904.800	1,279			

Based on the analysis in Table 8, a significance value of 0.000 was obtained, which is less than 0.05. This result indicates that there is a significant difference in numeracy skills among students from the 12 districts in Riau Province. The differences across the 12 districts are illustrated in Tables 9-18.

There is a significant difference in students' numeracy skills between Indragiri Hilir (Inhil) and Indragiri Hulu (Inhu) districts, with a significance value of 0.045. A significant difference in numeracy skills also exists between Inhil and Pelalawan districts, with a significance value of 0.009. Significant differences were also found between Inhil and Meranti districts, as well as between Inhil and Rokan Hulu (Rohul), both with a significance value of 0.009. No significant differences in numeracy skills were observed between Inhil and Bengkalis, Siak, Dumai, Pekanbaru, or Kampar districts. Further differences in numeracy skills between Rokan Hilir (Rohil) and the other 10 districts can be seen in Table 10.

There is a significant difference in students' numeracy skills between Rokan Hilir (Rohil) and Indragiri Hulu (Inhu) districts, with a significance value of 0.019. Significant differences in numeracy skills were also observed between Rohil and Pekanbaru, with a significance value of 0.024, between Rohil and Pelalawan, with a significance value of 0.003, and between Rohil and Meranti, with a significance value of 0.020. A significant difference in numeracy skills also exists between Rohil and Kampar, with a significance value of 0.020, and between Rohil and Rohul, with a significance value of 0.014. There was no significant difference in students' numeracy skills between Rohil and the districts of Kuantan Singingi (Kuansing), Bengkalis, Siak, and Dumai. Further differences in numeracy skills between Kuansing and the other nine districts can be seen in Table 11.

Table 9. Post-hoc of comparison 12 district of Riau Province [44]

(I) District	(J) District	(I-J)	Std. Error	Sig.	95% CI	
					Lower Bound	Upper Bound
Inhil	Rohil	11.431.755	32.262.578	0.723	-5.186.215	7.472.566
	Kuansing	47.724.525	31.910.209	0.135	-1.487.809	11.032.714
	Inhu	-604.54293	30.073.431	0.045	-11.945.345	-145.513
	Bengkalis	-12.878.080	31.582.847	0.684	-7.483.847	4.908.231
	Siak	27.853.570	33.274.254	0.403	-3.742.508	9.313.222
	Dumai	13.020.535	35.945.419	0.717	-5.749.850	8.353.958
	Pekanbaru	-51.552.929	27.180.603	0.058	-10.487.683	177.097
	Pelalawan	-829.20948	31.504.599	0.009	-14.472.782	-2.111.407
	Meranti	-738.59948	36.309.063	0.042	-14.509.240	-262.750
	Kampar	-54.917.726	29.038.094	0.059	-11.188.572	205.027
	Rohul	-640.41808	30.128.423	0.034	-12.314.885	-493.476

Table 10. Post-hoc difference of Rohil district with 10 other districts [45]

(I) District	(J) District	(I-J)	Std. Error	Sig.	95% CI	
					Lower bound	Upper bound
Rohil	Kuansing	36.292.770	32.426.545	0.263	-2.732.281	9.990.835
	Inhu	-718.86048	30.620.755	0.019	-13.195.897	-1.181.313
	Bengkalis	-24.309.835	32.104.448	0.449	-8.729.352	3.867.385
	Siak	16.421.815	33.769.741	0.627	-4.982.890	8.267.253
	Dumai	1.588.781	36.404.568	0.965	-6.983.103	7.300.859
	Pekanbaru	-629.84684	27.784.970	0.024	-11.749.426	-847.511
	Pelalawan	-943.52703	32.027.474	0.003	-15.718.538	-3.152.003
	Meranti	-852.91703	36.763.670	0.020	-15.741.602	-1.316.739
	Kampar	-663.49481	29.604.566	0.025	-12.442.880	-827.016
	Rohul	-754.73563	30.674.766	0.014	-13.565.244	-1.529.468

Table 11. Post-hoc difference of Kuansing district with nine other districts [46]

(I) District	(J) District	(I-J)	Std. Error	Sig.	95% CI	
					Lower bound	Upper bound
Kuansing	Inhu	-1081.78818	30.249.267	0.000	-16.752.294	-4.883.470
	Bengkalis	-60.602.605	31.750.325	0.057	-12.289.155	168.634
	Siak	-19.870.955	33.433.260	0.552	-8.546.155	4.571.964
	Dumai	-34.703.990	36.092.660	0.336	-10.551.189	3.610.391
	Pekanbaru	-992.77454	27.375.027	0.000	-15.298.278	-4.557.212
	Pelalawan	-1306.45474	31.672.490	0.000	-19.278.172	-6.850.922
	Meranti	-1215.84474	36.454.834	0.001	-19.310.290	-5.006.605
	Kampar	-1026.42251	29.220.161	0.000	-15.996.743	-4.531.707
	Rohul	-1117.66333	30.303.940	0.000	-17.121.771	-5.231.495

There is a significant difference in students' numeracy skills between the Kuansing and Inhu districts, with a significance value of 0.000. Significant differences in numeracy skills were also found between Kuansing and Pekanbaru, with a significance value of 0.000; between Kuansing and Pelalawan, with a significance value of 0.000; and between Kuansing and Meranti, with a significance value of 0.001. A significant difference also occurred between Kuansing and Kampar, with a significance value of 0.000, and between Kuansing and Rohul, with a significance value of 0.000. There was no significant difference in numeracy skills between Kuansing and the districts of Bengkalis and Dumai. Further differences in numeracy skills between Inhu and the other eight districts can be seen in Table 12.

There is a significant difference in students' numeracy skills between Inhu and Siak districts, with a significance value of 0.005. A significant difference in numeracy skills was also found between Inhu and Dumai, with a significance value of 0.033. No significant differences were observed in numeracy skills between Inhu and the districts of Bengkalis, Pekanbaru, Pelalawan, Meranti, Kampar, and Rohul. Further differences in numeracy skills between Bengkalis and the other seven districts can be seen in Table 13.

There is a significant difference in students' numeracy skills between Bengkalis and Pelalawan districts, with a significance value of 0.026. No significant differences were observed in numeracy skills between Bengkalis and the districts of Siak, Dumai, Pekanbaru, Meranti, Kampar, and Rohul. Further differences in numeracy skills between Siak and the other six districts can be seen in Table 14.

Table 12. Post-hoc difference of Inhu district with eight other districts [47]

(I) District	(J) District	(I-J)	Std. Error	Sig.	95% CI	
					Lower bound	Upper bound
Inhu	Bengkalis	47.576.213	29.903.728	0.112	-1.109.002	10.624.244
	Siak	883.07863	31.684.897	0.005	2.614.727	15.046.845
	Dumai	734.74828	34.479.413	0.033	583.185	14.111.780
	Pekanbaru	8.901.363	25.209.956	0.724	-4.055.645	5.835.918
	Pelalawan	-22.466.656	29.821.074	0.451	-8.097.073	3.603.742
	Meranti	-13.405.656	34.858.353	0.701	-8.179.205	5.498.074
	Kampar	5.536.566	27.202.346	0.839	-4.782.999	5.890.313
	Rohul	-3.587.515	28.363.332	0.899	-5.923.174	5.205.671

Table 13. Post-hoc difference of Bengkalis district with seven other districts [48]

(I) District	(J) District	(I-J)	Std. Error	Sig.	95% CI	
					Lower bound	Upper bound
Bengkalis	Siak	40.731.650	33.120.955	0.219	-2.424.625	10.570.955
	Dumai	25.898.615	35.803.559	0.470	-4.434.212	9.613.935
	Pekanbaru	-38.674.849	26.992.719	0.152	-9.163.015	1.428.045
	Pelalawan	-700.42869	31.342.645	0.026	-13.153.202	-855.372
	Meranti	-60.981.869	36.168.629	0.092	-13.193.881	997.507
	Kampar	-42.039.646	28.862.304	0.145	-9.866.277	1.458.348
	Rohul	-51.163.728	29.959.031	0.088	-10.993.845	761.100

Table 14. Post-hoc difference of Siak district with six other districts [49]

(I) District	(J) District	(I-J)	Std. Error	Sig.	95% CI	
					Lower bound	Upper bound
Siak	Dumai	-14.833.035	37.304.083	0.691	-8.801.755	5.835.148
	Pekanbaru	-794.06499	28.953.525	0.006	-13.620.859	-2.260.441
	Pelalawan	-1107.74519	33.046.349	0.001	-17.560.606	-4.594.298
	Meranti	-1017.13519	37.654.608	0.007	-17.558.571	-2.784.133
	Kampar	-827.71296	30.703.947	0.007	-14.300.742	-2.253.517
	Rohul	-918.95378	31.737.097	0.004	-15.415.838	-2.963.238

There is a significant difference in students' numeracy skills between Siak and Pekanbaru districts, with a significance value of 0.006. Significant differences were also observed between Siak and Pelalawan districts, with a significance value of 0.001; between Siak and Meranti districts, with a significance value of 0.007; between Siak and Kampar districts, with a significance value of 0.007; and between Siak and Rohul districts, with a significance value of 0.004. Further differences in numeracy skills between Dumai and the other five districts can be seen in Table 15.

There is a significant difference in students' numeracy skills between Dumai and Pekanbaru districts, with a significance value of 0.044. Significant differences were also observed between Dumai and Pelalawan districts, with a significance value of 0.007, between Dumai and Meranti districts, with a significance value of 0.030, between Dumai and Kampar districts, with a significance value of 0.043, and between Dumai and Rohul districts, with a significance value of 0.026. Further differences in numeracy skills between Pekanbaru and the other four districts can be seen in Table 16.

There was no significant difference in students' numeracy skills between Pekanbaru and Pelalawan districts, with a significance value of 0.244. No significant difference was observed between Pekanbaru and Meranti, with a significance value of 0.491. No significant difference was observed between Pekanbaru and Kampar, with a significance value of 0.888. No significant difference was observed between Pekanbaru and Rohul, with a significance value of 0.621. Further differences in numeracy skills between Pelalawan and the other three districts can be seen in Table 17.

There was no significant difference in students' numeracy skills between Pelalawan and Meranti districts, with a significance value of 0.802. No significant difference was observed between Pelalawan and Kampar, with a significance value of 0.33. No significant difference was observed between Pelalawan and Rohul with a significance value of 0.331. Further differences in numeracy skills between Meranti and the other two districts can be seen in Table 18.

There was no significant difference in students' numeracy skills Meranti and Kampar districts, with a significance value of 0.557. No significant difference was observed between Meranti and Rohul, with a significance value of 0.33. Further differences in numeracy skills between Rohul and Kampar district can be seen in Table 19. The table shows that there was no significant difference in students' numeracy skills Rohul and Kampar districts, with a significance value of 0.783.

Table 15. Post-hoc difference of Dumai with five other districts [50]

(I) District	(J) District	(I-J)	Std. Error	Sig.	95% CI	
					Lower bound	Upper bound
Dumai	Pekanbaru	-645.73465	31.987.557	0.044	-12.732.783	-181.910
	Pelalawan	-959.41484	35.734.554	0.007	-16.604.684	-2.583.613
	Meranti	-868.80484	40.034.568	0.030	-16.542.177	-833.920
	Kampar	-679.38262	33.580.196	0.043	-13.381.712	-205.940
	Rohul	-770.62343	34.527.388	0.026	-14.479.944	-932.525

Table 16. Post-hoc difference of Pekanbaru with four other districts [51]

(I) District	(J) District	(I-J)	Std. Error	Sig.	95% CI	
					Lower bound	Upper bound
Pekanbaru	Pelalawan	-31.368.019	26.901.122	0.244	-8.414.363	2.140.759
	Meranti	-22.307.019	32.395.658	0.491	-8.586.201	4.124.797
	Kampar	-3.364.797	23.965.424	0.888	-5.038.104	4.365.145
	Rohul	-12.488.879	25.275.532	0.621	-6.207.534	3.709.759

Table 17. Post-hoc difference of Pekanbaru with three other districts [52]

(I) District	(J) District	(I-J)	Std. Error	Sig.	95% CI	
					Lower bound	Upper bound
Pelalawan	Meranti	9.061.000	36.100.322	0.802	-6.176.193	7.988.393
	Kampar	28.003.222	28.776.659	0.331	-2.845.188	8.445.833
	Rohul	18.879.140	29.876.530	0.528	-3.973.373	7.749.201

Table 18. Post-hoc difference of Meranti with two other districts [53]

(I) District	(J) District	(I-J)	Std. Error	Sig.	95% CI	
					Lower bound	Upper bound
Meranti	Kampar	18.942.222	33.969.169	0.577	-4.769.974	8.558.418
	Rohul	9.818.140	34.905.807	0.779	-5.866.135	7.829.763

Table 19. Post-hoc difference of Rohul with Kampar district [54]

(I) District	(J) District	(I-J)	Std. Error	Sig.	95% CI	
					Lower bound	Upper bound
Rohul	Kampar	9.124.082	27.263.130	0.738	-4.436.172	6.260.989

Analysis shows that the content validity of the numeracy instrument was valid and reliable. The results show instruments in content can be used to get data in the field. Content validity is one of the critical aspects that must be considered in developing instruments to assess students' numeracy skills. Content validity refers to the extent to which the items in an instrument representatively cover all the aspects intended to be measured [55]. In the context of students' numeracy skills, content validity ensures that the instrument effectively measures the key components of numeracy, such as understanding basic mathematical concepts, problem-solving abilities, logical thinking, and the skill to apply mathematical concepts in real-life situations [56]. Content validity is crucial for ensuring the relevance and representation of the material being assessed [57], [58]. When developing an instrument for numeracy skills, the developer must ensure that each test item reflects the measured competencies, such as arithmetic operations, geometry, algebra, or statistics [59], [60]. An instrument lacking good content validity may lead to inaccurate measurement, where important aspects of numeracy are either neglected or overemphasized. Consequently, such an instrument will not provide a valid representation of students' overall numeracy skills.

Furthermore, the importance of content validity in developing a numeracy skills instrument is also tied to the learning objectives to be achieved. Every educational curriculum has specific competency standards that students must meet, including numeracy skills [61]. An instrument with valid content will help teachers and educators ensure that the instrument aligns with the learning objectives outlined in the curriculum [62], [63]. This way, the test results can accurately represent the extent to which students have achieved the expected competencies [64]. The process of ensuring content validity typically involves a panel of experts, including educators, mathematicians, and psychometricians, who review the alignment of test items with the intended measurement goals [65]. These experts evaluate whether the items sufficiently cover the various aspects of numeracy and how relevant each item is in the context of mathematics education [36]. Additionally, item analysis can be conducted to ensure that each item contributes meaningfully to the overall measurement of numeracy skills.

The analysis results also indicate that the construct validity falls under the good category. These findings demonstrate that the instrument's accuracy is accountable for data collection. Construct validity refers to the extent to which an instrument truly measures the construct or concept intended to be assessed [66]. In the context of students' numeracy skills, construct validity ensures that the instrument measures essential aspects of numeracy, such as arithmetic skills, mathematical concept understanding, and the application of these concepts in real-life situations [67]. Good construct validity indicates that the items in the instrument theoretically and empirically represent the students' numeracy abilities [68]. Therefore, ensuring that the instrument has strong construct validity is crucial for the measurement results to be used for making accurate decisions in the educational context, such as interventions or learning evaluations.

The reliability analysis results also show good outcomes, with reliability scores exceeding 0.8. Good reliability ensures that a valid and reliable instrument in terms of content and construct will yield optimal results in data collection. A reliable instrument will produce consistent results when administered to the same group of students at different times or under different conditions [69]. This is essential because reliability indicates that the instrument is stable and not influenced by irrelevant factors, such as the student's mood during the test or the environment where the measurement is conducted [70]. Good reliability is crucial for the numeracy test results to be trustworthy. If the instrument is unreliable, the results will fluctuate and cannot be trusted to assess students' abilities accurately [71]. For example, an instrument that produces significantly different results when administered twice to the same students under almost identical conditions shows low reliability. This could lead to errors in interpreting the results and inaccurate conclusions about students' numeracy abilities.

The evaluation results show that students' numeracy skills in 12 districts in Riau Province are very low. The percentage of students answering numeracy questions correctly is still below 40%. These findings indicate that many factors need to be addressed to improve students' numeracy skills. One of the main factors contributing to the low numeracy skills in Riau Province is the quality of teaching and teacher competence. Teachers play a crucial role in mathematics education, especially in developing numeracy skills [72]. However, many teachers in remote areas of Riau may not have adequate access to training and professional development [73]. Teachers who lack mastery of the material or the ability to teach numeracy concepts in an engaging and easy-to-understand manner will directly impact students' ability to grasp numeracy content [74]. Moreover, conventional and monotonous teaching methods pose additional challenges. Many teachers still use traditional approaches like lectures without actively engaging students in the learning process [75]. This causes students to become bored and less interested in learning mathematics. In fact, to improve numeracy skills, students need to be more involved in activities that encourage exploration, problem-solving, and applying concepts in real-life situations.

The limited facilities and infrastructure in schools, particularly in rural and remote areas of Riau Province, also contribute to students' low numeracy skills. Many schools in these areas lack adequate learning resources, such as textbooks, math teaching aids, or access to educational technologies that could help students better understand numeracy concepts [76]. In addition, access to up-to-date supplementary materials, such as textbooks and digital learning tools, is very limited [77]. This affects the quality of numeracy instruction in classrooms because students do not have enough resources for independent learning or to deepen their understanding outside of school hours. Socioeconomic factors also play a significant role in the low numeracy skills of students in Riau Province. Many students come from economically disadvantaged families. This impacts various aspects of their education, such as limited access to books and learning materials and lack of time for studying because they need to help their parents work [78]. Students from low socioeconomic backgrounds tend to have less support for their education at home, which ultimately affects their learning outcomes, including their numeracy skills [79]. In addition, children from low socioeconomic families often do not receive adequate educational stimulation at home, including in numeracy. Parents' limited knowledge of mathematics or lack of time to help their children study at home also contributes to their low numeracy skills.

Support from the environment and family is vital in developing students' numeracy skills. In many areas of Riau Province, family attention and support for children's education are still lacking. Some parents may not understand the importance of education, particularly in mathematics, or may feel unable to provide assistance due to their own limited knowledge [80]. As a result, children do not receive sufficient encouragement to learn and hone their numeracy skills at home. Another contributing factor is students' low motivation to learn mathematics [20]. Many students in Riau Province view mathematics as a difficult and unenjoyable subject. This negative perception often arises from unpleasant learning experiences in the classroom or the belief that mathematics is not relevant to everyday life [81]. Consequently, students become less motivated to study and practice numeracy, which ultimately affects their ability to master these skills.

4. CONCLUSION

The results show that the instrument development has content validity with a good category. Only 2 items must be revised to improve item quality. Construct validity shows that 20 indicators have a loading factor of more than 0.3. These results explain every indicator of students' numeracy skills was a good category. Overall, the numeracy ability of students in Riau Province is worrying because they could only answer 34.08% correctly out of the 40 items. The average percentage of students who successfully answered C3 level questions was 17.5%. For C4 level questions, the average was 11.25%. At the C5 level, the percentage was 4.25%, while for the C6 level, it was 1.083%. The overall percentage of students in Riau Province who answered the questions correctly amounted to 34.08%. The results show that there was a significant difference in numeracy skills in the 12 districts of Riau Province. Future research should explore the underlying factors contributing to students' low numeracy skills in Riau Province. Investigating aspects such as teaching methodologies, students' learning motivation, socio-economic conditions, and access to learning resources could provide a more comprehensive understanding of the issue. Additionally, further studies could focus on designing and testing intervention programs aimed at improving numeracy skills, particularly in higher-order thinking levels (C3–C6). Experimental or longitudinal studies could help evaluate the effectiveness of various teaching strategies, including problem-based learning, digital learning tools, and differentiated instruction. Moreover, a comparative study across different regions or provinces in Indonesia could offer valuable insights into best practices for numeracy education. Identifying successful models and adapting them to the Riau context may enhance students' mathematical proficiency.

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AUTHOR CONTRIBUTIONS STATEMENT

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C : **C**onceptualization
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E : Writing - Review & **E**diting
Vi : **Vi**sualization
Su : **Su**pervision
P : **P**roject administration
Fu : **Fu**nding acquisition

CONFLICT OF INTEREST STATEMENT

The authors declare that they have no conflicts of interest regarding the publication of this article.

DATA AVAILABILITY

The data that support the findings of this study are available from the corresponding author [DA], upon reasonable request.

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