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RECEIVED 13 October 2025

REVISED 10 January 2026

ACCEPTED 13 January 2026

PUBLISHED 09 February 2026

CITATION

Ginting N, Wuryandani W, Kawuryan SP,
Mustadi A, Firdaus FM and Sitorus J (2026)
Factors influencing students' critical skills
and cultural literacy skills: including
the factors of educational environment,
culture openness, socio-cultural
interactions, and information access.
Front. Educ. 11:1723815.
doi: 10.3389/educ.2026.1723815

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Factors influencing students' critical skills and cultural literacy skills: including the factors of educational environment, culture openness, socio-cultural interactions, and information access

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This research examines critical and cultural literacy skills among elementary students, along with influencing factors: gender, educational environment, cultural openness, socio-cultural interaction, and information access. It involved 200 fifth- and sixth-grade students in Karo District, Indonesia, using narrative tests to measure four components of critical skills (information gathering, understanding, application, and productive thinking) and four aspects of cultural literacy (understanding, awareness, reflection, and evaluation), supplemented by validated questionnaires. Findings show students' overall skills are moderate, with critical skills (mean = 72.20) slightly higher than cultural literacy (mean = 70.36). A significant gender gap was found, with males outperforming females in both critical skills (8.90-point gap) and cultural literacy (6.81-point gap), statistically confirmed ($p = 0.000$). Regression analysis indicates the four factors collectively and significantly influenced both skill sets ($p = 0.000$), accounting for 59.29% of variance in critical skills and 67.70% in cultural literacy. Educational environment most strongly influences critical skills ($b = 0.268$), while both educational environment ($b = 0.237$) and cultural openness ($b = 0.227$) are most dominant for cultural literacy. All factors showed significant individual influence per t -test results. These findings underscore the vital role of structured educational settings, cultural exposure, socio-cultural interaction, and information access in developing these competencies. The research highlights the need for gender-responsive pedagogy and comprehensive strategies addressing all four factors to enhance students' skills in elementary

education. The research's uniqueness and strength lie in its single empirical model, which integrates critical and cultural literacy skills into one instrument. This model applies a culturally responsive framework through Karo rituals, folklore, and cultural preservation in reflective-critical learning.

KEYWORDS

critical skill, cultural literacy, culture openness, educational environment, influence, information access, socio-cultural interaction

1 Introduction

Critical skills are a process of analyzing problems, sorting relevant information, and developing strategies for solving them (Azizah and Alnashr, 2022; Ennis, 2015). A person can connect various data and draw logical conclusions (Kibtiyah, 2022) by questioning, analyzing, evaluating, and reflecting on information (Facione, 2011; BSKAP, 2023).

In the globalization era, critical skills protect students from hoaxes, teach them to filter information, understand concepts (rather than simply memorize them), argue logically, and make decisions based on evidence. For example, to preserve culture, critical students can analyze traditional rituals or find ways to preserve them and discuss the tolerance value to combat extremism.

Critical and cultural literacy skills are mutually reinforcing, cultivating students who are both intellectually competent and culturally sensitive. This synergy manifests in their combined functions, such as preventing misinterpretation through critical scrutiny while deepening understanding via cultural insight, assessing viewpoints critically while broadening them culturally, formulating solutions analytically while ensuring their empathetic relevance, and challenging assumptions logically while considering their wider social impact (Andita and Tirtoni, 2024; Lin et al., 2023; Shliakhovchuk, 2019).

Developing these competencies from primary school is crucial, as this stage represents the golden period for nurturing logical thinking, curiosity, empathy, and cultural appreciation. Early educational interventions are foundational for cultivating higher-order cognitive and socio-emotional skills that form the basis for lifelong learning and intercultural understanding (Durlak et al., 2011; OECD, 2018). However, fewer than 50% of primary students possess adequate critical skills (Kharisma, 2018; Mullis et al., 2020), and only a minority master all their components (Firmansyah and Saepuloh, 2022; Kuhn, 2018; Paul and Elder, 2019; Sihotang and Warmi, 2023; Yurinda and Hidayat, 2023). This gap stems from insufficient exposure to thought-provoking questions (Prasetyo and Kristin, 2020; Willingham, 2008). Compounding this issue, Indonesia faces significant literacy challenges (Mawadah et al., 2024; World Bank, 2019), which constrain cognitive development and moral growth (Alexander, 2008; Fayza et al., 2021).

As a novelty value, this research examines two aspects of the same issue, namely students' critical and cultural literacy skills.

2 Literature review

2.1 Critical skills

Critical skills are higher-order competencies for solving complex problems that encompass not only critical thinking (analyzing, evaluating, and reconstructing thoughts) but also creativity, communication, collaboration, and digital literacy (Pellegrino and Hilton, 2012). Critical skills have 4 components (Lin et al., 2023; Moseley et al., 2005). *First*, gathering the information. Students actively seek and select information from various sources such as textbooks, worksheets, scientific papers, or other sources. They not only collect data but also assess the credibility of sources, check the relevance of information, and connect new knowledge with their existing understanding. Learning experiences and daily life also serve as sources of information, allowing existing knowledge to be connected to the topic being studied (Casey et al., 2017; Monchaux et al., 2015). *Second*, building understanding, which involves comprehending issues thoroughly by considering various perspectives, combining information from multiple sources, and analyzing each complexity to arrive at the right solution (Baron et al., 2017; Ritchhart et al., 2011). *Third*, applying knowledge, which involves offering new insights into a particular subject (Andrews and Higson, 2008; Bamber et al., 2019; Caswell, 2017; Clarke and Lunt, 2014; Heaviside et al., 2018). In applying knowledge, there are often several possible solutions to a single problem. Therefore, students need to choose which idea is most appropriate to use (Butterworth and Thwaites, 2013). *Fourth*, productive thinking, which is the ability to critically evaluate solutions and methodologies used, assess appropriately, propose new hypotheses, and develop new skills (Wallace and Wray, 2016). Students need to evaluate the effectiveness of their solutions by considering their positive and negative impacts, then adjust their decisions if necessary (Heard et al., 2025).

2.2 Cultural literacy skills

Cultural literacy is the ability to understand, appreciate, and apply cultural values in the context of everyday life (Ball and Mete, 2019; Desyandri, 2018; Hardiansyah, 2017; Hicks and Hirsch, 1988; Maine et al., 2019; Maine, 2021;

Ochoa et al., 2016; Ochoa et al., 2016; Pratiwi and Asyarotin, 2019). This ability not only encompasses an understanding of the diverse customs, values, beliefs, languages, arts, and lifestyles of a community but also enables individuals to connect these cultural elements to real-life situations (Segal, 2015). Thus, cultural literacy enables a person to interpret the implied meaning in cultural texts and situations and to apply it contextually and relevantly.

A person can be said to have good cultural literacy if she/he is able to understand the culture's complexity, including its values, strengths, weaknesses, and development dynamics (Halbert and Chigeza, 2015). In addition, she/he must also be able to see culture from the culture owners' perspective (Segal, 2015; Segal, 2015). This ability also includes the awareness to analyze various cultural elements, as well as concern for universal, internal, and external cultures and their relationship with language (Maine et al., 2019; Masita, 2021).

In this research, the concept of "cultural literacy" is developed as a contextual construct, not a universally applicable skill. This construct is operationalized through two main dimensions: in-depth knowledge of key narratives and symbol systems that frame Karo cultural identity and values and the individual's critical capacity to reflect on, reinterpret, and articulate the meaning and relevance of these cultural elements within the dynamics of contemporary society.

Cultural literacy skills can be assessed through four main indicators (Andita and Tirtoni, 2024; Shliakhovchuk, 2019). *First*, cross-cultural awareness, which is the ability to critically recognize and understand other cultures. *Second*, local cultural awareness, which is the acceptance and appreciation of local wisdom as the basis for developing cultural literacy. *Third*, reflection and critical thinking, which is the ability to reflect on and analyze culture from various perspectives. *Fourth*, cultural evaluation, which is a systematic process of assessing, analyzing, and providing value judgments about various aspects of culture. This process is not intended to declare a culture "good" or "bad" in absolute terms but rather to understand its complexity, dynamics, impact, and sustainability in the face of changing times.

2.3 Factors influencing students' critical and cultural literacy skills

The educational environment is an important foundation for developing cultural literacy, with critical skills at the core of understanding the diversity values (Haerul et al., 2024; Maimun et al., 2020; OECD, 2018; Sholikhah, 2022; UNESCO, 2020). This is implemented through curriculum that integrates culture, history, and the arts to train students to assess diversity analytically; the availability of diverse reading materials in libraries that encourage critical exploration of different cultural perspectives; activities such as cultural discussions, museum visits, or book clubs that train critical reflection on cultural practices; and the cooperation of the entire school community to create an environment that encourages critical analysis of

cultural values, rather than mere memorization (Banks, 2020; Safitri and Ramadan, 2022).

Openness to other cultures helps shape cultural literacy through individuals' ability to reflect on and critically analyze their cultural interactions. This includes direct interaction with other cultures through regional cultural/artistic events (Jackson, 2020; Sholikhah, 2022) or social media, as well as open-mindedness to accept differences and appreciate other perspectives, while constantly critically examining cultural biases. Openness to other cultures trains critical abilities and contributes to the creation of a social ecosystem of mutual respect and understanding (Deardorff, 2019; Yulianingsih et al., 2018).

Socio-cultural interaction shapes cultural perceptions through two main contexts: the role of the family as the initial foundation for instilling cultural values and encouraging critical analysis of these values from an early age (Nawir et al., 2025; Rogoff, 2020); and cross-cultural friendships that train critical skills in understanding different perspectives. Through these interactions, individuals not only receive cultural information but also develop the ability to critically evaluate and reflect on cultural values.

Openness to information access also influences critical and cultural literacy skills through the sources' availability that needs to be critically examined, including social media as a means of cultural exploration that requires in-depth analysis of content, books and other reading materials that provide comprehensive cultural perspectives, and information technology that facilitates access to information but requires careful assessment of its credibility. The use of these physical and digital facilities directly strengthens individuals' critical and cultural literacy skills (Nudiati, 2020; UNESCO, 2021).

2.4 Research questions

- Q1: What are the students' critical and cultural literacy skills?
 Q2: Does gender have an influence on the students' critical and cultural literacy skills?
 Q3: Do factors of the educational environment, openness to other cultures, socio-cultural interaction, and openness to information access simultaneously have an influence on the students' critical and cultural literacy skills?

The research goals are to describe the students' critical and cultural literacy skills and to examine the influence of gender, educational environment, openness to other cultures, socio-cultural interaction, and openness to information access simultaneously on the students' critical and cultural literacy skills.

2.5 Hypothesis

1. Gender has an influence on the students' critical and cultural literacy skills.
2. The educational environment, cultural openness, socio-cultural interaction, and information access simultaneously

have an influence on the students' critical and cultural literacy skills.

3 Methods

3.1 Instruments

This instrument is explicitly designed to measure in-depth knowledge of contextual and specific Karo culture (e.g., folklore, values, local history) and reflective capacity and is not claimed to be a measure of general cultural literacy.

First, researchers designed 3 narrative story problems that emphasized Karo culture, its current conditions, and contemporary issues. Each problem was equipped with trigger questions specifically designed to measure students' critical and cultural literacy skills by adapting the research location context in Karo Regency, where the population majority is from the Karo Tribe. Each problem was accompanied by steps for solving designed to guide students in developing both skills in an integrated manner, namely 4 critical skills aspects (information gathering, building understanding, applying knowledge in real contexts, and productive thinking) and 4 cultural literacy skills aspects (cultural understanding, cultural awareness, reflection and critical thinking, and cultural evaluation).

Each question is assessed based on 2 skill dimensions: critical and cultural literacy skills. Each dimension is divided into 4 assessment aspects, each with a maximum score of 10, resulting in a total maximum score of 40 for each question.

Critical skill aspects: a. information gathering, namely the ability to write and validate information from texts and identify the information needed to solve problems; b. building understanding, namely the ability to provide opinions regarding the culture's relevance in the modern era, the urgency of its preservation, and the factors causing the culture to be abandoned; c. application of knowledge, namely the ability to formulate concrete solutions to overcome cultural problems faced; and d. productive thinking, namely the ability to correct the solution's accuracy and validity and review solutions by considering various perspectives.

Cultural literacy skill aspects: a. cultural understanding, namely the ability to demonstrate knowledge about the culture in question; b. cultural awareness, namely the ability to explain how to accept and appreciate a culture; c. reflection and critical thinking, namely the ability to reflect on actions that have been and will be taken to preserve culture; and d. cultural evaluation, namely the ability to analyze the social and cultural impacts of proposed solutions.

Second, developing a questionnaire instrument containing 12 statements to measure the existing conditions of determinant factors suspected of influencing students' critical and cultural literacy skills. The statement distribution is arranged into 4 factor dimensions, namely: 1. educational environment (5 statements): measuring the extent to which the school environment stimulates critical analysis of culture through the integration of cultural content in the curriculum, the

availability of diverse reading sources in the school library, the implementation of culture-based extracurricular activities (such as museum visits), and the effectiveness of teachers in facilitating critical discussions about cultural values; 2. Openness to other cultures (2 statements): assessing students' capacity to construct and convey arguments to individuals from different cultures and to critically evaluate and appreciate other cultural perspectives, not just accepting them; 3. Socio-cultural interaction (2 statements): evaluating the frequency and quality of exchanges of perspectives that stimulate critical thinking in interactions with parents/family and with peers from different cultural backgrounds; 4. Openness to information access (3 statements): analyzing the role of social media, literary sources, and communication technology not only as sources of information but also as a means to practice skills in critiquing sources, verifying the cultural information validity, and analyzing it from various perspectives.

The questionnaire instrument uses a modified Likert scale with four answer choices that have been adjusted to the statement context. The score for each answer is determined ordinally from 0 to 3. For frequency statements, the scale used is never (score 0); rarely (1 time/week) (score 1); often (2–4 times/week) (score 2); and very often (>4 times/week) (score 3). Specifically for statement number 2 regarding the book quantity, the scale used is none (score 0); 1–5 books (score 1); 6–10 books (score 2); and > 10 books (score 3).

Third, testing the characteristics of the research instrument, which includes normality, validity, and reliability tests. Testing was conducted at a significance level (α) of 5% with a total of 200 respondents (N). The research instrument consisted of two parts: narrative story questions ($n_1 = 3$) and questionnaire statements ($n_2 = 12$). Data normality testing was carried out using the Kolmogorov-Smirnov Test, reliability testing using the Cronbach Alpha Coefficient, and item validity testing using the Pearson Product-Moment Correlation.

The test results for 3 narrative story questions (n_1) are: (1) Normality: the test statistic value (D) (0.094) < the D-table (0.096); (2) Reliability: the Cronbach's α coefficient value (0.701, high category) > 0.600; and (3) Validity: the correlation value of each question item ($r_1 = 0.633$; $r_2 = 0.772$; $r_3 = 0.811$) was greater than the r -table value (0.138). The test results for 12 questionnaire statements (n_2) are: (1) Normality: the test statistic value (D) (0.090) < the D-table (0.096); (2) Reliability: the Cronbach's α coefficient value (0.781, high category) > 0.600; (3) Validity: all item correlation values (r_1 to r_{12}) ranged from 0.507 to 0.801 and were all greater than the r -table (0.138).

Based on the test results above, the data from both research instruments (narrative story questions and questionnaires) were normally distributed, reliable, and valid.

3.2 Sample and population

The population is all students in grades V and VI with an age range of 11–13 years in 5 state elementary schools and 5 private

elementary schools in Karo District, Sumatera Utara Province, with a randomly selected sample size of 120 female and 80 male students. Overall, there were 200 students.

3.3 Data analysis

First, researchers calculated the average score of students' critical and cultural literacy skills using the formula (total score obtained from 3 questions/3). The average score was then converted into a value on a scale of 0–100 using the formula $(\text{average score}/40) \times 100$, where the comparative figure of 40 is the highest score for each question. Based on this conversion, students' ability levels were categorized into five levels (Sitorus et al., 2019), namely very low (0–54), low (>54–64), moderate (>64–79), high (>79–89), and very high (>89–100).

Second, researchers also calculated the average scores for 4 factors suspected of influencing critical and cultural literacy skills: educational environment, cultural openness, socio-cultural interaction, and information access openness. The average score for each factor was calculated by dividing the total score obtained by respondents by the statement number in that factor: 1. educational environment (total score of 5 statements/5); openness to other cultures (total score of 2 statements/2); socio-cultural interaction (total score of 2 statements/2); and openness to information access (total score of 3 statements/3). Then, the average score for each factor was converted to a scale of 0–100 using the formula $(\text{average score}/3) \times 100$, where 3 is the highest score for each statement.

Third, a statistical test was carried out by *t*-test to examine gender influences on the critical and cultural literacy skills and a multiple linear regression analysis to see the influence between the four factors and critical skills and cultural literacy skills. The confidence level was 95%, with a significance level of 5%. If the *t*-test is higher than the *t*-table or significance *F* is < 0.05, then there is a significant influence between each of the independent and dependent variables. If the *t*-test is less than the *t*-table or significance *F* is higher than 0.05, then there is no influence between each of the independent and dependent variables.

4 Results

4.1 The students' critical and cultural literacy skills

Table 1 presents the distribution of student competencies, showing critical skills at very low (<54): 14.79%, low (54–64): 8.13%, moderate (64–79): 39.58%, high (79–89): 23.13%, and very high (>89): 14.38%, while cultural literacy skills are distributed as very low: 9.79%, low: 17.71%, moderate: 41.25%, high: 23.33%, and very high: 7.92%.

Generally, the average of students' critical skills (mean = 72.20) is greater than the average of their cultural literacy skills (mean = 70.36), with a range difference of 1.84. The average of male students' critical skills (mean = 77.54) is much greater than

TABLE 1 Students' critical and cultural literacy skills.

No.	Variable	Students' critical skills Mean = 72.200					Students' cultural literacy skills Mean = 70.363					
		The percentage of respondents based on the category (%)					The percentage of respondents based on the category (%)					
		Very low	Low	Moderate	High	Very high	Very low	Low	Moderate	High	Very high	
1.	Gender											
	Male	8.750	3.750	35.000	28.750	23.750	6.250	16.250	30.000	35.000	12.500	
	Female	20.833	12.500	44.167	17.500	5.000	13.333	52.500	11.667	3.333	74.448	67.639

TABLE 2 The influence of gender on the students' critical and cultural literacy skills.

No.	Results of the <i>t</i> -test: two-sample assuming equal variances			
		1	2	
1.	Mean	Male	77.542	74.448
		Female	68.639	67.639
2.	Variance	Male	242.983	183.965
		Female	196.626	131.750
3.	Observations	Male	80	80
		Female	120	120
4.	Pooled variance		215.122	152.583
5.	Hypothesized mean difference		0	0
6.	Df		198	198
7.	t Stat		4.205	3.819
8.	<i>P</i> (<i>T</i> < = <i>t</i>) one-tail		0.000	0.000
9.	t critical one-tail		1.653	1.653
10.	<i>P</i> (<i>T</i> < = <i>t</i>) two-tail		0.000	0.000
11.	t Critical two-tail		1.972	1.972

1, The influence of gender on the students' critical skills. 2, The influence of gender on the students' cultural literacy skills.

the female one (mean = 68.64), with a range difference of 8.90, and the average of male students' cultural skills (mean = 74.45) is much greater than the female one (mean = 67.64), with a range difference of 6.81.

The percentage of male students who have critical skills in the category of high and above (high + very high), namely as much as 52.50%, is greater than that of female ones, namely as much as 22.50%. The percentage of male students who have cultural literacy skills in the category of high and above (high + very high), namely as much as 47.50%, is greater than that of female ones, namely as much as 15.00%.

4.2 The influence of gender on the students' critical and cultural literacy skills

Table 2 reveals that gender is a significant factor in influencing students' critical and cultural literacy skills, as evidenced by a 2-tailed significance value of 0.000, which is well below the critical threshold of 0.05.

4.3 Factors influencing students' critical and cultural literacy skills

Before conducting the linear regression analysis, a multicollinearity test was performed on the four independent variables. The results, presented as Variance Inflation Factor (VIF) and tolerance values, were as follows: educational environment (X_1): 1.620 (tolerance = 0.621), openness to culture (X_2): 1.702 (0.587), socio-cultural interaction (X_3): 1.625 (0.615), and access to information (X_4): 1.635 (0.612). All VIF values were well below 5

and all tolerance values were above 0.10, confirming the absence of serious multicollinearity issues.

Based on Table 3, it can be explained that 4 independent variables simultaneously influence students' critical skills and cultural literacy skills, with a significant *F* value for both abilities of 0.000, which is smaller than 0.05. For critical skills, the educational environment factor has the strongest influence (coefficient = 0.268), followed by access to information (0.217), openness to culture (0.209), and socio-cultural interaction (0.176). Meanwhile, for cultural literacy skills, the educational environment (0.237) and openness to culture (0.227) are the most dominant factors, followed by access to information (0.195) and socio-cultural interaction (0.116). The regression model's constant is 15.428 for critical skills and 19.715 for cultural literacy skills, indicating the baseline level of each skill when all factors are considered zero.

Based on the analysis, regression models were obtained to predict student abilities. The model for critical skills (Y_1) is represented by the equation $Y_1 = 15.428 + 0.268X_1 + 0.209X_2 + 0.176X_3 + 0.217X_4$, while for cultural literacy skills (Y_2) it is $Y_2 = 19.715 + 0.237X_1 + 0.227X_2 + 0.116X_3 + 0.195X_4$, where X_1 to X_4 , respectively represent educational environment, cultural openness, socio-cultural interaction, and access to information.

The coefficient of determination (R^2) for the regression model of critical skills is 0.5929, and for cultural literacy skills, it is 0.6770. These values indicate that the four independent variables (educational environment, cultural openness, socio-cultural interaction, and access to information) explain 59.29% of the variation in critical skills and 67.70% of the variation in cultural literacy skills. The remainder, 40.71 and 32.30%, respectively, is explained by other factors not included in this research.

To analyze the partial influence of each variable, a *t*-test was conducted. The results in Table 4 show that all variables have a significant influence on students' critical and cultural literacy skills.

TABLE 3 Factors influencing students' critical skills and cultural literacy skills (using a multiple linear regression).

Variables	Coefficients (b)	Standard Error	t Stat	P-value	Sig. F	Multiple R	R Square	Adjusted R square	Obs.
Factors influencing students' critical skills									
Intercept	15.428	3.554	4.341	0.000	0.000	0.770	0.5929	0.5846	200
X ₁	0.268	0.057	4.658	0.000					
X ₂	0.209	0.048	4.309	0.000					
X ₃	0.176	0.045	3.899	0.000					
X ₄	0.217	0.059	3.657	0.000					
Factors influencing students' cultural literacy skills									
Intercept	19.715	2.649	7.444	0.000	0.000	0.823	0.677	0.670	200
X ₁	0.237	0.043	5.532	0.000					
X ₂	0.227	0.036	6.272	0.000					
X ₃	0.116	0.034	3.462	0.001					
X ₄	0.195	0.044	4.420	0.000					

X₁ = Educational environment. X₂ = Culture openness. X₃ = Socio-cultural interactions. X₄ = Information access.

This is indicated by the t-statistic for each variable, which ranges from 2.769 to 5.327, being greater than the t-critical value (1.966).

5 Discussion

First, a significant gender disparity was found in students' critical and cultural literacy skills, with male students demonstrating a statistically higher average score than female students (Oda and Abdul Khadim, 2018). This finding aligns with previous research that has consistently identified gender as a significant predictor (Prastyo, 2020; Setiawan et al., 2024; Zhao et al., 2024) and revealed a clear disparity pattern in the mastery of these specific competencies (Liu and Pásztor, 2022; Liu et al., 2019). Furthermore, it corroborates the assertion that gender exerts a considerable influence on students' comprehension of cultural issues (Toti, 2024), which consequently impacts academic success, specifically in critical and cultural literacy skills (Koç, 2016; Wardani et al., 2018).

The observed superiority of male students in critical and cultural literacy skills is believed to stem from inherent biases in classroom learning. Male students often dominate classroom discussions, granting them more frequent practice in argumentation (Aguillon et al., 2020). Additionally, pedagogical approaches that emphasize competitive debate tend to favor them (Deiglmayr et al., 2019), while collaborative learning patterns more common among female students are less accommodated.

Furthermore, open-ended, project-based assessments often reward assertive styles of expression, which are more prevalent among male students (Oakhill and Petrides, 2007). The analysis of public discourse in cultural literacy also aligns more closely with the typical social experiences of male students (Banks and Banks, 2019). In terms of teacher interaction, educators tend to engage more frequently with male students on academic content, providing them with more complex cognitive feedback (OECD, 2015).

The disparity in critical and cultural literacy skills found in this research is most likely attributable not to innate biological determinism, but to a complex interaction of teaching practices, assessment formats, or classroom dynamics. Therefore, inclusive learning approaches such as portfolio assessment, structured discussions, and diverse cultural materials are needed to minimize gender bias and support the equitable development of all students' competencies.

Second, several factors develop students' critical and cultural skills: the learning environment, cultural openness, social interactions, and information access. A supportive, inclusive classroom that encourages idea exploration helps students think analytically and reflect on their learning (Ennis, 2011; Facione, 2015). Promoting dialogue about cultures and critical reflection on cultural experiences improves their ability to evaluate and appreciate diversity. Connecting learning to local cultural values directly enhances cultural understanding (Prihatiningsih et al., 2025), showing a well-designed environment is crucial for fostering both critical thinking and cultural awareness.

Cultural openness enables effective understanding and interaction with other cultures. Experiencing diversity helps students develop empathy, tolerance, and the ability to see from different viewpoints (Byram, 2008; Deardorff, 2006). This openness also enhances critical thinking by allowing students to analyze problems from multiple perspectives for a deeper understanding (Peng, 2024). Recent research confirms that students open to other cultures possess greater empathy and stronger thinking skills, particularly in diverse settings (Peña-Acuña et al., 2025). Furthermore, skills like interacting with diverse individuals and learning about cultures through media directly improve multicultural understanding (Haikuo, 2025).

Learning through social and cultural interaction is essential for internalizing knowledge and developing critical thinking (Vygotsky, 1978). Neuroscience confirms our brains are wired for social learning, making this both educationally valuable and biologically fundamental (Immordino-Yang et al., 2019).

TABLE 4 Factors influencing students' critical and cultural literacy skills (using a t-test).

No.	Results of the t-test: two-sample assuming equal variances									
			1	2	3	4	5	6	7	8
1.	Mean	X	64.033	65.917	65.500	66.167	64.033	65.917	65.500	66.167
		Y	72.200	72.200	72.200	72.200	70.363	70.363	70.363	70.363
2.	Variance	X	237.140	352.589	389.475	226.190	237.140	352.589	389.475	226.190
		Y	233.159	233.159	233.159	233.159	162.999	162.999	162.999	162.999
3.	Observations	X	200	200	200	200	200	200	200	200
		Y	200	200	200	200	200	200	200	200
4.	Pooled variance		235.150	292.874	311.317	229.674	200.070	257.794	276.237	194.595
5.	Hypothesized mean diff.		0	0	0	0	0	0	0	0
6.	Df		398	398	398	398	398	398	398	398
7.	t Stat		5.327	3.672	3.797	3.981	4.475	2.769	2.927	3.008
8.	P(T < = t) one-tail		0.000	0.000	0.000	0.000	0.000	0.003	0.002	0.001
9.	t critical one-tail		1.649	1.649	1.649	1.649	1.649	1.649	1.649	1.649
10.	P(T < = t) two-tail		0.000	0.000	0.000	0.000	0.000	0.006	0.004	0.003
11.	t Critical two-tail		1.966	1.966	1.966	1.966	1.966	1.966	1.966	1.966

1 = The influence of educational environment on the students' critical skills. 2 = The influence of culture openness on the students' critical skills. 3 = The influence of socio-cultural interactions on the students' critical skills. 4 = The influence of information access on the students' critical skills. 5 = The influence of educational environment on the students' cultural literacy skills. 6 = The influence of culture openness on the students' cultural literacy skills. 7 = The influence of socio-cultural interactions on the students' cultural literacy skills. 8 = The influence of Information access on the students' cultural literacy skills. X = Factor influencing. Y = Influenced factor.

Meaningful interactions with diverse peers help students understand social dynamics and values, aligning with effective learning through observation, discussion, and reflection (Bandura, 1977). These interactions help challenge assumptions and examine stereotypes, developing cultural understanding vital for transformative social-emotional learning (Jagers et al., 2019). Such engagement forms the core of cultural literacy frameworks using social discourse to explore cultural topics (Muhammad, 2020). Classrooms promoting collaboration among diverse students significantly strengthen critical thinking (Hu and Shu, 2025), while interactive environments develop these skills through observation, interpretation, evaluation, and reflection (Song et al., 2024).

Broad information access fundamentally supports students' critical thinking and cultural literacy development. When students can access diverse sources, they gain opportunities to explore various perspectives, compare different viewpoints, and filter reliable information, strengthening information literacy as an essential component of cultural literacy (Hobbs, 2010). Digital literacy has become equally vital, enabling students to distinguish credible information and use it ethically (Livingstone, 2004). Integrating digital literacy through project-based learning and verification methods significantly enhances critical thinking capacities while reducing vulnerability to misinformation (Sonni et al., 2025; Syakhrani, 2025).

These four factors have been proven to have a significant simultaneous influence on students' critical and cultural literacy skills. Experiences from the school environment, family, and social interactions significantly impact the understanding of culturally based reading materials (Koda, 2007; Shiotsu and Weir, 2007), while also facilitating the overall learning process (Koda, 2005).

6 Conclusion

First, students' overall skill levels are generally moderate, with critical skills slightly stronger than cultural literacy skills. However, a significant portion of students still score in the low to very low range in both areas.

Second, a substantial gender gap is evident. Male students significantly outperform female students in both critical and cultural literacy skills, with differences of nearly 9 points and 7 points, respectively. This disparity is further underscored by the fact that more than twice as many male students achieved "high" or "very high" skill levels compared to their female peers.

Third, gender is a statistically significant factor influencing students' critical and cultural literacy skills.

Fourth, four key factors: educational environment, cultural openness, socio-cultural interaction, and access to information, each have a significant impact, both individually and collectively, on students' critical and cultural literacy skills. The educational environment has the strongest influence on critical skills, while both the educational environment and cultural openness emerge as the most dominant factors for cultural literacy skills. Together, these four factors explain approximately 59% of the variance in critical skills and 68% in cultural literacy skills among students.

7 Implication and contribution

The research novelty lies in its in-depth understanding of the manifestations of critical and cultural literacy skills in one rich Karo cultural context. To illustrate, this research reveals the relationship

TABLE 5 Relationship between critical and cultural literacy skills.

No.	Critical skill (CS) and Cultural literacy skill (CLS)				Descriptions
	Assessment aspects		Assessment indicators		
1.	CS:	Information gathering	CS:	Writing the information obtained from the problem and needed to solve it and correcting the information accuracy	The first steps taken by students to solve problems about Karo culture (rituals, folklore, language, etc.) are (a) reading, validating data and information, and understanding the questions/problems; (b) making a list of known and needed facts; and (c) writing the answers
	CLS:	Cultural understanding	CLS:	Writing knowledge about culture (for example, Karo culture)	
2.	CS:	Building understanding	CS:	Writing an opinion on: the reasons for the importance of preserving Karo culture, the causes of the decline/erosion of Karo culture in the present day, and the relevance of Karo culture in the modern era	The second step is to write about the reason for the importance of preserving Karo culture, its decline, its contemporary relevance, and efforts to accept and appreciate it.
	CLS:	Local cultural awareness	CLS:	Writing how to accept and appreciate Karo culture	
3.	CS:	Applying knowledge in real-world contexts	CS:	Proposing solutions to the problems facing Karo culture	The third step is to provide solutions to Karo cultural problems, efforts students have made and will make to preserve it, and their impact.
	CLS:	Reflection and critical thinking	CLS:	Describing the efforts, both past and planned by students to preserve Karo culture, and their impact	
4.	CS:	Productive thinking	CS:	Correct the solutions by evaluating their accuracy and appropriateness for both the younger generation and the wider Karo community	The fourth step is to evaluate the solutions for their validity and suitability for the youth and the wider Karo community and to describe their social and cultural impact on Karo society
	CLS:	Cultural evaluation	CLS:	Writing the social and cultural impacts on society, especially the Karo community, resulting from the proposed solutions	

between critical and cultural literacy skills within that specific context, including its challenges and preservation efforts.

The main contribution of this research is the development of a locally responsive assessment model for critical and cultural literacy skills, demonstrating that valid evaluation must be embedded in a community's specific cultural narratives, values, and practices. The implication is that the teachers can use this model in classrooms but require professional development to implement it effectively. For example, it highlights the need for training programs that equip teachers to identify key cultural narratives, design authentic assessments based on them, and interpret results to inform instruction.

8 Limitations

1. This research is inherently limited by its culturally specific measurement tool, which is deeply rooted in the Karo context. Therefore, direct generalization to other cultures should be approached with caution. Future research should develop parallel instruments in other cultural settings to distinguish between context-specific and universal aspects of cultural literacy.
2. This research is cross-sectional in design, which limits causal inference. While regression indicates significant associations

between the four factors and the two students' skills, longitudinal or experimental research in future time is needed to confirm causality and examine how these factors shape competencies over time.

Data availability statement

The original contributions presented in this study are included in this article/supplementary material, further inquiries can be directed to the corresponding author.

Ethics statement

The studies involving humans were approved by the Ethics Committee/Institutional Review Board team of Universitas Quality Berastagi: (1) Fauzul Azhimah as Committee Chair; (2) Julius Boy NB Barus as Secretary; and (3) Frida Dian Handini, Aser Paul Nainggolan, & Jenita Anjani Sembiring as Members. The studies were conducted in accordance with the local legislation and institutional requirements. Written informed consent for participation in this study was provided by the participants' legal guardians/next of kin.

Author contributions

NG: Writing – original draft, Formal analysis, Writing – review & editing, Data curation, Methodology, Funding acquisition, Validation, Investigation, Conceptualization, Resources. WW: Writing – review & editing, Conceptualization, Writing – original draft, Formal analysis, Methodology, Data curation, Funding acquisition, Investigation, Resources, Validation. SK: Writing – original draft, Conceptualization, Resources, Writing – review & editing, Formal analysis, Investigation, Methodology, Data curation, Funding acquisition, Validation. AM: Writing – original draft, Investigation, Writing – review & editing, Methodology, Conceptualization, Resources, Data curation, Formal analysis, Funding acquisition, Validation. FF: Investigation, Resources, Conceptualization, Writing – review & editing, Writing – original draft, Data curation, Formal analysis, Funding acquisition, Methodology, Validation. JS: Validation, Formal analysis, Data curation, Methodology, Writing – review & editing, Funding acquisition, Conceptualization, Investigation, Writing – original draft, Resources.

Funding

The author(s) declared that financial support was not received for this work and/or its publication.

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Conflict of interest

The author(s) declared that this work was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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