Students' Chemistry Achievement, Learning Engagement and Cultural Awareness: A Needs Assessment for Ethno-Based Science Instruction

Norolayn K. Said and Edna B. Nabua

Mindanao State University-Iligan Institute of Technology, Philippines

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ABSTRACT

The inclusion of ethnochemistry serves as a critical catalyst for improving national and local chemical literacy rates. This study investigated the indigenous knowledge of the Meranaw people and assessed the learning outcomes of Grade 7 students to establish a foundation for culturally responsive science education in Lanao del Sur. Using a mixed-methods sequential exploratory design, the researcher documented indigenous knowledge involving traditional self-care essentials, such as face enhancers, perfumes, soaps, and shampoos derived from local flora, and conducted a needs assessment among 231 students purposively chosen in Marawi City. Qualitative findings revealed a sophisticated indigenous knowledge system rooted in local biodiversity, utilizing plants for hygienic and aesthetic purposes. Quantitative results, however, highlighted a critical educational crisis: 84.8% of students performed at the lowest achievement levels in chemistry, with 67.1% classified as Needs Improvement. Furthermore, students exhibited moderate-to-low learning engagement and a general lack of awareness regarding their own ethnochemical heritage. Moreover, statistical analysis indicated no significant relationship among students' achievement, engagement, and cultural awareness, suggesting that traditional engagement metrics are failing to drive academic success in this context. Accordingly, the existing science curriculum remains alienated from the students' lived realities. It recommends the urgent integration of Meranaw ethnochemistry into the MATATAG curriculum through localized learning materials to validate ancestral wisdom, improve chemical literacy, and foster educational equity in Lanao region.

Keywords: *Chemistry Achievement, Chemistry Learning Engagement, Cultural Awareness, Ethnochemistry, Indigenous Knowledge*

INTRODUCTION

The international community is currently reshaping science education by moving away from Eurocentric models to embrace inclusive, culturally relevant frameworks that integrate diverse knowledge systems. This transition aims to enhance educational quality and accessibility for marginalized populations, offering developing nations a significant opening for pedagogical creativity. Despite these advancements, indigenous groups continue to face substantial academic hurdles that frequently result in lower overall educational attainment. These challenges are primarily driven by a deep-seated disconnect between a student's native cultural background and the formal scientific curriculum provided by schools (1). Global assessments from the TIMSS 2023 cycle highlight a persistent learning gap, with many students failing to meet basic proficiency levels in mathematics and science. This trend is especially alarming in the Philippines, where PISA 2022 results show 15-year-olds performing significantly below international averages across all academic domains.

Lanao del Sur serves as a critical example of this crisis, as a history of conflict and poverty has led to science outcomes that consistently trail behind the rest of the nation. These recurring disparities suggest that the existing science curriculum is often perceived by local students as an alienated, external discipline rather than a relatable field of study. In response, the Department of Education has advocated for the urgent contextualization of the

K-12 curriculum to better serve the country's 110 million diverse citizens (2). Integrating ethnochemistry within the region education provides a unique opportunity to align the curriculum with a rich indigenous heritage while supporting Sustainable Development Goals for preserving traditional knowledge. By validating ancestral wisdom, educators can foster global partnerships that promote equitable benefit-sharing and ensure traditional ecological practices are integrated into modern conservation efforts (3). This inclusion serves as a catalyst for improving local chemical literacy and provides Meranaw students with a science education that honors their distinct identity.

This study specifically investigated the ethnochemical knowledge of the Meranaw people to address the historical marginalization of their intellectual heritage within the formal education system. While general ethnochemical studies exist, the specific chemical practices of the Meranaw remain largely undocumented, preventing the development of localized learning materials (4). In addition, the researcher conducted a needs assessment among Grade 7 learners to evaluate their chemistry achievement, learning engagement, and cultural awareness regarding traditional self-care essentials. Grade 7 students represent the ideal demographic for this diagnosis as they navigate the critical transition from concrete observations to abstract chemical reasoning in the K-12 spiral (5). By focusing on this formative stage of identity development, the study established a baseline for proficiency and measures how culturally responsive teaching can prevent the common dip in interest during secondary education. Hence, this research is a necessary step toward regional educational equity, serving as a springboard for appreciating Muslim heritage through the lens of modern science.

METHODOLOGY

This study employed a Mixed Methods Sequential Exploratory Design to systematically investigate the intersection of indigenous wisdom and learning outcomes. The research was strategically conducted in the 1st District of Lanao del Sur and Marawi City, specifically targeting the rural municipalities of Taraka, Poona Bayabao, and Butig for qualitative documentation due to their status as vital repositories of traditional knowledge. The participants included key community informants, selected through purposive and snowball sampling, who were at least 50 years old and knowledgeable or involved in Meranaw traditional self-care essentials. Additionally, the quantitative needs assessment involved specifically selected 231 Grade 7 students from a regular university high school in Marawi City. This demographic was chosen as they represent a critical entry point into the secondary K-12 science spiral and are in a formative stage of identity development. By integrating community-based documentation with validated assessments of student achievement, engagement, and cultural awareness, the methodology may provide a holistic framework for developing culturally responsive science education in the Bangsamoro region.

While this study may provide valuable insights into the documentation and potential curricular integration of Meranaw indigenous knowledge, several limitations were acknowledged. First, the scope of this research was restricted to a single-school sample, meaning the findings reflect localized institutional dynamics and may not be widely generalizable to other schools or divisions within the region. Second, the study was descriptive and exploratory in nature and lacked an experimental intervention or a controlled pre-test/post-test design. Accordingly, it did not provide empirical data regarding the direct causal impact of a contextualized curriculum on student academic performance. Finally, because this research serves as a foundational baseline, there remains a critical need for rigorous follow-up studies focused specifically on ethnochemistry integration to systematically implement and evaluate how the formal inclusion of Meranaw chemical practices influences learners' conceptual understanding of scientific principles.

Research Instruments

The study utilized a multi-faceted set of instruments designed to capture both qualitative and quantitative data, ensuring a holistic understanding of Meranaw ethnochemistry and student performance. The primary qualitative tool was an interview guide used to document indigenous Meranaw traditional self-care essentials from community elders and key informants. This was complemented by a literature search for secondary data from the Mamitua Saber Research and Creation Center to enrich the ethnographic findings and preserve diminishing cultural practices. Furthermore, the researcher developed an 80-item Chemistry Achievement Test to evaluate academic performance. Its purpose was to measure the mastery of Grade 7 students on specific learning competencies, particularly within the domains of the particle model of matter, changes of state, and solutions. The test underwent a rigorous validation process by science education experts to ensure its items were academically sound and aligned with the MATATAG curriculum.

Following pilot-testing and item analysis, questions categorized as either very difficult (difficulty indices between 0.00 and 0.20) or very easy (indices between 0.81 and 1.00) were removed. Consequently, the final instrument was reduced to 75 items, demonstrating high internal consistency with a Cronbach's alpha of .897. The levels of their achievement in Chemistry were then categorized using the following scale adopted from Department of Education (DepEd): 85% to 100% as high proficient, 70% to 84% as proficient, 55% to 69% as developing, 40% to 54% as beginning, and below 40% as needs improvement. On the other side, to determine the least mastered competencies among the topic domains, the Mean Percentage Scores (MPS) was determined by obtaining from the average score of the students relative to the total possible score with the following interpretations: Mastered (96% to 100%), Closely Approximating Mastery (86% to 95%), Moving towards Mastery (66% to 85%), Average (35% to 65%), Low Mastery (15% to 34%), Very Low Mastery (5% to 14%) and Absolutely No Mastery (0% to 4%).

Simultaneously, students' learning engagement and awareness were measured using two distinct survey tools. The Learning Engagement Scale was an adapted 25-item instrument (6) and used to assess students' attention, interest, and passion toward chemistry across affective, behavioral, and cognitive dimensions. The instrument possesses high psychometric integrity, having been validated through Exploratory Factor Analysis (EFA) and Confirmatory Factor Analysis (CFA) with a large sample size (N = 1,771). It indicated a strong goodness-of-fit, yielding values of chi2 df = 3.14, GFI = 0.939, CFI = 0.928, TLI = 0.922, SRMR = 0.0369, and RMSEA = 0.040. In the context of this study, the Cronbach's alpha resulted to a value of .919. The scale categorized the level of student engagement as Very Engaged (106 to 125), Engaged (86 to 105), Slightly Engaged (66 to 85), Less Engaged (46 to 65), and Not Engaged (25 to 45).

For cultural assessment, the researcher developed the Students' Awareness on the Traditional Self-care Essentials of Meranaws Questionnaire, which was a thematic tool categorized into domains such as face enhancers, perfumes, soaps and shampoos. This awareness questionnaire was crafted and validated with the assistance of science education experts following the qualitative phase to ensure it reflected authentic cultural contexts and achieved a high reliability coefficient of .924 during pilot testing. Mode was used to determine the awareness of the students on the traditional self-care essentials such as 4 (Strongly Aware), 3 (Moderately Aware), 2 (Slightly Aware) and 1 (Not Aware).

The administration of these instruments followed a standardized two-phase procedure governed by strict ethical safeguards. In the first phase, the qualitative interview guide was administered over three months after securing necessary permissions from local government units and university ethics committees. The second phase involved the needs assessment, where the achievement test, engagement scale, and awareness questionnaire were administered to 231 Grade 7 students in Marawi City. All data collection followed rigorous protocols for monitoring and secure storage to maintain objectivity and participant privacy.

Data Collection Procedure

The data gathering method was executed in two distinct phases, beginning with the acquisition of formal institutional and ethical clearances. Before any contact with participants, the researcher submitted a research proposal for review by the local government units (LGU) of Lanao del Sur and the accomplishment of forms from university ethics committee (RICO) of Mindanao State University (MSU)-Iligan Institute of Technology to ensure compliance with all governmental and institutional oversight regulations. Information sheets and consent forms were translated into the local vernacular for key informants, while student respondents provided assent alongside consent from their parents or guardians. All participants were explicitly informed of their right to voluntary participation and their ability to withdraw from the study at any time without penalty.

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The first phase focused on the qualitative documentation of Meranaw indigenous knowledge through community immersion and interviews. Over a period of three months, the researcher identified key informants based on established inclusion criteria (age, knowledge and involvement) and observed strict entry protocols. Primary data collection via interviews and field observations was continuously guided by the principle of data saturation. It was concluded only when subsequent dialogues with key informants yielded redundant information and no new thematic dimensions or insights regarding the subject, ensuring a robust and conceptually dense qualitative dataset. Moreover, the researcher supplemented the interviews with a rigorous review of historical documents, visual materials, and secondary literature archived at the Mamitua Saber Research and Creation Center to validate and enrich these primary accounts. This strategic triangulation of sources not only safeguarded the data against individual recall bias but also captured nuanced or diminishing traditional practices that may no longer be actively observed in contemporary daily life.

The second phase consisted of a quantitative needs assessment administered to 231 Grade 7 students at a regular high school within the MSU-Main Campus in Marawi City. During this phase, the researcher utilized three specialized instruments: a Chemistry Achievement Test to measure academic mastery, a Learning Engagement Scale, and a Cultural Awareness Questionnaire. The data collection was standardized through rigorous administration and monitoring protocols to maintain the integrity of the results. All gathered information was securely stored and managed using digital entry templates to ensure accuracy and the protection of participant privacy.

Data Analysis

The study started with a comprehensive qualitative analysis to document Meranaw indigenous knowledge regarding traditional self-care essentials. The researcher employed a four-step systematic procedure: domain analysis to establish semantic relationships in the gathered data, taxonomy development to group the data into sub-categories through diagrams or tables, componential analysis to specify components using direct quotations from informants, and finally thematic analysis. During the coding process, the researcher cross-checked topics, assigned descriptive wording, and performed data reduction and interpretation simultaneously with collection to ensure the narrative was grounded in authentic community transcriptions.

Furthermore, descriptive statistics including frequencies, percentages and mode were utilized to characterize the students' achievement, levels of engagement, and their awareness on the traditional self-care essentials. Spearman's rho correlation analysis was then employed to explore the interconnectedness of these variables.

RESULTS AND DISCUSSION

T his section addresses the objectives of the study, categorized into indigenous knowledge of Meranaws on traditional self-care essentials, levels of students' achievement, least mastered learning competencies, levels of students' learning engagement in Chemistry as well as their cultural awareness.

Indigenous Knowledge of Meranaws in terms of Traditional Self-care Essentials

The purpose, local, common, and scientific names as well as the method of use of the traditional self-care essentials of Meranaws are shown in Table 1.

Table 1 Traditional Self-care Essentials of the Meranaws

Purpose	Local Name	Common Name	Scientific Name	Method of Use
As face powder	Margas	Bigas	*Oryza sativum*	Processed into flour for topical application on the face
As lipstick	Galoga	Atsuete	*Bixa orellana*	Extract from seeds applied to the lips

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As Eyebrow	Nyog Niyog	*Cocos nucifera*	Burnt coconut shell/meat applied to eyebrow
As perfume	Sabe Aposotis/Pasotis	*Chenopodium ambrosiodes*	Whole part or roots extract sprinkled to the clothes
	Towa Tugli	*Derris elliptica*	Roots extract sprinkled to the clothes
	Kapompong Balanoy	*Labiatae spp.*	Leaves placed directly on the fabric or sprayed them with the leaf extract
	Kadelem Kablin	*Pogostemon cablin*	
	Kapal Suganda	*Coleus amboinicus*	
	Salapiin Papua	*Nothopanax fruiticosum*	
	Mombas Herba Buena	*Mentha arvensis*	
	Malimbato Sulasi/Balanoy	*Ocinnum sanctum*	
	Mengiyak Bulak-manok	*Ageratum conyzoides*	
	Magalaw Cilantro/Wansoy	*Coriandrum sativum*	
	Karasosi Madre cacao	*Plumeria acumingata*	Flowers placed directly on the fabric or sprayed them with the leaf extract
	Ngiran Ilang-ilang	*Cananguim odoratum*	
	Diyampaka Tsampaka	*Michelia champaca*	
	Makadadeg Lagrimas	*Chloranthus officinalis*	
	Kisol Dusol	*Kaemperia galanga*	Leaves and seeds placed directly on the fabric or sprayed them with the leaf extract
	Maraw Moras/Moro	*Andropogen zizanioides*	Roots extract sprinkled to the clothes
	Maror Sampagita	*Jasminum sambac*	Flowers and leaves placed directly on the fabric or sprayed them with the extracts
	Lenga Linga	*Sesamum orientale*	Oil from seeds sprinkled to the clothes
	Madang Marang	*Artocarpus odoratissimus*	Burnt fruit peelings allowed to aerate.
As deodorant	Apog Apog sa nga-nga/*lime*		Powder applied to the armpit
As soap	Kopaya Papaya	*Carica papaya*	Leaf extract rubbed into the skin
	Sapar Walis-haba	*Sida rhombifolia*	
	Kasep Bakalanga	*Drymaria cordata*	

	Biyaba	Bayabas	*Psidium quajava*	Leaf and fruit extract rubbed into the skin
	Citrus fruit peelings			Cut into pieces and rubbed into the skin
	Nyog	Niyog	*Cocos nucifera*	Extracted milk mixed with ash rubbed into the hair
As shampoo	Kapok	Bulak	*Ceiba pentandra*	Extract from young leaves rubbed into the hair
	Bentung, Mamaan, saging, nyog	Kawayan, Bunga, Saging, Niyog		Mixture of the roots rubbed into the hair
	Sapar	Walis-haba	*Sida rhombifolia*	Juice extracted from plant rubbed into the hair
	Ratan	Ratan	*Calamus rotang*	
	Mamaan	Bunga	*Areca catechu*	

As illustrated in the table, the Traditional Self-Care Essentials of the Meranaw people showcase a sophisticated indigenous knowledge system rooted in the local flora of their environment. This traditional apothecary covers a comprehensive range of personal hygiene and aesthetic needs, including facial powder, shampoos, soaps, deodorants, and even cosmetics like lipstick and eyebrow enhancers. By utilizing diverse plant parts, ranging from roots and seeds to flowers and fruit peelings, the Meranaw have developed specific applications for grooming. This reflects a deep-seated cultural reliance on biodiversity for maintaining both health and appearance.

The data further highlights the community's practical approach to hygiene through the formulation of natural shampoos and soaps. Hair care involves diverse methods, such as rubbing extracts from young Bulak leaves *(Kapok)* into the hair or using a complex mixture of roots from bamboo, banana, and coconut. Moreover, cleansing the body (as soap) often involves the use of Papaya *(Kopaya)* and Bayabas *(Biyaba)* leaf extracts, which are rubbed directly into the skin. These methods demonstrate an understanding of the cleansing and perhaps antimicrobial properties of these specific botanical species.

Analyzing the Method of Use, it reveals a high level of resourcefulness in how these natural materials are processed. Techniques vary from simple topical application and rubbing to more complex methods like burning fruit peelings for aeration or mixing coconut milk with ash for hair treatments. The use of lime *(Apog)* as a deodorant powder further illustrates the use of mineral-based substances alongside botanical ones. Thus, this dataset represents a rich cultural heritage where the Meranaw harmonize their lifestyle with nature, ensuring self-care is both accessible and sustainable.

Accordingly, the Meranaw ethnobotanical tradition demonstrates a sophisticated integration of local biodiversity into self-care, where plants like *Oryza sativum (Margas)*, *Bixa orellana (Galoga)*, and *Cocos nucifera (Nyog)* serve functional roles in aesthetic and hygienic practices. Contemporary pharmacological research validates these indigenous practices by identifying bioactive compounds that justify their traditional use; for instance, recent studies on *Psidium guajava (Biyaba)* confirm that its leaf extracts contain high phenolic and tannin content, providing robust antimicrobial activity against *Staphylococcus aureus* to support its use as a natural cleansing agent (7). Similarly, investigations into *Artocarpus odoratissimus (Madang)* highlight that its fruit peels possess significant antioxidant potential that neutralizes free radicals and supports skin health (8).

Furthermore, the traditional application of *Bixa orellana* as a lipstick is corroborated by its rich content of bixin and norbixin, carotenoids that serve as safe, natural pigments with additional antioxidant benefits (9). Research into *Kaempferia galanga (Kisol)* has also revealed that its major constituent, ethyl p-methoxycinnamate, offers potent photoprotective effects against UVB-induced skin aging with its role in topical face treatments (10). This synthesis of traditional wisdom and modern biochemistry suggests that Meranaw self-care is a functional bio-pharmacy that optimizes the therapeutic and protective properties of the Philippine landscape (11).

Levels of Students' Achievement in Chemistry

The frequency and the corresponding percentage of the levels of students' achievement in Chemistry is shown in Table 2.

The data presents the Chemistry achievement levels of 231 students, categorizing their performance into five distinct achievement levels. A significant majority of the participants, comprising 155 students (67.1%), are classified under the Needs Improvement level, representing the most frequent achievement category. This is followed by the Beginning level at 17.7% (41 students) and the Developing level at 13.0% (30 students). Furthermore, the higher achievement tiers are notably sparse, with only 5 students (2.16%) reaching the Proficient level and zero students (0%) attaining High Proficient status.

The result indicates a severe negative skew in academic performance, where a combined 84.8% of the student population falls within the two lowest categories. This distribution suggests that the vast majority of students have not mastered the fundamental competencies required in the Chemistry curriculum, particularly the Chemistry topic domains covered in Grade 7. The total absence of students in the High Proficient category further highlights a systemic challenge in reaching mastery, indicating that even the top-performing students struggle to transcend basic proficiency. These figures point toward a significant gap between instructional objectives and actual student learning outcomes within this group.

Table 2 Frequency and Percentage of the Levels of Students' Achievement in Chemistry

Levels	Frequency	Percentage
High Proficient	0	0%
Proficient	5	2.16%
Developing	30	13.0%
Beginning	41	17.7%
Needs Improvement	155	67.1%
Total	231	100%

Likewise, the high frequency of students in the Needs Improvement category may be interpreted as a reflection of the inherent complexity and abstract nature of Chemistry education. Modern research suggests that science achievement is often hindered by a lack of student motivation and engagement, which has been observed to decrease during adolescent years. When students are not sufficiently motivated, they may fail to engage with the symbolic and microscopic reasoning necessary for Chemistry, leading to the high failure or Beginning rates seen in this data. Furthermore, traditional lecture-based formats may not be meeting the diverse readiness levels of students, necessitating a shift toward more differentiated instructional strategies (12). Supporting literature emphasizes that low achievement levels in STEM subjects often correlate with high levels of academic stress and a lack of effective learning strategies (13).

Least Mastered Learning Competencies

The least mastered learning competencies with the topic domains of the students are shown in Table 3.

Table 3 outlines the performance of 231 students across various Chemistry domains and general achievement tiers. Generally, the bulk of the student population struggles, with 155 students (67.1%) categorized as Needs Improvement and zero students reaching High Proficient status. On a competency level, Use of Models yielded the highest Mean Percentage Score (MPS) at 46.7%, interpreted as Average. However, aside from Changes of

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State, more technical domains like Solutions, Solubility, and Concentration showed significantly lower performance, with scores dipping as low as 27.0%, falling into the Low Mastery category. These constitute the least mastered competencies among the respondents in Grade 7.

Table 3 Students' Mastery Level of Learning Competencies with the Corresponding Topic Domains in Chemistry

Learning Competency (LC)	Topic Domain	Mean Percentage Score (MPS)	Interpretation
1	Use of Models	46.7%	Average
2	The Particle Model and Changes of State	42.5%	Average
3		39.5%	Average
4		39.8%	Average
5		34.0%	Low Mastery
6	Planning, Following, and Recording Scientific Investigations	44.6%	Average
7		42.6%	Average
8	Solutions, Solubility, and Concentration	36.4%	Average
9		31.8%	Low Mastery
10		36.1%	Average
11		27.0%	Low Mastery
12		32.5%	Low Mastery

Furthermore, the result indicates a clear difficulty with quantitative and abstract concepts compared to descriptive scientific processes. While students maintained an Average interpretation in Planning and Recording Scientific Investigations (MPS 42.6% to 44.6%), they faced a sharp decline in Solutions and Concentration (MPS 27.0% to 32.5%). This specific deficiency in the Solutions domain correlates with the overall achievement data, where 84.8% of students are combined in the Beginning and Needs Improvement levels. As the complexity of the topic domain increases from conceptual models to mathematical applications, student mastery proportionally decreases.

Likewise, it suggests that the Low Mastery in solutions and concentrations is a byproduct of the mathematization of Chemistry, which often alienates struggling learners. High-level chemical literacy requires an integration of mathematical logic with microscopic visualization, a cognitive load that many students in the Needs Improvement level cannot yet manage. Recent literature suggests that students often perceive Chemistry as a fragmented set of facts rather than an interconnected system, leading to a failure in applying models to real-world solutions (14). This lack of conceptual scaffolding explains why students can achieve an Average score in investigation planning but fail significantly when calculating concentrations.

Current research emphasizes that the gap between Average and High Proficiency is often widened by a lack of System Thinking in science education. Students frequently encounter challenge with solubility and concentration because these topics require simultaneous processing of macroscopic observations and sub-microscopic interactions. Furthermore, the persistent Low Mastery (27.0%) in these domains is often linked to math anxiety within the science classroom, which prevents students from successfully transitioning between qualitative and quantitative data (15). This aligns with the data showing that even the highest MPS (46.7%) does not reach a Proficient threshold.

Accordingly, to elevate the 67.1% of students needing improvement, pedagogy must shift from rote calculation to model-based inquiry that bridges the gap between descriptive and mathematical Chemistry. By strengthening

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the Average performance in Use of Models, educators can create a foundation for tackling the more difficult Low Mastery areas. Addressing the specific competency gaps is the most direct route to shifting the overall achievement levels toward Proficient and High Proficient statuses.

Levels of Students' Learning Engagement in Chemistry

The frequency and the corresponding percentage of the levels of students' learning engagement in Chemistry is shown in Table 4.

Table 4 demonstrates the engagement levels of 231 students in Chemistry, categorized into five distinct levels of involvement. The highest concentration of students is found in the Slightly Engaged category, which includes 73 individuals (31.6%), followed closely by the Less Engaged group with 71 students (30.7%). In the higher tiers of engagement, 65 students (28.1%) are classified as Engaged, while a very small minority of 9 students (3.90%) are considered Very Engaged. Lastly, the Not Engaged category accounts for 13 students, representing 5.60% of the total population.

Table 4 Frequency and Percentage of the Levels of Students' Engagement in Chemistry

Levels	Frequency	Percentage
Very Engaged	9	3.90%
Engaged	65	28.1%
Slightly Engaged	73	31.6%
Less Engaged	71	30.7%
Not Engaged	13	5.60%
Total	231	100%

As can be gleaned, it reveals a moderate-to-low engagement profile, where approximately 62.3% of the students fall into the Slightly or Less Engaged categories. This suggests that while most students are present and participating to some degree, they lack the deep commitment required for high-level academic success in a complex science subject. The disparity between the Engaged (28.1%) and Very Engaged (3.90%) groups indicates that achieving peak immersion in Chemistry is a rare occurrence among the participants. Thus, the data points to a passive participation trend, where students do the bare minimum without becoming fully invested in the learning process.

Similarly, it suggests that student engagement is heavily influenced by the perceived relevance and difficulty of the subject matter. Low engagement levels often occur when students do not see the practical application of chemical theories to their everyday lives, leading to a compliance-only mindset. Recent research highlighted that engagement in science is a multidimensional construct that requires emotional, cognitive, and behavioral alignment to reach the Very Engaged status (16). Without active interest, students remain in the middle tiers, where their attention is easily fragmented and their retention of complex chemical concepts is significantly diminished.

Likewise, it indicates that the modern educational environment, particularly in Chemistry, faces a disengagement crisis due to traditional instructional methods. Academic anxiety and the fear of making mistakes in rigorous subjects can lead to learned helplessness, where students settle for the Less Engaged level as a defense mechanism (17). This behavioral pattern aligns with the data showing that over 30% of students are only Slightly Engaged, possibly to avoid the pressure of deeper academic involvement.

To shift the 67.9% of students currently below the Engaged level, educators must adopt student-centered approaches that prioritize active participation over passive listening. By creating a learning environment that rewards curiosity rather than just correct answers, teachers can encourage students to move from Slightly

Engaged to higher tiers of proficiency. Hence, addressing these engagement gaps is essential for improving the overall achievement levels previously observed in the student population.

Levels of Students' Awareness on the Traditional Self-care Essentials of Meranaws

The frequency and the corresponding percentage of the levels of students' awareness on the traditional self-care essentials of Meranaws is shown in Table 5.

The data quantifies the levels of cultural awareness among 231 students regarding the traditional self-care essentials of the Meranaw people. A substantial majority of the participants, totaling 141 students (61.0%), are categorized as Not Aware, representing the dominant segment of the sample. This is followed by those who are Slightly Aware at 20.8% (48 students) and Moderately Aware at 10.8% (25 students). Only a small minority of 17 students (7.40%) reached the Strongly Aware status, indicating a significant deficit in cultural knowledge among the surveyed group.

Consequently, the result reveals a stark lack of cultural literacy, with a combined 81.8% of students falling into the Not Aware or Slightly Aware categories. This suggests that the indigenous knowledge systems (IKS) related to Meranaw self-care are not being effectively transmitted to or retained by the younger generation. The low frequency of Strongly Aware individuals indicates that specialized cultural knowledge is becoming increasingly rare or localized. The data illustrates a clear downward trend in the preservation of traditional self-care practices within this student demographic.

In addition, the high percentage of students who are Not Aware can be interpreted as a consequence of modern globalization and the subsequent erosion of indigenous traditions. When local practices are not integrated into formal educational curricula, students often prioritize Westernized or global health standards over traditional self-care methods. This disconnect can lead to a cultural amnesia where the symbolic and practical importance of Meranaw essentials is lost to the digital-native generation. According to recent studies, the lack of cultural awareness often stems from a lack of intergenerational dialogue and the absence of ethno-scientific contexts in classroom settings (18).

Table 5 Frequency and Percentage of the Levels of Students' Cultural Awareness on the Traditional Self-Care Essentials of Meranaws

Levels	Frequency	Percentage
Strongly Aware	17	7.40%
Moderately Aware	25	10.8%
Slightly Aware	48	20.8%
Not Aware	141	61.0%
Total	231	100%

Parallel to that, current literature emphasizes that cultural awareness is a vital component of identity formation and psychological well-being for minority or indigenous students. Research suggests that students who lack awareness of their traditional practices may face a cultural gap that impacts their sense of belonging and community connection (19). Furthermore, the integration of indigenous knowledge into science education is crucial for fostering place-based learning that makes academic content more relevant (20). Without these interventions, the 61% Not Aware rate is likely to persist as students continue to view traditional essentials as obsolete rather than valuable resources.

Accordingly, to improve awareness levels, educational institutions should implement culturally responsive teaching strategies such as ethno-based instruction that honor and incorporate Meranaw traditional knowledge. This could involve collaborating with community elders to document self-care essentials and integrating these findings into the local curriculum. Moving students from Not Aware to Strongly Aware requires an active effort to bridge the gap between traditional wisdom and modern scientific concepts. Thus, preserving these indigenous self-care practices is essential for maintaining the cultural heritage and holistic health of the Meranaw community in a rapidly changing world.

Correlation among the Students' Achievement, Learning Engagement in Chemistry and their Cultural Awareness

The Spearman's rho correlation and p values on the relationship of the variables considered in the study such as the students' achievement and learning engagement in Chemistry as well as their cultural awareness on the traditional self-care essentials of Meranaws are shown in Table 6.

Table 6 Spearman's rho Correlation and p Values on the Relationship among the Students' Achievement in Chemistry, Learning Engagement in Chemistry and Cultural Awareness

		Achievement	Engagement	Awareness
Achievement	Correlation coefficient	1.000	.074	-.021
	Sig. (2-tailed)	.	.264	.751
	N	231	231	231
Engagement	Correlation coefficient	.074	1.000	.053
	Sig. (2-tailed)	.264	.	.420
	N	231	231	231
Awareness	Correlation coefficient	-.021	.053	1.000
	Sig. (2-tailed)	.751	.420	.
	N	231	231	231

As expressed in the table, the provided Spearman's rho correlation matrix indicates that there is no statistically significant relationship among Achievement, Engagement, and Awareness. Each correlation coefficient falls below .08, and all p-values (Sig. 2-tailed) are substantially higher than the conventional alpha level of .05. Specifically, the link between Engagement and Achievement stands at .074 (p = .264), while Awareness shows nearly zero correlation with the other two variables. This lack of significance implies that fluctuations in one variable do not reliably predict changes in the others within this specific dataset.

From a deeper interpretive lens, these results suggest a decoupling of student behaviors from academic outcomes, where active participation does not necessarily guarantee mastery. Recent research supports this, noting that students often engage in passive compliance where they complete tasks without deep cognitive involvement (21). This phenomenon explains why engagement scores can remain high or moderate while having no measurable impact on achievement scores. In such cases, the quality of engagement matters far more than the quantity of time spent on tasks.

The data also highlights a disconnect regarding Awareness, which showed a negligible negative correlation with Achievement at -.021. This suggests that simply being aware of the traditional self-care essentials is insufficient for driving performance improvements. In other words, awareness is a passive state that requires the intervention of self-regulation and agency to become a catalyst for success (22). Without these secondary psychological drivers, a students' awareness of their academic standing or goals remains a dormant variable that fails to influence their final grades.

Hence, these findings suggest that the educational environment for this group may be influenced by external variables not captured in this matrix. A meta-analysis underscored that in contemporary learning settings, traditional metrics of engagement are becoming less predictive of achievement due to the rise of diverse, non-linear learning paths (23). To improve student success, educators might need to move beyond monitoring general participation and instead focus on fostering high-level cognitive strategies. The independence of these variables indicates that a one-size-fits-all approach to engagement will likely fail to produce the desired gains in achievement.

CONCLUSION

The study established that while the Meranaw people possess an indigenous knowledge system regarding self-care, there is a profound disconnect between this cultural heritage and the current academic landscape of the students. Students exhibit a widespread lack of mastery in fundamental Chemistry competencies and a significant deficit in cultural awareness. In addition, the low achievement and engagement levels are further complicated by a total lack of correlation between student participation, cultural awareness, and academic success. This suggests that current instructional methods are failing to leverage local biodiversity and indigenous wisdom as a conceptual scaffold for complex scientific learning. Thus, there is an urgent necessity for educational institutions to adopt culturally responsive, ethno-based instruction that bridges the gap between traditional wisdom and modern chemical literacy. Congruently, revitalizing intergenerational knowledge transmission is essential not only for academic improvement but also for preserving the holistic health and identity of the Meranaw community.

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