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CONTEXTUALIZED LEARNING MODULE IN NEWTON MECHANICS FOR JUNIOR HIGH SCHOOL INDIGENOUS PEOPLES (IP) LEARNERS

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Abstract

Goat manure tea is a nutrient-rich liquid organic fertilizer noted for its relatively high potassium-to-nitrogen ratio and low pathogen and odor load compared with other animal manures. Kale (Brassica oleracea var. acephala) is valued for its dense micronutrient and antioxidant content, yet information on its response to organic liquid fertilization under Philippine lowland conditions remains limited. This study evaluated the growth, yield, sensory acceptability, and profitability of four kale varieties (Nero di Toscana, Chinese Kale Kailaan, Green Kale Reflex, and Red Kale Redbor) under three fertilizer regimes — no fertilizer (control), the recommended rate of inorganic fertilizer, and the recommended rate of goat manure tea (10 mL per 990 mL water, applied at 250 mL per plant through drenching). The experiment was laid out in a split-plot arrangement in randomized complete block design with three replications at DMMMSU–SLUC, Alipang, Rosario, La Union, from February 3 to March 10, 2018, with fertilizer regime as the main plot and variety as the subplot. Inorganic fertilization produced the greatest crop growth increment, plant height, weight per plant, yield, and return on investment, while goat manure tea consistently ranked second, outperforming the unfertilized control across most growth and yield parameters. Among varieties, Nero di Toscana was the most broadly adaptable to the Alipang site, recording the highest crop growth increment, plant height, and number of leaves, and was also the most acceptable variety in sensory evaluation regardless of treatment. Kailaan produced the greatest leaf width, weight per plant, yield, and return on investment. Redbor performed poorest across nearly all parameters, consistent with its documented preference for shaded, cooler conditions. These results indicate that goat manure tea, although slower-acting than inorganic fertilizer, is an agronomically viable organic input for kale production in lowland tropical environments, with Nero di Toscana identified as the variety best suited to site conditions similar to Alipang.

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Keywords: goat manure tea, organic fertilizer, kale varieties, Brassica oleracea, growth and yield, split-plot design

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Introduction

Physics education plays a vital role in shaping learners' analytical thinking and scientific literacy, providing a foundation for understanding the natural world and cultivating problem-solving, logical reasoning, and evidence-based decision-making (Department of Education, 2016). A strong foundation in physics fosters scientific literacy that empowers students to engage meaningfully with technology and address modern challenges, with early exposure shown to cultivate reasoning habits essential not only for STEM pathways but also for informed participation in a technology-rich society (Pasigon, 2023; Redish, 2017).

National policies underscore the importance of quality, inclusive science education. The Philippine Constitution mandates equal access to education, Republic Act No. 10533 (Enhanced Basic Education Act of 2013) emphasizes learner-centered and contextualized instruction, and Republic Act No. 8371 (Indigenous Peoples' Rights Act of 1997) affirms Indigenous Peoples' right to culturally appropriate education that respects their knowledge systems and practices. Collectively, these mandates highlight the need for instructional materials that are both culturally and contextually responsive. The MATATAG Curriculum (Department of Education, 2024) reinforces this by emphasizing deep understanding, contextualization, and learner readiness, introducing Newton's Laws of Motion under Grade 9 Science competencies while bridging prerequisite skills in motion and force for learners in rural and Indigenous contexts. Classroom observations, however, reveal weak mastery of these prerequisites among many junior high school students, leading to persistent misconceptions that hinder progression to higher-level physics topics such as work, energy, momentum, and circular motion.

Contextualization entails more than using local objects in teaching materials; it involves transforming physics problems into problems set within learners' authentic world of tools, terrain, and everyday goals (Bernardo, 2021). When lessons draw on learners' lived experiences, students can connect prior knowledge with multiple representations and link concrete experience to Newtonian concepts (Redish, 2017). Research on mechanics further shows that learners' everyday, intuitive models persist after conventional instruction, requiring explicit diagnostic probes and iterative conceptual-change designs; instruments such as the Force Concept Inventory and the Test of Understanding Graphs in Kinematics have been used to identify persistent alternative conceptions about force, motion, and graph interpretation from junior high school through the undergraduate level (Hestenes et al., 1992; Beichner, 1994). Among Philippine junior high school teachers and learners alike, alternative conceptions of force and motion remain prevalent, compounded by large class sizes, limited resources, and learner anxiety (Villarino, 2023).

For Indigenous learners such as the Aeta, these difficulties are more pronounced, as physics lessons often do not reflect their ways of knowing, living, and interacting with their environment, making the content feel remote or alienating (Pejaner & Mistades, 2020; Pawilen, 2023). Culturally responsive pedagogy holds that learners' identity, language, and worldview are inseparable from learning, and that science teaching in Indigenous communities should treat Indigenous Knowledge Systems (IKS) and school science as complementary rather than competing systems (Gay, 2021; Battiste, 2022). When Indigenous artifacts, environmental experiences, and traditional knowledge are incorporated into physics instruction—applied ethically through community vetting and Free, Prior, and Informed Consent—engagement, belonging, and conceptual understanding improve (Aikenhead, 2021; Pawilen, 2023).

Despite this growing body of work on contextualized instruction and culturally responsive science education, significant gaps remain. Most studies have focused on validating instructional materials for broad learner populations, with limited attention to IP learners in junior high school (Pawilen, 2023). While contextualized modules exist across various science subjects, few address Newtonian mechanics specifically, and there remains a lack of instructional development studies that simultaneously integrate IKSPs, align competencies with the MATATAG Curriculum, and undergo comprehensive validation involving experts, learners, and curriculum

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standards. This study addresses these gaps by developing and validating a contextualized Newtonian Mechanics module as a bridging instructional material for IP learners preparing for the Grade 9 Physics curriculum at Sta. Juliana High School, Capas, Tarlac.

Theoretical and Conceptual Framework

The study is anchored on three complementary theories: Contextualized Learning Theory, Culturally Responsive Pedagogy, and Constructivist Learning Theory. Contextualized Learning Theory holds that learning becomes more meaningful when instruction relates new knowledge to learners' real-world experiences (Bernardo, 2021); in this study, Newtonian mechanics was contextualized within learners' practices of harvesting bamboo and sweet potatoes, navigating rivers, and transporting cargo with carabaos. Culturally Responsive Pedagogy emphasizes recognizing and incorporating learners' cultural identities and knowledge into instruction (Gay, 2021), guiding the use of Aeta community practices as a bridge between school-based and community-based knowledge. Constructivist Learning Theory (Piaget, 1970; Vygotsky, 1978) frames learners as active constructors of knowledge who build on prior schemas through inquiry, hands-on tasks, and social interaction. Together, these theories informed a conceptual model in which curriculum inputs (MATATAG competencies, diagnostic results, learner characteristics, and contextual scenarios) were transformed, through a 5E-based (Engage–Explore–Explain–Elaborate–Evaluate) instructional design process, into a validated, effective, and culturally responsive module.

Objectives of the Study

This study aimed to develop and validate a contextualized learning module in Newtonian mechanics as a bridging instructional material for IP learners in a public secondary school in Capas, Tarlac. Specifically, it sought to (1) develop a contextualized learning module based on the MATATAG Curriculum for teaching Newton's Laws of Motion to IP learners; (2) determine the level of validity of the developed module in terms of expert validation (face validity) and student performance (pretest and posttest results); (3) determine the level of acceptability of the module among science teachers and content validators; (4) enhance the module based on evaluators' feedback; and (5) draw implications of the study for science education.

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Methods

Research Design

This study employed a Research and Development (R&D) design with a descriptive-evaluative approach, appropriate for the systematic development and testing of instructional materials in education (Richey & Klein, 2022). Anchored on the instructional development framework of Richey and Klein (2022) and the iterative R&D model of Borg and Gall (1989), the study began with a needs assessment through a diagnostic test to identify learners' least-mastered prerequisite competencies. Findings from the diagnostic test formed the basis for developing the contextualized learning module, which then underwent expert validation and learner face validation before revisions were incorporated to produce the final version, ensuring the material was evidence-based, curriculum-aligned, culturally responsive, and pedagogically sound (McKenney & Reeves, 2023).

Locale of the Study

The study was conducted at Sta. Juliana High School (O'Donnell High School Annex), a public secondary institution in Barangay Sta. Juliana, Municipality of Capas, Province of Tarlac, Region III (Central Luzon). Capas, a first-class municipality of 20 barangays with a population that grew from 156,056 (2020 Census) to 162,724 (2024), borders the eastern foot of the Zambales Mountain Range near Mt. Pinatubo and has long been home to Aeta communities whose cultural practices are tied to upland ecology. The school's proximity to Aeta communities and its location at the upland-lowland interface, combined with its implementation of the MATATAG Curriculum (DepEd Order No. 010, s. 2024) and the IPEd Curriculum Framework (DepEd Order No. 32, s. 2015), made it an instructionally strategic setting for embedding place-based, IKSP-informed contexts into Newtonian mechanics instruction.

Participants

The study used purposive sampling (Palinkas et al., 2020) to select two groups of participants. Forty (40) Grade 9 Aeta learners of Sta. Juliana High School, enrolled under the MATATAG Curriculum, participated in the diagnostic assessment, module implementation, and pretest-posttest evaluation. In addition, five (5) science teachers holding master's or doctoral degrees, with experience teaching Indigenous Peoples or working under the IPEd program, and more than five years of teaching experience served as expert validators. This number is consistent with recommendations that a panel of three to ten experts is sufficient for establishing content validity (Lynn, 1986) and that at least five experts constitute an adequate basis for computing a Content Validity Index (Polit & Beck, 2006).

Table 1. ***Profile of the Validators***

Code	Bachelor's Degree	Master's Degree	Doctorate Degree	Position	Years in Service
V1	BSEd, General Science	MA in Teaching Science	—	Master Teacher II	21
V2	BSEd, Physical Science	MA in Education, Physical Science	—	Teacher VI	6
V3	BSEd, General Science	MA in Educational Management	PhD, Educational Management	Master Teacher III	21

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Code	Bachelor's Degree	Master's Degree	Doctorate Degree	Position	Years in Service
V4	BSEd, Biological Science	MA in Education, Physical Science	—	Master Teacher II	20
V5	BS Nursing	MA in Nursing	PhD, Educational Leadership and Management	Head Teacher I	10

Note. All validators held teaching or leadership positions in public secondary schools within Tarlac and had direct experience teaching science to, or supporting, Indigenous Peoples learners.

Research Instruments

Four instruments were used. A researcher-developed diagnostic test assessed learners' mastery of prerequisite competencies in motion and force within the MATATAG Grade 8 Science curriculum, covering the description of motion, motion-graph interpretation, force identification, and cause-and-effect relationships; the results identified learning gaps that justified the module's content. The Contextualized Learning Module in Newton's Three Laws of Motion served as the primary instructional intervention, comprising a module overview, DepEd MELC-aligned objectives, "I Can" statements, pre-assessment items, and lessons on Newton's first, second, and third laws organized around the 5E learning cycle, with activities contextualized through indigenous daily practices such as carrying loads uphill, pushing carts, and traditional games. An expert validation tool, adapted from established instructional-material evaluation checklists (the DepEd Evaluation Rating Sheet for Print Resources and the LRMDS Educational Soundness General Evaluation Checklist), assessed content accuracy, curriculum alignment, organization and clarity, language and readability, and contextualization; content validity was quantified at the item level (I-CVI) and scale level (S-CVI), specifying whether S-CVI reflected universal agreement or the average of I-CVI values (Polit & Beck, 2006; Lynn, 1986). Internal consistency of the achievement test was estimated using the Kuder-Richardson Formula 20 (KR-20), with item difficulty (p) and discrimination (D) indices computed for revision planning (Kuder & Richardson, 1937). Finally, a Student Feedback Questionnaire, administered post-implementation, gathered learners' perceptions of the module's clarity, usability, engagement, and relevance (Almaiah et al., 2022).

Data Gathering Procedure

Data collection proceeded in four phases. First, ethical and administrative approval was secured from the school principal, recognized Indigenous community leaders, and parents or legal guardians of learner-participants; only learners with parental or guardian consent were included. Second, a diagnostic assessment was administered to identify learners' mastery of prerequisite motion and force concepts, with results combined with curriculum analysis and classroom observation to determine the least-mastered competencies. Third, the contextualized learning module was designed and developed around these identified gaps using the 5E instructional model, with translation support from the National Commission on Indigenous Peoples (NCIP) of Capas, Tarlac, to render module items in both English and the Aeta language for inclusivity and comprehension. Finally, the module underwent expert validation using the DepEd Evaluation Rating Sheet for Print Resources; evaluators' ratings, comments, and recommendations were analyzed and used as the basis for revising and finalizing the module.

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Data Analysis

A mixed-methods, descriptive-evaluative analysis consistent with the R&D design was used. Expert validation ratings were summarized using means, standard deviations, and 95% confidence intervals across the dimensions of content accuracy, curriculum alignment, organization and clarity, language and readability, and contextual appropriateness. Item-level Content Validity Index (I-CVI) values were computed as the proportion of experts rating each indicator as relevant and averaged to yield scale-level S-CVI; items with I-CVI below .78 were flagged for revision, and an S-CVI of .90 or higher was interpreted as strong content validity, with all flagged items and corresponding revisions recorded in a revision log. Learner achievement data from the pretest and posttest were analyzed using descriptive statistics, item difficulty (p) and discrimination (D) indices (target ranges: $p = .30–.80$, $D \geq .20$), KR-20 reliability (target $\geq .70$), and a paired-samples t-test to determine the significance of learning gains. Student Feedback Questionnaire responses were summarized using descriptive statistics and KR-20 reliability. Qualitative comments from experts and learners were analyzed thematically and grouped by content quality, instructional quality, language and readability, presentation and organization, and contextual relevance to guide module revision (Richey & Klein, 2022).

Ethical Considerations

Given the involvement of Indigenous and minor participants, the study strictly followed ethical research protocols. Informed consent was obtained from school authorities, teachers, parents or guardians, and Indigenous community representatives, with learner assent also secured; participation was entirely voluntary, with the right to withdraw at any time without penalty. Cultural sensitivity guided the selection of local examples to avoid misrepresentation, stereotyping, or trivialization of Aeta culture. Data confidentiality and anonymity were strictly observed, with all data coded, securely stored, and accessed only by the researcher. Risks to participants were minimal, consistent with standard classroom teaching and testing procedures, and steps were taken to minimize power imbalances between the teacher-researcher and learners. The study adhered to the ethical standards of educational research, including respect for persons, beneficence, cultural integrity, and protection of minors, in accordance with British Educational Research Association (BERA, 2021) guidelines.

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Results

Development of the Contextualized Learning Module

Module development began with a needs assessment to identify learners' prerequisite competency gaps, ensuring that the material addressed real rather than assumed learning needs (Richey & Klein, 2022).

Table 2. ***Results of the Diagnostic Test on Prerequisite Competencies***

Competency	Learners Who Mastered	Learners Who Least Mastered	% Least Mastered
Motion concepts (uniform motion)	8	32	80
Force concepts (balanced forces)	17	23	58
Graph interpretation	14	26	65

Table 3. ***Least-Mastered Competencies in Newton's Laws of Motion***

Competency	Frequency	Percentage (%)
Identify that forces cause objects to accelerate, and that acceleration is the rate of change of velocity	32	80
Observe and describe examples of accelerating objects at school and in the local community, including uniform circular motion	23	58
Construct and annotate distance–time and velocity–time graphs to represent uniform and non-uniform acceleration	26	65

Based on these results, a competency map was developed to align module content with Grade 8 competencies and their bridging to Grade 9 MATATAG competencies (Table 4).

Table 4. ***Competency Mapping: Module vs. MATATAG Curriculum***

Module Topic	Grade 8 Competency	Bridging to Grade 9 Competency	Alignment Notes
Newton's First Law of Motion	Describe motion without force	Identify inertia as the tendency of an object to stay at rest or in motion unless acted on by an unbalanced net force	Direct bridging
Newton's Second Law of Motion	Identify the effects of force	Demonstrate and describe acceleration as a change in speed and/or direction resulting from a net force; investigate the	Requires scaffolding

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Module Topic	Grade 8 Competency	Bridging to Grade 9 Competency	Alignment Notes
		relationship among force, acceleration, and mass	
Newton's Third Law of Motion	Recognize action–reaction pairs	Explain that interacting objects exert equal but opposite forces on each other, and identify action–reaction pairs in everyday situations using force diagrams	Contextualized with local examples

The competency mapping confirmed that the developed module addressed the prescribed learning competencies and was aligned at the level of objectives, activities, and assessment. The final module comprised three lessons corresponding to Newton's three laws of motion, each structured around the 5E instructional model and contextualized using indigenous daily practices such as carrying loads uphill, pushing carts, and traditional games, with performance tasks, rubrics, and reflection prompts included to assess conceptual understanding and application.

Validation of the Developed Module

Expert Validation

Five expert validators evaluated the module using the DepEd Evaluation Rating Sheet for Print Resources, covering content, format, presentation, organization, and accuracy and up-to-datedness.

Table 5. ***Expert Validation Results Using the Evaluation Rating Sheet for Print Resources***

Factor	Maximum Score	Mean Score	Verbal Interpretation
Factor 1: Content	28	28.0	Excellent
Factor 2: Format	72	71.8	Excellent
Factor 3: Presentation and Organization	20	20.0	Excellent
Factor 4: Accuracy and Up-to-datedness	24	24.0	Excellent
Grand Mean	144	143.8	Excellent

All four factors received "Excellent" ratings, indicating that the module's content was developmentally appropriate for Grade 9 learners, free from cultural, religious, or gender bias, and promoted higher-order thinking through inquiry and problem-solving; that the module's print quality, illustrations, and layout were aesthetically pleasing and easy to read; that its presentation, logic, and language were clear; and that it contained no conceptual, factual,

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or typographical errors. Only minor feedback was noted, involving a wording adjustment ("lazy" to "easy" when describing inertia) and closer text-visual blending on one item.

Table 6. ***Expert Validation Using the LRMDS Educational Soundness General Evaluation Checklist***

Criteria (selected)	Yes	NI	NA	WM	Verbal Interpretation
Content accuracy	5	0	0	3.00	Excellent
Supports deepening of knowledge	5	0	0	3.00	Excellent
Controversial issues handled fairly	4	0	1	2.60	Very Satisfactory
Use of language/symbols	5	0	0	3.00	Excellent
Correct use of terms/notations/diagrams	4	1	0	2.80	Very Satisfactory
Real-life/authentic content	5	0	0	3.00	Excellent
Scaffolded learning	5	0	0	3.00	Excellent
Accessible in underserved areas	5	0	0	3.00	Excellent
Connects to local knowledge/experience	5	0	0	3.00	Excellent
Avoids embarrassment/stereotypes	5	0	0	3.00	Excellent
Grand Mean (22 criteria)	—	—	—	2.97	Excellent

Note. NI = Needs Improvement; NA = Not Applicable; WM = Weighted Mean. All 22 LRMDS criteria were rated "Yes" by the majority of validators, with a grand mean of 2.97 (Excellent).

Table 7. ***Face Validity Results from Expert Validators***

Indicator	N	Mean	SD	Verbal Interpretation
Instructions and questions are clear and easy to understand	40	3.50	0.68	Very Satisfactory
Content is relevant to daily life and community experiences	40	3.48	0.75	Very Satisfactory

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Indicator	N	Mean	SD	Verbal Interpretation
Layout, visuals, and examples are attractive and engaging	40	3.58	0.68	Very Satisfactory
Language used is appropriate for the grade level	40	3.63	0.63	Very Satisfactory
Activities are easy to follow and can be performed safely	40	3.67	0.62	Very Satisfactory
Grand Mean	40	3.57	—	Very Satisfactory

The highest-rated indicator was the ease and safety of contextualized activities such as carrying firewood, pushing carts, and traditional games (M = 3.67), while the lowest, though still satisfactory, was content relevance (M = 3.48), suggesting learners' desire for an even stronger link between lessons and their community experiences.

Student Performance: Pretest and Posttest Results

Table 8. ***Descriptive Statistics of Pretest and Posttest Scores***

Test	Mean	SD	Median	SE	Verbal Interpretation
Pretest	10.4	2.37	10	0.38	Low Achievement
Posttest	17.3	4.00	17	0.63	Satisfactory Achievement
Mean Gain	6.9	—	—	—	Significant Improvement

Table 9. ***Paired-Samples t-Test Results***

Statistic	Value	Interpretation
t-value	11.60	Highly Significant
df	39	—
p-value	< .001	Reject H_0
Cohen's d	1.83	Large Effect Size

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Learners' performance improved significantly from the pretest (M = 10.4, SD = 2.37) to the posttest (M = 17.3, SD = 4.00), a mean gain of 6.9 points, $t(39) = 11.60$, $p < .001$. The large effect size (Cohen's d = 1.83) indicates that this improvement carries substantial practical and not merely statistical significance, moving learners from "Low Achievement" to "Satisfactory Achievement."

Table 10. ***Kuder–Richardson Formula 20 (KR-20) Reliability Results***

k (Number of Items)	Σpq	Variance	KR-20	Interpretation
20	4.58	15.60	0.73	Acceptable

The KR-20 coefficient of 0.73 falls within the acceptable range of internal consistency, indicating that the 20-item achievement test reliably measured the intended construct.

Acceptability of the Module

Table 11. ***Summary of Module Acceptability Ratings from Learners and Experts***

Validation Source	Criteria	Mean / Agreement	Verbal Interpretation
Face Validity (Students, N = 40)	Clarity, relevance, attractiveness, appropriateness, safety	3.57 (WM)	Very Satisfactory
LRMDS Educational Soundness (Experts, N = 5)	22 criteria (content accuracy, contextualization, accessibility, etc.)	100% agreement	Excellent
PRI Rating — Factor 1: Content (Experts, N = 5)	Content	100%	Excellent
PRI Rating — Factor 2: Format	Format	99.72%	Excellent
PRI Rating — Factor 3: Presentation & Organization	Presentation & Organization	100%	Excellent
PRI Rating — Factor 4: Accuracy & Up-to-datedness	Accuracy & Up-to-datedness	100%	Excellent
Overall Acceptability	—	—	Highly Acceptable

Overall, both learner and expert evaluations converged on high acceptability of the module. Learners rated it Very Satisfactory for clarity, relevance, attractiveness, appropriateness, and safety, while expert validators rated it Excellent across all LRMDS and PRI criteria, confirming its instructional validity, cultural sensitivity, and technical quality.

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Enhancement of the Module

Table 12. ***Summary of Suggested Enhancements to the Module***

Source	Common Suggestions	Frequency	Verbal Interpretation
Students (N = 40)	Simplify technical terms and use easier words	12	Frequently Suggested
Students (N = 40)	Add more visuals, colors, and illustrations	15	Frequently Suggested
Students (N = 40)	Provide answer keys for self-checking	10	Frequently Suggested
Students (N = 40)	Reduce text load; balance with activities	8	Occasionally Suggested
Students (N = 40)	Include more practice questions	6	Occasionally Suggested
Experts (N = 5)	Refine wording (e.g., "lazy" vs. "easy" for inertia)	2	Minor Refinement
Experts (N = 5)	Ensure harmonious blending of text and visuals	1	Minor Refinement
Experts (N = 5)	Expand interactive and engaging activities	3	Frequently Suggested
Experts (N = 5)	Maintain cultural responsiveness and contextualization	5	Strongly Affirmed

Learners primarily called for simplified language, more visuals, and answer keys for self-guided learning, consistent with cognitive load theory's emphasis on managing working-memory demands (Sweller, 1988) and with formative assessment principles that support learner self-monitoring (Black & Wiliam, 1998). Expert validators, while confirming the module's cultural appropriateness, recommended refining specific wording and strengthening text-visual integration, consistent with DepEd LRMDS guidelines.

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Discussion

The results collectively demonstrate the effectiveness and acceptability of a contextualized, culturally responsive learning module for teaching Newton's Laws of Motion to IP learners. The significant gain in posttest performance (mean gain = 6.9 points, $p < .001$, Cohen's $d = 1.83$) shows that grounding abstract Newtonian concepts in familiar Aeta practices—carrying loads on slopes, traversing rugged terrain, and using traditional tools—helped bridge the cognitive gap between formal physics content and learners' lived experience. This finding is consistent with Contextualized Learning Theory (Bernardo, 2021) and with prior Philippine and international research showing that contextualized modules produce greater achievement gains than conventional instruction (Caballero et al., 2023; Cruz, 2021).

The high face-validity ratings from learners (WM = 3.57) and the uniformly "Excellent" ratings from expert validators across content, format, presentation, and accuracy affirm that culturally grounded material can meet rigorous curriculum and quality standards without compromising scientific or instructional integrity. This supports the argument that culturally responsive instructional materials deepen learner engagement by connecting scientific concepts to learners' cultural experiences (Gay, 2021), and that inquiry-based, context-rich materials promote meaningful conceptual understanding by allowing learners to construct knowledge from authentic experience (Bybee, 2021). Notably, the slightly lower (though still satisfactory) rating for content relevance (M = 3.48) suggests room to further diversify community-based examples in future iterations of the module.

The acceptable KR-20 reliability coefficient (0.73) indicates that the achievement instrument consistently measured the intended construct, lending further credibility to the reported learning gains. At the same time, the enhancement feedback from both learners and experts—calls for simpler language, more visuals, answer keys, and refined wording—points to the importance of continuous, iterative refinement of instructional materials even after they achieve strong initial validation, consistent with cognitive load theory (Sweller, 1988) and DepEd's LRMDS quality standards.

These findings carry several implications for science education. First, the module's success affirms constructivist principles (Piaget, 1970; Vygotsky, 1978), demonstrating that IP learners construct stronger conceptual understanding when instruction begins from meaningful, culturally familiar contexts. Second, the high acceptability ratings reinforce the MATATAG Curriculum's emphasis on contextualization and inquiry, suggesting that culturally relevant materials can simultaneously improve engagement and comprehension. Third, the rigor of the expert validation process underscores the importance of aligning locally developed materials with DepEd LRMDS standards, ensuring that contextualization does not come at the expense of instructional quality. Finally, the enhancement recommendations point to instructional module development as an iterative, ongoing process rather than a one-time undertaking, one that should remain responsive to learners' evolving needs.

This study is not without limitations. The sample was drawn from a single school and a specific Aeta community in Capas, Tarlac, so findings are analytically rather than statistically generalizable to other Indigenous groups or regions. The validation process also focused on content appropriateness, instructional quality, language, and cultural relevance, while factors such as learners' prior knowledge, home environment, and broader language proficiency were beyond its scope. Future studies may extend this work through larger, multi-site samples, longer implementation periods, and broader physics topics across diverse Indigenous communities.

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Conclusion and Recommendations

This study developed and validated a contextualized learning module in Newtonian mechanics for Grade 9 Aeta learners of Sta. Juliana High School is aligned with the MATATAG Curriculum and DepEd LRMDS standards. The module was rated Excellent by expert validators for its accurate content and instructional format, with only minor suggestions for refinement in word choice and visual-text integration, and Very Satisfactory by learners (WM = 3.57) for its clarity, relevance, attractiveness, appropriateness, and safety. Learners' performance improved significantly from pretest to posttest (mean gain = 6.9 points, $t(39) = 11.60$, $p < .001$, Cohen's $d = 1.83$, a large effect size), with a normalized gain ($g = 0.64$) indicating moderate-to-high learning improvement.

Based on these findings, the study concludes that the developed module was well-accepted by learners and experts on the basis of its clarity, relevance, accuracy, and educational value; that it was an effective tool for enhancing student performance with a large practical effect; that contextualizing instruction through native practices such as firewood gathering and canoeing made abstract Newtonian concepts tangible and meaningful, in line with constructivist and culturally responsive teaching principles; and that continued refinement through plainer language, more graphics, and expanded assessment tools would further strengthen the module's effectiveness. Overall, the study affirms the value of contextualized, culturally responsive instructional materials in advancing inclusive science education for Indigenous learners.

In view of these findings, it is recommended that science teachers adopt the developed module to strengthen learners' prerequisite understanding of Newtonian mechanics; that school administrators support professional development programs encouraging contextualized instruction; that curriculum developers integrate cultural perspectives into science instructional materials; and that future researchers expand similar module-development and validation studies to other physics topics and Indigenous contexts.

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