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Evaluating the Instructional Models and Innovative Strategies for 21st Century Science Learners

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Abstract

Research was conducted at Quidaoen National High School in San Juan, Abra, a rural locality that necessitates flexible and adaptive pedagogical approaches.

Notably, the study sought to evaluate the efficacy of two instructional frameworks—LEARN (Listen, Examine, Analyze, Reflect, Narrate) and QUEST (Question, Understand, Explore, Solve, Transfer)—in conjunction with two novel methodologies: Mistake-Led Learning (MLL) and the Design Thinking Process (DTP). The study aimed to compare the effectiveness of computer-assisted instruction (CAI) and printed modules in enhancing science performance, validate the learning materials created, and identify the problems students encountered during implementation.

A repeated-measures, explanatory, sequential mixed-methods design was utilized. Sixty students from Grades 7 and 8 were selected using total enumeration sampling. The instruments comprised a 50-item standardized science achievement test (Cronbach's $\alpha = 0.801–0.812$), validated computer-assisted instruction (CAI), and modular materials, along with a student engagement survey. Quantitative data were examined by descriptive statistics, paired t-tests, ANOVA, and effect sizes, and qualitative data from reflection journals and focus group discussions underwent theme analysis.

Results and findings indicated statistically significant improvements across all combinations ($p < 0.001$). Seventh-grade students utilizing LEARN+CAI advanced from 67.86 (Did Not Meet Expectation) to 83.39 (Satisfactory), whereas those employing QUEST + Modules progressed from 63.64 to 85.07 (Very Satisfactory). Grade 8 students demonstrated comparable improvements, with QUEST + Modules producing marginally superior posttest scores in inquiry-based subjects. Expert validation demonstrated substantial to complete concordance ($\kappa = 0.63–1.00$), affirming content reliability.

In the end, the research concludes that integrating instructional models with creative tactics and contextually relevant materials improves science proficiency and engagement. It advocates for the incorporation of QUEST with modular learning and design thinking in secondary scientific education, as well as the enhancement of CAI and modular material to tackle student difficulties and bolster resilience in schools impacted by disasters.

Keywords: *Instructional Models, Mistake-Led Learning, Design Thinking, Computer-Assisted Instruction, Science Achievement, Descriptive Statistics, Paired T-Tests, ANOVA*

I. INTRODUCTION

Today's education system calls for learners to develop critical thinking, collaboration, creativity, adaptability, and problem-solving skills. Traditional teacher-centered methods that rely on rote memorization are no longer sufficient to prepare students for the challenges of the modern world. Science education, in particular, requires students to understand abstract processes, ask meaningful questions, and apply knowledge to real-life situations. Yet, many Filipino learners struggle with low engagement, limited resources, and minimal opportunities for inquiry-based exploration—challenges that are even more pronounced in rural areas.

This study aligns with SDG 4: Quality Education, which advocates for inclusive, equitable, and engaging learning experiences. It explores how learner-centered models and innovative strategies can transform science instruction. The LEARN Model (Listen, Examine, Analyze, Reflect, Narrate) and QUEST Model (Question, Understand, Explore, Solve, Transfer) provide structured frameworks for active learning, reflection, and knowledge construction. Two complementary strategies, Mistake-Led Learning (MLL) and the Design Thinking Process (DTP), were employed to turn errors into opportunities for growth, foster creativity, and enhance problem-solving. These were implemented using Computer-Assisted Instruction (CAI) for interactive, tech-enabled learning and Modular Learning for structured, technology-free instruction, ensuring equity and accessibility.

Conducted at Quidaoen National High School in San Juan, Abra, this study examined Grade 7 and 8 science instruction during a quarter disrupted by disasters. It compared the effectiveness of the LEARN and QUEST models, MLL and DTP strategies, and CAI versus modular learning in improving scientific literacy. The results aim to guide curriculum development, teacher training, and resilient instructional design that ensures no learner is left behind.

II. MATERIALS and METHODS

Part of this research includes the following research design, participants, instrument, procedure, and data analysis.

Research Design:

This research employed a mixed-methods within-subjects experimental design with repeated measures to assess the efficacy of two instructional models—LEARN (Listen, Examine, Analyze, Reflect, Narrate) and QUEST (Question, Understand, Explore, Solve, Transfer)—integrated with Mistake-Led Learning and the Design Thinking Process. A comparison was conducted between two educational resources, Computer-Assisted Instruction (CAI) and printed modules, regarding their impact on students' science achievement and engagement.

An Explanatory Sequential Mixed-Methods Design was utilized. During the quantitative phase, a standardized science achievement test functioned as both a pretest and posttest, facilitating the assessment of learning gains and the comparison of model-strategy-material combinations over time within the same cohort of students. The repeated-measures methodology enhanced internal validity.

The qualitative phase was conducted to elucidate and contextualize the findings. Data were gathered via a focus questionnaire that assessed students' challenges. Thematic analysis of responses identified patterns that corroborated the quantitative findings, offering a comprehensive picture of the effects of the instructional interventions.

Participants:

The study was conducted at Quidaoen National High School in Quidaoen, San Juan, Abra, a rural public secondary school serving students from diverse socio-economic backgrounds. Using total enumeration sampling, all Grade 7 and 8 students enrolled during the academic year were included.

A total of 60 students participated: 28 from Grade 7 (17 males, 11 females) and 32 from Grade 8 (10 males, 22 females), resulting in an overall distribution of 27 males and 33 females. This approach ensured comprehensive coverage of the target population and enhanced the internal validity of the study by capturing the full spectrum of learner experiences.

Instruments:

This study employed three main instruments: (1) a 50-item standardized science achievement test, (2) a survey questionnaire, and (3) instructional learning materials aligned with the LEARN and QUEST models.

The science test covered key competencies from the Grade 8 and 9 curriculum and was pilot-tested at Northern Abra National High School with four sections of students (Grade 8: n=84, Grade 9: n=80). Reliability analysis using Cronbach’s alpha yielded indices of 0.801 (Grade 9) and 0.812 (Grade 8), both rated Very Satisfactory, confirming the test’s internal consistency.

The survey questionnaire examined student engagement, experiences, and challenges during implementation. It was validated by master teachers and educational researchers to ensure clarity, relevance, and alignment with study objectives.

The instructional materials—Computer-Assisted Instruction (CAI) and printed modules—were reviewed by three expert validators for content accuracy, instructional alignment, and pedagogical quality. Revisions were made based on expert feedback.

These validation and reliability procedures confirmed that all instruments were credible, consistent, and appropriate for classroom use.

Procedure:

The data collection followed three stages: preparation, implementation, and assessment. In the preparation stage, LEARN- and QUEST-aligned learning materials and a 50-item science achievement test were developed and validated by expert science teachers to ensure accuracy and quality. Before the study started, we oriented teachers and students on the process and expectations.

Implementation was organized into four phases to ensure balanced exposure. Phase 1 used the LEARN Model, CAI, and mistake-led learning; Phase 2 employed the QUEST Model, printed modules, and the design thinking process; and Phases 3 and 4 alternated both models and strategies.

In the assessment stage, pretests established baseline performance, followed by scheduled interventions and posttests to measure learning gains. Qualitative data were collected through reflection journals and focus group discussions to capture engagement and challenges.

Permissions were secured from the Division office, school principal, and advisers. Parents were informed during a PTA meeting, and consent forms were distributed. Data were tallied, organized, and interpreted by the researcher

Ethical standards were upheld by obtaining informed consent, ensuring confidentiality, and allowing voluntary participation with the right to withdraw. This process provided reliable data on the effectiveness of the LEARN and QUEST models, mistake-led learning, and design thinking in improving science achievement and engagement.

Data Analysis:

Research employed both quantitative and qualitative analyses to examine the research topics and evaluate the hypotheses. Descriptive statistics (mean, standard deviation, and descriptive ratings) were calculated for the pretest and posttest scores of grades 7 and 8 learners.

Paired sample t-tests were conducted to determine whether there were significant changes in performance before and after the students were exposed to the interventions. One-way and two-way ANOVAs were utilized to compare mean scores across instructional models, techniques, and combinations of learning materials, as well as to investigate interaction effects. Effect sizes were computed to quantify the extent of enhancement. Cohen's Kappa was calculated to assess the dependability of the learning materials based on ratings from expert validators, with values interpreted as indicating slight, fair, moderate, substantial, or almost perfect agreement.

Responses from student surveys were thematically analyzed to identify common themes related to the challenges of educational interventions. The results from both quantitative and qualitative phases were synthesized to offer a thorough comprehension of the efficacy of the

LEARN and QUEST Models, incorporating mistake-led learning and design thinking methodologies, utilizing both CAI and modular resources.

III. RESULTS

Table 1a. The pretest and posttest performance levels of grade 7 students exposed to the Mistake Led Learning Strategy and LEARN and QUEST learning models

Learning Materials	Models	Learning Competencies	Pretest Mean	Pretest DR	Posttest Mean	Posttest DR
Computer Assisted Instruction	LEARN MODEL	identify the parts and functions and demonstrate proper handling and storing of a compound microscope	69.43	DNME	86.64	VS
		use proper techniques in observing and identifying the parts of a cell with a microscope such as the cell membrane, nucleus, cytoplasm, mitochondria, chloroplasts and ribosomes.	66.50	DNME	84.32	S
		recognize that some organisms consist of a singled cell (unicellular) like in bacteria and some consists of many cells (multicellular) like in a human	70.93	DNME	82.36	S
		Composite Mean	**67.86**	**DNME**	**83.39**	**S**
Modular	QUEST MODEL	use a labelled diagram to describe the connection between the levels of biological organizations to one another from cells to the biosphere;	63.64	DNME	85.64	VS
		describe the trophic levels of an organism as levels of energy in a food pyramid.	63.00	DNME	89.93	VS
		use examples of food pyramids to describe the transfer of energy between organisms	64.50	DNME	85.21	VS

		from one throphic level to another.				
		Composite Mean	**63.64**	**DNME**	**85.07**	**VS**

Scale	DR
90-100	Outstanding (O)
85-89	Very Satisfactory (VS)
80-84	Satisfactory (S)
75-79	Fairly Satisfactory (FS)
Below 75	Did Not Meet Expectation (DNME)

Table 1b. The pretest and posttest performance levels of grade 7 students exposed to the Design Thinking Process teaching strategy and LEARN and QUEST learning models

Learning Materials	Models	Learning Competencies	Pretest Mean	Pretest DR	Posttest Mean	Posttest DR
Computer Assisted Instruction	QUEST MODEL	differentiate plant and animal cells based on their organelles	66.54	DNME	82.32	S
		recognize the cells reproduce through the two types of cell division, mitosis and meiosis and describe meiosis as cell division for growth and repair	66.00	DNME	81.64	S
		composite Mean	**66.11**	**DNME**	**80.82**	**S**
Modular	LEARN MODEL	explain that genetic information is passed on to offspring from both parents by the process of meiosis and fertilization.	66.39	DNME	79.54	FS
		differentiate sexual from asexual reproduction in terms of a) number of parents involved and b) similarities of offspring to parents.	65.36	DNME	84.46	S
		composite Mean	**65.82**	**DNME**	**80.43**	**S**

Scale	DR
90-100	Outstanding (O)
85-89	Very Satisfactory (VS)
80-84	Satisfactory (S)
75-79	Fairly Satisfactory (FS)
Below 75	Did Not Meet Expectation (DNME)

Table 1c. The pretest and posttest performance levels of grade 8 students exposed to the Mistake Led Learning Strategy and LEARN and QUEST learning models

Learning Materials	Models	Learning Competencies	Pretest Mean	Pretest DR	Posttest Mean	Posttest DR
Computer Assisted Instruction	Learn Model	compare and contrast comets, meteors, and asteroids	64.81	DNME	76.75	FS
		Using models or illustrations, explain how movements along faults generate earthquake.	65.63	DNME	80.59	S
Modular	Quest Model	Differentiate the a. epicenter of an earthquake from its focus. B. intensities of am earthquake from its magnitude c. active and inactive faults.	66.13	DNME	80.47	S
		Composite Mean	**65.88**	**DNME**	**79.44**	**FS**

Scale	DR
90-100	Outstanding (O)
85-89	Very Satisfactory (VS)
80-84	Satisfactory (S)
75-79	Fairly Satisfactory (FS)
Below 75	Did Not Meet Expectation (DNME)

Table 1d. The pretest and posttest performance levels of grade 8 students exposed to the Design Thinking Process teaching strategy and LEARN and QUEST learning models

Learning Materials	Models	Learning Competencies	Pretest Mean	Pretest DR	Posttest Mean	Posttest DR
Computer Assisted Instruction	Learn Model	Explain how earthquake waves provide information about the interior of the earth	64.19	DNME	79.78	FS
Modular	Quest Model	Explain how typhoon develops and how it is affected by landmasses and bodies of water	64.88	DNME	82.81	S

trace the path of typhoons that enter the Philippine Asrea of Responsibility (PAR) using a map and tracking data.	64.00	DNME	82.34	S
Composite Mean	**64.44**	**DNME**	**81.84**	**S**

Scale	DR
90-100	Outstanding (O)
85-89	Very Satisfactory (VS)
80-84	Satisfactory (S)
75-79	Fairly Satisfactory (FS)
Below 75	Did Not Meet Expectation (DNME)

Table 2a. Comparison of the significant difference between the pretest and posttest performance levels of grade 7 students exposed to the Mistake Led Learning Strategy and LEARN and QUEST learning models

Learning Materials	Models	Learning Competencies	Pretest Mean	Posttest Mean	Mean Gain	t-value	t-prob
Computer Assisted Instruction	LEARN MODEL	identify the parts and functions and demonstrate proper handling and storing of a compound microscope	69.43	86.64	17.21	8.11	<0.001
		use proper techniques in observing and identifying the parts of a cell with a microscope such as the cell membrane, nucleus, cytoplasm, mitochondria, chloroplasts and ribosomes.	66.50	84.32	17.82	9.07	<0.001
		recognize that some organisms consist of a singled cell (unicellular) like in bacteria and some consists of many cells (multicellular) like in a human	70.93	82.36	11.43	5.03	<0.001
		Composite Mean	**67.86**	**83.39**	**15.53**	**12.12**	**<0.001**
Modular	QUEST MODEL	Use a labelled diagram to describe the connection between the levels of	63.64	85.64	22.00	9.20	<0.001

		biological organizations to one another, from cells to the biosphere.					
		describe the trophic levels of an organism as levels of energy in a food pyramid.	63.00	89.93	26.93	9.16	<0.001
		use examples of food pyramids to describe the transfer of energy between organisms from one trophic level to another.	64.50	85.21	20.71	8.64	<0.001
		Composite Mean	**63.64**	**85.07**	**21.43**	**15.82**	**<0.001**

Table 2b. Comparison of the significant difference between the pretest and posttest performance levels of grade 7 students exposed to the Design Thinking Process teaching strategy and LEARN and QUEST learning models

Learning	Models	Learning Competencies	Pretest Mean	Posttest Mean	Mean Gain	t-value	t-prob
Computer Assisted Instruction	QUEST MODEL	differentiate plant and animal cells based on their organelles	66.54	82.32	15.78	9.342	<0.001
		recognize the cells reproduce through the two types of cell division, mitosis and meiosis and describe meiosis as cell division for growth and repair	66	81.64	15.64	9.071	<0.001
		Composite Mean	**66.11**	**80.82**	**14.71**	**11.901**	**<0.001**
Modular	LEARN MODEL	explain that genetic information is passed on to offspring from both parents by the process of meiosis and fertilization.	66.39	79.54	13.15	7.737	<0.001
		differentiate sexual from asexual reproduction in terms of a) number of parents involved and b) similarities of offspring to parents.	65.36	84.46	19.1	8.585	<0.001
		Composite Mean	**65.82**	**80.43**	**14.61**	**12.24**	**<0.001**

Table 2c. Comparison of the significant difference between the pretest and posttest performance levels of grade 8 students exposed to the Mistake Led Learning Strategy and LEARN and QUEST learning models

Learning	Models	Learning Competencies	Pretest Mean	Posttest Mean	Mean Gain	t-value	t-prob
Computer Assisted Instruction	Learn Model	Compare and contrast comets, meteors, and asteroids	64.81	76.75	11.94	10.53	<0.001
		Using models or illustrations, explain how movements along faults generate earthquake.	65.63	80.59	14.96	9.33	<0.001
Modular	Quest Model	Differentiate the a. epicenter of an earthquake from its focus. B. intensities of am earthquake from its magnitude c. active and inactive faults.	66.13	80.47	14.34	8.14	<0.001
		Composite Mean	**65.88**	**79.44**	**13.56**	**12.27**	**<0.001**

Table 2d. Comparison of the significant difference between the pretest and posttest performance levels of grade 8 students exposed to the Design Thinking Process teaching strategy and LEARN and QUEST learning models

Learning	Models	Learning Competencies	Pretest Mean	Posttest Mean	Mean Gain	t-value	t-prob
Computer Assisted Instruction	Learn Model	Explain how earthquake waves provide information about the interior of the earth	64.19	79.78	15.59	17.18	<0.001
Modular	Quest Model	Explain how typhoon develops and how it is affected by landmasses and bodies of water	64.88	82.81	17.93	10.43	<0.001

	trace the path of typhoons that enter the Philippine Area of Responsibility (PAR) using a map and tracking data.	64	82.34	18.34	12.72	<0.001
	Composite Mean	64.44	81.84	17.4	15.88	<0.001

Table 3a. Significant agreement among the evaluators in the developed learning materials for Computer-Assisted Instruction

	Content			Instructional		
Instructional Materials	Kappa	DR	P-value	Kappa	DR	P-value
Earthquake	0.63	SA	<0.001	1.00	PA	<0.001
Comets	0.86	APA	<0.001	0.86	APA	<0.001
Science Equipment	0.76	SA	<0.001	1.00	PA	<0.001
Cell Observation	1.00	PA	0.000	0.87	APA	<0.001
Cell	1.00	PA	0.000	0.47	MA	0.001
Plant and Animal Cell	1.00	PA	0.000	0.76	SA	<0.001
Cell Division	1.00	PA	0.000	0.65	SA	<0.001

Kappa Value (κ)	Description
$\kappa \le 0.00$	No Agreement (NA)
0.01 - 0.20	Slight Agreement (SlA)
0.21 - 0.40	Fair Agreement (FA)
0.41 - 0.60	Moderate Agreement (MA)
0.61 - 0.80	Substantial Agreement (SA)
0.81 - 1.00	Almost Perfect Agreement. (APA)
$\kappa = 1.00$	Perfect Agreement (PA)
$P > 0.05$	No Significant Agreement (NSA)
$P < 0.05$	Significant Agreement (SA)

Table 3b. Significant agreement among the evaluators in the developed learning materials for Modular Instruction along the Content area.

Instructional Materials	Kappa	DR	P-value
Earthquake and Faults	**0.64**	**SA**	**<0.001**
Earthquake Epicenter and Magnitude	**0.08**	**SlA**	**0.460**
Understanding Typhoon	**0.03**	**SlA**	**0.752**
Tracking Typhoon	**0.64**	**SA**	**<0.001**
Cell Reproduction	**0.64**	**SA**	**<0.001**

Level of Biological Organization	0.64	SA	<0.001
Trophic Level and Transfer of E	0.64	SA	<0.001

Kappa Value (κ)	Description
κ ≤ 0.00	No Agreement (NA)
0.01 - 0.20	Slight Agreement (SlA)
0.21 - 0.40	Fair Agreement (FA)
0.41 - 0.60	Moderate Agreement (MA)
0.61 - 0.80	Substantial Agreement (SA)
0.81 - 1.00	Almost Perfect Agreement. (APA)
κ = 1.00	Perfect Agreement (PA)
P >0.05	No Significant Agreement (NSA)
P < 0.05	Significant Agreement (SA)

Table 3c. Significant agreement among the evaluators in the developed learning materials for Modular Instruction along the Social Content

Instructional Materials	Kappa	DR	P-value
Earthquake and Faults	1.00	PA	0.000
Earthquake Epicenter and Magnitude	1.00	PA	0.000
Understanding Typhoon	1.00	PA	0.000
Tracking Typhoon	1.00	PA	0.000
Cell Reproduction	1.00	PA	0.000
Level of Biological Organization	1.00	PA	0.000
Trophic Level and Transfer of E	1.00	PA	0.000

Kappa Value (κ)	Description
κ ≤ 0.00	No Agreement (NA)
0.01 - 0.20	Slight Agreement (SlA)
0.21 - 0.40	Fair Agreement (FA)
0.41 - 0.60	Moderate Agreement (MA)
0.61 - 0.80	Substantial Agreement (SA)
0.81 - 1.00	Almost Perfect Agreement. (APA)
κ = 1.00	Perfect Agreement (PA)
P >0.05	No Significant Agreement (NSA)
P < 0.05	Significant Agreement (SA)

Table 3d. Significant agreement among the evaluators in the developed learning materials for Modular Instruction along Language

Instructional Materials	Kappa	DR	P-value
Earthquake and Faults	0.30	FA	0.010

Earthquake Epicenter and Magnitude	**0.30**	**FA**	**0.010**
Understanding Typhoon	**0.30**	**FA**	**0.010**
Tracking Typhoon	**0.30**	**FA**	**0.010**
Cell Reproduction	**0.30**	**FA**	**0.010**
Level of Biological Organization	**0.30**	**FA**	**0.010**
Trophic Level and Transfer of E	**0.30**	**FA**	**0.010**

Kappa Value (κ)	Description
κ ≤ 0.00	No Agreement (NA)
0.01 - 0.20	Slight Agreement (SlA)
0.21 - 0.40	Fair Agreement (FA)
0.41 - 0.60	Moderate Agreement (MA)
0.61 - 0.80	Substantial Agreement (SA)
0.81 - 1.00	Almost Perfect Agreement. (APA)
κ = 1.00	Perfect Agreement (PA)
P >0.05	No Significant Agreement (NSA)
P < 0.05	Significant Agreement (SA)

Table 3e. Significant agreement among the evaluators in the developed learning materials for Modular Instruction along the Layout and Format

Instructional Materials	Kappa	DR	P-value
Earthquake and Faults	**0.30**	**FA**	**0.010**
Earthquake Epicenter and Magnitude	**0.30**	**FA**	**0.010**
Understanding Typhoon	**0.30**	**FA**	**0.010**
Tracking Typhoon	**0.30**	**FA**	**0.010**
Cell Reproduction	**0.30**	**FA**	**0.010**
Level of Biological Organization	**0.30**	**FA**	**0.010**
Trophic Level and Transfer of E	**0.30**	**FA**	**0.010**

Kappa Value (κ)	**Description**
κ ≤ 0.00	**No Agreement (NA)**
0.01 - 0.20	**Slight Agreement (SlA)**
0.21 - 0.40	**Fair Agreement (FA)**
0.41 - 0.60	**Moderate Agreement (MA)**
0.61 - 0.80	**Substantial Agreement (SA)**
0.81 - 1.00	**Almost Perfect Agreement. (APA)**
κ = 1.00	**Perfect Agreement (PA)**
P >0.05	**No Significant Agreement (NSA)**
P < 0.05	**Significant Agreement (SA)**

Table 4a. Comparison of the significant difference between the posttest performance of the students exposed to Computer Assisted Instruction and Module learning materials taught under Mistake-led learning strategy

	Computer Assisted Instruction	Module Learning Material	Mean Diff	t-value	t-prob
Grade 7	83.39	85.07	1.68	1.101	0.276
Grade 8	76.75	79.44	2.69	1.970	0.053
As a whole	79.85	82.07	2.22	1.916	0.058

Table 4b. Comparison of the significant difference between the posttest performance of the students exposed to Computer Assisted Instruction and Module learning materials taught under the Design learning strategy

	Computer Assisted Instruction	Module	Mean Diff	t-value	t-prob
Grade 7	80.82	80.43	-0.39	0.26	0.79
Grade 8	79.78	81.84	2.06	1.39	0.17
As a whole	80.27	81.18	0.91	0.88	0.38

Table 5. Comparison of the significant difference between the post-test performance of the students exposed to the instructional models paired with learning materials

Learning Materials	Grade Levels	QUEST model	LEARN Model	Mean Diff	t-value	t-prob
Computer-Assisted Instruction	Grade7	80.82	85.07	4.25	2.710	0.009
	Grade8	79.78	79.44	0.34	0.236	0.815
	As a whole	80.27	82.07	1.80	1.602	0.112
Module Learning	Grade7	83.39	80.43	2.96	2.080	0.042
	Grade8	76.75	81.84	5.09	3.665	0.001
	As a whole	79.85	81.18	1.33	1.233	0.220

Problem 6: What challenges did students encounter in the implementation of the two teaching strategies and learning materials?

C.H.A.L.L.E.N.G.E.S

C – Connectivity issues: Problems with internet or device compatibility affecting online learning and video access.

H – Hesitation to participate: Fear of speaking up, presenting ideas, or making mistakes in front of peers, leading to lack of engagement.

A – Access to resources: Difficulty in accessing or using required materials, especially when students lack appropriate devices like tablets or laptops.

L – Lack of time: Not enough time to finish assignments or engage fully in group activities, particularly when technology is involved.

L – Learning interruptions: Issues like class suspensions or lost internet during lessons, disrupting the flow of learning.

E – Engagement challenges: Difficulty maintaining motivation and active participation, especially in virtual or remote settings.

N – Non-participation in groups: Unequal participation among students in group tasks or activities, which can affect overall group dynamics.

G – Grammatical or language barriers: Language preference issues, where students feel that English isn't always accessible, and they may prefer using a local language for better understanding.

E – Emotional stress: Anxiety and stress around performing, especially when using tools and equipment like a microscope or during group presentations.

S – Shortage of materials: Insufficient physical or digital resources (e.g., art supplies, textbooks) to complete activities, especially those requiring hands-on work.

Problem 7: What instructional learning plan can be designed based on the results of the study?

The figure on the next page presents the instructional learning plan developed based on the demonstrated effectiveness of instructional materials within the LEARN and QUEST models. It incorporates innovative strategies—Mistake-Led Learning and the Design Thinking Process—to address learning challenges and strengthen the 21st-century skills of science learners.

Republic of the Philippines
Department of Education
Cordillera Administrative Region
SCHOOLS DIVISION OF ABRA
Bangued, Abra

Instructional Learning Plan for Enhancing Academic Performance Based on Two Instructional Models, LEARN and QUEST Model, and Innovative Strategies and Materials Effectiveness for Grade 7 and 8

I. Title

Enhancing Scientific Literacy through the Integration of Instructional Materials across QUEST and LEARN Models with Mistake-Led Learning and Design Thinking Strategies

II. Rationale

Scientific literacy is a foundational goal of science education, equipping learners not only with knowledge but also with the critical thinking and problem-solving skills necessary to navigate real-life challenges. In today's complex world, students must be able to analyze scientific data, interpret findings, and make informed decisions — skills that go beyond rote memorization. This instructional learning plan targets the development of scientific literacy among Grade 7 and 8 learners by integrating innovative and evidence-based teaching strategies within the QUEST and LEARN instructional models.

Despite the implementation of the K–12 science curriculum, numerous students continue to struggle with understanding abstract scientific concepts, especially in rural or resource-constrained environments. Classroom observations and achievement test results indicate ongoing misconceptions, low engagement in conventional activities, and a deficiency in higher-order thinking skills. The learning challenges are exacerbated by interrupted schooling due to disasters, issues with digital access, and diminished student motivation in modular learning environments.

This plan utilizes the LEARN Model (Listen, Examine, Apply, Reflect, Narrate) and the QUEST Model (Questioning, Understanding, Exploring, Solving, Thinking/Transferring) to address existing gaps. These models are selected for their emphasis on learner-centered, inquiry-based, and reflective approaches. The LEARN

Model effectively reinforces core concepts and procedural understanding via structured reflection and active engagement, whereas the QUEST Model promotes creativity, exploration, and problem-solving through real-world applications.

Two innovative strategies—Mistake-Led Learning (MLL) and the Design Thinking Process (DTP)—are embedded across these models to strengthen metacognition and collaboration. Mistake-Led Learning cultivates resilience and critical thinking by encouraging students to reflect on errors as learning opportunities. The Design Thinking Process nurtures empathy, innovation, and iterative problem-solving, which are crucial for deep scientific understanding and 21st-century competence. To further support diverse learner needs, the plan integrates Computer-Assisted Instruction (CAI) and modular materials. CAI provides dynamic and interactive learning experiences that accommodate visual and auditory learners, while modules ensure continuity of learning in remote or offline contexts. The strategic pairing of these materials with appropriate models and strategies ensures that learning remains flexible, inclusive, and effective.

Ultimately, this plan contributes to the goals of the DepEd Science Curriculum and supports Sustainable Development Goal 4 (Quality Education) by promoting equitable access to innovative science education. Through this integration, learners will not only master scientific content but also develop the mindset, skills, and confidence to apply science in everyday life.

III. Purpose

- Enhance the scientific literacy of Grade 7 and 8 learners through inquiry-based and reflective learning.
- Integrate validated instructional materials into the LEARN and QUEST models for structured, student-centered science instruction.
- Promote 21st-century skills such as critical thinking, creativity, collaboration, and problem-solving using Mistake-Led Learning and the Design Thinking Process.
- Implement flexible and inclusive modalities through CAI and Modular Learning to accommodate diverse learner needs.
- Address learning gaps and external challenges, including class suspensions and limited technology access.
- Align with the DepEd K to 12 Science Curriculum, ensuring competency-based and relevant instruction.
- Support SDG 4 by providing inclusive and equitable quality science education for lifelong learning.
- Ensure measurable learning outcomes through performance-based tasks and assessment tools.

IV. Targets Learners

- Junior High School students, specifically Grade 7 and Grade 8 learners.

V. Theoretical Framework

This instructional learning plan is anchored in three key educational theories:

- **Constructivism** - Learning is seen as an active process where students construct knowledge through experience and interaction. The LEARN and QUEST models reflect this by promoting inquiry, reflection, and real-world application. Mistake-Led Learning and the Design Thinking Process further support constructivist learning by encouraging problem-solving and self-discovery.
- **Cognitive Load Theory (CLT)** - emphasizes reducing unnecessary mental effort to enhance learning. The structured phases of the LEARN and QUEST models help manage cognitive load, while Mistake-Led Learning supports deeper understanding by guiding learners to identify and reflect on errors.
- **Zone of Proximal Development (ZPD)** - Vygotsky's ZPD highlights the role of guided support in learning. This plan incorporates scaffolding through teacher facilitation, peer collaboration, and digital tools like CAI and modules, helping learners move from basic understanding to more complex skills.

Together, these theories guide the design of an inclusive, engaging, and cognitively effective instructional plan for science learning.

VI. Learning Goals

- To develop learners' scientific literacy, enabling them to understand, apply, and communicate scientific concepts effectively.
- To improve students' ability to analyze, evaluate, and solve real-world problems using inquiry-based approaches rooted in the QUEST and LEARN models.
- To foster metacognitive awareness by helping learners reflect on and learn from their mistakes through Mistake-Led Learning.
- To enhance students' creative thinking, empathy, and collaboration through the application of the Design Thinking Process in science tasks and projects.
- To ensure learners achieve mastery of science competencies in alignment with the DepEd K to 12 Science Curriculum.
- To build learners' capacity to transfer knowledge across different contexts, both academic and practical.
- To support the development of 21st-century skills such as critical thinking, digital literacy, and teamwork through the integration of CAI and modular learning.

VII. Instructional Plan Matrix

Instructional Plan for second quarter topics of Grade 7 and Grade 8 using the Instructional Model – LEARN and QUEST Model.

Grade 7 Instructional Plan Matrix

Instructional Model	Topic	Recommended Instructional Materials	Instructional Strategy	Assessment Methods
LEARN	Parts and functions of a microscope	CAI (videos, digital microscope simulator)	Mistake-Led Learning	Practical test on microscope handling, error analysis worksheet
LEARN	Levels of biological organization	Printed charts, diagrams, and flashcards, module	Mistake-Led Learning	Organizational hierarchy activity sheet, reflection journal
QUEST	Plant and animal cells	Microscope activity sheet, cell model kit, and module	Design Thinking Process	Labeled diagrams, model presentation, peer critique
QUEST	Reproductive strategies (asexual vs. sexual)	CAI, module, reproductive comparison chart	Design Thinking Process	Venn diagram, prototype model, group report
LEARN	Biotic and abiotic components	Infographic posters, printed worksheets	Mistake-Led Learning	Concept mapping, quiz
QUEST	Ecological relationships	CAI simulations, real-life scenarios	Design Thinking Process	Scenario-based group role play, rubric-based evaluation

Grade 8 Instructional Plan Matrix

Instructional Model	Topic	Recommended Instructional Materials	Instructional Strategy	Assessment Methods

LEARN	Movements along faults and earthquakes	CAI (3D simulations, interactive fault models)	Design Thinking Process	Preparedness plan, fault model demo, peer review
QUEST	Epicenter and magnitude vs. intensity	Infographics, printed case studies	Mistake-Led Learning	Worksheet corrections, fault mapping exercise
LEARN	Seismic waves and Earth's structure	CAI animations, printed wave chart	Mistake-Led Learning	Concept quiz, wave simulation journal
QUEST	Typhoon formation and movement	Weather map simulation, printed storm path charts	Design Thinking Process	Tracking activity, group presentation
LEARN	Precautionary measures during typhoons	Infographics, emergency drill guide	Design Thinking Process	Emergency plan project, rubric scoring
QUEST	Solar and lunar eclipses	CAI eclipse simulation, models	Mistake-Led Learning	Diagram labeling, eclipse reflection log

VIII. Implementation Plan

1. Curriculum Integration

***Goal**: Align instructional delivery with the K to 12 Science Curriculum and MELCs for the second quarter in Grades 7 and 8.*

Action Steps	Responsible
▪ Review and map Grade 7 and 8 second quarter MELCs to LEARN and QUEST models	Science Coordinator, Teachers
▪ Identify appropriate topics for each model-strategy pairing (MLL with LEARN; DTP with QUEST)	Curriculum Team

▪ Design an instructional flow that integrates inquiry, reflection, and application	Science Teachers
▪ Embed performance tasks and authentic assessments within each topic	Science Teachers

2. Instructional Resource Development

***Goal:** Prepare accessible, inclusive, and validated instructional materials suitable for CAI and modular delivery.*

Action Steps	Responsible
▪ Develop and validate CAI materials (videos, simulations, interactive quizzes)	LR and Science Team
▪ Print and distribute modular learning resources aligned with MELCs and models	Teacher
▪ Prepare reflective worksheets and design templates for MLL and DTP activities	Teacher
▪ Provide differentiated versions of materials for varied learning styles and abilities	Science Team

3. Teacher Training and Support

***Goal:** Equip science teachers with skills and confidence to implement LEARN and QUEST models with innovative strategies.*

Action Steps	Responsible
▪ Conduct orientation on LEARN and	Division Science

QUEST Models and their phases	Supervisor
▪ Provide in-service training (INSET) on Mistake-Led Learning and Design Thinking	External Facilitators/Trainers
▪ Facilitate workshops on CAI tool usage, module adaptation, and integration of 21st-century skills	ICT & Instructional Coaches
▪ Establish peer coaching, lesson modeling, and professional learning communities (PLCs)	Master Teachers

4. Monitoring and Feedback

Goal: *Ensure instructional fidelity, monitor learner progress, and improve delivery through timely feedback.*

Action Steps	**Responsible**
▪ Monitor lesson implementation through classroom observations, learning walk-throughs	Department Head, School Head
▪ Collect learner performance data from pretest/posttest and performance tasks	Science Teachers
▪ Conduct focus group discussions with students and teachers to gather qualitative feedback	Research Team
▪ Use feedback to revise materials, instructional strategies, and pacing guides	Teacher-Researchers

IX. Expected Outcome

For Learners

- Learners will demonstrate improved scientific literacy, including a deeper understanding of biological and earth science concepts aligned with second-quarter MELCs. Learners will show measurable academic improvement, with a target of at least a 20% increase in posttest scores compared to pretests. Students will apply critical thinking and problem-solving skills in real-world science scenarios using the Design Thinking Process. Learners will develop a growth mindset, as reflected in their ability to reflect on and correct errors during Mistake-Led Learning tasks. Students will produce performance-based outputs (e.g., models, plans, infographics) that reflect mastery of concepts and collaboration skills. Learners will engage more actively in classroom and group activities, as evidenced by improved participation and peer interaction.

For Teachers

- Teachers will gain increased competence and confidence in delivering inquiry-based, reflective, and learner-centered science instruction. Educators will effectively implement LEARN and QUEST Models, adapting them to both digital and modular learning contexts. Teachers will use formative and performance-based assessments aligned with the MELCs and instructional strategies. Science instruction will become more inclusive and differentiated, responding to diverse learner needs through CAI and modular resources.

For School and Program Implementation

- Instructional delivery will be more responsive to curriculum standards, integrating innovative strategies that promote higher-order thinking. The implementation will support DepEd’s thrust for quality, accessible education, contributing to SDG 4 – Quality Education. Monitoring and reflection through feedback loops will facilitate the ongoing enhancement of materials and teaching practices. The school aims to create a replicable model of integrated instruction that synthesizes technology, innovation, and inclusive education in the context of science teaching.

X. Sustainability and Research Continuity

a. Sustainability

- Integrate LEARN and QUEST models into the regular science curriculum and planning.
- Conduct ongoing teacher training via INSET and LAC sessions.

- Maintain a shared repository for validated CAI and modular resources.
- Implement peer mentoring by master teachers.
- Engage community stakeholders in science-related school initiatives.
- Use internal evaluations to improve instructional practices regularly.

b. **Research Continuity**

- Track learner performance and engagement over time.
- Encourage action research among science teachers.
- Extend the use of models to higher grade levels (Grades 9–10).
- Partner with nearby schools for expansion and comparative studies.
- Present findings in educational conferences and journals.
- Include innovations in the SIP and allocate funding through MOOE

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Figure 2: Instructional Learning Plan using Two Instructional Models and Innovative Strategies.

IV. DISCUSSION

Table 1a shows that both the LEARN model with CAI and the QUEST model with Modular Learning significantly improved Grade 7 students' performance, with QUEST + Modular producing slightly better results, especially in higher-order thinking skills like biological organization. These findings are consistent with studies by Alim (2022) and De Guzman & Fajardo (2021), which confirm the effectiveness of Modular Learning and CAI in enhancing science performance. This implies that teachers should strategically pair instructional models with learning materials to encourage deep learning, using Modular Learning for more complex topics. However, the findings are limited to one school and may vary in settings with different student profiles or resources.

Table 1b indicates that both QUEST + CAI and LEARN + Modular improved student outcomes, though QUEST + CAI achieved slightly higher posttest means, particularly for cell division. This supports studies showing CAI's effectiveness in visualizing biological processes (Hassan & Yousuf, 2017). The results suggest that CAI works best with inquiry models for complex topics, while Modular Learning paired with LEARN supports understanding of genetics and reproduction. Slightly lower scores for LEARN + Modular indicate the need to make modules more interactive.

Table 1c reveals that Mistake-Led Learning with both LEARN and QUEST improved Grade 8 scores, but QUEST + Modular had higher ratings, particularly in earthquake-related competencies. These results align with Alim (2022), who reported that Modular Learning enhanced science comprehension. Teachers are encouraged to integrate QUEST with Modular Learning for topics that require exploration and real-world application. The relatively moderate gains for LEARN + CAI suggest that CAI materials could benefit from more interactive elements.

Table 1d shows that both LEARN + CAI and QUEST + Modular improved results, but QUEST + Modular reached Satisfactory levels while LEARN + CAI remained Fairly Satisfactory. This finding supports the claim that modular approaches paired with inquiry models are effective for real-world science concepts. Teachers should use QUEST + Modular for exploration-based lessons and enhance CAI with interactive simulations to raise engagement. Limited access to technology may have influenced the CAI results.

Table 2a demonstrates that both LEARN + CAI and QUEST + Modular yielded statistically significant improvements, with QUEST + Modular producing greater mean gains, particularly in biological organization and energy transfer. This is consistent with research highlighting modular learning's ability to build conceptual understanding. The findings imply that teachers should select model-material combinations that foster higher-order thinking, though results may differ for younger or older learners.

Table 2b shows that QUEST + CAI and LEARN + Modular both significantly improved scores, with QUEST + CAI slightly ahead in mean gains. This supports findings that CAI improves understanding of cell processes (Hassan & Yousuf, 2021). Teachers are encouraged to integrate CAI with inquiry models for visualization-heavy topics, while Modular Learning should be used for reflective tasks. These findings are context-specific and should be validated in other schools.

Table 2c highlights that both LEARN + CAI and QUEST + Modular improved student performance, with QUEST + Modular showing higher gains in earthquake science. These results match blended learning studies that emphasize the effectiveness of modular and inquiry-based approaches. Teachers should design modules with problem-solving tasks and use CAI for foundational lessons. The moderate performance of LEARN + CAI suggests a need for richer digital resources.

Table 2d indicates that QUEST + Modular had higher gains compared to LEARN + CAI, especially for typhoon-related competencies. This confirms that inquiry-based learning with modules best supports deep understanding of real-world topics. Teachers should combine QUEST with Design Thinking for exploration-based tasks, while CAI should include more interactive features to move students beyond Fairly Satisfactory levels.

Table 3a shows high inter-rater agreement, confirming that the CAI materials are valid and reliable. These results support Cheng & Tsai (2022), who found that strong agreement predicts better learning outcomes. Teachers can confidently use these CAI materials, and curriculum developers should integrate them into science programs. However, topics with only moderate agreement need refinement for better clarity and consistency

Table 3b reveals substantial agreement among evaluators on most modular science topics, confirming that the modules are well-aligned with curriculum standards and effective for classroom use. However, topics on Earthquake Epicenter and Magnitude and Understanding

Typhoon showed only slight agreement, indicating the need for revision to improve clarity and alignment. These findings align with Dela Cruz et al. (2022), who stressed that well-developed modular materials boost comprehension, and Binoya (2021), who recommended iterative refinement based on evaluator feedback. Teachers can confidently use the highly rated modules but should provide extra scaffolding for topics with lower agreement. Curriculum developers should prioritize revisions for modules with slight agreement to ensure coherence and prevent misconceptions.

Table 3c shows perfect inter-rater agreement for all modular materials in social content areas, confirming their exceptional quality and reliability. This indicates that the materials are consistent, well-structured, and ready for classroom use. These findings align with Dela Cruz et al. (2022) and Anderson et al. (2021), who emphasized that high evaluator consensus ensures validity and equity in instruction. Teachers can rely on these modules for accurate and consistent delivery, and curriculum planners should maintain this level of quality through regular review and collaborative development.

Language Content Area Results indicate fair agreement ($\kappa = 0.30$), meaning the materials are functional but need refinement for language clarity and consistency. This aligns with findings by Castro et al. (2022) and Dewey (2022), who noted that linguistic ambiguities can cause varied interpretations among evaluators. Teachers may need to clarify instructions when using these materials, while developers should revise language structure and readability to make content more accessible, especially in multilingual classrooms.

Layout and Format Results also show fair agreement, suggesting that while materials are acceptable, there are inconsistencies in layout, spacing, and visual organization that could hinder ease of use. Studies by Binoya (2021) and Anderson et al. (2021) highlight that well-structured layout improve comprehension and reduce cognitive load. Curriculum developers should adopt standardized templates and conduct regular design reviews to ensure that materials are visually cohesive and user-friendly.

Table 4b compares CAI and Modular Learning under the Design Learning Strategy and finds no significant difference in performance for Grades 7 and 8. This suggests that learning gains are driven more by the Design Thinking strategy than by the format of delivery. The results agree with Santos & Dela Cruz (2021) and Martinez & Garcia (2020), who found equal effectiveness of digital and print-based methods when content is well-aligned. Teachers can choose either CAI or Modular Learning based on student needs, access to technology, and context, without compromising learning outcomes.

Table 5 shows nuanced results: LEARN + CAI outperformed QUEST for Grade 7, but QUEST + Modular was better for independent, module-based learning. For Grade 8, LEARN paired with Modular Learning significantly outperformed QUEST, while both models with CAI had similar effects. These findings support Jaraba & Janer (2023) that older learners benefit from structured approaches with modules, and Rogayan Jr. et al. (2021) that CAI enhances motivation and achievement. Teachers should strategically pair models and materials based on learner maturity and topic complexity, and curriculum developers should provide guidelines for best-fit combinations.

C.H.A.L.L.E.N.G.E.S. Thematic Analysis highlights barriers such as poor connectivity, hesitation to participate, limited resources, time constraints, and emotional stress. Connectivity issues hinder access to digital materials, as students struggle with slow internet and lack of devices, consistent with Fidalgo & Castaño (2021). Hesitation to participate stems from fear of judgment, limiting engagement in strategies like Mistake-Led Learning and Design Thinking, as Dweck (2006) emphasized in her work on growth mindset. Teachers should provide offline alternatives, encourage peer scaffolding, and normalize mistakes as learning opportunities. Policymakers should address infrastructure gaps and ensure equitable access to technology to reduce learning disruptions.

V. CONCLUSIONS

The study concludes that aligning instructional models, strategies, and learning resources is crucial for improving science performance. The QUEST Model, particularly when paired with Modular Learning and Design Thinking, effectively promotes inquiry, creativity, and knowledge transfer, while the LEARN Model with Mistake-Led Learning strengthens foundational knowledge and procedural skills through structured reflection. The integration of CAI and modular approaches enhances engagement and ensures continuity of learning, especially in remote or disaster-prone areas. However, regular refinement of instructional materials is essential to improve clarity and support higher-order thinking, particularly in complex topics such as typhoons and earthquakes.

In light of these findings, it is recommended that schools institutionalize the QUEST Model with Modular Learning and Design Thinking to promote deep learning and critical thinking, while continuing to use the LEARN Model with Mistake-Led Learning for foundational competencies. Instructional materials—both print and digital—should undergo continuous evaluation and revision to maintain alignment with curriculum standards and improve comprehensibility. Teachers should receive regular professional development on learner-centered approaches, the effective use of CAI, and strategies that foster error analysis and reflection. Moreover, interventions should be implemented to support students' time management and vocabulary development, and steps should be taken to ensure equitable access to technology or offline resources. Finally, future research should include longitudinal studies to evaluate the sustained impact of these instructional approaches and explore students' emotional and social experiences to better inform teaching practices.

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