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Why Structured Instruction Matters: A Comparative Effect of Four Instructional Models on Mathematics Achievement in Printed Modular Distance Learning

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Abstract. The COVID-19 pandemic made substantial changes in educational delivery, prompting the Philippine public school system to implement printed modular distance learning to maintain instructional continuity. Prior studies have examined modular learning outcomes; however, empirical studies comparing instructional models within a fully printed modular approach are limited. Addressing this gap, the study examined the comparative effect of four instructional models, 5A, 5E, explicit direct instruction, and Gagné's nine events of instruction, on Grade 10 students' mathematics achievement within a printed modular learning environment. Using a quasi-experimental design, the study involved 80 Grade 10 students from four public junior high schools in northern Cebu, Philippines. Instructional modules aligned with each model were developed and administered, followed by a summative assessment to measure students' achievement. The results of a one-way analysis of variance revealed statistically significant differences in achievement across the instructional models ($F(3, 76) = 17.40$, $p < .001$), with post hoc results indicating that Gagné's nine events of instruction resulted in significantly higher student performance than the other approaches. Qualitative findings from student reflections further showed that clear explanations, guided practice, and structured feedback were important in the modular context. These findings contribute theoretically by reinforcing the role of structured instructional sequencing in self-directed learning and provide practical implications for the design of printed mathematics modules in low or no-connectivity learning settings.

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1. Introduction

Educational disruptions caused by crises such as pandemics and natural disasters have led the education system worldwide to adopt alternative modes of instructional delivery. The existing body of knowledge predominantly emphasizes technology-supported instructional delivery models (Bhutoria & Aljabri, 2022; Bond et al., 2021; Anderson & Dron, 2011; Ferreira et al., 2024). However, for students living in areas with limited access to technology and online resources, these delivery models poses a significant challenge to the continuity of their learning. Delivering instruction using online materials becomes less feasible in rural areas with limited or no internet access (Bustillo & Aguilos, 2022).

In the Philippine context, modular distance learning emerged as dominant due to its feasibility in remote, low-connectivity settings (Dhawan, 2020). The modular distance-learning mode breaks content into discrete units, or "modules," that promote pacing flexibility, learner autonomy, accountability, and engagement. This modular distance-learning approach has been instrumental in far-flung, asynchronous learning environments. Using printed modules with minimal technological support enables students to sustain their learning independently at home. Research shows that modular distance learning can support student achievement and ensure learning continuity. Studies have documented both the potential benefits of modular instruction (Bernard et al., 2014), including learner autonomy and flexible pacing, and persistent challenges related to instructional clarity, feedback, and student engagement (Bustillo & Aguilos, 2022; Means & Neisler, 2021).

Further evidence suggests that modular learning can support student achievement when instructional materials are well-designed and aligned with learning competencies (Aksan, 2021; Capinding, 2022). However, teachers reported difficulties in preparing instructional materials and providing feedback during remote learning implementation (Cayabas Jr. & Sumeg-ang, 2023). Although modular approaches have shown promising results in mathematics, particularly in enhancing knowledge acquisition and performance (Egara & Mosimege, 2024), considerable variability remains in the instructional models used in module design. The effectiveness of modular instruction depends mainly on how content is structured and systematically sequenced within learning materials (Kirschner et al., 2006; van Nooijen et al., 2024).

Instructional models are the frameworks that guide teachers in organizing and delivering content. These are grounded in diverse learning theories, including constructivism, behaviorism, and cognitivism, each of which contributes insights into structuring learning experiences (Mallari & Tayag, 2022). In mathematics education, exploratory approaches such as problem-based learning (Lim, 2023) and direct instruction models remain prominent. However, their application in printed modular formats has not been sufficiently examined, particularly in teaching mathematics (Stockard et al., 2018). While educational theories often debate the ideal balance between learner exploration and explicit instruction, a notable gap in research remains regarding how these models perform within printed mathematics modules. Most prior studies examine single instructional approaches or technology-supported modalities, leaving limited empirical evidence on the comparative effectiveness of instructional models in fully printed, low-resource environments.

To address this gap, a quasi-experimental study was conducted comparing four instructional models: 5A and 5E (constructivist–inquiry oriented), explicit direct instruction (EDI), and Gagné's nine events of instruction (cognitivist–behaviorist), within a fully printed Grade 10 modular mathematics environment. By examining how variations in instructional structure, scaffolding, and sequencing relate to student achievement, the study tested competing theoretical assumptions and translated them to student achievement.

Specifically, this study sought to answer the following research question: Which instructional model most effectively enhances student learning outcomes in a distance learning environment reliant on printed mathematics modules? To support this objective, the following null hypothesis was tested: H_{01}: There is no significant difference in student performance across the instructional models employed in modular mathematics instruction.

Through this investigation, the study sought to generate empirical evidence on effective instructional designs for printed modular learning and to contribute to the development of resilient education systems capable of sustaining instructional quality during periods of educational disruption.

2. Literature Review

This section synthesizes existing literature on printed modular distance learning, instructional design, and instructional models in mathematics education. It examines how different instructional frameworks function in low-interaction, print-based learning environments with limited teacher mediation. The review establishes the theoretical and empirical basis for comparing instructional models and identifies gaps that the present study then addressed.

2.1 Printed Modular Distance Learning in Mathematics

Printed modular distance learning is an educational approach in which learners' study independently using self-learning modules without requiring face-to-face interaction or internet connectivity (Bacus et al., 2023). Dejene (2019) described the modular approach as an instructional design that organizes the curriculum into short, independent learning units. Several studies have highlighted the potential benefits of modular instruction, including the development of self-directed learning skills and learner independence (Mukhithi et al., 2025; Ojo et al., 2024). Means and Neisler (2021) reported that students' learning experiences and engagement varied significantly across remote learning formats during the COVID-19 transition. Lu and Wang (2023) stated that modular instruction offers flexibility and individualized learning experiences for students.

Learning mathematics in modular contexts presents unique challenges. Unlike subjects that rely heavily on reading comprehension, mathematics requires step-by-step explanation, guided practice, and immediate feedback to correct misconceptions. Several studies have reported that learners using printed modules often struggle with abstract concepts, procedural accuracy, and sustained engagement due to the absence of teacher mediation (Bustillo & Aguilos, 2022). Recent research emphasizes that educators should deliberately select and align instructional models with cognitive and pedagogical principles to ensure effective lesson design and learning outcomes (van Nooijen et al., 2024). As a result, the effectiveness of modular mathematics instruction depends heavily on the quality and structure of the instructional materials provided.

Despite these challenges, modular learning remains a necessary and practical approach in low-connectivity settings. Research has shown that when modules are well-designed and aligned with learners' needs, students can demonstrate satisfactory learning outcomes even in the absence of face-to-face instruction (Dhawan, 2020). Moreover, creating a cohesive module can be achieved by aligning teaching methods, materials, activities, and assessments with the core question of what students need to learn and how best to facilitate their learning (Almomani et al., 2023). These findings highlight the importance of instructional design in printed modular learning, particularly in mathematics, for independent learning.

2.2 Instructional Design Challenges in Modular Learning Contexts

In modular distance-learning environments, instructional design serves as the primary mechanism for learning. Moreover, creating a cohesive module requires aligning learning outcomes with teaching methods, learning activities, and assessment practices so that students' needs are met, and learning is effectively facilitated (Loughlin et al., 2021; Khalil & Elkhider, 2016). Without sustained teacher presence, printed modules must function as self-contained instructional systems capable of introducing concepts, guiding practice, and reinforcing learning. It places significant emphasis on the sequencing of content, clarity of explanations, and alignment of activities and assessments.

One of the most frequently cited challenges in modular instruction is the lack of timely feedback. Learners are often unable to verify their understanding immediately due to delayed feedback, which can result in persistent misconceptions (Opitz et al., 2011), particularly in mathematics. Studies suggest that delayed feedback negatively affects learning outcomes, while clear instructional guidance and reinforcement can partially compensate for the absence of direct teacher interaction (Opitz et al., 2011). Studies have documented that teachers encounter challenges in preparing modular materials and providing timely feedback, while learners struggle with instructional clarity and limited academic support (Bustillo & Aguilos, 2022). Bacus et al. (2023) also identified that an excessive number of activities and limited time to complete them were key challenges in modular learning, and they recommended simplifying and revising modules to improve student understanding and ensure lesson continuity.

Further, research has shown that contextualized teaching strategies, in which instructional materials, examples, and activities are connected to students' real-world contexts, enhance learner engagement and academic performance (Mahmuti et al., 2025; Santoso et al., 2025). Taken together, these studies indicate that careful selection of instructional models and learning activities is essential to ensure clarity, feasibility, and effectiveness in printed modular learning.

Scaffolding has been identified as a critical design feature in modular learning. Well-scaffolded modules reduce cognitive load, provide structured support, and help learners navigate complex tasks independently (Faber et al., 2024; van Nooijen et al., 2024). In printed modular contexts, scaffolding must be embedded directly into the instructional materials through explicit explanations, worked examples, and guided practice. When these elements are absent or inconsistently applied, learners are more likely to disengage or rely on external assistance, undermining the integrity of the learning process.

Given these instructional constraints, the use of structured instructional models becomes essential, as these models systematically embed sequencing, scaffolding, and feedback within printed modules. Instructional models provide structured frameworks that guide how content is introduced, practiced, and reinforced, making them essential tools for designing practical printed modules in mathematics.

2.3 Instructional Models as Frameworks for Modular Teaching

Instructional models are systematic procedures that guide teachers in delivering effective instruction by organizing learning activities in a purposeful, coherent manner. Instructional models provide systematic guidance on selecting pedagogical strategies, structuring learning activities, and aligning assessments with learning goals, thereby supporting coherent and effective teaching–learning processes (Abuhassna et al., 2024).

Instructional models drawn from various theoretical foundations, including behaviorism, cognitivism, and constructivism, which collectively inform how learning occurs and how instruction should be designed. Educators and theorists have developed instructional models to translate these learning theories into practical classroom applications that guide lesson planning, implementation, and assessment. In this sense, instructional models serve as strategic frameworks for teachers' instructional decisions and classroom practices.

In the Philippine context, instruction is defined as the methods and processes used to direct learning (Department of Education [DepEd], 2016). Teaching involves systematic planning and organization of learning activities through deliberate step-by-step procedures that are aligned with intended learning outcomes to ensure effective learning (Khalil & Elkhider, 2016). In modular learning environments, this structured planning becomes even more critical, as students rely primarily on instructional materials rather than direct teacher guidance. As such, the instructional model embedded in a printed module effectively serves as a proxy for teacher-led instruction, guiding learners through content acquisition, practice, and assessment.

This study evaluated four instructional frameworks, the 5E and 5A constructivist cycles, EDI, and Gagné's nine events of instruction, selected for their distinct epistemological foundations and varying degrees of pedagogical scaffolding. While the 5A and 5E models are rooted in constructivist theory, emphasizing student-led inquiry and cognitive schema construction, EDI and Gagne's framework represent objectivist, systematic paradigms centered on procedural clarity and cumulative reinforcement. By analyzing these models through the lens of printed modular distance learning, this research investigates the efficacy of divergent scaffolding strategies in 'teacher-remote' environments, where the instructional design must compensate for the absence of synchronous mediation.

2.3.1 Constructivist models: 5E and 5A

Constructivist instructional models, such as the 5E and 5A models, emphasize learner exploration, inquiry, and reflection. The 5A instructional model is derived from the lesson planning framework mandated by the Department of Education under DepEd Order No. 42, s. (2016). This model follows a sequential process consisting of activity, analysis, abstraction, application, and assessment, which is intended to connect lesson content with learners' prior knowledge and experiences. The 5A model reflects constructivist principles by encouraging learners to engage with tasks and actively construct understanding through guided activities.

Similarly, the 5E instructional model—engage, explore, explain, elaborate, and evaluate—was developed by the Biological Sciences Curriculum Study and is likewise grounded in constructivist learning theory. Inquiry-based instructional models emphasize learner-centered teaching through exploration, questioning, discussion, and reflection, thereby promoting active participation and deeper conceptual understanding rather than passive learning (Lazonder & Harmsen, 2016). These models encourage students to construct knowledge actively by engaging with problems, exchanging ideas, and linking new concepts to prior experiences. Empirical evidence from mathematics education research indicates that constructivist and inquiry-oriented approaches significantly enhance student engagement, conceptual understanding, and situational interest in learning mathematics (Hwang et al., 2015; Lazonder & Harmsen, 2016; Mallari & Tayag, 2022).

While constructivist models have demonstrated effectiveness in interactive classroom environments, their application in printed modular learning presents challenges. Exploratory and inquiry-based activities often require timely teacher facilitation and feedback, which may be limited or unavailable in asynchronous modular settings. Without structured guidance or facilitation, learners may struggle to complete complex or abstract mathematical tasks independently (Kirschner et al., 2006; Faber et al., 2024). Studies have shown that discovery-based activities require substantial scaffolding to be effective, especially in distance learning contexts where learners cannot easily seek clarification (Zuo et al., 2023).

The 5A and 5E model encourages active engagement and exploration by guiding learners to connect new knowledge with prior experiences. However, the effectiveness of the constructivist models may be constrained by limited access to immediate feedback, which might increase students' misconceptions during independent exploration. In comparison with more structured instructional approaches, constructivist models such as 5A and 5E may place greater cognitive demands on learners in printed modular settings, where opportunities for real-time clarification and feedback are limited.

2.3.2 Explicit direct instruction

The EDI model is rooted in cognitive learning theory and emphasizes clarity, structured sequencing, and guided practice. Developed by Hollingsworth and Ybarra (2009), the model includes instructional components such as activating prior knowledge, stating learning objectives, explicit modeling, guided practice, independent practice, and lesson closure. This model has been widely recognized for its effectiveness in developing procedural fluency and foundational mathematical skills (Hollingsworth & Ybarra, 2009). Explicit instruction emphasizes clear teacher modeling, structured guided practice, and frequent formative assessment to monitor students' understanding throughout the learning process. By making learning processes explicit through step-by-step explanations and demonstrations, this approach supports the development of procedural knowledge and is particularly effective in mathematics instruction (Ali, 2020; Stockard et al., 2018).

Research suggests that learners in self-paced or modular environments value effective scaffolding and clear, guided examples when instructional support is limited (Faber et al., 2024; van Nooijen et al., 2024). However, critics argue that explicit instruction may not sufficiently promote higher-order thinking or conceptual understanding if used in isolation (Lim, 2023). Compared to the other structural models, EDI provides clarity, procedural guidance, and an emphasis on step-by-step instruction. However, this may limit opportunities for deeper conceptual exploration if not supplemented with reflective tasks. The model's structure is designed for direct delivery, rather than self-study.

2.3.3 Gagné's nine events of instruction

Gagné's nine events of instruction, proposed by Robert Mills Gagné, integrates behaviorist and cognitivist principles into a comprehensive instructional framework. The model outlines nine instructional events designed to support learning: gaining attention, informing learners of objectives, stimulating recall of prior knowledge, presenting content, providing learning guidance, eliciting performance, offering feedback, assessing performance, and enhancing retention and transfer (Gagné, 1985). Gagné conceptualized learning as the interaction of internal and external conditions, both of which must be addressed through systematic instructional design.

In distance learning settings, Gagné's model has been recognized for its structured sequencing and emphasis on feedback and reinforcement (Hricko, 2008). Gagné's model offers a structured and sequential approach that aligns well with the demands of independent learning. By explicitly guiding learners through each stage of the learning process, the model compensates for the absence of continuous teacher presence and provides built-in opportunities for reinforcement and feedback. While this instructional model provides a systematic framework with nine clear instructional steps that help learners progress step by step, it requires significant planning time and effort. The preparation of printed modular materials is more demanding than that of other instructional designs.

Table 1: Conceptual comparison of instructional models in printed modular mathematics learning

Instructional Model	Instructional Model	Structural Level	Feedback Mechanism	Strengths	Limitation
5A	Constructivist	Sequential, learner-centered	Delayed	Encourages Engagement & Reflection	Requires careful design, limited immediate feedback, and risk of superficial engagement
5E	Constructivist /Inquiry-Based	Cyclical, inquiry-driven	Delayed	Promotes inquiry, exploration, and critical thinking	Demands interactive exploration, requires the teacher's facilitation
EDI	Cognitivist	Highly structured, linear	Embedded	Clear step-by-step guidance, procedural knowledge	Less conceptual depth
Gagne's Nine Events	Cognitivist/ Behaviorist	Detailed, highly structured sequence of nine events	Embedded, Systematic Feedback	Comprehensive, systematic design through step-by-step progression	Time-consuming to design in modules, rigid structure

Overall, the literature shows that the effectiveness of printed modular mathematics learning depends significantly on how well instruction is structured, sequenced, and supported with feedback. Constructivist models encourage engagement and deeper understanding, but their reliance on learner independence can be problematic in low-interaction settings. In contrast, structured models focus on clarity, guided practice, and reinforcement, which may better support self-directed learning. However, few studies directly compare these approaches in fully printed modular mathematics contexts. This gap highlighted the need for an empirical study on how different instructional models affect student achievement in modular distance learning.

3. Methodology

This study employed a quasi-experimental research design to examine the comparative effectiveness of four instructional models—5A, 5E, EDI, and Gagné's nine events of instruction—within a printed modular distance learning environment. A quasi-experimental approach was deemed appropriate due to the constraints imposed by the COVID-19 pandemic when this study was conducted, which limited random assignment of participants and face-to-face instruction.

To complement the experimental component, descriptive data on learning modality, internet access, connectivity, and available learning devices were collected to contextualize the instructional environment. In addition, qualitative data in the form of short written student reflections were gathered to capture learners' experiences and perceived challenges during modular instruction. Although the study's primary focus was quantitative, supplementary data provided contextual and explanatory support for the findings.

3.1 Participants and Sampling

An a priori power analysis was conducted using G*Power 3.1 to determine the minimum sample size required for a one-way ANOVA with four independent groups. Assuming a large effect size (Cohen's f = 0.40), an alpha level of .05, and a desired power of .80, the analysis indicated a minimum total sample size of 76 participants. The present study included 80 students (n = 20 per group), yielding an actual statistical power of .82, which was sufficient to detect statistically significant differences among instructional models.

The participants were Grade 10 students from four public junior high schools in a municipality in northern Cebu Province, Philippines. Two of the schools were situated in lower *barangays* (community-level administrative unit) near the central highway, while the remaining two were located in the upper or mountainous *barangays*. Each school contributed 20 students, resulting in four intact groups corresponding to the four instructional models investigated.

Due to pandemic-related restrictions and limited mobility, convenience sampling was employed. While random assignment was not feasible, the participating schools shared comparable characteristics, including curriculum implementation, reliance on printed modular instruction, and adherence to the Department of Education's most essential learning competencies (MELCs). All participants were enrolled in a wholly modular learning modality at the time of the study, ensuring consistency in instructional delivery.

Table 2 shows the age and gender distribution of the respondents. The majority of students were within the expected age range for Grade 10, and both male and female learners were adequately represented. These characteristics suggest that the sample reasonably reflects the population of junior high school learners engaged in modular distance learning.

Table 2: Age and gender of the respondents

Range	Male		Female		Total	
	f	%	f	%	f	%
15-17	26	33	42	53	68	85
18-20	6	8	3	4	9	11
21-23	1	1	1	1	2	3
24-26	0	0	0	0	0	0
27-29	0	0	1	1	1	1
Total	**33**	**41**	**47**	**59**	**80**	**100**

3.2 Instructional Material and Instrument

The four printed instructional modules were developed for the study, each explicitly aligned with one instructional model: (1) 5A, (2) 5E, (3) EDI, and (4) Gagné's nine events of instruction.

Each module covered the same Grade 10 mathematics content based on the MELCs, specifically:

1. Illustrating measures of position (quartiles, deciles, and percentiles).
2. Computing specified measures of position for a given data set.
3. Interpreting measures of position.

To minimize instructional variability, all modules contained equivalent learning objectives, content scope, examples, and assessment tasks. The primary distinction among the modules lay in the organization, sequencing, and presentation of instructional activities, consistent with the principles of their respective instructional models. Each participating school implemented only one instructional model, and students completed the modules independently as part of their regular modular learning activities. The primary instrument used to measure student performance was a 28-item multiple-choice summative test adapted from standardized items in the Grade 10 mathematics learner's textbook issued by the Department of Education. The test comprised nine items for illustrating measures of position, 10 for computing them, and nine for interpreting them. The use of standardized textbook-based items was intended to ensure curricular alignment and content appropriateness.

The instructional modules and assessment instrument underwent content validation by the research adviser and a mathematics master teacher from the Department of Education. Validation focused on content accuracy, clarity of instructions, alignment with MELCs, and appropriateness for independent modular learning. Minor revisions were made based on the validators' recommendations prior to implementation. Construct validity of the summative test was established by ensuring alignment between test items and the intended mathematics constructs defined in the MELCs, specifically illustrating, computing, and interpreting measures of position. Each item was mapped to these competencies to ensure that the instrument adequately represented the targeted learning outcomes. The use of standardized textbook-based items further supported construct representation by reflecting commonly accepted mathematical content and cognitive demands appropriate for Grade 10 learners.

The internal consistency reliability of the summative multiple-choice test was examined using the Kuder–Richardson formula 20 (KR-20). The analysis yielded a KR-20 coefficient of 0.62, indicating acceptable internal reliability for a classroom-based summative assessment. Previous research has established that reliability coefficients within this range are generally considered acceptable for achievement tests used in educational settings, particularly when instruments assess multiple content domains or subskills (Bonett & Wright, 2015).

To supplement quantitative data, a survey questionnaire was administered to gather information on students' learning modality, internet access, connectivity, and available learning devices. Additionally, students were asked to provide brief written reflections describing their learning experiences and the challenges they encountered during modular instruction. These reflections served as qualitative support for interpreting the quantitative findings.

3.3 Data Collection

Prior to data collection, formal approval was obtained from the school's division district supervisor and the principals of the participating schools. Coordination with Grade 10 coordinators and class advisers ensured systematic distribution and retrieval of instructional modules and research instruments. Students and their parents or guardians were informed of the study's purpose, and informed consent was secured prior to participation. The students completed the assigned printed modules independently over the prescribed period. Upon completion, they answered the summative test and survey questionnaire and provided short written reflections. The participants were given tokens after completing the instruments. All data were collected in compliance with public health protocols and institutional ethical guidelines.

To mitigate potential bias from school-level variance, several procedural controls were implemented. All participating schools utilized the standardized Grade 10 mathematics curriculum and the printed modular distance learning modality as mandated by the Department of Education. To ensure construct equivalence, the instructional modules across the four models were kept identical in content, objectives, and assessment tasks, varying only in their pedagogical sequencing and structural delivery.

This study adopted a posttest-only static-group design. Due to the emergency shift to printed modular distance learning during the COVID-19 pandemic, a pre-test was not administered. This decision was made to prioritize instructional continuity and to avoid the logistical challenges of extra testing in a home-based learning environment where teacher supervision was absent. While this design limits the assessment of baseline equivalence, the risk was mitigated by the use of standardized summative instruments across all groups. Nevertheless, the influence of school-level contextual factors is acknowledged as a limitation, and results are interpreted with a focus on the relative efficacy of the instructional structures rather than absolute performance gains.

3.4 Data Analysis

Descriptive statistics, including frequencies, percentages, means, and standard deviations, were used to summarize students' demographic characteristics, learning modality, connectivity, and access to learning devices. To determine whether significant differences exist in student performance across the four instructional models, a one-way analysis of variance (ANOVA) was conducted. When the omnibus ANOVA yielded statistically significant results, Tukey's honestly significant difference (HSD) post hoc test was applied to identify specific group differences.

All statistical analyses were performed using Jamovi software, with the level of significance set at $p < .05$. Qualitative responses from students' written reflections were reviewed and thematically grouped to identify recurring challenges and learning preferences, which were used to contextualize and support the quantitative findings. In addition to statistical significance testing, effect sizes were computed to determine the magnitude of differences among instructional models, with Cohen's d reported for post hoc comparisons.

4. Results and Findings

To provide an analysis of the various instructional models on student performance, the subsequent tables illustrate the instructional strategies, learning modality, internet accessibility, connectivity status, and available learning devices, average scores, statistical significance, and post hoc comparisons of the results.

4.1 Descriptive Results

The students' learning modality, internet accessibility, connectivity status, and available learning devices during the implementation of modular distance learning are shown in Table 3. All respondents (100%) were under the modular learning modality, with no students participating in online, digital, or blended learning arrangements. In terms of internet access, a majority of the students (64%) reported having internet accessibility, while 36% indicated that they had no internet access. Regarding connectivity status, most students reported an average internet connection (65%), followed by those with weak connectivity (26%).

Only a small proportion reported strong connectivity (8%), and a minimal number reported no connectivity at all (1%). Among available learning devices, cellphones were the most commonly owned (91%), followed by televisions (35%). Ownership of more advanced learning devices, such as laptops (8%), personal computers (2%), and tablets (1%), was relatively low, and 1% of respondents reported having no available learning device.

Table 3: Learning modality, internet accessibility, connectivity status, and available learning devices

Category	Sub-category	f	%
Learning Modality	Modular	80	100
	Online/Digital	0	0
	Blended	0	0
Internet Accessibility	I have internet accessibility	51	64
	I do not have internet accessibility	29	36
Connectivity Status	Strong	6	8
	Average	52	65
	Weak	21	26
	None	1	1
Available Learning Devices	Cellphone	73	91
	Television (TV)	28	35
	Laptop/Netbook	6	8
	Personal Computer (PC)	2	2
	Tablet	1	1
	None	1	1

The three competencies measured under the topic of most essential learning outcomes were: (1) illustrating the measures of dispersion: quartiles, deciles, and percentiles, (2) calculating a specified measure of position of a set of data, and (3) interpreting the measures of position. The scores of the students across this section are presented in figures 1, 2, and 3.

Figure 1 presents the distribution of correct responses among the instructional models for competency 1. Across all items in this competency, students exposed to Gagne's model recorded the highest frequencies with consistent results across the questions. The EDI demonstrated moderate performance, while the 5E and 5A models exhibited lower and more variable correct-response frequencies at the item level.

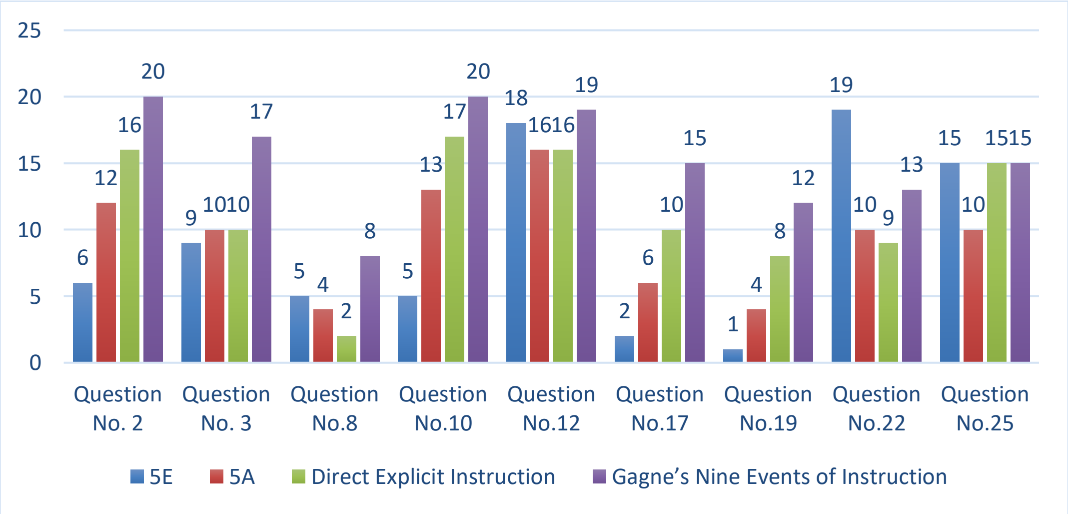

Figure 1: Students' scores in illustrating the measures of dispersion

Figure 2 illustrates item-level performance across competency 2. Students under Gagne's model obtained higher correct-response frequencies than those under the three models. Performance under the EDI varied across items but generally exceeded that under the constructivist model. The 5E and 5A models demonstrated the lowest frequencies of correct responses, suggesting uneven performance across procedural tasks.

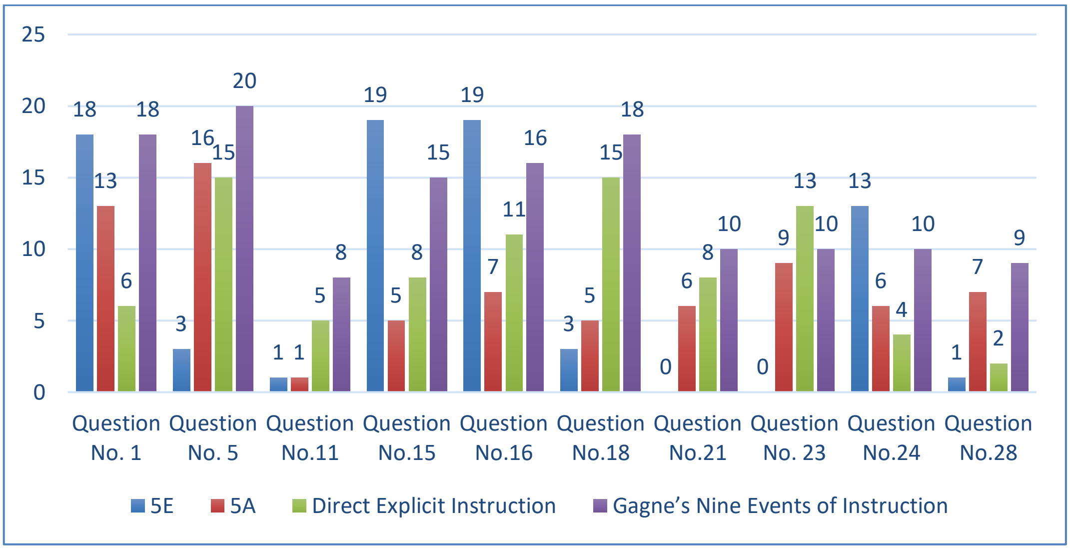

Figure 2: Students' scores in calculating a specified measure of the position of a set of data

The frequency of correct responses for competency 3 is shown in Figure 3. Students exposed to Gagné's nine events of instruction achieved higher correct response frequencies across most items. The 5A model showed higher performance on selected interpretation items than the 5E and EDI models. However, performance under the 5E and EDI models remained more variable across items, with lower correct response frequencies observed in several questions.

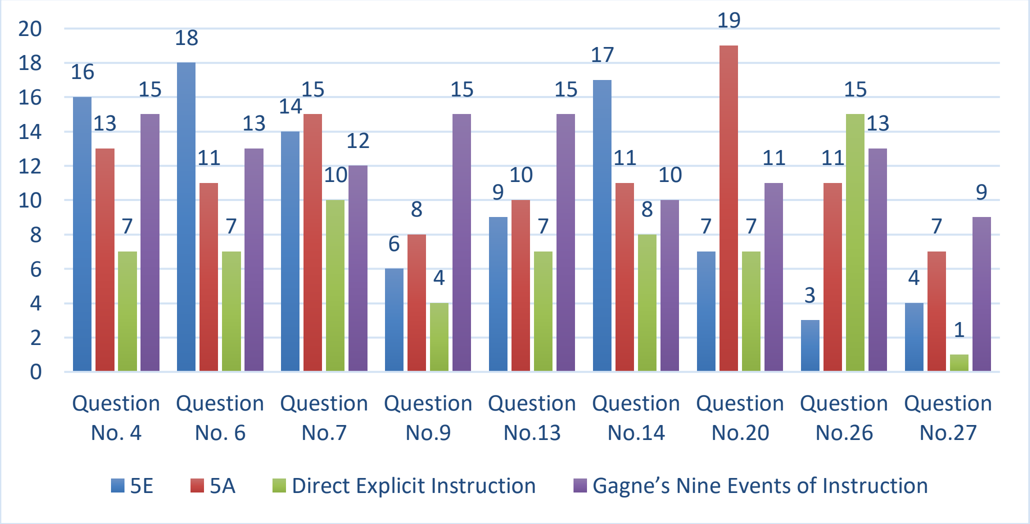

Figure 3: Students' scores in interpreting the measures of position

Overall, the item-level patterns observed across figures 1–3 indicate consistent differences in student performance across instructional models, which are further examined in the succeeding tables through competency-level summaries and inferential analyses.

Table 4 shows the percentage of correct responses across three mathematics competencies under four instructional models: 5E, 5A, EDI, and Gagné's nine events of instruction. Across all three competencies, learners exposed to Gagné's nine events of instruction consistently demonstrated higher mean scores than those taught using constructivist models, particularly on procedural-accuracy tasks. The highest percentage of correct responses across the three competencies under Gagné's models was 77.22%, 67.00%, and 62.78%, respectively.

Table 4: Percentage of correct responses by competency and instructional model

Competencies	**5E**		**5A**		**EDI**		**Gagné's**	
	n	%	**n**	%	**n**	%	**n**	%
(1) Illustrating the measures of dispersion	80	44.44	85	47.22	103	57.22	139	77.22
(2) Calculating a specified measure of position of a set of data	77	38.50	75	37.50	87	43.50	134	67.00
(3) Interpreting the measures of position	94	52.22	105	58.33	66	36.67	113	62.78

Note: n represents the total number of correct responses per competency. Percentages were computed by dividing the total number of correct responses by the product of the number of test items per competency and the number of students per instructional model.

4.2 Inferential Results

Table 5 further portrays whether these observed differences in student outcomes across instructional models are statistically significant when overall performance is compared. A one-way analysis of variance revealed a statistically significant difference in students' mean achievement scores across the instructional models, $F(3, 76) = 17.40$, $p < .001$, $\eta^2 = .41$. Students exposed to Gagné's nine events of instruction obtained the highest mean score ($M = 19.30$, $SD = 3.91$, $SE=0.87$), followed by the 5A model ($M = 13.25$, $SD = 1.99$, $SE=0.44$), EDI ($M = 12.80$, $SD = 4.41$, $SE=0.99$), and the 5E model ($M = 12.55$, $SD = 3.06$, $SE=0.68$). The relatively small standard errors across groups indicate stable estimates of the mean scores. The 95% confidence intervals for the mean score were [17.59, 21.01] for Gagné's nine events of instruction, [12.39, 14.11] for the 5A model, [10.86, 14.74] for EDI, and [11.22, 13.88] for the 5E model.

Table 5: Results of students' performance across four instructional models

Instructional Model	n	*M*	SD	SE	95% CI	F	p
5E	20	12.55	3.06	0.68	11.22, 13.88	17.4	<.001
5A	20	13.25	1.99	0.44	12.39, 14.11		
EDI	20	12.80	4.41	0.99	10.86, 14.74		
Gagné's	20	19.30	3.91	0.87	17.59, 21.01		

Note: n = 20 per instructional model. M = mean; SD = standard deviation; SE = standard error. F(3, 76) = 17.40.

Following the ANOVA reported in Table 5, Tukey HSD post hoc analyses were conducted to identify specific pairwise differences among the instructional models. As shown in Table 6, statistically significant differences were observed between Gagné's nine events of instruction and each of the other instructional models. Specifically, Gagné's model showed significant differences when compared with the 5E model (mean difference = −6.05, $t = -5.523$, $p < .001$, Cohen's $d = 1.746$), the 5A model (mean difference = −6.75, $t = -6.162$, $p < .001$, Cohen's $d = 1.950$), and EDI (mean difference = −6.50, $t = -5.933$, $p < .001$, Cohen's $d = 1.876$).

In contrast, comparisons among the 5E, 5A, and EDI Instruction models did not yield statistically significant differences ($p > .05$). Post hoc comparisons further showed that differences involving Gagné's nine events of instruction were associated with large effect sizes (Cohen's $d \approx 1.75$–1.95). In contrast, effect sizes among the 5E, 5A, and EDI models were small.

Table 6: Tukey post hoc test results for students' performance

Comparison	Mean Difference	t	Ptukey	Cohen's D
5E – 5A	-0.70	-0.639	.919	-0.202
5E – EDI	-0.25	-0.228	.996	-0.072
5E – Gagné's	-6.75	-6.162	<.001	-1.95
5A – EDI	0.45	0.411	.976	0.130
5A – Gagné's	-6.05	-5.523	<.001	-1.746
EDI – Gagné's	-6.50	-5.933	<.001	-1.876

Note: Comparisons are based on estimated marginal means.

4.3 Qualitative Findings

Student-written reflections were analyzed using thematic content analysis, with recurring ideas grouped into common categories. The most frequently cited themes emphasized the importance of clear explanations and step-by-step demonstrations. Worked examples indicated that students relied heavily on structured instructional support to understand mathematical concepts. These responses closely aligned with Gagné's instructional events related to presenting content, providing learning guidance, and eliciting performance, as well as with the principles of EDI. Students expressed that:

> *"Mas makasabut ko sa math kung tarung pagka discuss bisan sa module ra" (S42)* [I can understand Math even in a module if it is explained well]
>
> *"Explaining the lesson and activity that will make me understand and learn mathematics better because I understand the lesson step by step, how to solve the mathematics lesson and activities." (S50)*

This response exemplified the theme of instructional clarity and guided explanation, highlighting the role of step-by-step explanation in reducing confusion during modular learning. Students also highlighted the value of reviewing prior knowledge, clear learning objectives, and practice-oriented components. Additionally, many learners reported that assessments, quizzes, and teacher feedback contributed to their understanding by allowing them to identify and correct errors.

While independent reading of modules was mentioned, it appeared less frequently and was often described as insufficient without accompanying explanations, guidance, and examples. The responses indicated that students perceived mathematics learning to be more effective in a modular setup when instruction included clear explanations, ample examples, guided practice, and feedback. Independent reading of modules was mentioned less frequently and was often described as insufficient, lacking accompanying explanations, guidance, and examples.

5. Discussion

The findings underscore the reliance on printed modular instruction, a necessity dictated by the digital divide. While the Department of Education's self-learning modules provided a vital contingency during COVID-19 (DepEd, 2020), the shift to distance learning exposed significant accessibility gaps. Despite over half of the participants reporting internet access, the prevalence of unstable connectivity and limited hardware, primarily restricted to mobile phones, precluded meaningful digital or blended engagement. Consistent with the work of Bustillo and Aguilos (2022) and Casillano (2019), these socio-technical constraints validate the continued relevance of printed instructional materials as the primary pedagogical medium in rural and underserved contexts.

Inferential analyses using ANOVA revealed statistically significant differences in students' performance across instructional models, with Gagné's nine events of instruction consistently yielding higher mean scores than the 5E, 5A, and EDI models. No statistically significant difference was found among the remaining three instructional models. Tukey post hoc analysis further indicated that the significant variance observed in the ANOVA was primarily associated with the students exposed to Gagné's model. The comparisons indicated that differences involving Gagné's nine events of instruction were associated with larger effect sizes than those among the other models. While these differences are statistically significant, they must be interpreted considering potential confounding variables.

Given the quasi-experimental nature of the study, alternative explanations for Gagné's superior performance, such as varying levels of teacher follow-up across schools, differences in baseline mathematical readiness, or the socio-economic 'home-learning' environment, cannot be entirely discounted. However, the standardization of content and assessments across all groups suggests that the instructional structure itself remained a decisive factor. The performance observed in the Gagné condition may be attributed to the structured sequencing and explicit feedback mechanisms embedded within the model, consistent with cognitive load theory (Kirschner et al., 2006). Prior research indicates that learners in modular and distance learning settings benefit from clear explanations and illustrative examples, particularly when opportunities for teacher interaction are limited (van Nooijen et al., 2024; Faber et al., 2024).

Gagné's nine events of instruction emphasize clearly articulated objectives, guided presentation of content, practice opportunities, feedback, and assessment, all of which align with instructional design principles for supporting learning in self-directed environments. Well-structured instructional designs enhance learner comprehension and performance, particularly in self-directed or distance learning environments (Abuhassna et al., 2024). Alternatively, some researchers have noted that relying solely on explicit instruction may fall short of fostering higher-order thinking and deeper conceptual understanding (Lim, 2023), suggesting that the instructional structure should be carefully tailored to learning goals and competencies.

Conversely, the lack of significant differentiation among the 5E, 5A, and EDI models suggests that their effectiveness may be diluted when translated into a printed format without real-time mediation and teacher facilitation. Constructivist approaches such as the 5E/5A cycles often rely on teacher-led inquiry to bridge conceptual gaps; without this facilitation, learners may struggle to regulate their own discovery process (Anderson & Dron, 2011). Minimally guided methods do not work, especially when learners lack sufficient prior knowledge to regulate their learning independently (Kirschner et al., 2006).

While these approaches incorporate essential instructional features, their efficacy diminishes when translated into printed formats that fail to satisfy students' requirements for sustained guidance and immediate feedback. Constructivist and inquiry-based elements inherent in the 5E and 5A models are well supported in face-to-face classrooms and are optimized for synchronous or digitally mediated spaces. However, they encounter significant pedagogical barriers in purely printed contexts, where the absence of real-time facilitation limits adaptive scaffolding.

Scaffolding strategies that incorporate structured guidance and step-by-step explanations help learners process complex information by reducing cognitive strain and supporting conceptual understanding (van Nooijen et al., 2024). Instructional scaffolding has been shown to significantly enhance student performance, engagement, and learning outcomes across online and distance learning contexts by providing structured guidance and gradual release of responsibility (Lazonder & Harmsen, 2016; Belland et al., 2017). Modules that integrate formative assessment and reflective learning activities encourage learners to monitor their progress, regulate their learning, and identify areas needing improvement. In the absence of such support, learners often experience difficulties in sustaining task completion and consistency, which may result in learning gaps and lower achievement outcomes (Nicol & Macfarlane-Dick, 2006; Panadero, 2017).

The qualitative findings from students' written reflections provided contextual support for the quantitative result. The students frequently emphasized the importance of clear explanations, step-by-step demonstrations, worked examples, guided practice, and feedback, features that closely align with Gagné's instructional events and the principles underlying EDI. These perceptions are consistent with studies reporting that students in modular and distance learning contexts struggle when instructional materials lack sufficient explanation and scaffolding (Bustillo & Aguilos, 2022; Talimodao & Madrigal, 2021).

Structured problem sequencing and guided examples help enhance understanding and lessen cognitive load (Gürel, 2025). Instructional approaches aligned with contextual teaching strategies significantly influenced learner engagement and outcomes during pandemic-related shifts to distance learning (König et al., 2020). The qualitative data reinforce the conclusion that structured guidance is not merely a preference but a pedagogical necessity in modular mathematics, where the absence of a teacher necessitates a "gradual release of responsibility" embedded within the text itself (Belland et al., 2017).

These findings underscore the necessity of aligning instructional structure with the specific constraints of the learning environment, suggesting that models providing explicit guidance, through objectives, systematic explanations, and integrated feedback, are suited for independent mathematical learning in technologically lacking, low-internet settings and unmediated contexts. Consequently, this study provides critical empirical evidence for prioritizing structured instructional design to mitigate learning loss during periods of educational disruption. However, the scope of these conclusions is bounded by the quasi-experimental design using intact groups and the absence of pre-test data, which preclude definitive causal claims regarding baseline student readiness. Furthermore, the potential influence of school-level moderating variables, such as varying teacher follow-up and domestic learning conditions, necessitates a cautious interpretation of the observed performance gains.

6. Conclusion

This study investigated the comparative effectiveness of four instructional models implemented through printed modular distance learning in mathematics, revealing significant performance variances. Quantitative analyses demonstrated that Gagné's nine events of instruction yielded higher student achievement over the 5E, 5A, and EDI models. These findings were further supported by qualitative evidence from students' written reflections, which highlighted the importance of clear explanations, step-by-step demonstrations, guided practice, and timely feedback. In contexts where learner autonomy is high and teacher interaction is limited; the results suggest that cognitivists with behaviorist-oriented instructional frameworks provide more consistent support for procedural and conceptual learning in mathematics than purely exploratory approaches.

Theoretically, this research extends instructional design discourse by empirically demonstrating that Gagné's nine events of instruction remains highly effective when adapted into self-directed, printed modular formats, serving as a vital pedagogical surrogate for teacher mediation in low-connectivity settings. From a policy standpoint, the findings advocate for the establishment of design standards for self-learning modules that prioritize structured frameworks, incorporating explicit objectives, worked examples, and systematic feedback, over purely exploratory activities, particularly for procedural and abstract mathematical competencies.

By aligning instructional structure with the specific constraints of the learning environment, this research provides a strategic roadmap for maintaining educational quality and continuity amidst resource limitations or systemic disruptions. Ultimately, these results suggest that in the absence of a physical instructor, a well-structured module becomes the most critical determinant of student success.

Conflict of Interest

The authors declare no conflicts of interest associated with the conduct of this study.

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