**International Journal of Evaluation and Research in Education (IJERE)**
Vol. 15, No. 6, December 2026, pp. 5454~5465
ISSN: 2252-8822, DOI: 10.11591/ijere.v15i6.39182 

# Well-designed self-learning modules and mathematics retention in flexible learning contexts

**Gemma M. Valdez[1], Cherime P. Bautista[1,2], Alfeo B. Tulang[3]**
[1]Faculty of Advanced and International Studies, Davao Oriental State University, City of Mati, Philippines
[2]Department of Information Technology, Davao Oriental State University–Banaybanay Extension Campus, Banaybanay, Philippines
[3]Department of Mathematics, Bukidnon State University, Malaybalay City, Philippines

**Article Info**

***Article history:***

Received Feb 21, 2026
Revised Jul 16, 2026
Accepted Oct 25, 2026

***Keywords:***

Flexible learning
Learning retention
Mathematics education
Perceived effectiveness
Self-learning module

**ABSTRACT**

Educational disruptions led to widespread reliance on self-learning modules (SLMs), particularly in low-resource and low-connectivity settings. However, limited evidence exists on how SLM quality is associated with sustained mathematics learning in such contexts. This study addressed this gap by examining the relationship between perceived SLM effectiveness and learning retention among 237 grade 12 students from four public secondary schools in Davao Oriental, Philippines. A validated survey measured eight instructional dimensions of SLMs (objectives, content, discussion, activities, assessment, suitability, relevance, and aesthetics) and learning retention, conceptualized as retention-related psychological dispositions - motivation, self-efficacy, and perceived learning- reflecting students' engagement in modular contexts. Data were analyzed using descriptive statistics, Pearson correlation, and analysis of variance (ANOVA). Results showed that students perceived the SLMs as effective across all instructional dimensions, particularly in assessment and relevance. Perceived SLM effectiveness was moderately positively associated with retention-related dispositions ($r=0.50$, $p<0.001$). Home learning resources were significantly associated with perceived SLM effectiveness ($\eta^2=0.04$, $p<0.01$), while age was associated with retention. These findings suggest that well-designed SLMs are closely associated with sustained mathematics learning in flexible, resource-adaptive educational contexts.

*This is an open access article under the CC BY-SA license.*

***Corresponding Author:***

Gemma M. Valdez
Faculty of Advanced and International Studies, Davao Oriental State University
City of Mati, Davao Oriental, 8200 Philippines
Email: gemma.valdez@dorsu.edu.ph

## 1. INTRODUCTION

The COVID-19 pandemic compelled education systems internationally to adopt alternative learning modalities to sustain instructional delivery amid prolonged school disruptions [1]. In many low- and middle-income contexts, however, access to online learning remained uneven because of limitations in internet connectivity, device ownership, and household learning conditions [2], [3]. As a result, low-technology and paper-based learning modalities turned essential mechanisms for ensuring instructional continuity [4], [5]. In the Philippines, modular distance learning was institutionalized through the Department of Education's Basic Education Learning Continuity Plan (BE-LCP), with printed self-learning modules (SLMs) serving as the primary instructional resource in many public schools, particularly in geographically isolated and low-resource communities [4]–[6]. Reports additionally indicate that printed modular learning remained the most widely adopted modality beyond the pandemic period, reflecting persistent infrastructure constraints

and the continued role of SLMs in flexible and blended learning arrangements [7]. These conditions point up the urgent need to examine the instructional quality of SLMs as a basis for sustaining equitable and beneficial learning.

Mathematics presents particular challenges in modular learning because it is a cumulative subject that depends on a strong foundation, guided instruction, repeated practice, and timely feedback [8], [9]. Learners do not simply acquire isolated facts; they build understanding step by step, so weaknesses in early concepts can hamper later learning [8], [9]. In resource-limited flexible learning environments, SLMs frequently serve as the primary or sole instructional support available to students [3], [10]. When these modules are not clearly designed, students may complete the required tasks without developing deep conceptual understanding, leading to superficial learning, reduced confidence, and limited retention of critical mathematical ideas [10], [11]. Thus, while modular learning may preserve access to education, it does not necessarily ensure the quality and longevity of mathematical learning [7], [10].

To address this concern, the study draws on self-regulated learning (SRL) theory and Keller's attention, relevance, confidence, and satisfaction (ARCS) motivation model, which provides complementary explanations of how instructional materials shape learning processes. SRL theory claims that learners' ability to plan, monitor, and regulate their learning is strongly associated with motivation, self-efficacy, and task value, particularly in independent learning settings [12], [13]. This makes SRL relevant in modular environments, where learners work with content with minimal direct teacher support. Meanwhile, the ARCS model explains how instructional design can increase engagement by capturing learners' attention, establishing relevance, building confidence, and promoting satisfaction [14]. These dimensions are directly reflected in the design features of SLMs. Together, these frameworks themselves suggest that instructional design quality is associated with learners' motivation and self-efficacy, which support sustained engagement in learning tasks. In addition, cognitive involvement perspectives emphasize that well-designed materials can promote deeper mental effort and sustained participation in learning activities [15].

From these theoretical perspectives, learning retention in this study is conceptualized not simply as delayed recall or achievement, but as retention-related psychological dispositions, including motivation, self-efficacy, and perceived learning, which enable learners to sustain engagement with mathematical tasks over time [14]–[16]. Consistent with this view, Figure 1 presents the study's conceptual framework, showing that the perceived effectiveness of SLMs, as reflected in their instructional design features, is associated with learning retention in mathematics. At the same time, socio-demographic and learning-context variables are treated as contextual (grouping) factors to examine variations in both perceived SLM effectiveness and learning retention across different learner conditions.

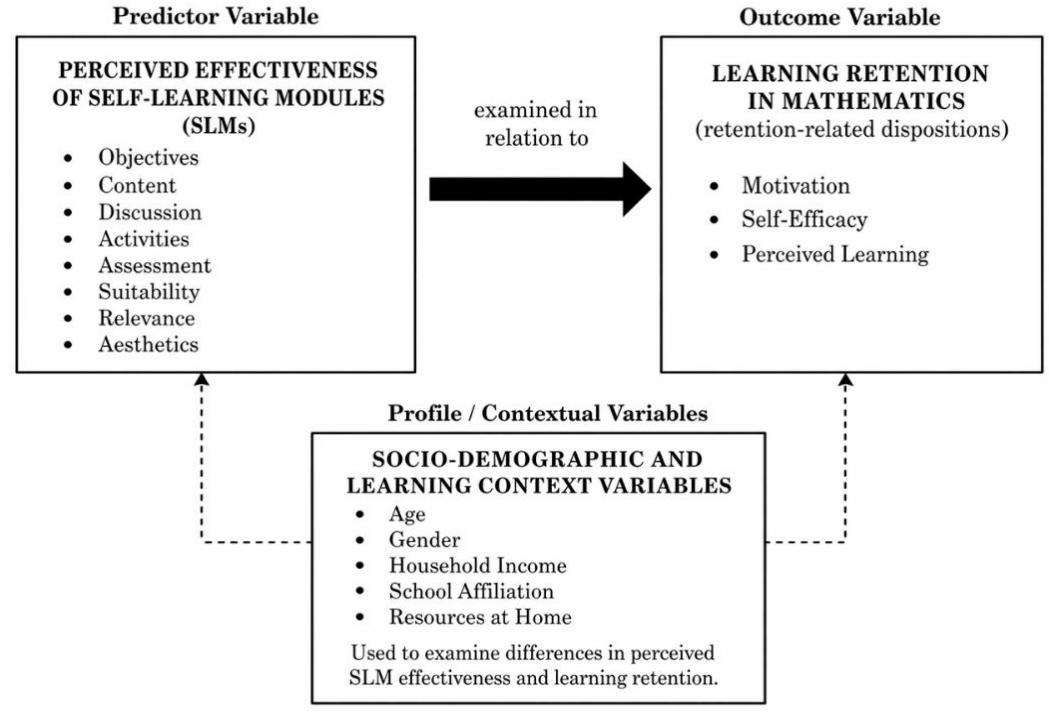



Figure 1. Conceptual framework of the study

Despite the growing corpus of literature on modular learning, most existing studies have focused on general usability, learner satisfaction, implementation challenges, or academic achievement outcomes [16], [17]. While these studies provide valuable descriptive insights, they offer a limited explanation of how specific instructional design features of SLMs facilitate sustained learning processes in mathematics. Prior research has largely relied on aggregate measures, such as overall satisfaction or achievement scores, without examining the means through which instructional design relates to learners' engagement and self-regulation or general perceptions, which do not fully capture learners' ability to sustain motivation, confidence, and perceived understanding within self-directed mathematics learning [14], [18]. Moreover, few studies have disaggregated SLM quality into specific instructional design dimensions such as objectives, content, assessment, relevance, and aesthetics, and examined how these are differentially associated with retention-related cognitive constructs, including motivation, self-efficacy, and perceived learning, especially in senior high school mathematics and low-resource, printed modular contexts [1], [8], [19], [20]. As a result, the field lacks a fine-grained theory-informed understanding of how particular design features relate to sustained engagement in independent learning environments.

This study is novel in that it provides a dimension-specific and theory-informed analysis of how instructional design quality of SLMs is associated with retention-related learning processes in mathematics. This area has not been sufficiently examined in prior research, which has largely focused on general usability, satisfaction, or achievement outcomes. It is also important as it addresses the gap by examining specific instructional design features. Features relate to learners' motivation, self-efficacy, and perceived learning, particularly in situations where students rely heavily on printed modules with limited instructional support. Perceiving these relationships is critical for improving the design, implementation, and evaluation of SLMs, especially in resource-limited settings where instructional materials play a central role in shaping learning outcomes. By identifying specific design features associated with learners' motivation, self-efficacy, and perceived learning, the study offers more precise guidance to enhance module effectiveness beyond general usability measures. In doing so, it supports more targeted and evidence-informed decisions among teachers and administrators seeking to strengthen learning engagement and equity in modular and flexible learning environments. Furthermore, conceptualizing retention as sustained motivational and self-regulatory engagement extends current understanding of modular learning effectiveness in resource-limited contexts. The findings provide theoretically grounded and practice-oriented insights to inform the improvement, contextualization, and quality assurance of SLMs, particularly in settings where printed modules remain a central mode of instruction.

Accordingly, this study examined the relationship between the perceived effectiveness of SLMs and learning retention in mathematics among senior high school students in Banaybanay District, Davao Oriental, Philippines. Specifically, it assessed students' perceptions of SLM effectiveness across eight instructional design dimensions. It analyzed their association with retention indicators, namely motivation, self-efficacy, and perceived learning, while also examining differences across selected socio-demographic variables and access to learning resources at home. In addition, the study delivers a dimension-level analysis of SLM quality to identify which specific instructional features are more closely associated with retention-related dispositions. This approach permits a more subtle understanding of how learners experience modular instruction in independent learning contexts.

## 2. METHOD

### 2.1. Research design

This study used a quantitative correlational research design to examine the strength and direction of associations between the perceived effectiveness of SLMs and learning retention in mathematics among senior high school students, without implying causal relationships. A correlational approach is appropriate when the objective is to identify the strength and direction of the association between variables without manipulating them or establishing causal relationships [21]. This approach corresponds with evaluation-oriented research in flexible learning environments, where the goal is to examine evidence of relationships among variables to inform instructional improvement, rather than to establish cause-and-effect relationships [22], [23].

### 2.2. Participants and research locale

Table 1 presents the distribution of senior high school respondents across the four participating schools. As shown in Table 1, there were 237 grade 12 senior high school students from the four public secondary schools implementing modular distance learning in Banaybanay District, Davao Oriental, Philippines. A total enumeration approach was used to include all available learners in the selected context, ensuring adequate representation of students exposed to printed SLMs [23]. However, the distribution of respondents across participating schools was not uniform, with a larger proportion of the sample

(approximately 77%) drawn from one school. This unevenness reflects actual enrollment patterns and administrative accessibility during data collection. While total enumeration strengthens contextual validity, the uneven distribution may introduce clustering effects, in which responses are influenced by shared instructional conditions within a dominant school. To address this, data were collected across multiple schools within the district to capture variability in learning environments, and school affiliation was treated as a grouping variable in the analysis to examine differences in perceived SLM effectiveness and learning retention [24]. Nevertheless, the findings were interpreted with caution, as the overrepresentation of one school may limit response variability and may reflect institutional similarities not completely accounted for by group comparisons.

Table 1. Distribution of senior high school students across participating schools

| School | Total population | Actual respondents | Percentage (%) |
|---|---|---|---|
| Manuel B. Guiñez Sr. National High School | 476 | 183 | 77 |
| Leandro G. Japos National High School | 40 | 15 | 6 |
| Puntalinao National High School | 54 | 21 | 9 |
| Donguila Pacres National High School | 46 | 18 | 8 |
| Total | 616 | 237 | 100 |

### 2.3. Research instrument

Data were collected using a validated survey questionnaire adapted from previously established instruments [25], [26]. The instrument consisted of three sections. The first section gathered respondents' socio-demographic profiles, including age, gender, household income, school affiliation, and availability of learning resources at home. The second section measured the perceived effectiveness of SLMs across eight instructional dimensions: objectives, content, discussion, activities, assessment, suitability, relevance, and aesthetics. The third section measured learning retention in mathematics through indicators of motivation, self-efficacy, and perceived learning [27]. In this study, learning retention is conceptualized not as delayed recall or direct measurement of mathematical achievement over time, but as sustained motivational and self-regulatory dispositions that support persistent engagement with mathematics in a modular learning context. Thus, the construct reflects students' persistence, confidence, and perceived understanding while learning through SLMs, rather than long-term retention, as measured by follow-up achievement tests. Responses were recorded on a 5-point Likert scale (1=totally disagree to 5=totally agree).

### 2.4. Validity and reliability

The instrument was pilot tested with 60 senior high school students, not included in the final sample, resulting in a Cronbach's alpha of 0.934, indicating high internal consistency [28]. Content validity was established through expert review using standard content validation procedures, guaranteeing the relevance, clarity, and representativeness of the instrument items [29], [30]. Three experts evaluated the instrument for clarity, relevance, coherence, adequacy, and objectivity, with all indicators achieving acceptable Aiken's V coefficients as presented in Table 2.

Table 2. Expert validation results of the survey questionnaire

| Item | Expert ratings | Aiken V coefficient | Interpretation |
|---|---|---|---|
| 1. Clarity of directions and items<br>Description: the vocabulary, language, structure, and level of the questions are suitable for the respondents' understanding. The directions and items are written clearly and understandably. | E1: 4, E2: 4, E3: 4 | 0.75 | Valid |
| 2. Presentation and organization of items<br>Description: the items are logically organized and well-presented. | E1: 5, E2: 4, E3: 5 | 0.92 | Very valid |
| 3. Suitability of items<br>Description: the items are appropriate and accurately represent the research content. They are designed to assess the conditions, knowledge, and perceptions they aim to measure. | E1: 5, E2: 4, E3: 5 | 0.92 | Very valid |
| 4. Adequacy of items per category or indicator<br>Description: the questions are grouped by category and are relevant to the research objectives. | E1: 5, E2: 4, E3: 5 | 0.92 | Very valid |
| 5. Attainment of purpose<br>Description: the instrument effectively addresses the study's objectives. | E1: 5, E2: 4, E3: 5 | 0.92 | Very valid |
| 6. Objectivity<br>Description: each question is clear and designed to elicit a single, unbiased response. | E1: 5, E2: 4, E3: 4 | 0.83 | Very valid |
| 7. Scale and evaluation rating scale<br>Description: the rating scales provided are appropriate for the questions. | E1: 5, E2: 4, E3: 4 | 0.83 | Very valid |

### 2.5. Data analysis

Descriptive statistics, including mean and standard deviation, were used to determine the levels of perceived SLM effectiveness and learning retention, guided by the descriptive scale in Table 3 [30]. To examine the relationship between perceived SLM effectiveness and learning retention, Pearson's product-moment correlation was employed [31]. This test was appropriate as variables were treated as continuous composite scores derived from Likert-scale items [32]. Before analysis, key assumptions for Pearson correlation, including linearity and approximate normality, were assessed through visual inspection of scatterplots and distribution configurations [33]. Correlation coefficients were interpreted using standard effect size guidelines: small (r=0.10-0.29), moderate (r=0.30-0.49), and large ($r \geq 0.50$) [34]. To determine differences in perceived SLM effectiveness and learning retention across socio-demographic groups, an analysis of variance (ANOVA) was conducted [35]. When statistical differences were identified, post hoc tests were performed to determine specific group differences [36]. In addition to statistical significance, effect sizes were reported using eta squared ($\eta^2$) and interpreted as small (0.01), moderate (0.06), and large (0.14) [37]. Confidence intervals (95%) were considered in the interpretation of key correlation coefficients to provide an estimate of the accuracy of the relationships observed [38]. All statistical tests were evaluated at a 0.05 level of significance [39].

Table 3. Descriptive equivalents for mean scores and their interpretations

| Mean range | Descriptive equivalent | Interpretation |
|---|---|---|
| 4.51–5.00 | Very high | Strong agreement with the statements. |
| 3.51–4.50 | High | Agreement with the statements. |
| 2.51–3.50 | Moderate | Moderate agreement with the statements. |
| 1.51–2.50 | Low | Somewhat agree with the statements. |
| 1.00–1.50 | Very low | Disagree with the statements. |

### 2.6. Ethical considerations

Permission to conduct the study was obtained from the schools division superintendent and participating school heads. Informed consent was obtained from all respondents before data collection, ensuring that participation was voluntary and based on a clear understanding of the study's purpose. Data collection was conducted during students' available learning periods in accordance with the Department of Education's No Disruption of Classes policy and prevailing health directives. The study adhered to ethical norms for research involving human participants and complied with Republic Act 10173 (The Data Privacy Act of 2012). Ethical clearance was obtained from the University Research Ethics Board (UREB). Participation was voluntary, and informed consent was secured from all participants, with parental consent obtained where required. All responses were treated with strict confidentiality, and no personally identifiable information was collected or reported. The data gathered were used solely for research purposes and were securely stored to prevent unauthorized access.

## 3. RESULTS AND DISCUSSION

### 3.1. Socio-demographic profile of respondents

A total of 237 grade 12 senior high school students from four secondary schools in the Banaybanay District participated in the study, as presented in Table 4. The majority of respondents were 18 years old or younger (80.17%), with only a small portion aged 21 years or older (5.49%). Female students (48.95%) slightly outnumbered male students (42.62%), while a small percentage identified as lesbian, gay, bisexual, or transgender (LGBT) (2.95%) or opted not to disclose gender (5.49%). Most respondents reported a household income of Php 10,000 and below (82.70%), indicating predominantly low-income backgrounds. Notably, 71.31% of students reported having no learning resources at home, while only a small number had access to devices such as cellphones, laptops, or printed supplementary materials.

These findings highlight the resource-constrained learning conditions under which modular instruction was implemented. Such conditions are consistent with global and local evidence indicating that inequalities in access to learning resources considerably shape students' participation and experiences in flexible and distance learning environments [1]–[4]. In low-resource contexts, learners commonly rely on alternative modalities due to limited infrastructure, reinforcing disparities in learning opportunities and outcomes [3], [4]. In this context, SLMs function not only as instructional materials but also as primary learning supports, particularly for students with limited access to extra resources. Prior studies have similarly shown that printed modular learning is still a dominant modality in resource-limited settings, where instructional materials play a central role in sustaining learning continuity [5]–[8], [40]. These conditions

underscore the importance of instructional design quality, as the effectiveness of SLMs is closely tied to students' ability to engage with the content and sustain learning in the absence of steady teacher support.

Table 4. Socio-demographic profile of the senior high school respondents in Banaybanay District

| Factor | Category | Frequency (n=237) | Percentage (%) |
|---|---|---|---|
| Age | 18 and below | 190 | 80.17 |
| | 19 to 20 | 34 | 14.35 |
| | 21 and above | 13 | 5.49 |
| Gender | Male | 101 | 42.62 |
| | Female | 116 | 48.95 |
| | LGBT | 7 | 2.95 |
| | Not disclosed | 13 | 5.49 |
| Household income | Php 10,000 and below | 196 | 82.70 |
| | Php 10,001 to Php 20,000 | 26 | 10.97 |
| | Php 20,001 to Php 30,000 | 8 | 3.38 |
| | Above Php 30,000 | 7 | 2.95 |
| Educational level | Grade 11 | 0 | 0.00 |
| | Grade 12 | 237 | 100.00 |
| School | Manuel B. Guiñez Sr. National High School | 183 | 77.22 |
| | Leandro G. Japos National High School | 15 | 6.33 |
| | Puntalinao National High School | 21 | 8.86 |
| | Donguila Pacres National High School | 18 | 7.59 |
| Resources at home | No learning resources | 169 | 71.31 |
| | Cellphone | 25 | 10.55 |
| | Cellphone and Laptop | 15 | 6.33 |
| | Laptop/Desktop Computer | 5 | 2.11 |
| | Printed Materials (books and modules) | 13 | 5.49 |
| | Cellphone, Laptop, Printed materials | 6 | 2.53 |
| | Others (TV and Radio) | 4 | 1.69 |
| Total | | 237 | 100.00 |

### 3.2. Perceived effectiveness of SLMs in mathematics

The perceived effectiveness of SLMs was assessed across eight instructional dimensions, as shown in Table 5. The overall mean score was 3.87 (SD=0.57), indicating a high level of perceived effectiveness and suggesting that students generally viewed the SLMs as effective instructional materials in mathematics. Among the dimensions, module assessment obtained the highest mean (M=4.01), indicating that students strongly valued organized evaluation components such as pretests, posttests, and self-check activities. This finding aligns with research highlighting the role of formative assessment and feedback in supporting SRL, as these mechanisms enable learners to monitor progress and adjust strategies [13], [41]. Similarly, module relevance (M=3.94, SD=0.73) and module discussions (M=3.89, SD=0.72) also received high ratings, indicating that students perceived the content as meaningful and understandable. From the perspective of ARCS motivation model, perceived relevance is a key driver of sustained engagement, as learners are more likely to invest effort when content is aligned with their goals and experiences [14], [42].

Table 5. Perceived effectiveness of SLMs in mathematics

| SLM component | Mean | Standard deviation | Descriptive equivalent |
|---|---|---|---|
| Module objectives | 3.83 | 0.54 | High |
| Module contents | 3.80 | 0.68 | High |
| Module discussions | 3.89 | 0.72 | High |
| Module activities | 3.80 | 0.74 | High |
| Module assessment | 4.01 | 0.76 | High |
| Module suitability | 3.82 | 0.66 | High |
| Module relevance | 3.94 | 0.73 | High |
| Module aesthetic | 3.88 | 0.56 | High |
| Overall | 3.87 | 0.57 | High |

All remaining dimensions, including objectives, content, suitability, and aesthetics, were also rated high, indicating overall consistency in instructional quality. However, the consistently high ratings across all components, coupled with relatively small standard deviations, suggest limited variability in responses. While this may reflect positive perceptions, it may also suggest response tendencies such as social desirability bias. Therefore, these results should be interpreted as students' subjective evaluations of SLM quality, rather than objective measures of instructional quality. Taken together, the results suggest that students viewed the SLMs as clear, organized, and aligned with curricular expectations, supporting earlier

findings on the importance of well-designed modular instructional materials in promoting engagement and independent learning, particularly in flexible and modular learning contexts [13], [43], [44].

### 3.3. Learning retention in mathematics

Students' learning retention in mathematics was measured using indicators of motivation, self-efficacy, and perceived learning as presented in Table 6. The overall mean retention score was 3.54 (SD=0.35), indicating a high level of retention-related dispositions. Among the indicators, motivation (satisfaction) had the highest mean (M=3.83), followed by motivation (relevance) (m=3.79) and self-efficacy (M=3.61). These results suggest that students generally experienced a sense of accomplishment and perceived the content as meaningful, both of which are closely associated with sustained engagement and persistence in learning. Recent studies emphasize that motivation and self-efficacy are central drivers of sustained learning effort and engagement in mathematics, particularly in independent learning environments [9], [45], [46].

By contrast, motivation (attention) (M=3.42) and motivation (confidence) (M=3.16) were rated at moderate levels. This suggests that although students valued and completed the modules, sustaining focus and confidence during independent mathematics learning was more difficult. This pattern is consistent with the ARCS model, in which relevance and satisfaction can be achieved through well-structured materials, whereas attention and confidence often require additional support and interaction [14]. In modular settings, the absence of immediate teacher feedback and guided explanation may limit opportunities for clarification and confidence-building, especially when learners engage with abstract mathematical concepts independently [8], [47]. These findings suggest that while SLMs can support meaningful and satisfying learning experiences, they may be less effective at sustaining attention and confidence without additional scaffolding. Recent research highlights that guided feedback, structured prompts, and interactive supports are important in strengthening attention, confidence, and sustained engagement in self-directed learning environments [46], [48].

Table 6. Learning retention in mathematics among senior high school students

| Retention indicator | Mean | Standard deviation | Descriptive equivalent |
|---|---|---|---|
| Motivation (attention) | 3.42 | 0.40 | Moderate |
| Motivation (relevance) | 3.79 | 0.53 | High |
| Motivation (confidence) | 3.16 | 0.39 | Moderate |
| Motivation (satisfaction) | 3.83 | 0.57 | High |
| Perceived effectiveness | 3.44 | 0.55 | Moderate |
| Self-efficacy | 3.61 | 0.43 | High |
| Overall retention | 3.54 | 0.35 | High |

### 3.4. Relationship between perceived effectiveness of SLMs and learning retention

The relationship between the perceived SLM effectiveness and learning retention in mathematics was examined using Pearson's product-moment correlation coefficient. As shown in Table 7, a moderate positive association was observed between overall SLM effectiveness and overall retention ($r=0.56$, $p<0.01$). Given that retention was operationalized through motivation, self-efficacy, and perceived learning, this finding indicates that higher perceived instructional quality is associated with stronger retention-related dispositions in mathematics, rather than direct improvement in achievement. Recent research similarly emphasizes that instructional quality is closely linked to learners' motivation, engagement, and self-regulatory processes in independent and flexible learning environments [9], [46].

Table 7. Relationship between the SLM Effectiveness and mathematics learning retention

| SLM components | Motivation (attention) | Motivation (relevance) | Motivation (confidence) | Motivation (satisfaction) | Perceived effectiveness | Self-efficacy | Overall retention |
|---|---|---|---|---|---|---|---|
| Objectives | 0.31** | 0.39** | 0.18** | 0.44** | 0.28** | 0.29** | 0.43** |
| Contents | 0.45** | 0.38** | 0.20** | 0.46** | 0.29** | 0.37** | 0.48** |
| Discussions | 0.51** | 0.39** | 0.28** | 0.43** | 0.26** | 0.41** | 0.50** |
| Activities | 0.48** | 0.34** | 0.21** | 0.38** | 0.22** | 0.33** | 0.43** |
| Assessment | 0.39** | 0.30** | 0.19** | 0.38** | 0.17* | 0.38** | 0.40** |
| Suitability | 0.55** | 0.31** | 0.26** | 0.40** | 0.23** | 0.43** | 0.48** |
| Relevance | 0.57** | 0.42** | 0.28** | 0.47** | 0.22** | 0.45** | 0.53** |
| Aesthetic | 0.60** | 0.46** | 0.26** | 0.50** | 0.23** | 0.31** | 0.53** |
| Overall correlation | 0.58** | 0.44** | 0.28** | 0.51** | 0.28** | 0.45** | 0.56** |

Note: *p<0.05, **p<0.01 (all p-values=0.00 indicate statistically significant relationships)

The correlation matrix also reveals meaningful patterns across instructional dimensions. The relatively strong association between aesthetic design and attention (r=0.60) suggests that visual organization may serve as an initial trigger for engagement. This interpretation is consistent with recent studies on multimedia learning and cognitive load, which highlight that well-structured visual design can guide attention, reduce extraneous processing, and support engagement in a self-paced learning environment [49], [50]. Likewise, the association between module relevance and overall learning retention (r=0.53, $p<0.01$) suggests that students who perceive the modules as meaningful and useful tend to report stronger retention-related dispositions, consistent with expectancy-value perspectives, where perceived value supports persistence and sustained effort [48], [51].

In contrast, weaker associations with confidence suggest that instructional design alone may not fully support self-efficacy, which also depends on feedback, mastery experiences, and opportunities for interaction. Recent studies confirm that self-efficacy in mathematics is shaped not only by instructional materials but also by feedback mechanisms and learning support structures [9], [48]. Interpreted through SRL theory, these findings suggest that clearer, more organized, and more meaningful modules may support goal orientation, self-monitoring, and perceived understanding in independent learning contexts [45], [46]. The results indicate that different dimensions of module quality are associated with distinct aspects of learning retention: aesthetics with attention and initial engagement; relevance with persistence and sustained effort; and confidence with support conditions that extend beyond design features alone. This pattern reinforces the view that while well-designed SLMs are associated with stronger engagement and retention-related dispositions, additional scaffolding and feedback mechanisms remain important in modular learning environments [46], [48].

### 3.5. Differences in perceived SLM effectiveness and learning retention based on socio-demographic variables

ANOVA revealed no significant differences in perceived SLM effectiveness across age, gender, household income, and school affiliation ($p>0.05$), suggesting that instructional design was experienced consistently across groups. However, access to learning resources was significantly associated with higher perceived effectiveness ($p<0.05$), indicating that learning conditions shape how the instructional materials are experienced. Similar findings have been reported in recent studies showing that resource availability, including access to devices and learning materials, influences students' engagement and perceptions of instructional quality in flexible and distance learning environments [1], [19]. In terms of learning retention, age was the only variable that differed significantly ($p<0.05$), with older students reporting higher retention-related dispositions. This may reflect greater maturity in self-regulation, autonomy, and prior learning experience, which are important in independent learning contexts. Contemporary research supports this interpretation, indicating that self-regulatory capacity and metacognitive control tend to improve with age and learning experience, thereby supporting stronger engagement and persistence in a self-directed learning environment [45], [46]. No significant differences were observed across gender, income, school, or resource access.

These findings suggest that while perceived instructional quality remains relatively stable across demographic groups, learner readiness and resource availability are important contextual factors associated with engagement and retention in modular learning environments. In turn, this indicated that the effective use of SLMs depends not only on instructional quality but also on the conditions under which learners engage with the modules. This highlights the need for resource-responsive pedagogy, where teachers are prepared to design clear, relevant, and well-structured modules across varying levels of technological access [25]. Results further indicate that instructional features such as relevance, assessment, and visual organization are associated with retention-related dispositions. This underscores the importance of training teachers in instructional design principles, including formative assessment, contextualization, and clear visual structuring, to support engagement and self-regulation [1], [48]. Furthermore, the results reinforce earlier findings in this study, indicating that instructional features such as relevance, assessment, and visual organization are associated with retention-related dispositions. This underscores the importance of preparing teachers to apply instructional design principles, including formative assessment, contextualization, and clear visual structuring, to support engagement and self-regulation. Recent literature similarly emphasizes that effective instructional design, combined with supportive learning conditions, is associated with improved engagement and sustained learning in flexible and modular contexts [46].

### 3.6. Practical and educational implications

The findings suggest that while well-designed SLMs are associated with positive learning experiences, their effectiveness is conditioned by contextual constraints, particularly access to learning resources and learners' readiness for independent study. Although students rated the modules as clear, relevant, and well-structured, the module-level ratings of attention and confidence suggest that instructional

design alone may not fully support sustained engagement and self-efficacy in mathematics. This implies that SLM quality, while important, cannot fully compensate for limitations in resources, feedback mechanisms, and opportunities for guided interaction. From a practical standpoint, the findings provide several directions for implementation across stakeholders. For module developers, the results highlight the importance of designing SLMs that go beyond content delivery by incorporating formative assessment, clear visual organization, and contextualized examples, as well as embedded scaffolding such as guided problem-solving steps, prompts, and feedback cues to support attention and confidence. For curriculum planners, the findings suggest the need to ensure that instructional materials are developmentally appropriate and aligned with learners' readiness, particularly in supporting self-regulation and independent learning skills. For school administrators, the results emphasize the importance of establishing support systems that complement the use of modules, including structured monitoring, teacher facilitation schedules, and feedback mechanisms, especially in resource-constrained settings. Access to learning materials, devices, and communication channels should be strengthened to reduce disparities in students' experiences of modular instruction. Meanwhile, for education policymakers, the findings underscore the need to support modular learning through resource-responsive policies, including investments in learning infrastructure, teacher training in instructional design and feedback practices, and quality assurance mechanisms for SLM development and implementation.

## 4. CONCLUSION

This study provides evidence that the perceived effectiveness of SLMs is associated with students' retention of learning in mathematics, particularly in flexible and resource-constrained learning environments. Students generally viewed the SLMs as effective across key instructional dimensions, especially in assessment, relevance, and discussion quality, and reported high levels of retention-related dispositions reflected in motivation, self-efficacy, and perceived learning. By operationalizing learning retention through these psychological indicators, the study advances a broader understanding of retention in modular contexts–not merely as knowledge recall, but as sustained engagement and learning persistence. The findings highlight that contextual conditions shape instructional design quality matters, but its effectiveness. While perceptions of SLM quality were consistent across socio-demographic groups, variations in learning resources and learner readiness were associated with differences in perceived effectiveness and retention. These results underscore that improving learning in modular environments requires both well-designed instructional materials and supportive learning conditions.

The study is important because it provides a theory-informed and dimension-specific analysis of how instructional design features of SLMs are associated with retention-related learning processes in mathematics, particularly in settings where printed modules remain central to instruction. However, the findings should be interpreted with caution due to several limitations. The correlational design does not allow causal inferences, the use of self-reported measures reflects perceived rather than objective learning outcomes, and the unequal distribution of participants across schools may introduce clustering effects. Future research is recommended to employ longitudinal or experimental designs to examine causal relationships and to assess retention using performance-based or delayed achievement measures. Further studies may also explore integrating feedback mechanisms, scaffolded supports, and technology-enhanced features into SLMs to strengthen learners' attention, confidence, and sustained engagement.

## ACKNOWLEDGMENTS

The authors wish to express their sincere gratitude to the faculty and staff of the participating schools and to the senior high school students who voluntarily participated in this study.

## FUNDING INFORMATION

The authors state no funding is involved.

## AUTHOR CONTRIBUTIONS STATEMENT

This journal uses the Contributor Roles Taxonomy (CRediT) to recognize individual author contributions, reduce authorship disputes, and facilitate collaboration.

| Name of Author | C | M | So | Va | Fo | I | R | D | O | E | Vi | Su | P | Fu |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Gemma M. Valdez | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | |
| Cherime P. Bautista | ✓ | ✓ | | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | | ✓ | | ✓ | |
| Alfeo B. Tulang | | ✓ | | | | | | | | ✓ | | | | |

C : **C**onceptualization
M : **M**ethodology
So : **So**ftware
Va : **Va**lidation
Fo : **Fo**rmal analysis
I : **I**nvestigation
R : **R**esources
D : **D**ata Curation
O : Writing - **O**riginal Draft
E : Writing - Review & **E**diting
Vi : **Vi**sualization
Su : **Su**pervision
P : **P**roject administration
Fu : **Fu**nding acquisition

## CONFLICT OF INTEREST STATEMENT

Authors state no conflict of interest.

## INFORMED CONSENT

We have obtained informed consent from all individuals included in this study.

## ETHICAL APPROVAL

The research related to human use has been conducted in accordance with all relevant national regulations and institutional policies, in accordance with the tenets of the Declaration of Helsinki. It has been approved by the authors' institutional review board or equivalent committee.

## DATA AVAILABILITY

The data that support the findings of this study are available from the corresponding author, [GMV], upon reasonable request.

## REFERENCES


[1] M. Bond, S. Bedenlier, V. I. Marín, and M. Händel, "Emergency remote teaching in higher education: mapping the first global online semester," *International Journal of Educational Technology in Higher Education*, vol. 18, no. 1, p. 50, Dec. 2021, doi: 10.1186/s41239-021-00282-x.

[2] M. Hossain, "Unequal experience of COVID-induced remote schooling in four developing countries," *International Journal of Educational Development*, vol. 85, p. 102446, Sep. 2021, doi: 10.1016/j.ijedudev.2021.102446.

[3] E. Bustillo and M. Aguilos, "The challenges of modular learning in the wake of COVID-19: a digital divide in the Philippine countryside revealed," *Education Sciences*, vol. 12, no. 7, p. 449, Jun. 2022, doi: 10.3390/educsci12070449.

[4] S. J. Daniel, "Education and the COVID-19 pandemic," *Prospects*, vol. 49, no. 1, pp. 91–96, Oct. 2020, doi: 10.1007/s11125-020-09464-3.

[5] C. A. Conto, S. Akseer, T. Dreesen, A. Kamei, S. Mizunoya, and A. Rigole, "Potential effects of COVID-19 school closures on foundational skills and country responses for mitigating learning loss," *International Journal of Educational Development*, vol. 87, p. 102434, Nov. 2021, doi: 10.1016/j.ijedudev.2021.102434.

[6] J. König, D. J. Jäger-Biela, and N. Glutsch, "Adapting to online teaching during COVID-19 school closure: teacher education and teacher competence effects among early career teachers in Germany," *European Journal of Teacher Education*, vol. 43, no. 4, pp. 608–622, Aug. 2020, doi: 10.1080/02619768.2020.1809650.

[7] J. C. M. Tanucan, B. A. Alejandro, and R. B. Corcino, "Towards an enhanced implementation of printed modular distance learning in the Philippines: a meta-synthesis," *International Journal of Learning, Teaching and Educational Research*, vol. 22, no. 3, pp. 341–358, Mar. 2023, doi: 10.26803/ijlter.22.3.21.

[8] J. Engelbrecht, M. C. Borba, and G. Kaiser, "Will we ever teach mathematics again in the way we used to before the pandemic?" *ZDM – Mathematics Education*, vol. 55, no. 1, pp. 1–16, Feb. 2023, doi: 10.1007/s11858-022-01460-5.

[9] Y. F. Zakariya, "Improving students' mathematics self-efficacy: a systematic review of intervention studies," *Frontiers in Psychology*, vol. 13, p. 986622, Sep. 2022, doi: 10.3389/fpsyg.2022.986622.

[10] V. R. Rodriguez, Z. D. Dueñas, and Z. C. Collado, "What's wrong with self-learning modules (SLMs)? Examining public school teachers' experiences in modular classes," *Improving Schools*, vol. 26, no. 2–3, pp. 99–115, Nov. 2023, doi: 10.1177/13654802251325387.

[11] K. Rozen, C. Meniano, and R. G. Tan, "Challenges in studying mathematics using self-learning module during COVID-19 pandemic," *American Journal of Educational Research*, vol. 10, no. 4, pp. 182–187, 2022.

[12] A. Elmabaredy and N. Gencel, "Exploring the integration of self-regulated learning into digital platforms to improve students' achievement and performance," *Discover Education*, vol. 3, no. 1, p. 262, Dec. 2024, doi: 10.1007/s44217-024-00233-4.

[13] B. J. Zimmerman, "Becoming a self-regulated learner: an overview," *Theory into Practice*, vol. 41, no. 2, pp. 64–70, May 2002, doi: 10.1207/s15430421tip4102_2.

[14] J. M. Keller, "Development and use of the ARCS model of instructional design," *Journal of Instructional Development*, vol. 10, no. 3, pp. 2–10, Sep. 1987, doi: 10.1007/BF02905780.

[15] D. An, C. Ye, and S. Liu, "The influence of metacognition on learning engagement the mediating effect of learning strategy and learning behavior," *Current Psychology*, vol. 43, no. 40, pp. 31241–31253, Oct. 2024, doi: 10.1007/s12144-024-06400-y.
[16] R. A. Utami, Ernawati, W. Nelmira, and H. Hafidza, "Digital learning modules: perspectives on usability, content quality, and effectiveness," *Jurnal Teknologi Pendidikan: Jurnal Penelitian dan Pengembangan Pembelajaran*, vol. 10, no. 4, pp. 639–646, Oct. 2025, doi: 10.33394/jtp.v10i4.17561.
[17] R. L. Suson, "Factors influencing student satisfaction in blended learning: a structural equation modelling approach," *International Journal of Learning, Teaching and Educational Research*, vol. 23, no. 7, pp. 207–227, Jul. 2024, doi: 10.26803/ijlter.23.7.11.
[18] E. Panadero, "A review of self-regulated learning: six models and four directions for research," *Frontiers in Psychology*, vol. 8, p. 422, Apr. 2017, doi: 10.3389/fpsyg.2017.00422.
[19] H. G. van de Werfhorst, E. Kessenich, and S. Geven, "The digital divide in online education: inequality in digital readiness of students and schools," *Computers and Education Open*, vol. 3, p. 100100, Dec. 2022, doi: 10.1016/j.caeo.2022.100100.
[20] J. A. Fredricks, P. C. Blumenfeld, and A. H. Paris, "School engagement: potential of the concept, state of the evidence," *Review of Educational Research*, vol. 74, no. 1, pp. 59–109, Mar. 2004, doi: 10.3102/00346543074001059.
[21] E. A. Curtis, C. Comiskey, and O. Dempsey, "Importance and use of correlational research," *Nurse Researcher*, vol. 23, no. 6, pp. 20–25, Jul. 2016, doi: 10.7748/nr.2016.e1382.
[22] Y. Bertiz and A. K. Karoğlu, "Distance education students' cognitive flexibility levels and distance education motivations," *International Journal of Research in Education and Science*, vol. 6, no. 4, pp. 638–648, Sep. 2020, doi: 10.46328/ijres.v6i4.1022.
[23] I. Etikan, "Sampling and sampling methods," *Biometrics & Biostatistics International Journal*, vol. 5, no. 6, p. 00149, May 2017, doi: 10.15406/bbij.2017.05.00149.
[24] O. Lüdtke, A. Robitzsch, and S. G. West, "Regression models involving nonlinear effects with missing data: a sequential modeling approach using Bayesian estimation," *Psychological Methods*, vol. 25, no. 2, pp. 157–181, Apr. 2020, doi: 10.1037/met0000233.
[25] A. M. Bustoba and M. C. A. D. Cruz, "Development and validation of self-paced learning digital module in mathematics 10," *Polaris Global Journal of Scholarly Research and Trends*, vol. 1, no. 1, pp. 12–28, Oct. 2022, doi: 10.58429/pgjsrt.v1n1a84.
[26] L. Alemayehu and H.-L. Chen, "The influence of motivation on learning engagement: the mediating role of learning self-efficacy and self-monitoring in online learning environments," *Interactive Learning Environments*, vol. 31, no. 7, pp. 4605–4618, Oct. 2023, doi: 10.1080/10494820.2021.1977962.
[27] E. Fernández-Gómez, A. Martín-Salvador, T. Luque-Vara, M. A. Sánchez-Ojeda, S. Navarro-Prado, and C. Enrique-Mirón, "Content validation through expert judgement of an instrument on the nutritional knowledge, beliefs, and habits of pregnant women," *Nutrients*, vol. 12, no. 4, p. 1136, Apr. 2020, doi: 10.3390/nu12041136.
[28] E. B. Vaughan, A. Montoya-Cowan, and J. Barbera, "Investigating evidence in support of validity and reliability for data collected with the meaningful learning in the laboratory instrument (MLLI)," *Chemistry Education Research and Practice*, vol. 25, no. 1, pp. 313–326, 2024, doi: 10.1039/D3RP00121K.
[29] R. Setiawan, W. Wagiran, and Y. Alsamiri, "Construction of an instrument for evaluating the teaching process in higher education: content and construct validity," *REID (Research and Evaluation in Education)*, vol. 10, no. 1, pp. 50–63, Jun. 2024, doi: 10.21831/reid.v10i1.63483.
[30] G. M. Sullivan and R. A. Anthony, "Analyzing and interpreting data from Likert-type scales," *Journal of Graduate Medical Education*, vol. 5, no. 4, pp. 541–542, 2013, doi: 10.4300/JGME-5-4-18.
[31] H. Akoglu, "User's guide to correlation coefficients," *Turkish Journal of Emergency Medicine*, vol. 18, no. 3, pp. 91–93, Sep. 2018, doi: 10.1016/j.tjem.2018.08.001.
[32] G. Norman, "Likert scales, levels of measurement and the 'laws' of statistics," *Advances in Health Sciences Education*, vol. 15, no. 5, pp. 625–632, Dec. 2010, doi: 10.1007/s10459-010-9222-y.
[33] P. Schober, C. Boer, and L. A. Schwarte, "Correlation coefficients: appropriate use and interpretation," *Anesthesia & Analgesia*, vol. 126, no. 5, pp. 1763–1768, May 2018, doi: 10.1213/ANE.0000000000002864.
[34] D. C. Funder and D. J. Ozer, "Evaluating effect size in psychological research: sense and nonsense," *Advances in Methods and Practices in Psychological Science*, vol. 2, no. 2, pp. 156–168, Jun. 2019, doi: 10.1177/2515245919847202.
[35] M. Blanca, R. Alarcón, J. Arnau, R. Bono, and R. Bendayan, "Non-normal data: is ANOVA still a valid option?" *Psicothema*, vol. 29, no. 4, pp. 552–557, Nov. 2017, doi: 10.7334/psicothema2016.383.
[36] T. K. Kim, "Understanding one-way ANOVA using conceptual figures," *Korean Journal of Anesthesiology*, vol. 70, no. 1, pp. 22–26, 2017, doi: 10.4097/kjae.2017.70.1.22.
[37] D. Lakens, "Calculating and reporting effect sizes to facilitate cumulative science: a practical primer for t-tests and ANOVAs," *Frontiers in Psychology*, vol. 4, p. 863, 2013, doi: 10.3389/fpsyg.2013.00863.
[38] G. Cumming, "The new statistics," *Psychological Science*, vol. 25, no. 1, pp. 7–29, Jan. 2014, doi: 10.1177/0956797613504966.
[39] R. L. Wasserstein, A. L. Schirm, and N. A. Lazar, "Moving to a world beyond "p<0.05"," *The American Statistician*, vol. 73, no. sup1, pp. 1–19, Mar. 2019, doi: 10.1080/00031305.2019.1583913.
[40] J. Hattie and H. Timperley, "The power of feedback," *Review of Educational Research*, vol. 77, no. 1, pp. 81–112, Mar. 2007, doi: 10.3102/003465430298487.
[41] D. J. Nicol and D. Macfarlane-Dick, "Formative assessment and self-regulated learning: a model and seven principles of good feedback practice," *Studies in Higher Education*, vol. 31, no. 2, pp. 199–218, Apr. 2006, doi: 10.1080/03075070600572090.
[42] J. S. Eccles and A. Wigfield, "Motivational beliefs, values, and goals," *Annual Review of Psychology*, vol. 53, no. 1, pp. 109–132, Feb. 2002, doi: 10.1146/annurev.psych.53.100901.135153.
[43] R. E. Mayer, "Using multimedia for e-learning," *Journal of Computer Assisted Learning*, vol. 33, no. 5, pp. 403–423, Oct. 2017, doi: 10.1111/jcal.12197.
[44] K. Li and J. M. Keller, "Use of the ARCS model in education: a literature review," *Computers & Education*, vol. 122, pp. 54–62, Jul. 2018, doi: 10.1016/j.compedu.2018.03.019.
[45] D. H. Schunk and M. K. DiBenedetto, "Motivation and social cognitive theory," *Contemporary Educational Psychology*, vol. 60, p. 101832, Jan. 2020, doi: 10.1016/j.cedpsych.2019.101832.
[46] E. Panadero, J. Broadbent, D. Boud, and J. M. Lodge, "Using formative assessment to influence self- and co-regulated learning: the role of evaluative judgement," *European Journal of Psychology of Education*, vol. 34, no. 3, pp. 535–557, Jul. 2019, doi: 10.1007/s10212-018-0407-8.
[47] N. A. K. Alreshidi, "Enhancing topic-specific prior knowledge of students impacts their outcomes in mathematics," *Frontiers in Education*, vol. 8, p. 1050468, Feb. 2023, doi: 10.3389/feduc.2023.1050468.

[48] B. Lyu, "The effect of self-regulated learning and community of inquiry on the online learning engagement of Chinese as foreign language learners," *Education Sciences*, vol. 14, no. 7, p. 691, Jun. 2024, doi: 10.3390/educsci14070691.
[49] L. Fiorella and R. E. Mayer, "Eight ways to promote generative learning," *Educational Psychology Review*, vol. 28, no. 4, pp. 717–741, Dec. 2016, doi: 10.1007/s10648-015-9348-9.
[50] T. van Gog, F. Paas, and J. Sweller, "Cognitive load theory: advances in research on worked examples, animations, and cognitive load measurement," *Educational Psychology Review*, vol. 22, no. 4, pp. 375–378, Dec. 2010, doi: 10.1007/s10648-010-9145-4.
[51] A. Wigfield and A. Ponnock, "The relevance of expectancy–value theory to understanding the motivation and achievement of students with cognitive and emotional special needs," in *Handbook of Educational Psychology and Students with Special Needs*, A. J. Martin, R. A. Sperling, and K. J. Newton, Eds., New York, NY: Routledge, 2020, pp. 388–425, doi: 10.4324/9781315100654-19.

## BIOGRAPHIES OF AUTHORS



**Gemma M. Valdez** is an associate professor at the Faculty of Advanced and International Studies, Davao Oriental State University, Philippines. She specializes in mathematics education, flexible learning modalities, instructional material evaluation, and teacher education. Her research focuses on improving mathematics performance through evidence-based instructional design, modular learning, and learner-centered pedagogies. She has authored and co-authored studies on self-learning modules, digital mathematics games, and instructional supervision in secondary education. She actively participates in academic research initiatives aimed at strengthening mathematics instruction in low-resource environments. She can be contacted at email: gemma.valdez@dorsu.edu.ph.



**Cherime P. Bautista** is an instructor I and a member of the General Education Faculty at Davao Oriental State University – Banaybanay Campus, Philippines. She joined the University on November 16, 2023. She earned her Master of Science in Teaching Mathematics from Davao Oriental State University, where she developed a strong foundation in mathematics pedagogy and instructional practice. She is deeply committed to advancing the quality of teaching and learning in higher education, particularly in the field of mathematics. Her scholarly interests center on mathematics education, with emphasis on effective teaching strategies, learner-centered instruction, and the enhancement of students' conceptual understanding in mathematics. She can be contacted at email: cherime.bautista@dorsu.edu.ph.



**Alfeo B. Tulang** is a professor V at Bukidnon State University in Malaybalay City, Philippines, with expertise in higher education, research, extension, quality assurance, and academic leadership. Throughout his academic career, he has held various leadership and administrative roles, contributing to institutional development through accreditation, quality assurance initiatives, curriculum enhancement, and research project evaluation. He is an active reviewer for international peer-reviewed journals and has published scholarly work in mathematics education, quantitative research methodology, and flexible learning pedagogy. His research focuses on applying advanced quantitative methods to educational challenges and informing evidence-based policy and practice. He can be contacted at email: alfeotulang@buksu.edu.ph.