THE DEVELOPMENT AND EVALUATION OF A COMPUTATIONAL THINKING - INTEGRATED ENGLISH WRITING MODULE FOR PRIMARY ESL EDUCATION

Sheleena Gopalakrishnan[1], Aslina Saad[2], Haslinda Hashim[2]

[1]Faculty of Computing and Meta-Technology, Sultan Idris Education University, Perak, Malaysia
[2]The SIG of Information Systems & Technology Integration, Faculty of Computing and Meta-Technology, Sultan Idris Education University, Perak, Malaysia

ABSTRACT

English writing remains a key challenge in Malaysian primary ESL classrooms, where instruction often follows conventional approaches. This study evaluates a Computational Thinking (CT)-based English writing module developed for Year 5 pupils using the ADDIE model. The module integrates decomposition, pattern recognition, abstraction, and algorithmic thinking across eight thematic units. A quantitative survey involving 30 primary English teachers assessed the module's format, content, accuracy, teaching–learning activities, and usefulness. Results showed high acceptance (overall M = 4.67, SD = 0.25), with format rated the highest (M = 4.79). Teachers indicated that the CT-integrated approach improved writing structure, increased engagement, and aligned with Common European Framework of Reference for Languages and the Malaysian national curriculum. Findings suggest that CT provides a promising framework for enhancing writing instruction. Future studies should investigate its effects on pupils' writing outcomes and potential use in other language skills.

KEYWORDS

Computational thinking, English writing, module development, primary education, ADDIE model

1. INTRODUCTION

Writing is a key component of second language acquisition and remains essential for academic and professional communication. Globally, education reforms emphasize the development of competencies such as critical thinking, collaboration, creativity, and digital literacy to prepare learners for future demands. In line with these global trends, the Malaysian education system has integrated higher-order thinking skills across subject areas, including English, to meet both global and national expectations for 21st-century learning.

Despite these efforts, writing continues to be one of the most challenging skills for Malaysian primary school pupils, where English is taught as a second language. The major issues faced by pupils are often linked to their linguistic and cognitive skills, as insufficient linguistic proficiency remains a key barrier to producing effective written work in a second language [4]. Studies have consistently shown that pupils struggle with poor sentence construction, limited vocabulary, underdeveloped ideas, and grammatical inaccuracies Fareed et al. [13]; Misbah et al. [23]. These weaknesses frequently result in disorganized and simplistic compositions that fall short of curriculum expectations.

For teachers, teaching writing at the primary level adds another layer of complexity. As noted by Moses and Mohamad [24], teaching English to young learners differs significantly from teaching at the secondary or tertiary levels. Bhandari [7] further highlights that teachers often struggle to teach writing due to difficulties in motivating pupils, limited parental support, lack of teaching experience, the need to cater to mixed-ability classrooms, insufficient professional training opportunities, and pupils' lack of interest. These factors frequently impede collaborative learning and compel teachers to rely on ready-made writing tasks rather than more engaging, learner-centred activities.

One emerging pedagogical framework with the potential to address these gaps is Computational Thinking (CT). Introduced by Wing [37], CT is a problem-solving approach that involves decomposition, abstraction, pattern recognition, sequencing, and algorithmic thinking. Saad and Zainudin [29] revealed the use of CT in different fields, including mathematics, biology, computer science, language, and programming. While rooted in computer science, CT has been recognized as transferable to other disciplines, including language education, where it can foster structured reasoning and logical expression. In literacy contexts, CT provides cognitive scaffolds that help learners generate ideas, organize content, and structure written expression by supporting skills such as abstraction, sequencing, and problem decomposition [18]. Research also shows that integrating CT concepts into digital storytelling environments can increase learners' motivation and improve their overall learning performance, further demonstrating CT's potential beyond STEM-related tasks Parsazadeh et al. [25], yet most studies have been concentrated in STEM contexts, with limited exploration in primary ESL writing instruction.

In the context of English writing instruction, CT is conceptualised not as a technological or programming skill, but as a cognitive framework that mirrors the writing process itself. Writing requires learners to analyse tasks, generate and organise ideas, sequence information logically, and revise drafts, processes that closely align with core CT elements such as decomposition, pattern recognition, abstraction, and algorithmic thinking. For instance, decomposition supports planning by breaking writing tasks into manageable components, pattern recognition reinforces sentence structures and grammatical regularities, abstraction enables learners to focus on essential ideas, and algorithmic thinking guides logical sequencing and coherence. Through this alignment, CT functions as a cognitive scaffold that supports pupils' writing development while complementing conventional language instruction.

In Malaysia, there remains a scarcity of classroom-based studies and instructional tools that integrate CT into ESL writing, particularly at the primary level, and align with national frameworks such as CEFR and DSKP. This shortage limits teachers' ability to implement structured approaches that support both linguistic and cognitive development in writing lessons. Moreover, a recent review of CT initiatives in Malaysian schools found significant structural and resource-related barriers to implementation, especially outside traditional STEM subjects, suggesting that CT integration in language and writing classrooms remains rare [3]. Similarly, although efforts have been made to embed CT in the national curriculum, teacher-reported data indicate limited CT-related training and uncertainty among educators, factors that further hinder widespread adoption in ESL writing instruction [35]. Overall, this gap demonstrates the ongoing need for well-designed instructional resources that equip teachers with practical tools to foster both language development and higher order thinking skills within writing lessons.

Responding to this need, the present study develops and evaluates a CT-based English writing module for Year 5 pupils in Malaysian primary schools, grounded in the ADDIE instructional design model. The module is designed to integrate CT elements into writing tasks and was evaluated through feedback from TESL-trained primary school teachers. The findings aim to

determine user acceptance of the module and contribute to interdisciplinary pedagogical approaches that merge cognitive and linguistic development in ESL instruction. In this study, CT serves as a guiding instructional framework for structuring writing tasks and activities, while teachers' evaluations provide evidence of the module's pedagogical feasibility and classroom relevance as a CT-integrated writing approach.

2. LITERATURE REVIEWS

This section reviews key literature related to Computational Thinking (CT) in education, its application in language and writing instruction, challenges in ESL writing among primary learners and existing pedagogical gaps that highlight the need for CT-based modules.

2.1. Computational Thinking in Education

Aho [5] defines Computational Thinking (CT) as the thought processes involved in formulating problems so that their solutions can be represented as computational steps and algorithms. As a transferable cognitive skill, CT facilitates systematic reasoning across disciplines, including language learning [1]. It enables learners to break down complex tasks into manageable components and organize information in ways that strengthen higher-order thinking [16].

Beyond its theoretical framework, CT has been shown to enhance executive functioning skills including planning, working memory, and problem-solving which are closely linked to writing development (Zhang et al. [40]; Robertson et al. [28]). Robot-based and unplugged CT activities not only foster logical sequencing and algorithmic thinking but also strengthen students' ability to organize ideas and revise written work systematically Zhang et al. [40]. In Malaysia, CT is embedded in subjects such as Fundamental Computer Science, and efforts are underway to extend CT-infused pedagogies into language classrooms [35]. Collectively, these findings suggest that CT serves as a bridge between computational logic and language proficiency, providing a strong rationale for its integration into English writing instruction.

2.2. Applications of CT in Language and Writing Instruction

While traditionally associated with STEM fields, CT's applications in language learning have been expanding. Li et al. [20] advocate for CT-enhanced instruction to support content organization, sequencing, and idea development in English classes. Building on this, Liang and Hwang [21] reported improvements in learners' narrative modeling and composition through robot-based digital storytelling tasks, and [11] found increased vocabulary retention and cohesion when combining digital storytelling activities with language learning. Together, these studies highlight the potential of CT-aligned pedagogical approaches to strengthen both linguistic accuracy and narrative structure.

Extending these instructional applications, digital platforms and mobile applications are increasingly incorporating CT elements to enhance writing. Wu and Chen [39] and Peng et al. [26] explored digital storytelling and CT frameworks that foster creative writing and structural coherence. Li et al. [20] also observed that CT-integrated tools promote problem-solving, learner engagement, and agency, further reinforcing their relevance in language classrooms. Nevertheless, most existing research focuses on general or secondary education contexts, leaving a notable gap in empirical investigations on CT applications within Malaysian primary ESL settings. This study contributes to addressing this gap by implementing a CT-based writing module specifically tailored to the Malaysian primary ESL context.

2.3. ESL Writing Challenges in Primary Education

Primary ESL learners in Malaysia frequently struggle with limited vocabulary, grammatical inaccuracies (such as tense and article misuse), and L1 interference, which contribute to both sentence-level weakness and poor cohesion in their written compositions (Ahmad Ghulamuddin et al. [4]; Govindarajoo et al. [15]). These linguistic difficulties are further compounded by challenges in idea development and discourse organization.

Teachers face significant obstacles in implementing differentiated instruction, especially in large or mixed-ability classrooms, due to time constraints, limited resources, and insufficient support for tailoring materials [2]. In addition to these structural challenges, writing instruction often remains transactional and surface-level rather than process-oriented, limiting opportunities for students to engage in structured thinking and higher-order cognitive skill development. These instructional constraints highlight the need for innovative approaches that can support both teachers and learners in the writing process.

For Malaysian primary ESL learners, computational thinking frameworks can be effectively integrated into writing instruction to scaffold cognitive processes such as decomposition, pattern recognition, and algorithmic planning, which in turn help students organize and refine their written work (Peng et al., 2023). This integration has also been shown to reduce writing anxiety and boost motivation, offering both cognitive and affective benefits.

2.4. Pedagogical Gaps and the Need for CT-Based Modules

Despite increasing interest in CT integration across education, practical resources that couple CT with language-learning goals remain scarce, especially for younger learners [30]. This lack of resources reduces opportunities for teachers to implement CT in ways that meaningfully support literacy development. Existing materials tend to emphasize coding skills rather than language-learning objectives aligned with standards like CEFR, leaving a gap for interdisciplinary tools that bridge both areas.

In Malaysia, although teachers show readiness to adopt innovative and 21st-century pedagogical approaches, they continue to face challenges accessing structured CT-based materials that are aligned with CEFR requirements, particularly for writing instruction (Wok Zaki & Darmi, [38]; Ahamad Said et al. [3]). Current digital tools in language classrooms also tend to prioritize surface-level activities rather than supporting deeper cognitive structuring or meaningful language production. Research further emphasizes that effective integration of CT into literacy learning requires context-sensitive, task-based materials that are explicitly aligned with curriculum standards [16]-[18]. Therefore, this study addresses these gaps by developing and evaluating a CT-based English writing module aligned with CEFR and DSKP to support more systematic and scalable ESL writing instruction.

2.5. Conceptual Comparison of CT Integration in Educational Modules

Table 1. Conceptual comparison of CT integration in educational modules.

Module category	Learning context	Primary skill focus	Level of CT integration	Instructional design orientation	Identified limitation
Conventional English writing modules	Primary ESL	Writing accuracy and fluency	None	Content-driven	Limited support for structured thinking processes
English language modules with implicit CT features	Primary ESL	Writing and language practice	Partial (task decomposition)	Activity-based	CT elements not explicitly scaffolded
CT-oriented STEM modules	Secondary	Problem-solving and inquiry	Explicit	Systematic	Limited transfer to language learning contexts
Programming-based CT modules	Secondary	Computational thinking skills	Explicit	Constructivist	Less suitable for young ESL learners
Present CT-based writing module	Primary ESL	English writing	Explicit (core CT elements)	ADDIE-based	Addresses CT-writing integration gap

As shown in Table 1, although Computational Thinking has increasingly been incorporated into educational modules, its application in primary ESL writing remains limited and often implicit. Existing language modules rarely operationalise CT as an explicit cognitive scaffold, while CT focused initiatives are predominantly situated within STEM or programming-based contexts. The present study is novel in its explicit integration of core CT elements into English writing instruction for primary ESL learners through a structured instructional module aligned with curriculum requirements. Unlike existing approaches, this study positions CT not as a technological or programming skill but as a process-oriented cognitive framework that systematically supports planning, organisation, and coherence in ESL writing.

Although recent studies have explored the integration of Computational Thinking in ESL and language-related contexts, much of the existing research either situates CT within STEM- or programming-oriented activities or embeds CT implicitly without systematic instructional scaffolding. Studies focusing on language learning frequently emphasise engagement or general cognitive development rather than the structured application of CT elements within the writing process itself. Moreover, limited attention has been given to the development of curriculum-aligned instructional modules that operationalise CT as a cognitive framework for primary ESL writing. The present study addresses these gaps by explicitly integrating core CT elements into English writing instruction through a structured, ADDIE-based module tailored for primary ESL classrooms.

3. RESEARCH METHODOLOGY

This study adopted a quantitative survey design to evaluate a CT-based English writing module developed for Year 5 primary school pupils. The module was designed using the ADDIE instructional design model and evaluated through feedback collected from primary school English teachers. This section details the methodology in six parts: research design, module development, participants, instrument, data collection and analysis and ethical considerations.

A quantitative, non-experimental survey design was employed to collect systematic feedback from teachers regarding the user acceptance of the CT-based English writing module. This design enabled the researcher to gather descriptive data from a relatively large sample in a cost-effective and time efficient manner. The evaluation focused on five key aspects: module format, content, accuracy, teaching and learning activities, and usefulness. Descriptive statistics, including mean score, were used to analyze the collected responses.

The module was developed based on the ADDIE model, a widely recognized instructional design framework comprising five key phases: Analysis, Design, Development, Implementation, and Evaluation. This model provided a systematic process to ensure that the instructional materials were pedagogically sound and aligned with learners' needs. During the analysis phase, a comprehensive review of relevant literature was conducted to identify common writing challenges faced by Malaysian primary school pupils. Findings revealed recurring issues such as weak sentence structure and limited vocabulary, which often hinder pupils' ability to produce coherent written work. These insights informed the direction and focus of the module design.

In the design phase, the overall structure and content of the module were planned in accordance with pupils' learning needs and curriculum requirements. Reference was made to national curriculum documents, including the CEFR-aligned Year 5 English syllabus and the Dokumen Standard Kurikulum dan Pentaksiran (DSKP). Learning objectives were mapped to specific Computational Thinking (CT) elements such as decomposition and sequencing as well as relevant language functions, ensuring integration of both linguistic and cognitive skill development.

The development phase involved the creation of eight thematic writing units, each embedding CT elements within writing tasks. Activities were designed to promote skills such as sequencing events, organizing details, and identifying patterns. For example, in Unit 2 ("Days"), pupils practiced abstraction by brainstorming and categorizing adjectives to describe a birthday party. Each unit included scaffolding tools such as sentence starters, vocabulary lists, and graphic organizers to support learners' writing process and cognitive engagement.

In the implementation phase, the module was piloted in selected classrooms. Participating teachers integrated the module into their regular English lessons and were provided with a user guide to facilitate effective implementation. This phase allowed for practical observation of the module's usability and classroom adaptability, offering insights into how well the activities aligned with lesson flow and pupil readiness.

The evaluation phase involved collecting feedback from teachers through an evaluation questionnaire. Teachers reflected on the module's usability, instructional effectiveness, and overall user acceptance based on their real classroom experiences during the implementation phase. The questionnaire required teachers to rate the module across five aspects, enabling a structured assessment of its strengths and areas for improvement. The use of descriptive statistics allowed for a clear interpretation of the results, highlighting trends in teacher perceptions and ensuring that refinement decisions were supported by data. This comprehensive evaluation served

not only to measure user acceptance but also to validate the module's pedagogical suitability, clarity, practicality, and alignment with curriculum expectations.

30 TESL primary school teachers participated in the evaluation phase, representing different states within Peninsular Malaysia. Purposive sampling was used to select teachers who had at least five years of experience teaching Year 5 English and were familiar with CEFR-aligned materials. Most of the teachers had prior exposure to 21st-century learning strategies and had attended professional development sessions on curriculum implementation. This sampling ensured that the feedback was informed by pedagogical experience and curriculum familiarity.

3.1. Conceptual Framework of the Study

This study is guided by a conceptual framework that integrates pupils' English writing challenges, Computational Thinking (CT) elements, and the ADDIE instructional design model. The framework begins with the identification of key writing difficulties faced by primary ESL pupils, including limited vocabulary, weak grammatical control, and challenges in organising ideas. To address these challenges, core CT elements namely decomposition, pattern recognition, abstraction, and algorithmic thinking are embedded into writing activities as cognitive scaffolds to support planning, organisation, and logical sequencing. The development of the CT-based English writing module is systematically guided by the ADDIE model to ensure alignment with curriculum requirements and instructional coherence. Following development, the module is evaluated by primary school English teachers to determine its usability, clarity, and overall acceptance for classroom implementation. Figure 1 illustrates the overall flow of the conceptual framework underpinning the study.

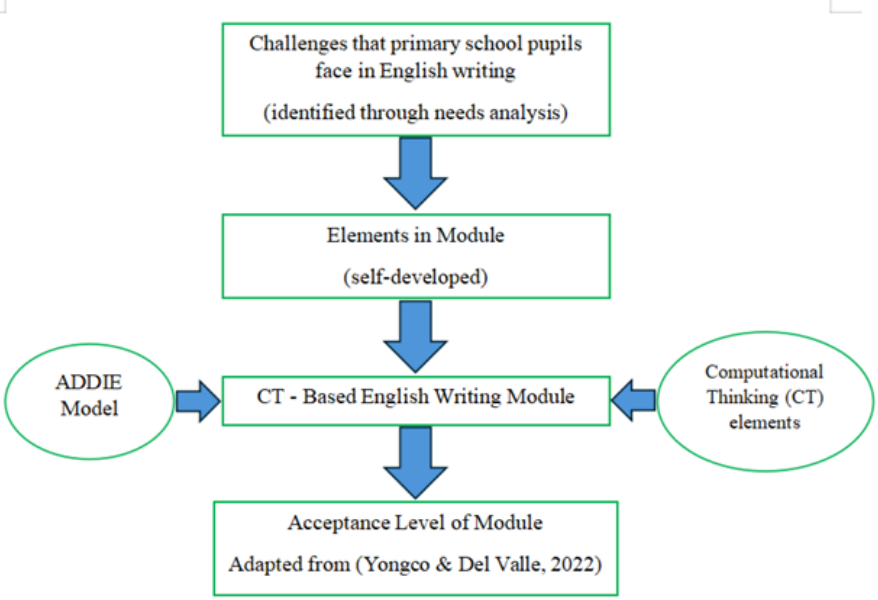

Figure 1. Conceptual framework

3.2. Research Instrument

Survey questionnaires were distributed to TESL primary school teachers to evaluate the user acceptance of the developed module. Prior to completing the survey, the teachers implemented the CT-based English writing module in their classroom for one month. The questionnaire

comprised six sections: demographics, module format, module content, module accuracy, teaching and learning activities, and module usefulness. Each item was evaluated using a five-point Likert scale (1 = Very Poor; 5 = Very Good). The instrument was adapted from validated module evaluation rubrics and refined through expert review. Details regarding its validity and reliability are presented in the following section.

To ensure content validity, the questionnaire was reviewed by three experts in English education and instructional design, who provided feedback on item clarity and alignment with the study objectives. Minor wording adjustments were made based on their suggestions. Reliability was established through a pilot test involving 30 ESL teachers, following [10] recommendation for pilot studies. Cronbach's alpha values ranged from 0.797 to 0.908 across all dimensions, indicating strong internal consistency [14]. These results confirmed that the instrument was both valid and reliable for data collection.

3.3. Data Collection and Analysis

Data were collected online via Google Forms after the teachers completed the module implementation in their classroom. Participants were given two weeks to respond to the survey. The collected data were analyzed using SPSS Version 26. Descriptive statistics were used to calculate mean scores and standard deviations for each evaluation criterion. The mean interpretation followed standard educational benchmarks, where scores between 1.00-2.49 indicated a low level, 2.50-3.49 indicated a moderate level, and 3.50-5.00 indicated a high level.

3.4. Ethical Considerations

Ethical clearance was obtained from the university's research ethics committee before conducting the study. All participants were provided with an online consent form outlining the study's purpose, their rights as participants and the voluntary nature of their participation. Confidentiality and anonymity were assured by removing identifiable information from the dataset and limiting access to data to the research team. Participants were also informed that they could withdraw from the study at any stage without penalty.

This methodology ensured that the module development was grounded in instructional design theory, and its evaluation was conducted systematically using reliable instruments and ethical procedures. These measures not only safeguarded participant welfare but also strengthened the validity of the study's findings. The feedback gathered provides valuable insights into the user acceptance of integrating CT in ESL writing skill at the primary level, offering guidance for future curriculum development and instructional design in similar contexts.

4. RESULTS AND DISCUSSION

This section presents the findings of the study based on the three research objectives: identifying writing challenges among primary pupils, designing a CT-based English writing module and evaluating teachers' acceptance of the developed module.

4.1. Writing Challenges Among Pupils

The review of literature showed that many pupils face difficulties in English writing. Key challenges commonly identified include a lack of understanding of paragraph or essay organization, poor knowledge of English grammar, limited vocabulary, negative attitudes toward academic writing, insufficient awareness of cohesion and coherence, incorrect use of punctuation,

weak understanding of parallelism, misuse of connectors, difficulties transferring ideas from the native language to English, and limited support from teachers (Ariyanti & Fitriana [6]; Bulqiyah et al. [8]; Sogutlu & Veliaj-Ostrosi, [34]; Saputra [31]). These issues highlight the need for more structured and supportive writing instruction in the classroom.

Another issue affecting Malaysian pupils' writing performance is the teaching methods used in classrooms, as pupils often find writing lessons boring due to the reliance on non-technology materials, and these traditional approaches are increasingly unsuitable because pupils view writing as a passive and unengaging activity [27]. This indicates that instructional practices also contribute to pupils' writing challenges, not only their linguistic weaknesses. Therefore, writing lessons need to be more interactive, cognitively stimulating, and aligned with 21st-century learning demands to better support pupils' writing development.

The findings also show a gap between what the curriculum expects and what pupils experience in the classroom. Many pupils lose interest in writing tasks because they do not find them meaningful or connected to real-life situations [12]. Without teaching methods that support thinking and idea development, pupils may continue to struggle with writing, especially those with low English proficiency. These challenges highlight the importance of exploring approaches like Computational Thinking, which can help pupils organize their ideas and improve their writing skills.

4.2. The Design of the CT-Based English Writing Module

The CT-based English writing module was developed based on the ADDIE model and consisted of eight thematic units. Each unit embeds CT elements such as decomposition, pattern recognition, abstraction, algorithmic thinking and logical reasoning into writing tasks as shown in Table 2. This approach enables pupils to structure their thoughts more logically and systematically.

Table 2. Mapping of CT elements across module units.

Unit	Topic	CT elements integrated
1	Towns and Cities	Decomposition, Pattern Recognition
2	Days	Decomposition, Abstraction, Pattern Recognition, Algorithm
3	Wild Life	Pattern Recognition, Logical Reasoning
4	Learning World	Decomposition, Pattern Recognition, Algorithm, Abstraction
5	Food and Health	Pattern Recognition, Decomposition, Abstraction, Algorithm
6	Sport	Abstraction, Pattern Recognition
7	Growing Up	Pattern Recognition, Logical Reasoning
8	Going Away	Pattern Recognition, Logical Reasoning

Table 2 illustrates the implementation of CT skills across the activities in each unit of the developed module. Each CT element contributes uniquely to enhancing pupils' writing skills. The following sections present an in-depth exploration of these skills and their roles within the module activities, beginning with decomposition - a key skill that supports pupils in organizing and approaching writing tasks effectively.

4.2.1. Decomposition

Decomposition was applied across several units in the English writing module to help pupils break down complex writing tasks into manageable parts. For example, in Unit 1, pupils decomposed the task of describing a town or city into smaller subtopics such as location,

landmarks, transportation, amenities, and people. This approach enabled them to focus on one aspect at a time, ensuring that all relevant details were covered systematically. In Unit 2, decomposition was applied when pupils analyzed a video of a birthday party by breaking it into smaller, more manageable subtasks. Similarly, in Unit 4, pupils decomposed an interactive school tour into different sections based on various areas of the school. In Unit 5, they analyzed a video showing the process of making a sandwich and broke it down into its key components such as ingredients and preparation steps. This consistent application of decomposition across units helped pupils approach writing tasks methodically and develop a structured thought process.

4.2.2. Pattern Recognition

Pattern recognition was also embedded throughout multiple units to help pupils identify and apply recurring structures in language and writing. In Unit 1, pupils learned to recognize sentence patterns by analyzing syntax and grammar rules, improving their understanding of how coherent sentences are formed. In Unit 2, they identified verbs related to actions in a birthday celebration, while in Unit 3, pupils observed animal pictures to recognize shared features and categorize them accordingly. Unit 4 focused on identifying common elements in different areas of an interactive tour and recognizing cause-effect relationships using the connector “so.” In Unit 5, pupils recognized sequencing words in a text to organize ideas logically, and in Unit 6, they constructed sentences using patterns such as SVO, SVN, and SV structures. Unit 7 required recognizing patterns in questions and biography texts to identify appropriate question words, while Unit 8 encouraged identifying recurring keywords or phrases that indicated tourist attractions and famous foods in Penang. These activities strengthened pupils’ ability to detect and apply linguistic and conceptual patterns in their writing.

4.2.3. Abstraction

Abstraction was integrated into several tasks that required pupils to focus on essential features while filtering out unnecessary details. In Unit 2, pupils brainstormed and categorized adjectives suitable for describing a birthday party, while in Unit 4, they focused on key features and unique aspects of different school areas when creating an interactive tour. In Unit 5, pupils extracted essential steps from a video on sandwich-making and organized them logically using a flow map. In Unit 6, abstraction was applied when pupils identified and listed core linguistic elements such as subjects, nouns, verbs, adjectives, and objects from a paragraph, helping them focus on the essential grammatical structure of sentences.

4.2.4. Algorithmic Thinking

Algorithmic thinking was incorporated to encourage pupils to plan and execute writing tasks logically. In Unit 2, pupils constructed sentences using the adjectives and verbs identified in previous tasks, while in Unit 4, they designed the sequence and logical flow of a school tour, determining the order of areas and corresponding information to be presented.

4.2.5. Algorithm Design

Algorithm design was explicitly implemented in Unit 5, where pupils wrote a complete recipe for making a sandwich using sequencing words appropriately. This task required them to design a clear, step-by-step algorithm that others could follow, emphasizing logical order and clarity in instruction writing.

4.2.6. Logical Reasoning

Finally, logical reasoning was emphasized in several units to help pupils make connections, justify decisions, and structure coherent sentences. In Unit 3, pupils used logical reasoning to analyze clues about endangered animals and determine accurate answers. They also decomposed provided information, identified key details, and organized them into meaningful sentences. In Unit 7, pupils matched question words with relevant details in a biography and determined the correct placement of punctuation marks such as commas and full stops. In Unit 8, logical reasoning was applied when pupils planned the sequence of attractions in an itinerary, taking into account factors such as proximity, timing, and special requirements.

This comprehensive integration demonstrates that the incorporation of Computational Thinking (CT) elements namely decomposition, pattern recognition, abstraction, algorithmic thinking, algorithm design, and logical reasoning was not symbolic but strategically embedded throughout the English writing module. Each CT element was intentionally aligned with specific writing tasks to enhance pupils' analytical, organizational, and problem-solving skills within the context of English language learning.

4.3. Evaluation of CT-based English writing module by Teachers

A total of 30 teachers evaluated the module using a structured questionnaire. The results for each evaluation criterion are shown in Table 3.

Table 3. Teachers' evaluation of the CT-based English writing module (n=30).

Evaluation aspect	Mean score (M)	Interpretation
Module format	4.79	Very high
Module content	4.72	Very high
Module accuracy	4.54	High
Teaching and learning activities in module	4.64	Very high
Module usefulness	4.67	Very high

Table 3 presents the descriptive statistics of teachers' evaluations, indicating a consistently high level of acceptance across all evaluated dimensions of the CT-based English writing module.

4.3.1. Module Format

The module's format received an overall mean score of M = 4.79, classified as "Very Satisfied." The evaluation result shows that the module is visually clear and well-organized (M = 4.80). The font size used in the module is easy to read (M = 4.80); the module uses appropriate spacing between words to make reading easier (M = 4.80); the quality of the module is good (no broken words, letters, or images) (M = 4.80) and the module includes images that are easily identifiable as being related to the texts (M = 4.77).

4.3.2. Module Content

In terms of content, the teachers' evaluation of the module got a mean score of 4.72, interpreted as very satisfactory. Specifically, the teachers strongly agreed that the module is compatible with learning objectives, as reflected in the mean score of 4.73. Also, as shown in the computed mean score of 4.67, teachers strongly agreed that the module contains content that is logically

organized and will be of interest to the target readers. It was also found that the teachers strongly agreed that the module's content is interesting, clear, and easy to understand., as shown by the mean score of 4.73. Lastly, the module's activities are both feasible and appropriate for the reader's level of learning comprehension., with a mean score of 4.73.

4.3.3. Module Accuracy

The module accuracy achieved an overall mean of M = 4.54 ("Very Satisfied"). Teachers strongly agreed that there are no much conceptual errors in the developed module (M = 4.63). Teachers strongly agreed that lesser factual inaccuracies found in the module (M = 4.60). Teachers strongly agreed that small number of grammatical mistakes found in the developed module (M = 4.50). Teachers agreed that there are several mistakes in computation found in the developed module (M = 4.47). In addition, teachers strongly agreed that less obsolete information found in the developed module (M = 4.53). Lastly, the teachers strongly agreed that minor typographical and other errors such as inappropriate or unclear illustrations, missing labels and incorrect captions (M = 4.53).

4.3.4. Teaching and learning activities

Most teachers strongly agreed that the instructions for each exercise were clear and easy for pupils to follow (M = 4.63). They also strongly agreed that the activities were relevant to the writing skills being taught (M = 4.67), and that the tasks were practical and easy for pupils to do (M = 4.70). Teachers strongly agreed that the exercises encouraged pupils to take part in learning activities (M = 4.67). They also felt that the activities were suitable for pupils with different learning styles (M = 4.53) and matched the pupils' general level of understanding (M = 4.53). The highest score was given to the activity that helped pupils connect new knowledge with what they already know (M = 4.80). Lastly, teachers strongly agreed that the explanation of how CT elements were used in each task was clear and easy to understand (M = 4.60). The overall mean score of 4.64 shows that the teachers were very satisfied with the teaching and learning activities in the module.

4.3.5. Module Usefulness

In terms of usefulness, the teachers' evaluation of the module got an overall mean score of 4.67, interpreted as very satisfactory. The teachers strongly agreed that the writing module assists pupils in using proper spelling, capitalization and punctuation, as reflected in the mean score of 4.67. Also, as shown in the computed mean score of 4.67, teachers strongly agreed that the writing module helps pupils recognize their English writing errors and use that information to help do better. It was also found that the teachers strongly agreed that the writing module assists pupils in brainstorming ideas prior to writing, as shown by the mean score of 4.70. In addition, teachers strongly agreed that the writing module assists pupils in editing their writing in areas such as word order, grammar, punctuation and spelling, as reflected in the mean score of 4.73. Teachers also strongly agreed that the writing module helps pupils to write an effective paragraph, as shown by the mean score of 4.70. Besides, teachers strongly agreed that the writing module guides pupils through the use of appropriate vocabulary in paragraphs (M = 4.70). Teachers also strongly agreed that the writing module helps pupils organize their thoughts when writing a paragraph (M = 4.67). Furthermore, teachers strongly agreed that the writing module teaches pupils how to use various sentence structures such as simple, compound and complex (M = 4.57). Teachers strongly agreed that the writing module helps pupils to write a good conclusion for an English essay (M = 4.70). Lastly, teachers strongly agreed that the writing module helps pupils to write in English quickly, with a mean score of 4.63.

4.4. Discussion and Interpretation

The completed module demonstrates several strengths that support its readiness for classroom implementation. It aligns with the Year Five KSSR English curriculum, requiring no adjustments to existing assessments. These findings reinforce the role of Computational Thinking as a process oriented cognitive framework in ESL writing instruction, supporting pupils' organisation, coherence, and systematic idea development rather than functioning as a technology- or programming-based skill. Clear teacher instructions, ready-to-use worksheets, and appealing visual layouts reduce preparation time and sustain pupil engagement. Recent studies suggest that instructional modules with high usability and well-organised content significantly improve teacher adoption and engagement (Utami et al. [36]; Shahruddin et al. [33]). The modular structure offers flexibility for teachers to adopt the full sequence or integrate selected units according to their lesson plans. The integration of CT elements into specific writing genres ensures that the module remains both curriculum-relevant and innovative in supporting higher-order thinking skills. Unlike many existing CT-language learning initiatives, which either embed CT implicitly or focus on technology-driven activities, this study demonstrates how CT can be systematically operationalised as a cognitive framework to support primary ESL writing instruction.

The module underwent multiple rounds of expert validation and pilot testing, ensuring linguistic accuracy, pedagogical coherence, and practical feasibility. Validation studies of instructional modules indicate that expert feedback and iterative testing during development help refine content, enhance usability, and ensure the module meets both pedagogical and practical standards ([19]; [32]). This systematic refinement process distinguishes the module from existing writing resources by embedding CT principles into lesson design in a structured manner. It also provides evidence of academic reliability and demonstrates responsiveness to both expert and classroom-based feedback.

The evaluation findings show that the CT-based writing module effectively addressed the issues identified in the needs analysis. The module successfully targeted key weaknesses in pupils' writing, particularly idea organisation, coherence, and revision skills. Research indicates that CT strategies such as decomposition and pattern recognition enhance students' planning and revision processes by helping them break tasks into smaller cognitive steps (Peng et al., 2023). Through the incorporation of CT strategies, decomposition for planning, pattern recognition for grammar and vocabulary, abstraction for summarising ideas, and algorithmic thinking for sequencing narratives, the module aligned closely with the diagnosed needs and supported systematic skill development.

Teachers' ratings across the five evaluation aspects, format (M = 4.79), content (M = 4.72), accuracy (M = 4.54), teaching and learning activities (M = 4.64), and usefulness (M = 4.67), indicate strong satisfaction and acceptance. Teacher-based evaluation is commonly employed in instructional design and module development studies to assess pedagogical feasibility, usability, and classroom readiness during the initial stages of implementation. Feedback confirms that the design features translated effectively into classroom practice, enhancing pupils' engagement and supporting writing performance. Current evidence suggests that computational-thinking-infused modules, particularly those using structured, stepwise approaches and unplugged activities, can enhance student engagement [9]. These findings demonstrate that the module is both theoretically grounded and practically viable for sustained classroom use.

The study further confirms that CT can be purposefully applied to improve ESL writing instruction. When CT elements are explicitly taught and integrated into writing tasks, pupils

demonstrate better control over organisation, coherence, and accuracy. CT provides a process-oriented approach that complements existing literacy frameworks by emphasising planning, testing, and refining ideas rather than focusing solely on final written products. Decomposition supports task management, pattern recognition reinforces linguistic accuracy, abstraction enhances summarisation skills, and algorithmic thinking strengthens logical flow in narratives and procedural texts.

In comparison with existing CT-integrated language education studies, which often emphasise digital tools, coding environments, or isolated CT activities, the present study adopts a pedagogically grounded approach that embeds CT explicitly within the writing process itself. While prior research has demonstrated the benefits of CT for enhancing general problem-solving or digital literacy, fewer studies have operationalised CT as a structured cognitive scaffold aligned with specific ESL writing stages, genres, and curriculum standards. This study therefore extends existing work by demonstrating how CT elements can be systematically mapped onto planning, drafting, revising, and organising writing tasks in a primary ESL context.

From a pedagogical perspective, the module provided teachers with structured scaffolding aligned to the ADDIE model. Classroom feedback revealed that teachers viewed CT not as a technological skill but as a practical cognitive tool that supports lesson planning and problem-solving. This interpretation expands the application of CT to broader subject areas and aligns with Malaysia's educational reforms that promote critical thinking, creativity, collaboration, and communication. A recent systematic review found that professional development programs and structured support systems are critical for teachers to successfully integrate CT into their classrooms [22]. The feasibility of the module is further supported by its minimal technological requirements, making it accessible across diverse school contexts. Embedded CT routines can be incorporated into existing classroom practices without additional resources, supporting equity and scalability.

Overall, the findings show that CT-based writing instruction enhances both linguistic proficiency and cognitive flexibility. The module encourages systematic thinking, active learning, and deliberate self correction skills consistent with 21st-century education goals. The insights gained from this study provide a strong basis for future module development and teacher training, ensuring that CT becomes a sustainable and meaningful component of English language education. Collectively, this study contributes to the CT–language learning literature in three key ways. First, it reconceptualises Computational Thinking as a process-oriented cognitive framework rather than a technology-driven skill, making it accessible for non-digital ESL classrooms. Second, it provides a systematically designed, curriculum-aligned CT-based English writing module developed using the ADDIE model, addressing a gap in practical instructional resources for primary education. Third, it offers empirical insights into teacher acceptance and classroom feasibility, which are often underreported in CT–language integration research. These contributions position the study as a meaningful extension of existing CT-based language education research.

4.4.1. Theoretical Implications

The findings of this study contribute to the growing theoretical understanding of how Computational Thinking (CT) principles can be systematically embedded within language learning frameworks. By aligning CT elements such as decomposition, algorithmic thinking, and pattern recognition with CEFR-aligned writing skills, this study extends the theoretical foundation of CT-language integration. It demonstrates that CT not only enhances problem-solving but also serves as a cognitive scaffold that supports idea generation, organization, and textual coherence in ESL writing. This theoretical linkage advances interdisciplinary research

connecting digital literacy, cognitive strategy use, and second language acquisition, reinforcing CT's role as a transferable cognitive process in literacy development.

4.4.2. Practical Implications

From a practical standpoint, the CT-based English writing module provides a model for classroom implementation that is both structured and adaptable. Teachers can employ decomposition and flowchart-based activities to help pupils plan their writing systematically, while algorithmic thinking tasks guide learners in sequencing and revising their drafts. These strategies foster metacognitive awareness and encourage pupils to view writing as an iterative process rather than a final product. Additionally, incorporating problem-solving activities such as vocabulary categorization or sentence pattern recognition enhances engagement and promotes collaborative learning through peer interaction and feedback.

4.4.3. Curricular and National Relevance

In alignment with the Kurikulum Persekolahan 2027 (KP2027), which emphasizes competency based, interdisciplinary, and digitally enriched learning, this study provides timely and relevant insights for ongoing curriculum reform. The CT-based writing module aligns with KP2027's focus on critical and creative thinking, communication, and digital competency, as outlined in the Profil Murid Malaysia. It supports the curriculum's goal of developing learners who are independent, reflective, and adaptable in addressing real-world challenges.

Furthermore, the findings suggest that the module can be scaled for national implementation through integration into teacher professional development programs, digital learning platforms, and English Language curriculum frameworks. Curriculum planners and developers in the Ministry of Education could adapt the module as a pilot component for upper primary writing instruction, aligning it with KP2027's emphasis on competency-based and process-oriented learning. Such adoption would not only standardize CT-based literacy instruction but also strengthen teacher readiness for KP2027 implementation across Malaysian schools.

5. CONCLUSION AND FUTURE WORK

This study evaluated a Computational Thinking (CT)-based English writing module which has been developed for Year 5 primary school pupils in Malaysian ESL classrooms. The study first identified common writing challenges among pupils, such as limited vocabulary, weak sentence structure, and low engagement, which highlighted the need for more effective instructional support. To address these issues, the module was designed using the ADDIE model, aligned with CEFR standards, and purposefully embedded CT elements such as decomposition, pattern recognition, abstraction, algorithmic thinking, and logical reasoning within writing tasks.

The module was found to be user-friendly and adaptable across different classroom environments, including those with varied resources and learner proficiency levels. Teachers emphasized that its structured design and clear activities made it suitable for both high- and low-resource settings. This adaptability strengthens its scalability and supports equitable access to quality writing instruction, positioning it as a potentially valuable asset within the Malaysian education system.

This study is limited by its reliance on teachers' perceptions to evaluate the CT-based English writing module. While teachers' feedback provides valuable insights into the module's practicality, clarity, and classroom applicability, the study did not include direct measurement of

pupils' writing performance. Therefore, the findings should be interpreted as evidence of instructional feasibility and user acceptance rather than empirical learning gains.

Future studies should extend this work by employing rigorous experimental designs, including control and intervention groups, to examine pupils' writing performance through pre- and post-intervention measures. Such investigations could combine quantitative pre- and post-tests with qualitative insights from classroom observations and teacher–pupil interviews. Comparative studies contrasting CT based and traditional writing approaches may further clarify their effects on fluency, coherence, and idea development. Longitudinal research could also explore the sustainability of CT's impact on writing and its transferability across subjects and educational stages.

ACKNOWLEDGEMENTS

The author would like to express sincere appreciation to the participating primary school English teachers for their time, insights, and valuable contributions to this study. The author also gratefully acknowledges the guidance and support provided by the supervisors and the Faculty of Computing and Meta-Technology, Sultan Idris Education University, throughout the development of this research.

REFERENCES

[1] Acevedo-Borrega, J., Valverde-Berrocoso, J., & Garrido-Arroyo, M. del C. (2022). Computational Thinking and Educational Technology: A Scoping Review of the Literature. Education Sciences, 12, 39. https://doi.org/10.3390/educsci12010039

[2] Adnan, E. F., Darus, N. M., Faizal, S. N., Mohamad, M., & Kamarudin, R. (2024). Benefits and challenges of differentiated learning in Malaysian classrooms: Literature review. International Journal of Academic Research in Business and Social Sciences, 14(8). https://doi.org/10.6007/ijarbss/v14 i8/22428

[3] Ahamad Said, N. N., Hanafi, H. F., Naning, F. H., Mat Alim, M., & Dewi, I. P. (2024). A review of barriers and benefits for implementing computational thinking initiatives in secondary schools. Journal of ICT in Education, 11(1), 127–140. https://doi.org/10.37134/jictie.vol11.1.10.2024

[4] Ahmad Ghulamuddin, N. J., Mohd Mohari, S. K., & Ariffin, K. (2021). Discovering Writing Difficulties of Malay ESL Primary School Level Students. International Journal of Linguistics and Translation Studies, 2(1), 27–39. https://doi.org/10.36892/ijlts.v2i1.105

[5] Aho, A. V. (2012). Computation and Computational Thinking. The Computer Journal, 55(7), 832 835. https://doi.org/10.1093/comjnl/bxs074

[6] Ariyanti, A., & Fitriana, R. (2017). EFL Students' Difficulties and Needs in Essay Writing. Advances in Social Science, Education and Humanities Research (ASSEHR), Proceedings of the International Conference on Teacher Training and Education 2017 (ICTTE 2017), 158, 111–121. https://doi.org/10.2991/ictte-17.2017.4

[7] Bhandari, B. L. (2024). Challenges of Teaching and Learning Writing Skills in Nepalese English Classes. Tribhuvan University Journal, 39(1), 50–62. https://doi.org/10.3126/tuj.v39i1.66667

[8] Bulqiyah, S., Mahbub, Moh. A., & Nugraheni, D. A. (2021). Investigating writing difficulties in essay writing: Tertiary students' perspectives. English Language Teaching Educational Journal, 4(1), 61 73. https://doi.org/10.12928/eltej.v4i1.2371

[9] Chen, P., Yang, D., Metwally, A. H. S., Lavonen, J., & Wang, X. (2023). Fostering computational thinking through unplugged activities: A systematic literature review and meta-analysis. International Journal of STEM Education, 10(47). https://doi.org/10.1186/s40594-023-00434-7

[10] Creswell, J. W. (2014). Research design: Qualitative, quantitative, and Mixed Methods Approaches (4th ed.). Sage Publications Ltd. skills.

[11] Demi rbaş, İ., & Şahi n, A. (2022). The effect of digital stories on primary school students' creative writing Education and Information https://doi.org/10.1007/s10639-022-11440-7 Technologies, 28 (7), 7997–8025.

[12] Eryilmaz, A., & Yesilyurt, Y. E. (2022). How to Measure and Increase Second Language Writing Motivation. LEARN Journal: Language Education and Acquisition Research Network, 15(2), 922 945. [13] [14] [15] [16]

[13] Fareed, M., Ashraf, A., & Bilal, M. (2016). ESL learners' writing skills: Problems, factors and suggestions. Journal of Education https://doi.org/10.20547/jess0421604201 & Social Sciences, 4(2), 81–92.

[14] Fraenkel, J. R., Wallen, N. E., & Hyun, H. H. (2012). How to design and evaluate research in education (8th ed). McGraw-Hill Education.

[15] Govindarajoo, M. V., Hui, C. C., & A Aziz, S. F. (2022). Common errors made in English writing by Malaysian Chinese primary year 6 ESL learners at a tuition centre in Puchong, Malaysia. Asian Journal of University Education, 18(3). https://doi.org/10.24191/ajue.v18i3.18954

[16] Grover, S., & Pea, R. (2013). Computational thinking in K–12. Educational Researcher, 42(1), 38 43. https://doi.org/10.3102/0013189x12463051 [17] [18] [19] [20] [21] [22] [23] [24] [25]

[17] Hsu, T.-C., Chang, S.-C., & Hung, Y.-T. (2018). How to learn and how to teach computational thinking: Suggestions based on a review of the literature. Computers & Education, 126(3), 296–310. https://doi.org/10.1016/j.compedu.2018.07.004

[18] Jacob, S. R., & Warschauer, M. (2018). Computational Thinking and Literacy. Journal of Computer Science Integration, 1(1). https://doi.org/10.26716/jcsi.2018.01.1.1

[19] Lacanilao, I. C., & Manalastas, A. (2023). Development and validation of instructional learning module in tailoring. World Journal of Advanced Research and Reviews, 20(1), 1071–1088. https://doi.org/10.30574/wjarr.2023.20.1.2166

[20] Li, X., Sang, G., Valcke, M., & Van Braak., J. (2024). Computational thinking integrated into the English language curriculum in primary education: A systematic review. Education and Information Technologies, 29, 17705–17762. https://doi.org/10.1007/s10639-024-12522-4

[21] Liang, J.-C., & Hwang, G.-J. (2023). A robot-based digital storytelling approach to enhancing EFL learners' multimodal storytelling ability and narrative engagement. Computers & Education, 201, 1 24. https://doi.org/10.1016/j.compedu.2023.104827

[22] Liu, Z., Gearty, Z., Richard, E., Orrill, C. H., Kayumova, S., & Balasubramanian, R. (2024). Bringing computational thinking into classrooms: a systematic review on supporting teachers in integrating computational thinking into K-12 classrooms. International Journal of STEM Education, 11(1). https://doi.org/10.1186/s40594-024-00510-6

[23] Misbah, N. H., Mohamad, M., Yunus, M. M., & Ya'acob, A. (2017). Identifying the Factors Contributing to Students' Difficulties in the English Language Learning. Creative Education, 08(13), 1999–2008. https://doi.org/10.4236/ce.2017.813136 contexts: A

[24] Moses, R. N., & Mohamad, M. (2019). Challenges faced by students and teachers on writing skills in ESL literature review. https://doi.org/10.4236/ce.2019.1013260 Creative Education, 10(13), 3385–3391.

[25] Parsazadeh, N., Cheng, P.-Y., Wu, T.-T., & Huang, Y.-M. (2020). Integrating Computational Thinking Concept into Digital Storytelling to Improve Learners' Motivation and Performance. Journal of Educational Computing Research, 59(3), 1–26. https://doi.org/10.1177/0735633120967315 [26] [27] [28] [29] [30] [31]

[26] Peng, H.-H., Murti, A. T., Silitonga, L. M., & Wu, T-T. (2023). Effects of the Fundamental Concepts of Computational Thinking on Students' Anxiety and Motivation toward K-12 English Writing. Sustainability, 15(7), 5855. https://doi.org/10.3390/su15075855

[27] Rahim, S., & Wahi, W. (2023). Improving Low Proficiency ESL Primary School Students' Writing Skills using Flipped Classroom. International Journal of Social Science and Human Research, 06(04), 2434–2441. https://doi.org/10.47191/ijsshr/v6-i4-56

[28] Robertson, J., Gray, S., Martin, T., & Booth, J. (2020). The relationship between Executive Functions and Computational Thinking. International Journal of Computer Science Education in Schools, 3(4), 35-49. https://doi.org/10.21585/ijcses.v3i4.76

[29] Saad, A., & Zainudin, S. (2022). A review of Project-Based Learning (PBL) and Computational Thinking (CT) in teaching and learning. Learning and Motivation, 78, 101802. https://doi.org/10.1016/j.lmot.2022.101802

[30] Saad, A., Hashim, H., & Rahmatullah, B. (2026). Integrating computational thinking into english writing: development of a computational thinking-integrated module. Journal of Education and Learning (EduLearn), 20(1), 126–135. https://doi.org/10.11591/edulearn.v20i1.23260

[31] Saputra, R. (2023). Students' error analysis in writing essay of English language teaching. Dharmas Education Journal (DE_Journal), 4(1), 252–260. https://doi.org/10.56667/dejournal.v4i1.912 [32] [33] [34] [35] [36] [37] [38] [39] [40] [41]
[32] Sefriani, R., Wijaya, I., Menrisal, M., & Dewi, M. (2020). Testing of the validity of interactive learning module on creative and entrepreneurs learning products. Journal of Educational Science and Technology, 6(1), 73–78. https://doi.org/10.26858/est.v6i1.10277
[33] Shahruddin, N. E., Din, R., & Othman, N. (2023). Self-Learning Modules in Improving Malaysian Primary Teachers' Skills in Using Google Applications. International Journal of Academic Research in Business and Social Sciences, 13(12). https://doi.org/10.6007/ijarbss/v13-i12/20282
[34] Sogutlu, E., & Veliaj-Ostrosi, M. (2022). Efl learners' challenges in essay writing: The case of a non public high school in Albania. Journal of Positive School Psychology, 6(4), 3958-3981. a localised
[35] Ung, L.-L., Labadin, J., & Mohamad, F. S. (2022). Computational thinking for teachers: Development of E-learning system. https://doi.org/10.1016/j.compedu.2021.104379 Computers & Education, 177, 104379.
[36] Utami, R. A., Ernawati, Nelmira, W., & Hafidza, H. (2025). Digital Learning Modules: Perspectives On Usability, Content Quality, And Effectiveness. Jurnal Teknologi Pendidikan: Jurnal Penelitian Dan Pengembangan Pembelajaran, 10(4), 639–646. https://doi.org/10.33394/jtp.v10i4.17561
[37] Wing, J. M. (2006). Computational thinking. Communications of the ACM, 49(3), 33–35. https://doi.org/10.1145/1118178.1118215
[38] Wok Zaki, A., & Darmi, R. (2021). The implementation of CEFR in ESL Learning: Why does it matter to the Malaysian Education System? Asian Journal of Assessment in Teaching and Learning, 11(2), 1–13. https://doi.org/10.37134/ajatel.vol11.2.1.2021
[39] Wu, J., & Chen, D.-T. V. (2020). A systematic review of educational digital storytelling. Computers & Education, 147, 103786. https://doi.org/10.1016/j.compedu.2019.103786
[40] Yongco, J. O., & Del Valle, J. M. (2022). Development and Evaluation of Instructional Module for Special Program in Journalism. International Journal of Educational Management and Development Studies, 3(4), 97–117. https://doi.org/10.53378/352948
[41] Zhang, X., Chen, Y., Hu, L., Hwang, G.-J., & Tu, Y.-F. (2025). Developing preschool children's computational thinking and executive functions: unplugged vs. robot programming activities. International Journal of STEM Education, 12(1). https://doi.org/10.1186/s40594-024-00525-z

AUTHORS

Sheleena Gopalakrishnan is a postgraduate researcher at the Faculty of Computing and Meta-Technology, Sultan Idris Education University (UPSI), Malaysia. She completed her Master of Education (Information Technology) with a dissertation focused on the development and evaluation of a Computational Thinking-based English writing module for primary school teachers. Her research interests include instructional design, computational thinking integration, educational technology, and English language pedagogy. She is passionate about designing innovative learning materials that support 21st-century skills in Malaysian classrooms. She can be contacted at: gsheleena2203@gmail.com.

Aslina Saad is an associate professor at the Faculty of Computing and Meta Technology, Sultan Idris Education University (UPSI), Malaysia. She obtained her PhD in computer science from Loughborough University, UK, in 2011, after completing her earlier study in Malaysia. With over 2 decades of teaching experience in the fields of computer science and information technology, she has become a respected expert in the areas of information systems, software engineering and digital technology. Her research interests include the integration of digital tools into education, information system development, and the advancement of learning technologies. She can be contacted at email: aslina@meta.upsi.edu.my

Haslinda Hashim is a lecturer at the Faculty of Computing and Meta Technology at Sultan Idris Education University, Malaysia. With a specialization in instructional technology, educational technology, computing education, and teacher training, she is committed to enhancing the integration of technology in educational practices. She also focuses on teacher training for computing subjects in schools, ensuring that educators are well-equipped to deliver effective instruction. She holds a degree in education (information technology) from Sultan Idris Education University, Malaysia, a master's in instructional technology from the University of Malaya, Malaysia and a PhD in instructional technology from The University of Sheffield, UK. She can be contacted at email: haslinda@meta.upsi.edu.my.