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IMPLEMENTATION OF DIGITAL PEDAGOGY MODEL FOR DEVELOPING COMPUTATIONAL THINKING IN MATHEMATICAL PROBLEM-SOLVING

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Abstract

The purpose of this study is to examine the integration of Computational Thinking (CT) into mathematics education through a comprehensive framework that emphasizes active student engagement and effective teacher facilitation. The research delves into the development and validation of a digital pedagogy model, focusing on guiding principles, teachers' roles, and students' active participation across various phases. The findings highlight the importance of aligning digital tools and pedagogical strategies to enhance problem-solving skills and technological proficiency among students. Despite demonstrating the robustness of the pedagogical model and student book prototype, certain challenges emerge, such as the need for reliable internet connectivity and adequate gadget access. Recommendations include refining instructional materials for clarity, accommodating diverse learning preferences, and considering parental involvement to enrich the digital learning environment. Continuous teacher development is crucial to effectively leverage the model and guide students through CT activities. Addressing these suggestions will refine the model into a more adaptable and impactful educational tool, fostering an environment where students actively engage with CT in mathematics, supported by well-equipped educators for effective implementation.

Keywords: Computational thinking, Mathematics, Pedagogy digital, Problem-solving.

1. Introduction

The implementation of a digital pedagogy model in education requires a rethinking of academic practices and the development of teachers' competence in using digital tools to enhance teaching and learning experiences [1, 2]. The effectiveness of curriculum for teachers at the elementary level has been studied, highlighting the need for in-service training to improve their competence [3]. Much research on curriculum have been well-documented [4-9].

Factors contributing to teachers' mastery of digital pedagogical competence have been explored, emphasizing the importance of understanding the dimensions of e-learning for successful implementation [10-14]. Additionally, critical digital pedagogy perspectives have been proposed to address the creation of anti-oppressive digital spaces for social justice education [15, 16]. The significance of digital transformation in education and the impact of digital technologies on teaching and learning has been acknowledged. It emphasizes the need to balance new pedagogies and digital tools for effective innovation in online learning [17-22].

Computational thinking (CT) is an innate ability that makes it feasible to solve problems using the computer and other tools in a way that makes sense [23]. Much research regarding CT has been well-documented [24-27]. The process involves multiple stages, such as formulating problems, organizing and analysing data logically, data abstraction, algorithms, identifying and analysing solutions, generalizing, and applying the process to different types of problems [28]. The ability of students to solve problems can be greatly enhanced by CT [29]. As a result, teaching pupils to think computationally can aid them in solving challenges they may encounter in daily life. The studies on mathematics have been well-documented [30, 31]. Additionally, its correlation to CT are closely intertwined [32-37].

It is crucial to solve complicated mathematical issues by following the stages of the CT process. Both algebraic and technological approaches can be used to solve certain mathematical puzzles [38]. Computer programs can solve more mathematical problems faster than human problem solvers. CT, of course, includes modeling in large measure. A balance between the theoretical and practical aspects of mathematics education can be achieved by computer-related logic [39]. The goal of learning mathematics in schools is to not only impart knowledge and concepts, but also to empower students to break down problems into smaller, more manageable chunks, look for and identify patterns and abstractions, and use these different aspects of CT to create algorithms [40]. Depending on the subject and issue at hand, there can be connections between CT and mathematics [41].

Based on constructivist learning theory, which holds that students create new information through their thinking and the interaction of experience with prior knowledge, a framework that combines CT with digital pedagogy [42]. A model is required as a conceptual framework to facilitate integrated mathematics learning CT and to arrange learning objectives integrating grammar, social systems, reaction principles, and support systems methodically. This model is intended to enhance and connect the CT stages. To enable students to experiment numerically, geometrically, and procedurally by modeling and tracing simple examples and searching for plots, patterns, symmetry, and other elements, the digital pedagogical model in this instance is made to be simple to use by both teachers and students. To help students become more adept at solving problems.

The purpose of this study is to examine whether the pedagogy digital model for developing CT in mathematical problem-solving is a valid, practical, and effective manner. To solve challenges about the mathematics learning materials in junior high schools, this model will integrate both direct CT activities and digital CT activities.

2. Method

This type of research is design research, because this research designs and develops an intervention to overcome a problem [43]. Based on objectives design research differentiated above development studies and validation studies. Educational design research (educational design research) with this type of development studies aims to develop solutions to complex problems in research-based educational practice. Objective educational design research with type validation studies is to develop or validate a theory [43]. This research is included in educational design research with type development studies and validation studies.

3.Results and Discussion

According to Plomp's development approach, preliminary research comes first. A context analysis and literature review on digital and CT pedagogy in mathematics learning are needed at this point. According to Table 1, the digital pedagogy model contains five phases: context, CT experience, reflection, project action, and evaluation. Direct and digital CT activities are used in CT experience. In the entire framework for introducing CT (CT) into mathematics education, teachers facilitate group work, explain technology use, explain problem-solving activities, provide digital feedback, and manage evaluations. It also highlights students' enthusiastic engagement with teacher explanations, collaborative problem-solving in groups, confidence in solving mathematical problems, active listening, asking clarifying questions, presenting solutions to the class, and commitment to excellence. This structured method promotes critical thinking, teamwork, and technological skill while effortlessly integrating CT into mathematics [44-52].

Figure 1 demonstrates that, overall, the pedagogical digital model prototype has very valid criteria, with an 84,91-feasibility achievement percentage and a total average of 4,25. The logic model and background, syntax, social system, principle of reaction, supporting systems, instructional impact, learning implementation, language, and graphics are all addressed in many ways.

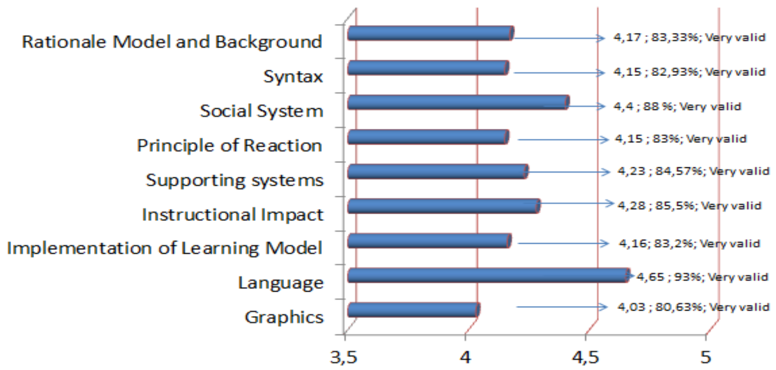

Fig. 1. Validation result of pedagogy digital model handbook.

Table 1 provides five-phase digital pedagogical model principles for CT mathematics learning. In Phase 1, the teacher guides balanced activities and explains technology use as students follow instructions, collaborate, and show commitment. The teacher explains arithmetic issues using digital activities in Phase 2, and pupils confidently solve them. Phase 3 involves the teacher giving feedback and clarifications and students listening and asking questions. Teachers led conversations and promote participation in Phase 4, with students answering and giving feedback. Phase 5 is when the teacher prepares and gives exams, which students take carefully.

Figure 2 shows that the student book prototype in general is very valid. There are several suggestions related to the appropriateness of content, linguistic appropriateness, suitability of presentation, and graphic feasibility. This digital pedagogy model is a challenge to the development of technology for education. In the trials carried out it turned out that the needs for this model exceeded the results of the initial model analysis, that the model is a new learning alternative where students can learn independently, directed, and measurable using the Geogebra classroom application.

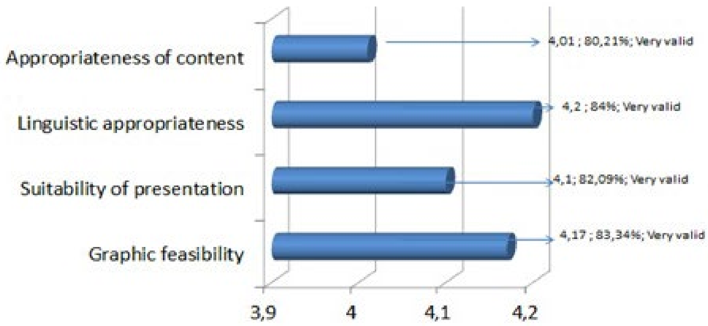

Fig. 2. Validation result of student book.

Table 1. Guidelines for implementing digital pedagogical models in integrated CT mathematics learning.

Syntax	Teacher's Role	Student Roles
Phase 1. Context of problem	Facilitate student activities optimally and in balance in terms of cognitive, affective, and psychomotor aspects. Guiding students in group work. Explain the use of technology.	Follow the teacher's explanation well and enthusiastically. Work together in groups to discuss solutions to the given problems. Full of commitment to complete the assigned task.
Phase 2. Experience of CT Activities	Provides explanations regarding mathematical problems that are solved using direct activities and digital activities.	With confidence in solving mathematical problems given by the teacher.

Syntax	Teacher's Role	Student Roles
		Full of commitment to complete the task as best as possible.
Phase 3. Reflective of problem	Provide feedback on student work results directly through the digital application used Check the assignments that students answer most incorrectly. Provide a further explanation of previously assigned tasks.	Listen to the teacher's explanation as best as possible. Ask when something is not understood.
Phase 4. Action of the Project	Guide the class discussion and ask one of the representatives to present an answer. Encourage students and other groups to pay attention and respond to the answers that appear in front of the class. Providing reinforcement and apperception to students.	Present answers in front of the class. Provide feedback to other groups.
Phase 5. Evaluation	Prepare a grid of exam questions that will be given to students. Complete test questions on the learning platform used.	Completing the test as best as possible.

In the design of the model, this model prioritizes students' CT activities through instructions that have been given previously. To achieve student independence, awareness is needed from the students themselves. In testing this model, there were still some students who were lazy to read the instructions in the model and they preferred to ask their friends or teachers about what they should do beforehand.

During its development, several aspects can be added to this model, one of which is the role of parents. However, the application used in this model trial was not able to support the implementation of the parent's role. Based on the trials that have been carried out, one of the findings in implementing this model is student enthusiasm and teacher persistence in learning. Students are very enthusiastic about participating in learning using this digital pedagogy model, apart from that, students are also happy to be able to use computers for learning activities.

Findings from the evaluation results of this digital pedagogy model trial show that the implementation of this digital pedagogy model still requires technical improvements such as internet connections and adequate gadgets. The success of this model depends on the infrastructure and policies taken by the school principal. Finally, this study can give additional ideas in mathematics learning, as reported in previous studies [53-58].

4. Conclusions

The integration of CT into mathematics education, as outlined in the structured framework, presents a pivotal advancement, emphasizing active student engagement and teacher facilitation. This comprehensive approach fosters critical thinking and technological proficiency, validated by the pedagogical model's robustness and the student book's overall validity. However, technical challenges, such as ensuring reliable internet connectivity and providing adequate gadget access, require attention for seamless implementation. Refining instructional materials for clarity, aligning with diverse learning preferences, and considering parental involvement can elevate student engagement and enrich the digital learning environment.

Continuous teacher development to leverage the model effectively and guide students optimally through CT activities is vital. Addressing these suggestions will refine the model into a more adaptable and impactful educational tool, ensuring a dynamic space where students actively engage with CT within mathematics, supported by educators equipped with resources for effective implementation.

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