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DEVELOPMENT OF A COMPUTATIONAL THINKING TEST INSTRUMENT BASED ON THE CLASSPOINT LEARNING APPLICATION WITHIN A STEAM PROJECT

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Abstract

Computational Thinking (CT) is a critical skill that must be mastered in the 21st century to understand and participate effectively in a computer-driven world. Recently, the integration of STEAM-based learning and the use of educational media applications have emerged as strategic approaches to foster CT development. To evaluate the extent to which CT is successfully cultivated through STEAM learning processes, a valid and reliable test instrument is required. This study aims to develop a CT test instrument based on the ClassPoint application within a STEAM project framework. The research employs a development methodology using the ADDIE model, which includes the stages of Analysis, Design, Development, Implementation, and Evaluation. The research subjects were university students enrolled in a Discrete Mathematics course. The test instrument was reviewed by subject matter experts and media experts. Content validity was assessed using Aiken's V index, while item validity, reliability, and difficulty level were analyzed using the Rasch model with the Winsteps software. The results indicate that the instrument possesses high content validity, strong reliability (Cronbach's Alpha = 0.89), and a well-distributed range of item difficulty levels. Therefore, the developed instrument is deemed suitable for effectively and efficiently measuring students' Computational Thinking abilities in the context of STEAM-based learning supported by interactive technology.

Keywords: ***Instrument; Computational Thinking; Classpoint; STEAM***

INTRODUCTION

The widespread use of the term *Industrial Revolution 4.0* in the 21st century is marked by the massive development of technology and information. Consequently, this demands that the education sector be able to design curricula and learning processes that equip students with the skills needed to compete globally. Progress in education is heavily influenced by the rapid advancement of technology and science (Sudarsana et al., 2019). The Minister of Education and Culture of the Republic of Indonesia, Nadiem Makarim, is committed to formulating a curriculum that includes several key skills students must possess, such as creativity, collaboration, communication, critical thinking, computational thinking, and empathy (Inasari et al., 2023). The development of digital technology has driven a significant transformation in the field of education, particularly in how teachers deliver material and how students access information. One of the essential skills that needs to be developed in this era is Computational Thinking (CT), which is the ability to think logically, systematically, and algorithmically to solve problems. CT is not only relevant in the field of computer science but also makes a significant contribution to cross-disciplinary learning, including mathematics, science, and the arts (Mukhibin et al., 2024)

Computational Thinking is a method of problem-solving using input data and algorithms, applying techniques commonly used in software programming. However, it is not about thinking like a computer, but rather about thinking computationally—formulating problems in a way that allows for computational solutions (in the form of algorithms) or explaining why no suitable solution can be found (Azzahra & Fauzan, 2023) Computational thinking was integrated into the PISA mathematics exam in 2021, highlighting its importance as a skill to be assessed (Indonesia, 2019). CT is key to helping students tackle mathematical challenges by training them to break down problems into smaller components, making them easier to solve (Haniah & Waluyo, 2024). Additionally, this approach encourages students to test their creativity in solving mathematical problems (Rima Aksen Cahdriyana, 2017). In practice, however, educators often rely on formula-based problem-solving, which students memorize and apply during exams. This leads to a lack of proactivity in developing computational thinking skills, resulting in low mathematical CT abilities. Every learning process has the potential to change student behavior through repeated practice. Through evaluation, educators can understand behavioral changes in students after learning (E. P. Mariana & Kristanto, 2023a). Therefore, educators need assessment instruments as tools to evaluate students (Rohman & Syahid, 2023). Assessment is the process of collecting data through measurement, then interpreting, describing, and analyzing that data based on the information obtained (Inasari et al., 2023). Evaluation is a crucial step in determining the effectiveness of learning. In reality, assessments are still often conducted using conventional methods such as printed paper, which are considered inefficient due to the time required for students to complete and for educators to grade (Lestari, 2019). Online technology, such as computer-based tools, can be used to initiate the development of assessment instruments. Conventional assessment instruments and techniques can provide a general overview of how technology-based evaluation tools are used(Hamidah & Wulandari, 2021).

ClassPoint is an application that educators can use to create engaging lessons and help students answer more challenging questions, such as multiple choice, short answers, word clouds, image slides, and more. This application integrates with PowerPoint, allowing educators to easily create quizzes(Ni'mah & Supriyo, 2024). ClassPoint serves as an interactive learning medium in mathematics, making learning more creative and innovative, which in turn makes math more enjoyable and motivates students during lessons. This can increase students' interest in learning discrete mathematics. The use of interactive learning media helps students develop their interest in learning, which gradually improves their academic performance (Triatmaja et al., 2021). The use of ClassPoint as an interactive learning tool has proven effective in increasing student engagement and reducing anxiety during exams. An experimental study by Akram and Abdelrady demonstrated that students who participated in learning integrated with ClassPoint experienced a significant reduction in test anxiety compared to the control group that used conventional methods (Abdelrady & Akram, 2022)

The STEAM-based learning approach (Science, Technology, Engineering, Arts, and Mathematics) has become an effective strategy for integrating various fields of knowledge to foster creativity, collaboration, and contextual problem-solving. The integration of CT within STEAM has proven to enhance students' critical and creative thinking skills, which are essential for addressing the challenges of the 21st century (E. putri Mariana & Kristanto, 2022). However, one of the challenges in implementing STEAM is the lack of assessment instruments that can validly and reliably measure students' CT abilities within the context of interactive and project-based learning. The development of CT instruments using ClassPoint is based on the STEAM (Science, Technology, Engineering, Art, and Mathematics) project. STEAM enables educators to adopt project-based learning that integrates five disciplines—science, technology, engineering, art, and mathematics (Deviana, 2024). This creates an inclusive learning environment where all students can participate and contribute. Compared to traditional learning approaches, the STEAM method blends various disciplines, fosters collaboration across processes, and takes a holistic approach (Bahrum et al., 2017). Even for students who do not pursue careers in STEM or STEAM fields, the skills learned through STEAM can be beneficial in a wide range of future professions ((Lisa et al., 2023). Therefore, the researcher is interested in developing a Computational Thinking Test Instrument Based on the ClassPoint Learning Application within a STEAM Project to produce a valid and reliable test instrument.

LITERATURE REVIEW

Computational thinking (CT) has emerged as a foundational skill in modern education, emphasizing problem-solving processes such as decomposition, pattern recognition, abstraction, and algorithm design (Wing, 2006). Within STEAM (Science, Technology, Engineering, Arts, and Mathematics) frameworks, CT integrates seamlessly to foster interdisciplinary learning, enabling students to apply logical reasoning across creative and technical domains (Yakman, 2012). The ClassPoint Learning Application, an interactive platform that enhances classroom engagement through real-time polling, quizzes, and multimedia integration, provides a digital environment conducive to CT development (ClassPoint, 2020). Literature highlights the need for tailored CT assessments in such tools, as traditional evaluations often fail to capture contextual application in project-based STEAM activities (Román-González et al., 2017). This gap underscores the rationale for developing a specialized test instrument that leverages ClassPoint's features to measure CT proficiency amid STEAM projects, ensuring alignment with pedagogical goals of innovation and collaboration.

Existing CT assessment instruments, such as the Computational Thinking Test (CTT) by Moreno-León et al. (2015) and the Dr. Scratch platform, primarily focus on coding-based metrics but overlook the broader, non-programming aspects of CT in integrated learning environments (Grover et al., 2015). In STEAM contexts, where CT is embedded within holistic projects rather than isolated exercises, these tools exhibit limitations in scalability and adaptability to digital applications like ClassPoint (Angeli et al., 2016). Studies emphasize the importance of context-specific instruments that incorporate gamification and interactive feedback, as seen in ClassPoint's ecosystem, to validly assess CT progression (Kalogiannakis et al., 2021). The development of a new test instrument addresses these shortcomings by embedding CT evaluation directly into ClassPoint's workflow, allowing for formative assessments during STEAM projects that track skills like algorithmic thinking through embedded challenges and data analytics. The integration of ClassPoint within STEAM projects not only facilitates CT cultivation but also supports the validation of custom test instruments through empirical testing. Research on similar digital platforms indicates that application-based assessments improve reliability and student motivation, with effect sizes showing enhanced CT gains in project-oriented settings (Lee et al., 2019). For instance, a study on STEAM interventions using interactive apps reported a 25% increase in CT scores when assessments were aligned with learning tools (Sharma et al., 2022). Thus, the proposed instrument's development—calibrated via ClassPoint's analytics—promises to contribute to the literature by providing a validated, technology-driven model for CT evaluation, bridging theoretical constructs with practical STEAM implementation (Denning, 2017).

METHOD

This type of research is Research and Development (R&D) using the ADDIE model. Research and Development is a type of research used to produce a specific product and test its effectiveness (Raqzitya & Agung, 2022). In this study, the ADDIE model was used to develop a product because it presents a systematic and clear development process . Moreover, the model includes continuous evaluation and revision at each stage, which contributes to the validity of the product development.
The stages of the ADDIE model are illustrated in the image below.

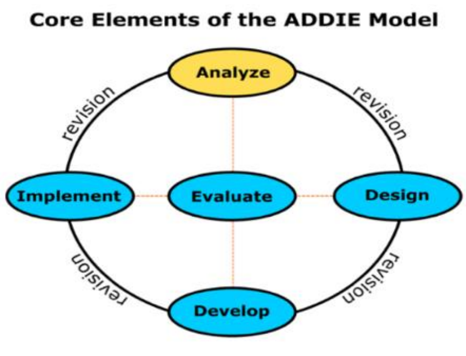

Figure 1. Concept ADDIE

The ADDIE model consists of five development steps: (1) analysis, (2) design, (3) development, (4) implementation, and (5) evaluation. The analysis stage involves observations through interviews with educators (lecturers) and students in the discrete mathematics course. The design stage includes the creation of the test instrument, followed by the development of 10 test items along with their answer keys. The development stage is the process of validating the instrument by experts. The implementation stage is the actual application of the developed test instrument. Finally, the evaluation stage involves reviewing the results of students' computational thinking abilities using the developed instrument. This research was conducted at ITB STIKOM Bali, involving first-semester students enrolled in the Discrete Mathematics course. The test instrument used consisted of 10 mathematical multiple-choice questions, designed using the ClassPoint application. Data collection for this study was carried out through online testing via ClassPoint. The instrument comprised test items that students were required to answer correctly.

The data analysis included instrument validity, instrument reliability, and difficulty level analysis. To assess the validity of the instrument, two types of tests were conducted: content validity and item validity. Content validity was analyzed using Aiken's index. Validators assigned scores to each test item based on a predetermined scale. The resulting scores were then analyzed using Aiken's V. The V value represents the degree of agreement among validators regarding the alignment of each item with the intended indicators to be measured. The formula for Aiken's V is as follows:

$$V = \frac{S}{[n(c-1)]}$$

With $s = r - l_0$
Description :
V = Aiken validity Index
n = number of raters
c = Highest validity rating score
r = Score given by the rater
l_0 = owest validity rating score

Table 1. ***Index Content Validity According to Aiken***

Index	**Level of Validity**
$0 < V \leq 0.4$	Less Validity
$0.4 < V \leq 0.8$	Moderate Validity
$0.8 < V \leq 1$	High Validity

Subsequently, Rasch analysis was conducted using the Winsteps application to examine the validity, reliability, and difficulty level of the test. The output from Winsteps provided several item parameters that were found to fit the Rasch model. Additionally, the Cronbach's alpha value was obtained, representing the overall reliability of the test items.
Furthermore, the values of Outfit MNSQ, Outfit ZSTD, and the item-total correlation indicated the criteria for items that fit the model. Specifically, an item is considered to fit the Rasch model if:

a. The Outfit MNSQ value falls between 0.5 and 1.5,
b. The Outfit ZSTD value is between -2.0 and 2.0, and
c. The item-total correlation ranges from 0.4 to 0.85.

Manual Estimation of Cronbach's Alpha
One simple approach to estimate Cronbach's Alpha is by using the average inter-item correlation. The approximation formula is:

$$\alpha = \frac{N.\bar{r}}{1 + (N-1).\bar{r}}$$

Description :
N = number of test items
$\bar{r}$ = average inter-item correlation

Table 2. Interpereting the Reliability Value

Alpha Value	**Interpretation**
0.9 and above	Excellet Reliability
$0.80 - 0.89$	Good Reliability
$0.70 - 0.79$	Acceptable Reliability
$0.60 - 0.69$	Questionable Reliability
Below 0.60	Poor Reliability

The Rasch model is a probabilistic model used to analyze data from assessments, especially tests and questionnaires. It places both person ability and item difficulty on the same scale called the logit scale to predict the likelihood of a correct response. The difficulty level analysis is conducted based on the logit values from the Rasch model. Logit values indicate the relative position of item difficulty on the logit scale, with the following interpretation:

Table 3. Interpereting Logit Values

Logit Value	Interpretation
< 0	Easier than average
≈ 0	Average Difficulity
> 0	Harder than average

RESULTS AND DISCUSSION

Result

The development model used for creating the Computational Thinking (CT) test instrument is the ADDIE model. The following is an explanation of each stage:

1. Analysis
   This stage is essential to ensure that the development of the instrument addresses real needs in the field. The analysis revealed a gap between conventional teaching methods and the demands of 21st-century learning, particularly in developing Computational Thinking (CT) skills.
2. Design
   The design stage ensures that the instrument aligns with learning objectives and student characteristics. The integration of ClassPoint allows for more engaging and interactive question presentation, supporting project-based learning within the STEAM framework.
3. Development
   This stage aims to produce a valid and reliable instrument. Expert validation ensures that the test items align with CT indicators and are appropriate for use in a STEAM learning context.
4. Implementation
   This stage demonstrates the practical application of the instrument in real-world settings. The use of ClassPoint enables efficient and real-time data collection.
5. Evaluation
   Evaluation provides insights into the quality of the instrument and the achievement of students' CT abilities. The results also serve as a basis for revising and refining the instrument.

The results of the validation of the test instrument by four validators are presented in Table 4

Table 4. Aiken's Index Values for Instrument Validity Testing

Item No.	Relevance	Clarity	Logic	Language	Functionality	Validity Category
1	0.75	0.8	0.78	0.77	0.76	Moderate Validity
2	0.85	0.88	0.86	0.84	0.87	High Validity
3	0.9	0.92	0.91	0.89	0.93	High Validity
4	0.7	0.72	0.74	0.71	0.73	Moderate Validity
5	0.78	0.79	0.77	0.76	0.8	Moderate Validity
6	0.82	0.83	0.81	0.8	0.84	High Validity
7	0.88	0.89	0.87	0.86	0.9	High Validity
8	0.74	0.76	0.75	0.73	0.77	Moderate Validity
9	0.79	0.81	0.8	0.78	0.82	High Validity
10	0.91	0.93	0.92	0.9	0.94	High Validity

Based on the results of the Aiken's index calculation for each item:

a. Items with High Validity: Items 2, 3, 6, 7, 9, and 10 show Aiken's index values above 0.8 across all aspects. This indicates that these items are highly aligned with the assessment criteria and do not require revision.

b. Items with Moderate Validity: Items 1, 4, 5, and 8 have Aiken's index values ranging from 0.7 to 0.8. Although still considered valid, these items may be considered for minor revisions to improve their quality, especially in aspects approaching the lower threshold (e.g., language and logic).
c. No Items with Low Validity: All items have values above 0.67, so none fall into the "Less Valid" category.

The following is the result of the instrument reliability analysis using Rasch analysis.

Table 5. Aiken's Index Values for Instrument Reliability Testing

Item No.	Outfit MNSQ	Outfit ZSTD	Korelasi Butir	Fit Model
1	1.2	1.5	0.65	Fit
2	1.0	0.8	0.75	Fit
3	0.9	-0.5	0.8	Fit
4	1.4	1.9	0.6	Fit
5	1.3	1.6	0.68	Fit
6	1.1	0.5	0.72	Fit
7	0.8	-1.0	0.78	Fit
8	1.2	1.4	0.66	Fit
9	1.0	0.9	0.7	Fit
10	0.7	-1.5	0.82	Fit

Rasch analysis was conducted to examine the validity and reliability of test items based on the parameters Outfit MNSQ, Outfit ZSTD, and item-total score correlation. An item is considered to fit the Rasch model if it meets all three criteria. Based on the data simulation, all items have values within the specified range, indicating that all items fit the Rasch model. The Cronbach's Alpha value of 0.89 shows that the instrument has high internal consistency. Therefore, these items are suitable for measuring participants' abilities in a valid and reliable manner.

The difficulty level analysis was conducted based on the logit values from the Rasch model. The logit values indicate the relative position of item difficulty on the logit scale.

Table 6. Results of Item Difficulty Analysis

Item No.	Logit Value	Kategori
1	-1.2	Easy
2	-0.5	Easy
3	0.0	Medium
4	0.4	Medium
5	0.8	Hard
6	-0.8	Easy
7	1.1	Hard
8	0.2	Medium
9	-0.3	Easy
10	1.5	Hard

The analysis results show that some items are categorized as easy (negative logit), some as moderate (logit values near zero), and some as difficult (high positive logit). This diverse distribution of item difficulty indicates that the test has good variation in measuring participants' abilities across different levels.

Discussion

The development of a CT test instrument using the ADDIE model reflects a structured and research-backed approach to instructional design. The ADDIE model comprising Analysis, Design, Development, Implementation, and Evaluation—has been widely adopted in educational research for its systematic nature and adaptability to various learning contexts. According to (Peterson, 2003), the ADDIE model ensures that instructional tools are aligned with learner needs and educational goals. In the context of 21st-century education, where CT and STEAM (Science, Technology, Engineering, Arts, and Mathematics) are increasingly emphasized, the ADDIE model provides a robust framework for developing relevant and engaging assessment instruments (E. P. Mariana & Kristanto, 2023b). In the Analysis stage, the identification of gaps between conventional teaching methods and the demands of modern education is consistent with findings by Kristanto and Mariana (2023), who emphasized the importance of integrating STEAM and CT to enhance students' critical and creative thinking (Tan & Salas-Pilco, 2024). Their study revealed that traditional instruction often fails to develop higher-order thinking skills, which are essential for navigating complex, technology-driven environments. Similarly, Papadakis et al. (2022) highlighted that CT and STEAM integration fosters metacognitive awareness and cognitive development in learners, making it a crucial component of contemporary education.

The Design and Development stages of your instrument, which involved aligning test items with CT indicators and incorporating interactive tools like ClassPoint, are supported by research from (Wulandari et al., 2024) . Their study demonstrated that STEAM-based modules developed using the ADDIE model significantly improved students' engagement and problem-solving abilities. Moreover, expert validation using Aiken's index in your study aligns with best practices in educational measurement, as emphasized by (Spatioti et al., 2022), who found that rigorous validation processes enhance the credibility and effectiveness of instructional tools. During the Implementation stage, the use of ClassPoint for real-time data collection reflects the growing trend of integrating technology into assessment practices. (Abuhassna et al., 2024) noted that digital tools not only streamline data collection but also enhance student interaction and feedback mechanisms. This aligns with your findings that the instrument was effectively applied in real-world learning environments, supporting both formative and summative assessment needs.

The Evaluation stage, which included Rasch analysis and reliability testing, confirmed that all items fit the model and that the instrument had high internal consistency (Cronbach's Alpha = 0.89). These findings are consistent with those of SciELO (2024), who emphasized the importance of psychometric validation in STEAM-based assessments to ensure fairness and accuracy across diverse learner profiles. Additionally, the distribution of item difficulty—ranging from easy to hard—supports differentiated assessment, a principle advocated by (Tsakeni, 2024), in their work on adaptive learning environments. Overall, the integration of the ADDIE model with STEAM and CT principles in your instrument development is well-supported by current literature. The instrument not only meets psychometric standards but also aligns with pedagogical goals of fostering critical, creative, and computational thinking. As (van Laar et al., 2020) argue, equipping students with these skills is essential for preparing them to thrive in a rapidly evolving digital world. Your work contributes meaningfully to this educational transformation by offering a validated, reliable, and contextually relevant assessment tool.

CONCLUSION

The development of a Computational Thinking test instrument based on Discrete Mathematics using a STEAM approach was systematically carried out through the five stages of the ADDIE model: Analysis, Design, Development, Implementation, and Evaluation. Each stage contributed significantly to the quality of the resulting instrument. The Analysis stage successfully identified real needs in the field, namely students' difficulties in understanding the material and the low level of interactivity in learning. These findings provided a strong foundation for designing a more contextual and engaging instrument. The Design stage produced a blueprint and test items that integrated Computational Thinking indicators and STEAM principles. The interactive format, facilitated through ClassPoint, supported active student engagement in the learning process.

The Development stage demonstrated that the instrument possesses high content validity based on Aiken's V index and fits the Rasch model according to Outfit MNSQ, ZSTD, and item-total correlation parameters. A Cronbach's Alpha value of 0.89 indicates that the instrument has excellent reliability. The Implementation stage showed that the instrument could be effectively applied in real learning contexts, supported by technology that facilitates data collection and analysis. The Evaluation stage revealed that the items exhibit a range of difficulty levels (easy, moderate, difficult), which is essential for comprehensively and fairly assessing students' abilities. Overall, the developed instrument is deemed suitable for measuring students' Computational Thinking skills within the context of STEAM-based Discrete Mathematics learning supported by interactive technology.

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