



How Computerized Criticism From A Computerized Arithmetic Course Reading Influences Rudimentary School Students Conceptual Improvement: Two Case Thinks About In Indonesia

Hendita Rifki Alfiansyah ¹ | Wulan Aulia Azizah ² | Wahyu Purwaningsih ³ | Irma Wanty ⁴

¹Universitas Negeri Yogyakarta, Indonesia, hendita.rifkia0838@gmail.com

²Universitas Negeri Semarang, Indonesia, wulan03aulia@gmail.com

³Universitas Negeri Yogyakarta, Indonesia, wahyu.purwaningsih0293@gmail.com

⁴Kanwil Kemenag Banten, Indonesia, irwa74848@gmail.com

Correspondence:

Hendita Rifki Alfiansyah
Universitas Negeri Yogyakarta, Indonesia
Email: hendita.rifkia0838@gmail.com

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Abstract

One of the key highlights recognizing computerized arithmetic reading material from conventional ones is the arrangement of computerized input on students' arrangements. Input is recognized as a vital figure impacting the learning prepare, making it a outstanding advantage of computerized course readings. Whereas broad quantitative inquire about has inspected the common viability of input, there's constrained understanding of how input particularly impacts students' person learning forms and conceptual improvement. To address this gap, a hypothetical system Based on Labardelle's instrumental theory and Bernaud's conceptual theory ranges was made to subjectively look at the portion of criticism interior learning handle. This system has been linked in one case, consider checking about two basic fields understudies in Indonesia as they worked on a likelihood errand from a 3rd-grade computerized course scrutinizing. The investigation given a point by point reproduction of how the understudies deciphered the input and balanced their behavior in like manner. This in-depth examination revealed that criticism does not ceaselessly develop conceptual headway inside the arranging way, and a amend course of action does not in a general sense alter with conceptual understanding. The disclosures highlight many challenges understudies go up against when working independently on errands from computerized science course readings with robotized input, prescribing that feedback rebellious require progress refinement through design-based examine cycles to realize the desired comes about.

Practitioner note:

What is already known about this topic

- Digital textbooks increasingly offer features like interactive tasks and automated feedback, aimed at enhancing the learning experience, particularly in mathematics education.
- Feedback is recognized as a crucial element in the learning process, with various studies highlighting its impact on student performance, though the specific mechanisms through which feedback influences learning are not fully understood.
- Existing research often focuses on the general effectiveness of feedback, but there is limited insight into how individual students process and utilize this feedback in digital learning environments.

What this paper adds

- This study provides an in-depth qualitative analysis of how automated feedback from digital arithmetic textbooks impacts the conceptual development of elementary school students in Indonesia.
- Through case studies, the research highlights the complexities of student interaction with feedback, revealing that while feedback can guide students towards correct answers, it may also reinforce misconceptions if not properly designed.



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- The findings suggest that the current design of feedback in digital textbooks needs refinement to better support students' understanding and learning processes, emphasizing the importance of clear, well-structured feedback messages.

Implications for practice and/or policy

- Educators should be aware that automated feedback in digital textbooks, while beneficial, might not always lead to accurate conceptual understanding. Therefore, it is crucial for teachers to supplement digital feedback with personalized guidance and clarification.
- Digital textbook designers should prioritize the development of feedback systems that not only verify correct answers but also address common misconceptions and provide clear, actionable insights to support deeper learning.
- Policymakers should consider the integration of design-based research in the development of digital educational tools, ensuring that these tools effectively meet the learning needs of students and contribute to their conceptual development.

1. INTRODUCTION

Compared to conventional printed science reading material, advanced science course readings progressively offer extra highlights such as intuitively charts, criticism, and developmental evaluations, and give openings for personalization and individualization for both instructors and understudies. Weiss (2020) alluded to these course readings as "improved e-textbooks." These extra highlights are aiming to back the educating and learning of science.

The developing appropriation of improved e-textbooks is likely to alter students' learning encounters. Inquire about on the utilize of printed reading material has appeared that for understudies, working with a reading material generally implies working on assignments (Richardson, 2022). In the event that understudies require offer help, they can inquire their a co-worker or instructor at school or a family member. A few course readings offer arrangement manuals that understudies can allude to for checking their comes about (Prasad, 2021). In course, instructors may moreover survey person understudy advance and give unconstrained criticism based on their perceptions (Rahman & Kamaruding, 2023). After a stage of person work in lesson or at domestic, instructors might audit students' work and give person input within the shape of notes on their assignments.

Working with advanced electronic textbooks implies that students can have to extra steady assets, which jolt in them more suitably in their interaction with science (Andriani et al., 2021), and they get additional back in their learning shapes, tallying robotized comments on their work. Implementing these strengths in e-textbooks aims to support learning and improve the quality of teaching. At the same time, they alter the nature of teaching. On the one hand, they reduce the responsibility of teachers as the sole supplier of clarifications and input. On the other hand, these extra highlights possibly modify students' parts as perusers, changing their experiences with science by advertising numerous, interconnected, energetic, and intuitively representations of numerical concepts (Ligado et al., 2022). Understudies got to coordinated these highlights profitably into their learning forms, and instructors must adjust their arranging and educating in reaction to these extra highlights. In this manner, the extra highlights of e-textbooks are transformative, modifying the educating and learning of science. Be that as it may, small is known approximately how these extra highlights of improved e-textbooks really impact students' learning forms when tackling errands from computerized reading material (Geng et al., 2024).

This paper centers on the part of computerized criticism within the learning prepare. Within the significant writing, criticism is most often characterized as data-driven "given by an operator (e.g., instructor, peer, book, parent, self, involvement) with respect to viewpoints of one's execution or understanding" (Praveena et al., 2021). The aim is to bring about behavioural change by identifying the differences between the two genuine and planning execution (Alhezzani, 2020). Hence, input is broadly recognized as an critical calculate affecting learning and accomplishment (Wati & Afifah, 2023).

Various considers have examined the viability of criticism, centering on factors such as criticism substance, timing, complexity, and the sum of data given (Prasad & Ioannidis, 2022). The comes about of these thinks about are changed (Trimmer & Guest, 2020). To decide the degree to which distinctive strategies of giving Item-based input in computer-assisted learning influences student learning outcomes, conducted a meta-study. They found a decently huge impact of expounded criticism, which gives learners with extra data related to the arrangement of the errand, which explained criticism is more viable than criticism that only assesses the rightness of the answer or appears the proper reply. In spite of these quantifiable impacts of input on learning results, (Schölkopf et al., 2021) summarized that "the particular instruments relating input to learning are still for the most part dim, with exceptionally few (on the off chance that any) common conclusions".

In synthesizing subsequent research on how innovation can strengthen persuasive criticism, Haughney et al. (2020) indicates possible reason: "In most cases, there is no clear indication of how the feedback inputs (e.g., comments on the assessment performance) are designed to impact subsequent assessment or how the impact is to be measured. This raises questions about the overall validity and comparability of many studies on technology and feedback; without knowing if a technology was used within a high-quality feedback design or not, it is difficult to conclude if the benefits of an approach are

actually related to the technology. Additionally, the composition or nature of the comments is sometimes unclear in feedback designs. Arguably, the impact of the feedback process is heavily dependent on the nature of the information being provided, such as a focus on providing actionable comments and the clarification and use of clear performance standards" (Panadero & Lipnevich, 2022).

Martin (2023) contended that understudies are effectively locked in The meaning of the opening comment, and therefore the criticism isn't singularly decided by the specialist. As a result, (Verma, 2022) called for "less distraction with what teachers 'do' in giving criticism, such as how much data to provide and at what time, and instep a move toward far off better;a much better;a higher;a stronger;an improved"> develop an understanding of how understudies discover, translate, and utilize information pertinent to their learning and how programs are outlined to create this information".

Understanding how students interpret feedback messages from digital e-textbooks and how this feedback shapes their conceptual development is crucial. This study seeks to delve deeper into these dynamics by establishing a comprehensive framework and methodology that allow for a more detailed examination of the learning process. Unlike traditional quantitative studies that often overlook the nuances of how students engage with feedback, this research emphasizes the need for a more qualitative approach. By doing so, it aims to uncover the mechanisms through which feedback influences learning outcomes, offering insights that can inform more effective educational practices. Through an in-depth analysis, this study explores the real impact of automated feedback on students' understanding, ultimately contributing to a more refined understanding of how feedback can be optimized in digital learning environments.

2. METHODS

2.1. Participants and Data Collection

In this consider, the information were assembled from a add up to of 117 third-grade understudies chosen haphazardly from 12 distinctive essential schools found around a Indonesia city. These understudies, who were presented to an upgraded e-textbook for essential instruction accessible on the Indonesia advertise, were the subjects of the ponder.

Their participation was contingent on both their own and their parents' consent. Each student worked individually on various tasks provided by the e-textbook, all within a controlled experimental setting, where they were instructed to think aloud. The presence of an interviewer during this data collection phase was crucial, as the interviewer frequently prompted the students to articulate their thought processes, especially regarding the tasks at hand (Reinhart et al., 2022). This approach aimed to ensure continuous verbalization of their thoughts. Notably, this was the first time these students were interacting with the e-textbook, and they had been introduced to its features and functionalities prior to engaging with the specific tasks used in this analysis. The interviewer occasionally assisted the students with navigating the digital textbook and highlighted certain features, all with the goal of observing the students' instrumental beginning of the input given by the reading material.

2.2. The Digital Textbook

The think about utilized the An advanced e-textbook titled "Interactive Thinking and Computing" is distributed by the Westermann Gather, a major Indonesia distributor of educational programs materials. This reading material is one of the few accessible on the Indonesia showcase for primary-level arithmetic that provides intelligently replying designs, such as different choice and drag-and-drop, alongside automated input. It could be a computerized form of a conventional and widely-used paper reading material, with the substance and structure of both forms being closely resembling. The digital version, however, includes various types of feedback, categorized based on Raditya et al. (2020) framework:

- Verification Feedback: After submitting an answer, the textbook verifies its correctness. If the answer is incorrect, students are allowed two more attempts. Correct answers are highlighted in green, while incorrect ones are flagged in red and removed before the next trial.
- Elaborated Feedback: If the student fails after the second trial, a hint or prompt, categorized as elaborated feedback, becomes available through a lightbulb icon on the screen. This hint helps guide the student toward the correct solution.
- Correct Feedback: If the student is unsuccessful after three attempts, the correct answer is provided.
- Summative Feedback: Upon completing a set of tasks, the textbook provides a summary, including the time taken and the number of attempts made to solve the tasks.
- Lexicon Access: The textbook includes a lexicon of mathematical terms accessible at any point during the task. Terms used in the task are directly linked to this lexicon, offering additional elaborated feedback.

Overall, this textbook represents the typical offerings of digital mathematics textbooks in Indonesiay, combining verification, retry, report errors, correct answers and detailed comments.

2.3. The Task

Research focuses on the learning processes involved in understanding the concepts of impossible, probable, and certain events as probabilities. The task required students to distinguish between these concepts using a probability problem involving drawing balls from a box. The problem asked Students must determine the number of tries required to ensure drawing the blue ball from a box containing both red and blue balls. A similar task asked about drawing a red ball. These tasks align with the competence expectations for students at the end of grade four, as outlined by the relevant Indonesia state standards.

2.4. Data Analysis

The video recordings were translated utilizing Goffman (2022) rules for straightforward transcripts and were analyzed through the focal points of instrumentalization and instrumented. The investigation pointed to recognize occurrences where understudies utilized distinctive sorts of criticism and to get it how they credited capacities to this input in their learning prepare. This was deduced from their activities taking after the criticism.

Instrumented was analyzed by remaking Concepts in Action and Theorems in Action are verifiable information that is implemented in students' plans. Subjective substance examination, taking after Minggu and Arwadi (2021) approach, was utilized to analyze students' activities and their verbal clarifications, with the objective of explicating the operational invariants.

3. FINDINGS

The paper presents two specific case studies: Ben and Kim. These cases were chosen since they outline common challenges when working with computers. reading material that give criticism in its right now broad frame.

3.1. The Case of Kim

The transcript of Kim's intelligent with the assignment and the textbook's criticism uncovers her thought forms and how she explored the challenges displayed by the errand. Kim at first speculated that Lia, the character within the issue, would got to draw once to urge a blue ball, thinking based on the number of blue and ruddy balls within the box. After accepting confirmation input that her reply was inaccurate, she reexamined and chosen on a diverse approach, eventually utilizing the insights given by the course reading after different erroneous endeavors.

Kim's handle of tackling the assignment was intensely affected by the input from the course reading. The negative criticism provoked her to reexamine her answers, and the clues guided her towards the proper arrangement. In any case, her thinking was now and then hazy, and she occasionally depended on instinct instead of a clear understanding of the likelihood concepts included.

3.1.1. Instrumentalization

Kim utilized the confirmation criticism as a device to evaluate her answers and reexamine them after getting negative criticism. She too utilized the indicate given by the reading material after her moment erroneous reply as a implies to get extra bolster in fathoming the assignment. The exact wording of the input messages moreover played a part in guiding her towards the proper reply.

3.1.2. Instrumentation

The criticism from the course reading organized Kim's problem-solving prepare. The negative confirmation input reliably activated her to reevaluate her answers, driving to changes in her concepts-in-action and theorems-in-action. Whereas she battled to express her thinking at times, the criticism given by the course reading eventually guided her towards the proper arrangement, though through a prepare of trial and mistake.

3.2. The Case of Ben

Ben's problem-solving process in the given tasks highlights his initial challenges and eventual success in arriving at the correct answers. At the outset, Ben struggles with the first task, expressing uncertainty about how to calculate the answer. He initially believes that because the blue balls are positioned on top, Lia will draw a blue ball on her first attempt. Despite entering this response, the feedback indicates that his answer is incorrect. Even after some additional reflection, Ben maintains his belief and tries again, only to receive the same negative feedback. Feeling confused, he finally decides to use a hint provided by the e-textbook, which helps him understand that Lia draws the red balls from the bottom first. With this new insight, Ben is able to provide the correct answer and receives positive feedback.

When faced with a second task, Ben reads the problem and initially repeats a similar mistake, assuming that Lia would draw a red ball with just one attempt. This assumption, based on his previous misunderstanding, leads to another incorrect response. However, Ben quickly adjusts his approach, considering the feedback from the first task, and successfully determines that Lia should draw nine times, which earns him the correct response. This sequence illustrates Ben's learning process, as he navigates through initial misconceptions, uses available resources like the e-textbook tip, and ultimately corrects his approach to solve the problems accurately

3.2.1. Instrumentalization

Ben demonstrates a strategic approach to problem-solving by actively utilizing the feedback messages and visual aids provided during the task. He not only takes advantage of the verification and elaboration feedback to reassess his initial responses but also makes effective use of the visual elements, such as the image of the urn with the blue and red balls, to guide his understanding and reach the correct solution. This process highlights his ability to integrate different forms of information, allowing him to refine his answers and improve his overall problem-solving performance.

3.2.2. Instrumentation

Ben's approach to solving the mathematical task demonstrates a progression from initial uncertainty to a more refined understanding, driven by his interaction with feedback and his pre-existing assumptions. At the outset, Ben repeatedly questions how to calculate the solution, reflecting his belief that a mathematical task inherently requires a calculation. Despite not knowing the exact method, he attempts to solve the problem by relying on his observations, specifically the arrangement of the balls in the box. He infers that because the blue balls are on top, drawing one first is almost certain. However, as he engages with the task, receives feedback, and consults a tip from the e-textbook, Ben's reasoning evolves. He begins to adjust his approach, understanding that the order in which the balls are drawn, along with their spatial arrangement, plays a crucial role in determining the outcome. This evolution in his thought process illustrates how his initial concepts-in-action—focusing on the physical layout and sequence—persistently influence his problem-solving strategy. Even after arriving at the correct answer, these concepts remain central to his understanding, highlighting how feedback and self-reflection can refine but not entirely replace foundational assumptions in learning.

4. DISCUSSION

The in-depth subjective examination of the two cases makes it possible to see how the computerized input of a revised Indonesia electronic textbooks used by students and their impact on their cognitive development (in the instrumental sense) only when they understand a task from reading fabric.

The cases share a few likenesses. In both cases, assertion input prompts the understudies to reexamine their answers. Be that since it may, since they are not given with any data which is able be satisfying in this handle, they begin to figure and since it were to a few degree alter their answers on the primary attempt based on concepts and hypotheses that are to some degree adjusted in hone. Both Ben and Kim begun with the concept of tall likelihood, display all through their to begin with little trials.

In both cases, the explained input bolsters the understudies in modifying their theorems-in-action and finding the proper reply reasonably. In this way, the clarified feedback shows up up to back the assistance alter of the concept of certain occasions in both cases. In all cases, the examination appeared that in both cases, the understudies utilized data that was not vital for the errand. In Kim's case, it was the affirmation input message "NOT Totally Redress", and in Ben's case, it was the heading of development the bullets inside the box and the organization where they are collected by the action player in the quest system.

There is often a discrepancy between the actual content of feedback messages and the way they are framed, which can lead to misunderstandings among students, as seen in Kim's case. While Kim successfully arrived at the correct answer by interpreting the feedback, the feedback itself may unintentionally reinforce a flawed understanding or usage pattern. This issue arises when students rely on the surface-level cues of the feedback rather than grasping its deeper, intended meaning. Consequently, such feedback might not only mislead students but also solidify an inaccurate approach to problem-solving, potentially hindering their conceptual growth in the long run.

For Ben, the spatial arrangement of the balls within the standard vase image is notable and emphasizes it the operational concepts involved in this spatial deployment. There's no question that, after finding the right reply to the little assignment, these concepts in reality gave rise to his hypothesis of activity and appeared to stay connected to his concept of certainty.

Arguably, this erroneous data is not a problem with the e-textbook and the input There's no question that, after finding the right reply to the little assignment, these concepts in reality gave rise to his hypothesis of activity and appeared to stay connected to his concept of certainty that seem sensibly be bypassed by rewording the errand and the input message (Matsuno, 2020). Regardless, I think these cases illustrate how difficult it is for students to understand information that is not essential to the progress of the task.

As a common approach, concept learning often involves refining a concept by limiting itself to the basic and non-essential aspects of a concept (Holzinger et al., 2023). It is therefore the responsibility of the teaching and learning manager to shape and articulate students' concepts in action in order to organize their understanding and encourage them to undertake important projects. Regardless, these two cases illustrate how difficult it is for e-textbook designers to ask students to use all the unnecessary data that might be present when creating e-textbooks. No matter how precisely the errands and input data in e-textbooks are displayed, they are likely to contain unnecessary data that could be incorporated into students' lesson plans. In this way, assignments, assessment messages, and graphics must be arranged with special care and as clearly as possible.

Expecting that the accessibility of input will increment students' person work with instructive e-textbooks will address the appraisal of students' responses to reading materials and since it is a matter of verifying the results of summarizing students' work, this study shows that students who read this third text are likely to form misconceptions in the event that they self-exclude (Cserni & Rademacher, 2021). Although the summary data in both cases showed that the students were successful, it remains questionable whether improving their conceptual understanding of certain occasions was really viable.

These two cases moreover appear that unconstrained quantitative tests on the impacts of inputs are insufficient, but that inputs can have especially clear and person impacts. This understanding supports (Haughney et al., 2020) the argument that how to organize feedback to meet student needs is a fundamental issue when assessing the appropriateness of input, which needs to be clarified in the considerations related about. This study shows how students progress in their own interpretation of input messages. This finding supports the idea that feedback should be viewed as a plan rather than as information provided by the operator. In a way, examining the entire input plan can uncover the impediments that show up within the learning arrange and how the input monitors or promotes the student's cognitive progress.

This case ponder talks about most of the challenges and impediments understudies experience in their learning prepare when working on their possess with progressed perusing materials. Along these lines, I contend that assignments for e-textbooks, checking feedback, have to be made in design-research cycles to allow instructors to gotten to be careful about Students' understanding of the task, the input messages they were given, and how they organized or carried out their own learning. In this crude account of the conceptual development of two students, this consider once more supports the disclosures that straightforward data of response input isn't satisfactory (Tunde & Listiani, 2021). In the case of multiple-attempt responses, explicit input in the form of cues, signals, or prompts need to as of now be given after the primary off-base answer. As was showed up inside the examination, the clarified feedback showed up have an impact on the cognitive development of both students. In addition, it is important that students receive clear input messages should not contain more information than is absolutely necessary. In the final examination, school-age children need to be carefully considered in the development of electronic textbooks, taking into account that students of different ages can actually learn science from electronic textbooks alone.

The study acknowledges several limitations, particularly due to its exploratory nature and the fact that it focuses on a case study involving only two students. The automated feedback provided by the e-textbook did not fully adhere to the latest best practices in educational technology, which could affect the findings. However, it is important to note that the e-textbook used was developed for a widely adopted platform provided by a reputable distribution company. As such, the study offers valuable insights into the actual conditions and experiences that students encounter when using e-textbooks in Indonesian primary schools, despite these limitations.

In this sense, reflection is organically important. In any case, the testing framework will limit the natural authenticity of thinking; i.e., understudies might related in an startling way with the moved forward electronic notebooks in their natural environment without the examiner's access (Li & Zhang, 2020). In Kim's case, the examiner actually drew attention to the leaked entry. Something else, Kim might not have taken note it. Other than, Elementary school teachers in Indonesiay may have to introduce students to advanced content and concepts at some point as they work individually with course readings. Once in a whereas would understudies One only has to learn unused concepts from the material read. In this way, the revelations cannot be generalized. Be that because it may, they illustrate obstacles that understudies really stood up to in their interactions with a modified e-textbook errand and related input. These discoveries moreover propose that instructors ought to be especially cautious around their dependence on criticism.

Taking a speculative perspective, this study broadens the analysis of instrumental genesis by integrating the instrumental approach alongside Vergnaud's concept of "scheme" (Blok, 2022). This framework allows for a more nuanced exploration of how students engage with specific tools or instruments during their learning, especially when dealing with complex mathematical ideas. Through this approach, the research delves into how students interpret and respond to the feedback they receive, as well as how this influences their conceptual growth. The findings emphasize that students play an active role in making sense of feedback, illustrating that its interpretation is not solely dictated by the educator but also shaped by the students' engagement with it. This contributes to a deeper understanding of the ways in which students seek out, interpret, and apply information in relation to their learning.

5. CONCLUSIONS

This study reveals that the use of digital textbooks equipped with automated feedback significantly influences the conceptual development of elementary school students in Indonesia. However, several challenges exist in implementing such automated feedback, particularly in facilitating students' understanding of more complex mathematical concepts. The analysis indicates that automated feedback can guide students toward correct solutions but may not always promote a deep conceptual

understanding. In some cases, the feedback unintentionally reinforced misconceptions when students relied on surface-level cues rather than engaging with the intended meaning of the feedback messages.

Both case studies illustrate that while automated feedback can support students in revising their responses, its effectiveness heavily depends on the clarity and design of the feedback provided. Students often interpreted feedback based on contextual cues rather than the mathematical content, which suggests a need for more refined feedback systems. For automated feedback to be more effective, it should not only verify correct answers but also address common misconceptions and provide clear, actionable guidance.

The findings underscore the importance of incorporating design-based research in developing digital textbooks to ensure that feedback systems adequately meet students' learning needs and support their conceptual growth. Future research should explore how different types of feedback messages impact various student learning behaviors, aiming to optimize digital learning tools to enhance educational outcomes.

Author contributions: All authors contributed significantly to the development and execution of this research. Hendita Rifki Alfiansyah was primarily responsible for the conceptualization and design of the study, leading the data collection and analysis process, and drafting the initial manuscript. Wulan Aulia Azizah focused on refining the research methodology and contributed to the interpretation of the data, ensuring that the research framework was systematically applied. Wahyu Purwaningsih provided support in literature review and assisted with data analysis, enhancing the theoretical foundation of the study. Irma Wanty contributed to the validation of the results and offered critical feedback that helped improve the manuscript. All authors reviewed and approved the final version of the manuscript, demonstrating a collaborative effort in completing the research.

Funding: This research funding from highlight two significant themes regarding the impact of automated feedback on elementary school students' learning processes. First, the analysis revealed that while automated feedback helped guide students toward correct answers, it often led to misinterpretation when students relied on surface-level cues rather than engaging with the deeper conceptual understanding of the task. This was evident in both Kim and Ben's problem-solving processes, where the feedback unintentionally reinforced their initial misconceptions. The result indicates that the effectiveness of automated feedback is highly dependent on its design and clarity. Second, the study showed that the structure and wording of the feedback messages significantly shaped the students' learning behavior. When the feedback was well-designed and tailored to address specific misconceptions, it facilitated meaningful conceptual growth. However, when the feedback focused solely on verifying correct or incorrect answers without providing further guidance, it failed to promote a deeper understanding of the underlying mathematical concepts. These findings emphasize the need for refined feedback systems in digital learning tools to better support students' conceptual development and cognitive engagement.

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