Developing Technology-Enhanced Learning Media Using Articulate Storyline to Support Numeracy Skills on Ratio and Proportion

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Abstrak

Penelitian ini menjawab tantangan pedagogis dalam mengimplementasikan pembelajaran berdiferensiasi dan meningkatkan kemampuan numerasi dalam pembelajaran matematika berbasis teknologi. Secara khusus, penelitian ini bertujuan untuk merancang dan memvalidasi media pembelajaran digital interaktif menggunakan Articulate Storyline pada materi perbandingan dan proporsi untuk siswa Sekolah Menengah Pertama (SMP). Menggunakan metode Research and Development (R&D) dengan model 4D (Define, Design, Develop, dan Disseminate), media yang dikembangkan mengintegrasikan navigasi berbasis avatar, kustomisasi gaya belajar, serta tugas numerasi kontekstual yang relevan dengan situasi dunia nyata. Validitas media dinilai oleh ahli materi dan ahli media, sementara kepraktisannya dievaluasi melibatkan 39 siswa melalui uji coba skala kecil dan besar. Hasil penelitian menunjukkan tingkat validitas yang sangat tinggi, dengan skor 99% untuk kelayakan isi dan 82% untuk kelayakan media. Lebih lanjut, uji kepraktisan menunjukkan respons siswa yang positif, dengan skor rata-rata 86% pada uji coba skala kecil dan 81% pada uji coba skala besar. Temuan ini mengonfirmasi bahwa media berbasis Articulate Storyline ini valid secara pedagogis dan praktis untuk mendukung pembelajaran numerasi yang terpersonalisasi. Studi ini berkontribusi pada pengembangan literatur mengenai media instruksional adaptif dan merekomendasikan penerapannya secara lebih luas untuk memfasilitasi strategi pembelajaran berdiferensiasi.
__Kata Kunci__: Articulate Storyline; pembelajaran berdiferensiasi; numerasi; R&D; perbandingan dan proporsi.

Abstract

This study addresses the pedagogical challenges of implementing differentiated instruction and fostering numeracy skills in technology-enhanced mathematics classrooms. Specifically, it aims to design and validate interactive digital learning media using *Articulate Storyline* focused on ratio and proportion for junior high school students. Employing a Research and Development (R&D) approach with the 4D model (Define, Design, Develop, and Disseminate), the developed media integrates avatar-based navigation, learning style customization, and contextual numeracy tasks aligned with real-world situations. The validity of the media was assessed by subject matter and media experts, while its practicality was evaluated involving 39 students through small- and large-scale trials. The results demonstrated a high level of validity, with scores of 99% for content feasibility and 82% for media design. Furthermore, practicality tests revealed positive student engagement, yielding average scores of 86% in small-scale trials and 81% in large-scale trials. These findings confirm that the *Articulate Storyline*-based media is pedagogically valid and practical for supporting personalized numeracy learning. This study contributes to the literature on adaptive instructional media, suggesting its potential for broader implementation to facilitate differentiated learning strategies.
Keywords: Articulate Storyline; differentiated instruction; numeracy; R&D; ratio and proportion.

I. INTRODUCTION

In recent years, numeracy has gained increasing attention as one of the essential competencies that students must acquire to succeed in academic and real-life settings. As defined by OECD (2021), numeracy involves the ability to access, use, interpret, and communicate mathematical information and ideas to engage with the world and make informed decisions. In mathematics education, numeracy is increasingly viewed as a fundamental competence that enables students to interpret, reason, and make decisions using mathematical information in everyday contexts. Rather than focusing solely on procedural calculation, numeracy emphasizes the application of mathematical concepts to real-life situations. In the Indonesian context, this emphasis is reinforced through the *Merdeka Curriculum* and national assessments such as the *Asesmen Kompetensi Minimum (AKM)*, which evaluate students' capacity to apply mathematical reasoning in authentic and contextual problems (Kemdikbudristek, 2022). However, various reports and research findings indicate that Indonesian students often demonstrate low performance in mathematical literacy and numeracy tasks, particularly in proportional reasoning, which is fundamental to understanding more advanced mathematics topics (Bito et al., 2023; Widaningsih et al., 2023).

One of the contributing factors to this problem is the lack of learning approaches that accommodate the diverse learning styles, abilities, and interests of students (Nurhaliza et al., 2024). Traditional one-size-fits-all instructional models are often ineffective in addressing the heterogeneity of learners, resulting in disengagement and poor understanding of mathematical concepts. In response, differentiated learning has been introduced as a strategy that tailors instruction based on students' readiness, learning profiles, and interests. This approach has shown promising results in promoting inclusive and effective learning environments (Andarika & Rofiki, 2023). Nevertheless, implementing differentiated instruction remains a challenge for many mathematics teachers due to limited pedagogical resources, time constraints, and the complexity of managing varied learning needs in large classrooms (Umayrah & Wahyudin, 2024).

The integration of educational technology is considered a potential solution to bridge this gap. Digital learning tools can support differentiated instruction by offering flexible content delivery, personalized pathways, and interactive features that engage students more deeply. Among various authoring tools, Articulate Storyline stands out for its capacity to develop interactive, multimedia-based instructional content with customizable navigation, user control, and embedded assessments. Prior studies (e.g., Yusuf et al., 2023; Andriani et al., 2024) have highlighted the effectiveness of Articulate Storyline in enhancing students' engagement and understanding in science and mathematics. However, most existing research focuses on general multimedia development, with limited attention given to its use in the context of differentiated learning for enhancing numeracy.

This study seeks to address this research gap by developing and validating interactive learning media based on Articulate Storyline that supports differentiated instruction and aims to improve students' numeracy skills. The media integrates multiple features tailored to students' learning styles visual, auditory, and kinaesthetic through avatar selection, contextual problem sets, and multimedia-supported instruction. Unlike conventional learning modules, this product embeds user decision-making into the learning flow, allowing students to engage with content that matches their learning preferences.

The topic of ratio and proportion was deliberately selected for this study due to its foundational role in developing proportional reasoning a critical component of numeracy that enables learners to understand rates, scaling, percentages, and real-world comparisons. Numerous studies (Savelsbergh et al., 2010; OECD, 2021) have emphasized that ratio and proportion are often poorly understood by students when taught through conventional methods. As such, innovative, contextualized, and adaptive media are required to promote deeper conceptual understanding.

Thus, the novelty of this research lies in the integration of Articulate Storyline within a differentiated learning framework to promote numeracy through interactive, contextual tasks aligned with national curriculum goals. This development not only supports individual learning needs but also provides a practical solution for teachers seeking to implement technology-enhanced differentiated instruction in mathematics classrooms.

Therefore, this study aims to: (1) design and develop an interactive digital learning media using Articulate Storyline that aligns with the principles of differentiated instruction in teaching ratio and proportion; (2) implement the developed media in a junior high school mathematics classroom to support students' numeracy development; and (3) evaluate the effectiveness of the media in enhancing students' numeracy skills through contextual, interactive, and personalized learning experiences.

This research is expected to contribute both theoretically and practically by providing a model of technology-enhanced learning that accommodates diverse learner needs while promoting essential mathematical competencies, particularly numeracy, in accordance with current curriculum standards, this study focuses on development, validity, and practicality, while effectiveness testing is suggested for future research.

II. METHOD

This research was conducted as a development study aimed at producing and examining interactive learning media created with Articulate Storyline for ratio and proportion topics in junior high school mathematics. The developed media was designed to facilitate differentiated instruction and support students' numeracy-oriented learning experiences. The development process was guided by the 4D framework proposed by Thiagarajan and colleagues (1974), which involves the

stages of defining learning needs, designing instructional solutions, developing the media, and conducting limited dissemination.

In the Define stage, a needs analysis was conducted through classroom observation and interviews with a mathematics teacher. The analysis focused on identifying instructional challenges related to differentiated learning and students' difficulties in solving ratio-related mathematical problems. The analysis was carried out through five dimensions: front-end analysis, learner analysis, task analysis, concept analysis, and specification of instructional objectives. These dimensions provided insight into the importance of creating personalized and interactive learning experiences to support students' understanding of proportion-related concepts.

The Design stage focused on developing a prototype based on previously identified needs. At this stage, the learning objectives were translated into numeracy-focused tasks. The instructional media was constructed using Articulate Storyline software and supported by Canva to design visual components, including avatars, icons, and interface graphics. The product included various interactive features such as learning style selection, contextual problem-solving activities, and dynamic feedback mechanisms.

In the Develop stage, the prototype was evaluated for validity by two material experts and two media experts. The material validation covered content alignment with curriculum standards, clarity of objectives, and integration of numeracy skills, while the media validation

focused on visual design, navigation, language use, and user interface. Each expert completed a validation sheet using a four-point Likert scale (1 = very poor, 4 = very good). The validity score was calculated using the formula:

$$Product\ Validity = \frac{Total\ score}{Maximum\ score} \times 100\ \%$$

The results were categorized using criteria adapted from Arikunto (in Hidayat et al., 2023), where scores above 80% were classified as "Very High." Suggestions from validators were used to revise the product before testing with students.

After revision, the media underwent practicality testing in two phases. The first phase was a small-scale trial involving 15 eighth-grade students who were asked to provide feedback on their learning experience with the media. The second phase was a large-scale implementation with 24 seventh-grade students as the target audience. Both trials used student questionnaires to evaluate the media's practicality based on four aspects: content, language, engagement, and contribution to numeracy skills. The practicality score was also computed as a percentage and interpreted using the following criteria in Table 1.

Table 1.
Practicality Criteria

Score Interval	Criteria
$80\ \% < score \le 100\ \%$	Very High
$60\ \% < score \le 80\ \%$	High
$40\ \% < score \le 60\ \%$	Sufficient
$20\ \% < score \le 40\ \%$	Low
$score \le 20\ \%$	Very

The participants of this study consisted of 39 students from a public junior high school in West Java. The participants were selected purposively by considering the

school's preparedness for digital learning implementation as well as the diversity of students' learning characteristics. The data collection techniques included classroom observation, interviews, expert validation forms, and student response questionnaires. The overall data analysis technique used in this study was descriptive quantitative, supported by qualitative comments from experts and students to guide product improvement.

Although the Disseminate phase of the 4D model typically includes broader adoption and implementation, in this study, the dissemination was limited to validation and classroom testing. Further expansion for packaging, diffusion, and adoption is recommended for future research.

III. RESULT AND DISCUSSION

The initial phase of this study focused on identifying the needs underlying the development of the learning media. This phase involved an analysis of several key components, including instructional conditions, learner characteristics, task demands, conceptual structures, and learning objectives. To obtain this information, data were collected through classroom observations and semi-structured interviews with a mathematics teacher. The findings reveal that, although differentiated learning has been widely encouraged, its implementation in classroom practice remains challenging, particularly when integrated with digital technology. Teachers continue to experience difficulties in designing learning activities that can effectively accommodate students' diverse learning needs. In the *learner analysis* aspect, the researcher found that the problem is related to the teacher's understanding ability in understanding differentiated learning and also the limited time in delivering mathematics content. This causes students to be less accustomed to exploring to solve mathematical problems independently.

Based on the identified learning needs, ratio was selected as the focus of the developed learning media because it represents a foundational concept that underpins students' understanding of more advanced mathematical topics. The task analysis was then formulated to guide the learning activities, emphasizing students' ability to develop a comprehensive understanding of ratios, recognize relationships among equivalent ratios, scale, and proportion, and interpret the concept of rate of change. These tasks informed the conceptual analysis, which concentrated on key ideas related to ratio and proportion. Accordingly, the learning objectives were directed toward enabling students to explain ratio, scale, and rate of change concepts and apply them meaningfully in everyday contexts.

Furthermore, at the *design* stage, researchers make product designs based on the initial information collected at the previous stage by paying attention to four aspects, namely *constructing criterion-referenced tests, media selection, format selection,* and *initial design.* The first aspect of *constructing criterion-referenced tests* is that researchers compile various questions based on the results of analyzing learning objectives and characteristics of students,

in this case the question in question is the question of numeracy skills on ratio material. The preparation of this question is diverse and gradual according to the character of differentiated learning.

Furthermore, the selection of instructional media was directed toward identifying a platform that could encourage students' independent problem-solving while providing clear guidance and active learning opportunities. The learning media therefore needed to support student interaction and engagement throughout the learning process. Based on these considerations, Articulate Storyline was chosen as the primary development tool, as it allows the integration of differentiated learning principles within ratio and proportion instruction.

In addition to media selection, decisions regarding the format of presentation were also considered. Findings from classroom observations and teacher interviews indicated that students were familiar with digital learning environments and had adequate access to online learning resources. Accordingly, the developed learning media was designed to be delivered in an online format.

The initial design stage involved constructing a structured product framework to guide the subsequent development phase. This framework was developed by organizing ratio and proportion content in alignment with differentiated learning principles through curriculum analysis. Visual and graphical elements of the learning media were then designed using supporting applications such as Microsoft Word, PowerPoint, and Canva to ensure clarity, consistency, and

ease of use prior to implementation in Articulate Storyline.

Figure 1. Articulate Storyline-based teaching media design.

During the develop stage, the initial design was transformed into a functional prototype, followed by a series of evaluations to examine the quality of the developed product. This stage began with identifying and organizing the main components of the learning media, including backgrounds, animations, icons, and menu features.

Articulate Storyline was used as the primary software to assemble these components into an interactive learning application. To support the development process, additional design tools such as Canva and Freepik were utilized to create visual elements, including backgrounds, interface components, icons, and supporting images. Each tool served a specific function within the development process, with Canva and Freepik assisting in visual design and Articulate Storyline enabling the integration of content, interactivity, and navigation into a complete learning media application.

The selection of these tools was based on their flexibility, ease of use, and ability to support the development of interactive learning experiences aligned with the objectives of differentiated instruction.

The development process involved several activities aimed at refining the structure and visual format of the learning media. One of the initial steps focused on determining the visual and layout formats required to support the functionality of the interactive media. These formats were designed to ensure clarity, consistency, and ease of navigation for users.

Typography was selected by considering its suitability for different sections of the learning media. Several typefaces were applied to specific components, such as menus, learning materials, and evaluation sections, to enhance readability and visual distinction across features, as summarized in Table 2.

Table 2.
Font and Letter Layout

No	Font	Used on
1	Anja Eliane	Material Menu
2	Low Budget	Profile
3	Open Sans (Body)	Menu Profile, Materials, Sample Questions, Practice Questions, Evaluation Questions

In addition to typography, background elements were designed to support the visual presentation of the media. Backgrounds used in the Articulate Storyline-based learning media were adapted from visual resources obtained through Canva and Freepik, then modified to align with the instructional content and interface layout.

Icon design also formed an important part of the media development process. Icons were applied to navigation buttons and menu features to assist users in interacting with the media intuitively. Most of the icons were sourced from Freepik and

adjusted as needed to maintain visual consistency throughout the application.

Following the completion of the previous development stages, the learning media was assembled into a functional application through processes of content integration, editing, testing, and publishing. These steps resulted in an interactive learning application on ratio and proportion designed to support numeracy learning within a differentiated instruction framework.

When the application is accessed, users are first presented with an initial interface that functions as the start page. This page displays the title of the learning material and serves as an entry point to the application. Upon selecting the start option, the interface automatically directs users to the main menu or home page, where the learning activities can be accessed.

Figure 2. View of *Running App*.

In the display of Figure 2 above can be seen when the application is opened, where there is an application icon, application name and educator character and also the initial page of the application displays the title of the material contained in the application, the subject and the intended level of education, the "start"

button, the information button, and the help button.

Figure 3. Help Page (Button Description).

In the display of Figure 3 above, help is displayed in the form of a description of the buttons contained in the application to assist users in navigating while using the application.

Figure 4. Avatar Selection Page.

Figure 5. Page for Entering Username.

In Figures 4 and 5, two avatars are available, a male avatar and a female avatar. The user will be asked to select one of the avatars displayed, then the user will

be asked to enter a username. In Figure 6, the user-name and learning style menu are displayed, which must be selected in order to start learning.

Figure 6. Learning Style Menu Page.

Figure 7. Initial Display of Learning Activities.
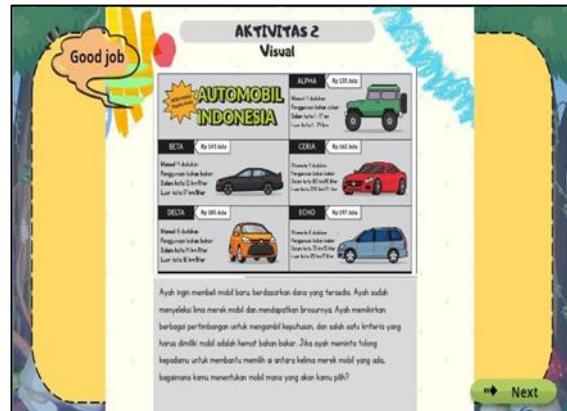
Figure 8. Learning Style Activity Page.

Figure 7 displays two buttons to select activity 1 or 2 before starting learning, then in Figure 8 displays activities according to learning style along with a discussion of the activity.

Figure 9. Problem View.

In the display of Figure 9, after going through several activities then given contextual problems regarding ratio and proportion material. After that, each student answers the question on the icon (answer) to enter the googleform link that has been provided on the media display.

Figure 10. Initial View of Sample Numeracy Problem Set.


Figure 11. Display of Numeracy.
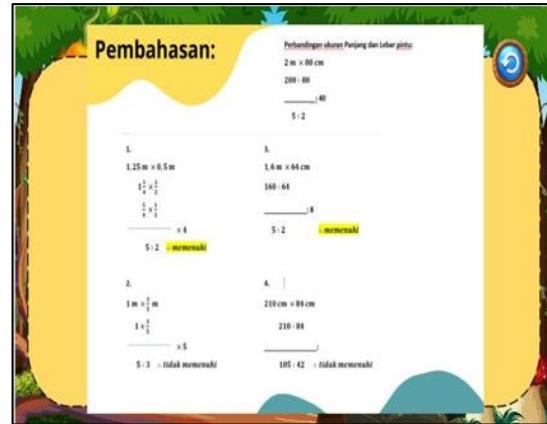
Figure 12. Discussion Page Display of Numeracy Ability Questions.

In the display of Figures 10, 11 and 12, sample problems and discussions on ratio and proportion material are also given to explore students' numeracy skills in solving numeracy problems.

At this point in the development process, the completed prototype underwent two forms of evaluation, namely expert review and development testing. Expert review was conducted to examine the validity of the learning media prior to its implementation with students. The evaluation involved material experts, who focused on the quality and relevance of the learning content, including content suitability, alignment with learning objectives, and integration of numeracy-related components. In addition, media experts evaluated the technical aspects of the product, such as visual appearance, readability, clarity of language, and overall usability. The outcomes of the material expert assessment are presented in the Table 3.

Table 3.
Material Expert Assessment Results

No.	Aspect assessed	Score Total	Percentage
1.	Legality and	24	100 %

No.	Aspect assessed	Score Total	Percentage
	morality		
2.	Content eligibility	119	99 %
3.	Presentation feasibility	23	96 %
4.	*Numeracy*	39	98%
Average			99 %
Criteria			Very high

Material validation involved two reviewers, consisting of one university lecturer and one mathematics teacher. The evaluation results indicate that the developed learning media achieved a very high level of material validity, with an overall score of 99%, suggesting that the product was appropriate for subsequent testing stages. Several representative comments and suggestions provided by the material experts are summarized below in Table 4.

Table 4.
Material Expert Responses

No.	Validator	Comment and Suggestion
1.	1st Validator	In general, it is in accordance with differentiated learning by facilitating students' diverse learning styles.
2.	2nd Validator	Activities for students with kinesthetics learning styles should be considered with study time.

Comments and suggestions from both material experts were taken into consideration by researchers in improving the developed product. In this stage, researchers made improvements according to the directions mentioned before conducting the trial stage. The results of product assessment from media experts are presented in the following Table 5.

Table 5.
Media Expert Assessment Results

No.	Aspect assessed	Score	Percentage
1.	Anatomy	30	75 %
2.	Graphics	65	90 %
3.	Linguistics	88	79 %
Average			82 %
Criteria			Very high

Media validation was carried out by two mathematics teachers who are competent in the field of making learning media. Based on the table above, the validity level of the media received a score of 82% so that it received the criteria "very high" and the product could be tested. The following are some examples of responses, suggestions, and comments given by media experts which are material for improving the products developed (see Table 6).

Table 6.
Media Expert Response

No.	Validator	Comment and Suggestion
1.	1st Validator	Overall, this media is good, equipped with questions in the form of numerical problems and facilitates 3 learning styles of students.
2.	2nd Validator	The media display is attractive and clear

Products that have been improved based on suggestions from material experts and media experts then enter the *development testing* stage which aims to test the quality of the product on target users. At this stage, product testing was carried out on a small scale with fifteen respondents from class VIII students. The reason researchers chose a higher grade level was so that researchers could get constructive feedback and see how students responded when recalling the material they had previously learned. So that researchers can find out whether the

expected potential usefulness of the product has been achieved or not. The following are the responses of students in the small-scale trial (see Table 7).

Table 7.
Results of Product Practicality Assessment (Small Scale)

No.	Aspect assessed	Score Total	Percentage
1.	Material	108	84 %
2.	Language	86	90 %
3.	Interest	83	86 %
4.	Numeracy	135	84 %
Average			86 %
Criteria			Very Practical

Overall, the results of the small-scale trial indicate that students responded positively to the developed learning media, with practicality scores classified in the *very practical* category. These findings suggest that the media was suitable to proceed to the next stage of development involving broader implementation.

Following the testing phase, the development process entered the dissemination stage, which generally includes validation, packaging, and diffusion or adoption. In this study, however, dissemination was limited to the validation and implementation phases. After completing the small-scale trial, the learning media was applied in real classroom settings through a large-scale trial. This implementation involved 24 seventh-grade students from one class and was conducted over four learning sessions. The results of student responses obtained from the large-scale trial are presented in the Table 8.

Table 8.
Results of Product Practicality Assessment

No.	Aspect assessed	Score Total	Percentage
1.	Material	302	79 %
2.	Language	242	84 %
3.	Interest	229	80 %
4.	Numeracy	388	81 %
Average			81 %
Criteria			Very Practical

The findings indicate that the development of Articulate Storyline-based learning media was able to respond to the issues identified during the initial needs analysis stage. In particular, the media addresses teachers' challenges in applying technology-supported differentiated learning by providing learning activities that accommodate students' visual, auditory, and kinesthetic learning preferences. This result aligns with previous studies (Andarika & Rofiki, 2023; Wahyuningsari et al., 2022), which highlight that differentiated learning can contribute positively to learning outcomes when students' individual characteristics are taken into account.

The practicality results, which were classified as *very practical* in both small- and large-scale trials, suggest that the developed media is feasible for use in supporting students' numeracy-oriented learning activities. Similar findings have been reported by Bito et al. (2023) and Widaningsih et al. (2023), who found that interactive technology-based learning environments can enhance student engagement and support numeracy development through contextual tasks.

In addition, the high validity scores obtained from material experts (99%) and media experts (82%) indicate that the learning media meets relevant instructional

and technical standards. The content validity confirms that the media is aligned with the intended learning objectives related to ratio, scale, and rate of change. The design of the media incorporates differentiated learning principles through features such as avatar selection, interactive learning activities, and context-based problem tasks.

It should be noted that this study was limited to validation and classroom testing within the dissemination stage; therefore, the wider adoption of the media has not yet been examined. This limitation provides direction for future research to focus on broader diffusion and adoption of technology-based learning media in diverse educational contexts.

IV. CONCLUSION

Based on the findings of this study, the development of interactive technology-based learning media using Articulate Storyline demonstrates strong potential to support differentiated learning in mathematics through context-based activities. The media was designed to address teachers' challenges in implementing technology-supported differentiated instruction by accommodating students' diverse learning styles, levels of readiness, and learning profiles.

Validation results from material and media experts indicate that the developed product achieved a very high level of validity, suggesting that the learning content and technical aspects are appropriate for instructional use. In addition, practicality testing with students yielded positive responses, with the media

categorized as *very practical* in both small-scale and large-scale trials. These results suggest that the learning media is feasible and suitable for classroom implementation to support numeracy-oriented learning activities.

This interactive technology-based learning media is designed with features that support contextual learning, such as interactive activities, context-based problems, and the use of attractive visual elements. This finding is consistent with earlier studies indicating that interactive technology-based learning environments approaches can improve students' engagement and their numeracy skills. The materials developed, namely ratio and proportion, were chosen due to their relevance to more complex basic math skills. It also makes a real contribution in training students' critical and independent thinking skills through innovative learning activities. This study suggests further development on a larger scale to measure the long-term impact of the learning media on student learning outcomes. The *dissemination* stage can also be extended to the *packaging* process and *diffusion and adoption* so that the product can be widely utilized. This study is limited to development, validation, and practicality testing; therefore, conclusions regarding effectiveness and learning gains should be interpreted cautiously.

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