

INTEGRATING TECHNOLOGY AND PEDAGOGY: THE DEVELOPMENT OF AN RME-BASED INTERACTIVE WEBSITE FOR RE-CONTEXTUALIZING NUMBER CONCEPT

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ABSTRACT

This study aims to design and develop an interactive website grounded in the Realistic Mathematics Education (RME) approach to support the learning of number concepts for seventh-grade junior high school students. The novelty of this study lies in the systematic integration of core RME principles contextual problems, guided reinvention, and horizontal mathematization into a web-based interactive learning environment. The research employed a Research and Development (R&D) methodology using the ADDIE model, encompassing five phases: Analysis, Design, Development, Implementation, and Evaluation. The validation process involved five experts consisting of mathematics education lecturers and teachers. The validation results indicate that the developed media met the feasibility criteria and was categorized as good in terms of media, content, and language. A limited implementation involving 20 students showed highly positive responses, with an average score exceeding 85%, indicating high practicality and acceptance. The findings suggest that the developed website effectively facilitates contextual learning and student engagement in number concepts, positioning it as a feasible digital learning medium in junior high school mathematics instruction.

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1. INTRODUCTION

Mathematics learning at the junior high school level (SMP) still faces various challenges, particularly in efforts to develop students' conceptual understanding of number concepts. According to the results of the 2022 Programme for International Student Assessment (PISA), the mathematical literacy level of Indonesian students was recorded at 366, which is significantly below the international average of 472 (OECD, 2023). Various studies in Indonesia, such as the one conducted

by Muliwana et al., (2024) in Kupang, indicate that the majority of students are still unable to progress beyond the cognitive domains of application and reasoning in mathematical literacy, particularly in algebra topics that share similar levels of complexity with number concepts. Meanwhile Stuart & Stuart (2024) added that there is a significant variation in the mathematical literacy of junior high school students based on their cognitive styles, and overall, the results remain suboptimal. This condition highlights an urgent need to develop learning media that are not only interactive but also capable of translating number concepts into real-world contexts and supporting critical thinking skills as well as mathematical literacy.

Realistic Mathematics Education (RME) has proven effective in enhancing students' mathematical understanding and reasoning skills when implemented through interactive media (Ariffah & Rusnilawati, 2023). The study conducted by Gulo et al., (2024) applied the Realistic Mathematics Education (RME) approach to mathematics topics in Grade VIII of junior high school and found that RME significantly improved students' critical thinking and mathematical abilities. This includes the process of transitioning from informal to formal reasoning through contextual and reflective activities. However, the study was still limited to print-based media such as modules and worksheets, and had not yet explored the optimization of interactive web platforms. Research Maskur et al., (2020) also showed that implementing RME through worksheets enhanced mathematical skills, but did not offer digital-based interactivity features. On the other hand, several alternative approaches such as Problem-Based Learning and Inquiry-Based Learning demonstrated improvements in mathematical literacy in statistics and algebra topics, but did not incorporate the contextual aspects of RME within online platforms (Lestari et al., 2021).

This condition reflects a fundamental issue in the mathematics learning process at the junior high school level, namely the lack of instructional media that can accommodate contextual approaches such as Realistic Mathematics Education (RME) in an interactive digital format. Although RME has been conceptually proven to be effective, its implementation through print-based media has limited the full potential of this approach in technology-based learning (Rusiyanti et al., 2022). On the other hand, the demand for online learning media continues to grow in line with the times and changes in students' learning patterns following the COVID-19 pandemic (Imran et al., 2025). This presents a unique challenge for teachers and educational media developers to create learning tools that are not only informative but also contextual, visual, and capable of supporting students' active and independent engagement. In other words, there is an urgent need to develop web-based learning media that can concretely and comprehensively apply the principles of RME in mathematics education, particularly in number-related topics. Realistic Mathematics Education (RME) emphasizes the use of contextual problems, guided reinvention, and progressive mathematization to support students' conceptual understanding. In recent empirical studies, the integration of Realistic Mathematics Education (RME) with artificial intelligence (AI) and gamification within web-based learning environments has been shown to significantly enhance both learning motivation and mathematical problem-solving competence, demonstrating that technology-supported RME frameworks can foster deeper cognitive and affective student engagement in mathematics instruction (Susilawati et al., 2025).

As an effort to address these issues, this study proposes an innovation in the form of developing an interactive website based on the Realistic Mathematics Education (RME) approach, specifically designed to facilitate the learning of number concepts at the junior high school level (SMP). This website will be equipped with features that support material visualization, simulations of real-life contexts aligned with RME principles, as well as interactive and evaluative practice exercises. This medium is expected to bridge the gap between contextual learning theory and its practical implementation in the digital realm. By applying the RME model, students are not only guided to understand number concepts mechanistically, but also through processes of discovery, modeling, and reflection on real-world problems relevant to their lives (Gravemeijer, 1994).

From a theoretical perspective, this study contributes to the extension of Realistic Mathematics Education by demonstrating how its pedagogical principles can be operationalized within a fully interactive digital environment. Practically, the developed website provides mathematics teachers with a contextual and technology-supported learning medium that aligns with students' digital learning preferences and the Independent Curriculum. The integration of contextual

simulations and interactive feedback is expected to support students' conceptual understanding of number concepts in a more meaningful learning process.

The objectives of this study are: (1) to develop an interactive website based on the Realistic Mathematics Education (RME) approach for teaching number concepts to junior high school (SMP) students, with a high level of validity, practicality, and effectiveness in the learning process; (2) to assess the validity and practicality of the media through evaluations conducted by experts and education practitioners; and (3) to analyze students' responses to the implementation of the web-based instructional materials. Through the application of the Research and Development (R&D) approach by adapting the ADDIE model, this study is expected to produce meaningful digital learning media that also contribute to the development of innovative mathematics instruction aligned with the characteristics of 21st-century learners (Branch, 2009).

1.1 Research Question

Based on the objectives of this study, the research questions are formulated as follows:

- a. How valid is the RME-based interactive website in terms of media, content, and language?
- b. How practical is the developed website based on expert and student evaluations?
- c. How do students respond to the implementation of the RME-based interactive website in learning number concepts?

2. METHOD

2.1 Type of Research

This study is a Research and Development (R&D) study with a descriptive qualitative approach, aimed at developing and evaluating the quality of a product in the form of an interactive website based on the Realistic Mathematics Education (RME) approach for teaching number concepts to junior high school students. The research procedure consists of two stages: a qualitative stage involving needs exploration and product design, and a quantitative stage to examine students' responses to the web-based instructional materials.

2.2 Time and Location of the Research

This research was conducted during the second semester of the 2024/2025 academic year, encompassing all stages of development from needs analysis to final product evaluation. The research site was selected purposively at a public junior high school (SMP) in the city of Cirebon, based on the school's openness to implementing digital-based learning innovations and its alignment with the current curriculum implementation.

2.3 Research Subjects and Objects

The object of this research is an interactive website based on the Realistic Mathematics Education (RME) approach, developed for teaching number concepts to Grade VII junior high school students. The research subjects include university lecturers, mathematics teachers, and Grade VII students at the selected school. The lecturers and teachers serve as expert validators in the content validity assessment, while the students act as users during the limited trial phase and provide feedback on the instructional materials. The selection of subjects was carried out purposively to ensure the involvement of individuals who align with the development objectives.

2.4 Research Procedure

The research procedure follows the steps of the ADDIE model, which consists of the following stages:

- a. *Analysis*: Identifying the needs of students and teachers regarding digital learning media through observation and interviews.

Table 1. Interview Analysis Results

Aspects	Teacher Interview Results
Characteristics Learning Style	& Students are visually and kinesthetically dominant. Prefer to learn through videos, pictures, or educational games.
Difficulties Misconceptions	& Students have difficulty distinguishing types of numbers and performing positive-negative number operations.

The Need for Teaching Print modules are less effective. Students need audiovisual-based Materials interactive media to understand the concept.

- b. *Design*: Designing the interactive appearance and flow of the website based on RME principles, as well as compiling contextual number material content.

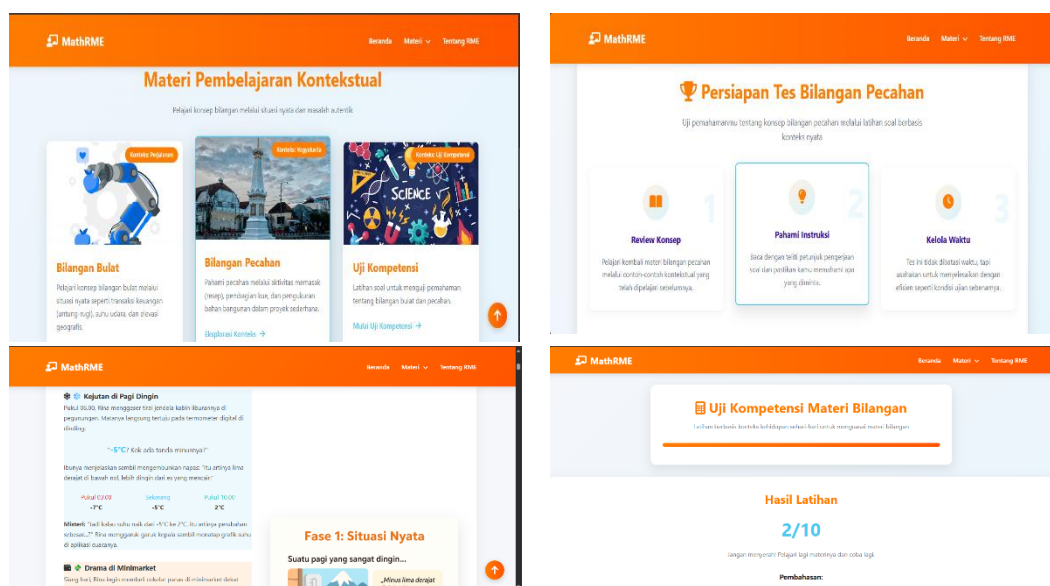


Figure 1. Design Stage

- c. *Development*

The development stage aims to realize a product design in the form of an interactive website based on the *Realistic Mathematics Education* (RME) approach on the number material for grade VII junior high school. This website is developed using HTML5, CSS, and JavaScript-based platforms so that it can be accessed through computer devices and gadgets. The initial product development is carried out by referring to the results of needs analysis and design design, as well as paying attention to the characteristics of students and learning outcomes in the Independent Curriculum.

The initial product was developed in the form of a website with several main features, namely: (1) a material menu, which presents an explanation of number concepts in the form of narrative texts, illustrations, and learning videos; (2) the exercise menu, containing contextual questions based on the RME approach; (3) a context simulation menu, which facilitates students to conduct interactive exploration of real problems; (4) self-evaluation menu, in the form of digital quizzes with direct feedback; and (5) the discussion forum menu, which allows interaction between teachers and students in online learning. All content and activities on the website are designed to support the process of *guided reinvention*, *horizontal mathematization*, and encourage active student engagement through realistic situations.



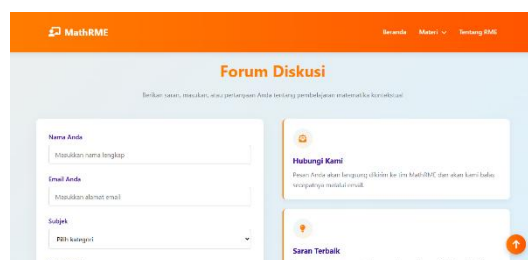


Figure 2. Website Display

After the initial product was developed, a validity test was carried out by lecturers and mathematics teachers. Validation was carried out using a 4-point Likert scale validation sheet instrument which covers several aspects, namely: (1) media; (2) content; and (3) Language.

d. Implementation:

The implementation stage aimed to examine the applicability and practicality of the developed learning media on a limited scale. The trial was conducted with 20 Grade VII students at a public junior high school in Cirebon City, selected purposively based on the availability of digital facilities and the school's openness to learning innovations. Mathematics teachers were involved as facilitators during the implementation of the website-based learning activities. The trial was carried out over two face-to-face meetings focusing on number types and integer operations, in accordance with the learning outcomes outlined in ATP Phase D. Students accessed the website using their own devices, including laptops and smartphones, and followed the structured learning sequence consisting of material exploration, contextual simulations, practice exercises, and self-evaluation activities. Prior to data collection, students were informed about the research objectives and procedures. Participation was voluntary, and ethical considerations were applied by ensuring anonymity, confidentiality, and informed consent from the school and participants.

e. Evaluation:

The evaluation stage is the final stage in the media development process, which aims to improve the product based on input from validators and users, in this case teachers and students. The evaluation was carried out to identify shortcomings in the learning media that had been developed, both in terms of content, appearance, and technical use. Input was obtained from 2 main sources, namely:

- 1) Lecturers, who provide assessments of media aspects, content, and language in website teaching materials.
- 2) Students, who provide responses or responses to the media used, the practicality of media use, and the presentation of material in the media.

Based on the results of the evaluation, a number of improvements were made to the teaching materials, including:

- 1) Eliminate the Log in menu to make it easier for students to access the website.
- 2) Revise the contextual illustration in the question.
- 3) Simplification of language and vocabulary in teaching materials.
- 4) Revise the button name on the phase in each lesson.
- 5) Provide a discussion forum for website users.

2.5 Data, Instruments, and Data Collection Techniques

This study utilizes two types of data, namely qualitative data and quantitative data. Qualitative data was obtained through interviews, observations, as well as input and responses from validators, teachers, and students. The data is used to describe media development needs, user responses, and feedback on the resulting product. The quantitative data is collected through

questionnaires and validation sheets, which function to measure the level of validity, practicality, and effectiveness of the developed learning media.

The instruments used in this study are:

- a. The Structured interview sheet is used in the *Analyze stage* to explore information from teachers about students' difficulties, learning media needs, and characteristics of mathematics learning in the classroom.
- b. Validation sheets, used by expert lecturers and teachers to assess aspects of media, content and language in learning media. This instrument is in the form of a 4-point likert scale.
- c. The Student and Teacher Response Questionnaire is used at the *Implementation stage* to measure perceptions of the practicality, ease of use, and attractiveness of the media. The instrument also uses a Likert scale.

The data collection technique is carried out by the following procedure

- a. In the *Analyze stage*, data is collected through structured interviews with direct mathematics teachers to find out the needs and context of learning.
- b. In the *Develop stage*, validation sheets are given to two validators (lecturers and mathematics teachers) online and offline, then analyzed for product improvement.
- c. In the *Implement stage*, a questionnaire is given to students and teachers after a media trial session. Data is collected directly with the guidance of the researcher to ensure the clarity of the filling instructions.
- d. Observations were carried out during implementation activities to support quantitative data and enrich the interpretation of results.

2.6 Data Analysis Techniques

The data in this study was analyzed using qualitative and quantitative descriptive approaches. Qualitative data obtained through interviews, observations, and open responses were analyzed through three main stages, namely data reduction, data presentation, and conclusion drawn. This process aims to describe the needs of media development, user response, and input related to the learning media that has been developed. The quantitative data sourced from the validation sheet and response questionnaire was analyzed by calculating the average score on each aspect of the assessment. The results of the calculation are then converted into percentage form and classified into eligibility categories, namely "very feasible", "feasible", "reasonably feasible", or "not feasible".

Data triangulation is carried out by comparing the results of observations, questionnaires, and interviews to ensure the consistency and validity of the findings. All analysis results were used to assess the quality of media in terms of validity, practicality, and effectiveness in supporting mathematics learning.

3. RESULT AND DISCUSSION

This study aims to develop and evaluate the feasibility of website-based teaching materials with a *Realistic Mathematics Education* (RME) approach on number material for grade VII junior high school students. To ensure the feasibility of the teaching materials, a validation process was carried out by five validators consisting of lecturers and mathematics teachers. Validation is carried out on three main aspects, namely media, content/material, and language. This research process uses validation analysis with the Aiken's V formula to measure the level of validity of the content of each statement.

Each item in the validation sheet is graded using a 4-point Likert scale (1 = non-compliant, 2 = less compliant, 3 = compliant, 4 = compliant). The assessment results data are then analyzed using the Aiken's V formula to measure the level of validity of the content of each statement item. The Aiken's V formula used is as follows:

$$V = \frac{\sum s}{n(c - 1)}$$

With Description:

V = Aiken validity index

s = The score given by the validator minus the lowest value

n = Number of validators

c = Total categories of the rating scale

The following is a list of names of teachers, occupations, and fields of education that are their responsibility in the application of website teaching materials:

Table 2. Expert Validators

No.	Name	Work	Education
1	Herani Tri Lestiana, M. Sc.	Lecturer	Mathematics Education
2	Onwardono Rit Riyanto, M. Pd.	Lecturer	Mathematics Education
3	Hj. Aqsomah Ambarkoni, S. Pd.	Teacher	Mathematics
4	Yuliawati, S. Pd.	Teacher	Mathematics
5	Haris Maulana, S. Pd.	Teacher	Mathematics

Table 3. Overall Validation Results

Aspects	Number of Items	Valid	Invalid	Valid Percentage	Information
Media	12	10	2	83%	Media-Worthy
Fill	13	8	5	62%	Recommended
Language	5	4	1	80%	Recommended
					Reviews

Based on the validation results of five experts using the Aiken's V approach, it was found that the media aspect of teaching materials has been declared suitable for use with a validity percentage of 83%. Meanwhile, the content and language aspects obtained a validity percentage of 62% and 80%, which shows that in general it is quite feasible, but it is recommended to make improvements in several items so that the quality of teaching materials is more optimal.

Table 4. Validation results for each validator

	Validator 1	Validator 2	Validator 3	Validator 4	Validator 5	Average
Media	3,75	3,75	3,08	3,67	3,58	3,57
Fill	3,62	3,62	3,23	3,62	4	3,62
Language	4	4	2,6	3,8	4	3,68
Average	3,79	3,79	2,97	3,69	3,86	3,62

Based on the results of validation conducted by material experts and media experts, a total average assessment of 3.62 was obtained, which is included in the "Good" category. This assessment includes three main aspects, namely media, content, and language. In the media aspect, the average score obtained was 3.57, which shows that the learning media was rated well by the validators. This reflects that the visual appearance, presentation of the interface, and the effectiveness of the media have met the standards of feasibility for use in the learning process.

In terms of content, the media obtained an average score of 3.62, which is also included in the "Good" category. This assessment shows that the content presented is in accordance with the learning objectives, in line with the Independent Curriculum, and contains material that is accurate, relevant, and supports *the Realistic Mathematics Education* (RME) approach. Meanwhile, the language aspect received an average score of 3.68, with the category "Good", which indicates that the use of language in this media is communicative, in accordance with the rules of good and correct Indonesian, and easy to understand by students.

In general, the learning media developed is in the "Good" category and is declared suitable for use in the mathematics learning process at the junior high school level. However, developers can still make further improvements based on validators' suggestions, so that the quality of the media becomes more optimal, especially in terms of improving visual elements, interface navigation, and rich context in the presentation of the material.

The limited trial results indicate that the RME-based interactive website supports students' engagement and conceptual exploration of number material. High response scores reflect students' positive perceptions of the website's usability, presentation, and contextual features. These findings align with the research objective, which emphasizes feasibility and practicality rather than measuring learning outcomes quantitatively. In addition, the research conducted by Siregar, (2021) found that RME improves the understanding of mathematical concepts of junior high school students which suggests that digital modes such as interactive websites can strengthen the effectiveness of RME in the field of numbers.

This is in line with previous research conducted by Elly Nafsiah & Tiur Malasari Siregar, (2023) which shows the validation stage in this study obtained "very valid" assessments from material and media experts, as well as positive responses from teachers in the limited trial. This shows that the RME-based learning media developed meets the criteria of valid, practical, and suitable for use.

After the validation process, a limited trial was carried out on 20 students in grade VII of junior high school as direct users of learning media. Students are asked to access media through the website and provide responses through a questionnaire that covers three main aspects, namely the appearance of the media, the level of practicality, and the presentation of the material.

Table 5. Media display response results

No Item	Number of Items	Score	F	Total Average Score	Percentage
Media	4	SS (4)	35	140	49%
		S (3)	48	144	50%
		TS (2)	1	2	1%
		STS (1)	0	0	0%
Sum			84	286	100%
Maximum Score				336	
Average Percentage				85%	
Criterion				Highly Appropriate	

Based on the table above regarding media indicators, the percentage of those who answered very well was 49%, and those who answered according to 50%. It can be concluded that the students' response to this indicator with an average percentage of 85% is very appropriate.

Table 6. Media practicality response results

No Item	Number of Items	Score	F	Total Average Score	Percentage
Practicality	6	SS (4)	56	224	52%
		S (3)	67	201	47%
		TS (2)	3	6	1%
		STS (1)	0	0	0%
Sum			126	431	100%
Maximum Score				504	
Average Percentage				86%	
Criterion				Highly Appropriate	

Based on the table above regarding the practicality indicators, the percentage of those who answered very appropriately was 52%, and those who answered appropriately was 47%. It can be concluded that the students' response to this indicator with an average percentage of 86% is very appropriate.

Table 7. Response results for the presentation of the material

No Item	Number of Items	Score	F	Total Score	Average	Percentage
Presentation Materials	of 7	SS (4)	72	288		56%
		S (3)	74	222		43%
		TS (2)	1	2		0%
		STS (1)	0	0		0%
Sum			14	512		100%
Maximum Score			7		588	
Average Percentage					87%	
Criterion						Highly Appropriate

Based on the table above regarding the indicators of material presentation, the percentage of those who answered strongly agreed was 56%, and those who answered agreed was 43%. It can be concluded that the students' response to this indicator with an average percentage of 87% is very appropriate. The results indicate that the web-based learning media with the RME approach on linear inequality in one variable is suitable for use and improves students' self-determination in mathematics (Muhammad et al., 2025).

The use of RME-based interactive digital media, such as websites with simulation and automatic exercise features, has been proven to significantly improve concept exploration, mathematical reasoning skills, and student learning independence (Cahyani et al., 2024). The use of interactive websites has been shown to improve students' reasoning skills, as found by Lestari et al., (2025), which shows that the application of the *Realistic Mathematics Education* (RME) assisted by interactive technology significantly affects the improvement of mathematical problem-solving skills in grade VIII students of junior high school (SMP). The results of this study confirm the findings, where students showed high enthusiasm in exploring website features, which indicates the role of digital media in increasing motivation and participation. The findings propose mobile devices' integration, running developmentally appropriate apps, in kindergarten classrooms. These apps were based on the three levels of Realistic Mathematics Education (RME), targeting fundamental mathematical concepts for the kindergarten level (Papadakis et al., 2021). Learning using the RME approach based on the e-module System aims to become a real learning experience for education and students in implementing mathematical concepts into web-based software systems (Rusiyanti et al., 2022). RME, assisted by interactive media, has long been proven to be able to increase student learning activities (Sari & Mutaqin, 2023). Research conducted by Erlina & Sutarni, (2024) reported significant improvements in the activities of answering questions (from 33% → 60%) and expressing opinions (33% → 56%) in grade VII junior high school students after the implementation of RME.

Although the findings indicate positive student responses toward the developed media, this study focused on feasibility and practicality rather than measuring learning outcomes. The limited scope of implementation and the small sample size restrict the generalizability of the results. Therefore, the findings should be interpreted as evidence of user acceptance and media feasibility. Future studies are encouraged to employ experimental or quasi-experimental designs to examine the impact of RME-based digital learning media on students' learning outcomes more rigorously. The results of this study confirm the findings, where students showed high enthusiasm in exploring website features, which indicates the role of digital media in increasing motivation and participation.

4. CONCLUSION

This study successfully developed an interactive website based on the Realistic Mathematics Education (RME) approach for teaching number concepts to Grade VII junior high school students. The development process was conducted systematically using the ADDIE model, encompassing the stages of analysis, design, development, implementation, and evaluation. Validation results from five experts indicate that the developed learning media met the feasibility criteria and were categorized as good in terms of media, content, and language quality. Furthermore, a limited trial involving 20 students showed positive responses, with average scores exceeding 85% across practicality, visual appearance, and material presentation indicators. This research is expected to be a reference in the development of other contextual digital learning media, especially for abstract mathematics topics. Future research on RME is encouraged to integrate emerging technologies to further enhance the effectiveness of mathematics teaching and learning (Fajri et al., 2025).

Theoretically, this study supports the applicability of Realistic Mathematics Education within digital learning environments by demonstrating that core RME principles can be effectively operationalized through interactive web-based features. Practically, the developed website can function as a supplementary learning medium to support contextual mathematics instruction in junior high schools, particularly for abstract number concepts.

Future research is recommended to conduct large-scale implementation across diverse school settings to enhance generalizability. Further development should also focus on integrating adaptive feedback systems, expanding content coverage, and strengthening interactive discussion features to better accommodate students' learning needs.

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