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Development of Android-Based Interactive Media as a Learning Tool for Informatics Education in Junior High School

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ABSTRACT

This study aimed to develop and evaluate Android-based interactive media as a learning tool for Informatics education in junior high schools, addressing the continued reliance on conventional print media that limits active student engagement with computational-thinking and digital-literacy competencies. A Research and Development (R&D) design was employed, synthesizing the Plomp, ADDIE, and Borg and Gall models into five stages: investigation, design, development, analysis and revision, and dissemination. The media was validated by two subject-matter experts and two media experts, then trialed with students and teachers from two public junior high schools in Makassar City, Indonesia, culminating in a large-group trial involving 60 students and 12 teachers. Data were analyzed descriptively for validity and practicality and inferentially using a paired-sample t-test for effectiveness. The media achieved a very valid rating from subject-matter experts (82%) and media experts (85%), and very practical ratings across the individual (81%), small-group (87%), large-group (87%), and teacher-response (90%) trials. Learning outcomes improved significantly from pre-test ($M = 58.92$, $SD = 19.03$) to post-test ($M = 85.83$, $SD = 11.76$), $t(59) = -10.91$, $p < .001$. These findings indicate that Android-based interactive media integrating instructional videos, self-paced navigation, automated-feedback quizzes, and educational games is a valid, practical, and effective tool for improving Informatics learning outcomes at the junior secondary level. The study contributes an empirically validated, game-enhanced mobile-learning model that can inform the design of similar digital learning media in resource-constrained secondary-school settings.

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1. INTRODUCTION

The integration of informatics education into school curricula is no longer optional; it has become a necessity as information technology increasingly underpins modern education (Hol et al., 2024). Informatics education plays a strategic role in preparing the younger generation to adapt to rapid technological change (Fitrihana & Nurdiyanto, 2023) and reflects a broader national responsibility to advance science and technology

as a means of strengthening human-resource competitiveness in the global arena (Agustino et al., 2026).

Consistent with recent curriculum reform, Information and Communication Technology (ICT) instruction in Indonesia has evolved into a distinct informatics subject (Arifin & Setiawan, 2025). This shift is not merely nominal; it carries substantive pedagogical implications. Rather than positioning students as passive technology users, the reformed curriculum positions them as active, creative problem-solvers capable of designing technology-based solutions, enriching students' conceptual and practical understanding of the discipline (Hasibuan, 2025).

Effective Informatics instruction requires an integrated approach that combines conceptual mastery, technical skill, and higher-order thinking (Ruwaidah, 2021). Central to this approach is computational thinking-a systematic problem-solving process mediated by technology-which both supports classroom learning and equips students with competencies essential for the twenty-first century (Uska et al., 2025). When implemented well, Informatics education is expected to strengthen teacher-student collaboration, foster learner autonomy, and cultivate creativity, collaboration, and critical thinking as core competencies for the next generation (Nabilah et al., 2022; Rohman & Khaliza, 2025).

Despite this potential, informatics instruction at two public junior high schools in Makassar City—SMP Negeri 3 Makassar (Mamajang District) and SMP Negeri 7 Makassar (Ujung Tanah District)—continues to face obstacles in achieving expected learning competencies. Preliminary observations and interviews indicated that teachers still rely predominantly on conventional media such as textbooks and student worksheets. Although useful for conveying concepts, these materials are insufficient for supporting the applied, practice-oriented learning that characterizes informatics as a discipline. The problem, therefore, extends beyond the medium itself to the broader learning process, which has yet to provide the applicative experience the subject demands.

Android-based interactive media offers a means of complementing-rather than replacing-the teacher's role by presenting text, images, video, and interactive quizzes as an integrated instructional resource (Elida et al., 2025). Given the limited availability of computer-laboratory facilities in many schools, mobile-based media also offers a flexible alternative, allowing students to access learning materials anytime an internet connection is available (Bernacki et al., 2020). This study is positioned within that need: to design media that support both the teaching process and teachers' efforts to improve the quality of Informatics instruction.

A growing body of research supports the validity, practicality, and effectiveness of Android-based interactive media in informatics education. Emor et al. (2025) reported that Android-based interactive media for a senior-high informatics course were highly feasible. Uska et al. (2025) similarly found very feasible ratings from material experts (85%) and media experts (92%), alongside 94% student satisfaction. Tarigan et al. (2025) confirmed that Android-based media for informatics was valid, practical, and effective, while Prayudha et al. (2024) reported 87.11% validity for Android-based

media used in vocational informatics classes. Sari et al. (2025) found very high validity from material experts (100%) and media experts (97%) for Android-based mobile learning on informatics' social-impact content, with very feasible student-trial outcomes in both small groups (91%) and large groups (98%). Diana et al. (2024) likewise reported very high feasibility for Android-based interactive multimedia built on the problem-based learning model, with material-expert (92.5%), media-expert (92.3%), and student-response (92-95%) ratings.

Collectively, these studies confirm the feasibility of Android-based media for Informatics instruction but have concentrated primarily on interactive multimedia and general mobile-learning formats. What remains underexplored is the integration of an educational-game component designed specifically to sustain motivation through a structured challenge-and-reward mechanism. The present study addresses this gap by developing Android-based interactive media that combines conventional interactive-learning features (text, video, and automated-feedback quizzes) with an educational-game module, and by empirically evaluating its validity, practicality, and effectiveness for Informatics instruction at the junior-secondary level in Makassar City. The specific research questions guiding this study were:

1. What are the characteristics and features of the Android-based interactive media developed as a learning tool for Informatics education in junior high school?
2. What are the levels of validity, practicality, and effectiveness of the developed media?

Correspondingly, this study aimed to (1) produce Android-based interactive media as a learning tool for Informatics education in junior high school, and (2) determine the validity, practicality, and effectiveness of the developed media.

2. METHOD

This study employed a Research and Development (R&D) design based on a combined model synthesizing the Plomp, ADDIE, and Borg and Gall frameworks. Data were collected between September 2025 and February 2026 at two public junior high schools in Makassar City, Indonesia: SMP Negeri 3 Makassar (Mamajang District) and SMP Negeri 7 Makassar (Ujung Tanah District). The two schools were purposively selected based on the availability of Android devices among students, ongoing technology-based learning initiatives, and the representation of distinct student characteristics across districts.

The development process followed five sequential stages: (1) Investigation, (2) Design, (3) Development, (4) Analysis and Revision, and (5) Final Product and Dissemination. In the Investigation stage, field conditions, curriculum alignment, and system requirements were examined through literature review, teacher interviews, and classroom observation. In the Design stage, the content flow and storyboard interface were developed, comprising nine screens: splash screen, home screen, main menu, instructions menu, curriculum-achievement (CP/ATP) page, content menu, video menu, exercise menu, and a game menu with four progressive levels. In the Development stage, the initial product was implemented as a functioning Android application and

evaluated by two media experts (assessing interface design, navigation, technical compatibility, and instructional effectiveness) and two subject-matter experts (assessing curriculum alignment, conceptual accuracy, and language appropriateness), followed by staged student trials. In the Analysis and Revision stage, practicality and effectiveness data were evaluated and the product was revised accordingly. In the final stage, the validated product was disseminated to the participating schools and reported through scientific publication.

Consistent with R&D terminology, the study used "trial subjects" rather than population and sample. Trial subjects comprised: (1) two media experts and two subject-matter experts as product validators; (2) three students from each school for individual trials (n = 6); (3) ten students from each school for small-group trials (n = 20); and (4) 30 students from each school together with 12 Informatics teachers for the large-group trial (n = 72, comprising 60 students and 12 teachers). Three variables were measured: (1) media validity, assessed by subject-matter and media experts; (2) media practicality, assessed through student- and teacher-response questionnaires; and (3) media effectiveness, measured by comparing students' pre-test and post-test learning outcomes.

Data was collected using semi-structured interview guidelines (administered to teachers during the investigation stage) and structured questionnaires. All questionnaires used a four-point Likert scale (1 = strongly disagree, 2 = disagree, 3 = agree, 4 = strongly agree), omitting a neutral midpoint to elicit more decisive responses. Four instruments were used, summarized in Tables 1-4.

Table 1. Subject-Matter Expert Validation Instrument (15 items)

No.	Assessment Indicator	Score (1-4)
1	Alignment of content with the curriculum	
2	Accuracy of the presented material	
3	Correctness of concepts and terminology	
4	Integration across learning topics	
5	Depth of material appropriate for junior-secondary level	
6	Clarity of stated learning objectives	
7	Sequencing of material according to difficulty level	
8	Relevance of examples to students' daily life	
9	Media's capacity to enhance conceptual understanding	
10	Student engagement fostered by the media	
11	Clarity of instructions provided in the media	
12	Language suitability for junior-secondary students	
13	Appropriateness of illustrations/images to content	
14	Consistency of terms and symbols used	
15	Potential of the media to increase student motivation	

Table 2. Media Expert Validation Instrument (40 items)

Assessment Aspect	Indicators	Items
Display design	Color/layout consistency, visual composition, font readability, icon/image usage	8
Navigation ease	Clear navigation, button clarity, media responsiveness, immediate feedback	8
Technical suitability	Multi-device compatibility, absence of bugs/errors, loading speed, OS compatibility	8

Assessment Aspect	Indicators	Items
Content suitability	Curriculum alignment, clarity of language, content accuracy, currency of content	8
Learning effectiveness	Encourages active learning, increases motivation, aids comprehension, enables independent learning	8
Total		40

Table 3. Student Response Instrument (15 items)

Assessment Aspect	Indicators	Items
Media display	Attractive design, legible font, appropriate colors/images, easy navigation	5
Content/material	Comprehensible material, suitable language, helpful examples, curriculum alignment	5
Learning benefit	Increases interest, supports self-study, enhances understanding, encourages exploration, enjoyable experience	5
Total		15

Table 4. Teacher Response Instrument (15 items)

Assessment Aspect	Indicators	Items
Content/material quality	Curriculum alignment, clarity of objectives, language suitability, conceptual accuracy, meaningfulness	5
Design and media display	Attractive appearance; color, font, and image support for learning; easy navigation; appropriate illustrations; design consistency	5
Learning benefit and effectiveness	Assists delivery of instruction, aids student comprehension, increases motivation, supports independent learning, twenty-first-century relevance	5
Total		15

Data were collected through three techniques: (1) interviews with Informatics teachers at both schools to identify learning needs, student characteristics, and instructional challenges; (2) questionnaires distributed to media experts, subject-matter experts, students, and teachers to obtain validation, practicality, and user-response data; and (3) documentation of curriculum materials, syllabi, and related instructional resources to ensure alignment with prevailing competency standards.

Data were analyzed using a combined quantitative-descriptive and qualitative approach. Validity analysis. Expert-validation data were converted to percentage scores using Equation (1):

$$p = (\Sigma x / \Sigma xm) \times 100\%$$

where p is the percentage score, Σx is the total score obtained, and Σxm is the maximum possible score. Resulting percentages were classified using the criteria in Table 5. Media scoring below 60% were considered unsuitable for use, whereas media scoring above 61% were considered suitable for use as a learning resource.

Table 5. Validity Assessment Criteria (adapted from Sumarni et al., 2020)

Percentage	Interpretation
80% - 100%	Very valid
60% - 79.99%	Valid
50% - 59.99%	Sufficiently valid
0% - 49.99%	Not valid

Practicality analysis. Student- and teacher-response data were analyzed descriptively using the same percentage formula (Equation 1) and classified according to the criteria in Table 6.

Table 6. Practicality Assessment Criteria (adapted from Nesri & Kristanto, 2020)

Percentage Range	Category
$80\% < P \leq 100\%$	Very practical
$60\% < P \leq 80\%$	Practical
$40\% < P \leq 60\%$	Sufficiently practical
$20\% < P \leq 40\%$	Impractical
$0\% < P \leq 20\%$	Very impractical

Effectiveness analysis. Effectiveness was evaluated by comparing students' pre-test and post-test scores in the large-group trial (n = 60). Students completed a pre-test, engaged with the Android-based interactive media during regular Informatics lessons, and then completed a post-test. The difference between pre-test and post-test scores was analyzed using a paired-sample t-test, with statistical significance set at $p < .05$ (Sig. 2-tailed). Qualitative data from teacher interviews and expert recommendations were analyzed following the data reduction, data display, and conclusion-drawing procedures of Miles and Huberman.

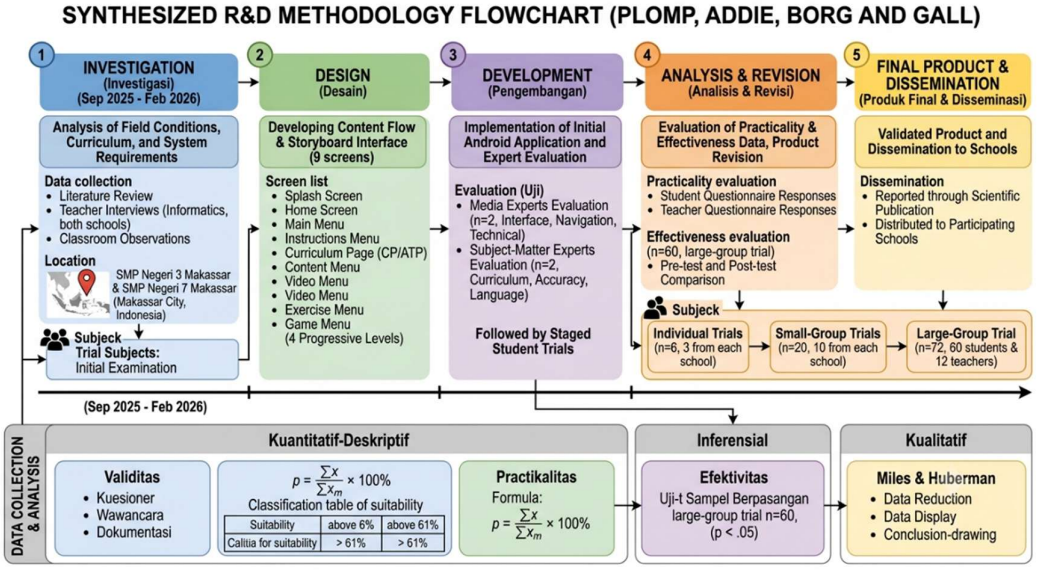

Figure 1. Research and Development Flow

3. RESULTS AND DISCUSSION

Results

The development process produced Android-based interactive media as a learning tool for informatics education in junior high school, implemented through the five stages described below.

Investigation Stage

Needs analysis, conducted through observation at both schools, indicated that Informatics instruction remained dominated by conventional textbook- and worksheet-based methods, with limited use of digital technology despite most students already owning Android smartphones. Curriculum analysis showed that instruction referred to Phase D Learning Outcomes (Capaian Pembelajaran), encompassing computational thinking and digital literacy. Based on the system-requirements analysis, Kodular (version 2025.8), Windows 11, Google Cloud Platform, Wayground, and Google Sheets were selected as the primary development tools.

Design Stage

The media content framework was developed around the Grade 7 curriculum, covering eight topics: data concepts and structured data sets, introduction to spreadsheets, computational thinking, digital information literacy, browsers and search engines, evaluation of digital information quality, the digital press-media ecosystem, and technology devices. The instructional strategy emphasized systematic material presentation, multiple-choice practice questions, automated feedback, active student engagement, and engaging visual design. The interface flow proceeded from a splash screen and home page to a main menu containing instructions, curriculum-achievement information, learning materials, videos, quizzes, games, and researcher profile sections.

Development Stage

The initial product was implemented as a functioning application and subsequently validated by subject-matter and media experts. Validation results are presented in Table 7.

Table 7. Expert Validation Results

Validator	Mean Score	Percentage	Category
Subject-matter expert	3.30	82%	Very valid
Media expert	3.40	85%	Very valid

The empirical evaluation of the developed application demonstrated a high level of validity across both content and technical dimensions, as detailed in Table 7. The rigorous expert validation phase revealed that the subject-matter expert yielded a mean score of 3.30, corresponding to a percentage of 82%, which firmly positions the application within the "Very Valid" category. Concurrently, the assessment by the media expert indicated an even higher rating, achieving a mean score of 3.40 and a percentage of 85%, which likewise denotes a "Very Valid" quality standard. These quantitative metrics robustly underscore that the initial product possesses strong

pedagogical alignment and highly viable media design elements, rendering it a solid and credible instrument for further instructional deployment.

Beyond the commendable quantitative indices, the constructive qualitative feedback provided by the validators served as a critical benchmark for iterative optimization before progressing to the stage trials. Grounded in the validators' strategic recommendations, comprehensive revisions were systematically executed to enhance both the pedagogical substance and the user experience (UX) of the application. Specifically, the adjustments entailed calibrating the font size for improved readability, aligning the content explicitly with the seventh grade even-semester curriculum standards, integrating a necessary "back" button on the quiz interface, and optimizing the responsiveness of the navigation controls. This dual approach of rigorous statistical validation and targeted qualitative refinement ensures that the finalized media is not only theoretically sound but also practically optimized for subsequent field trials and student interaction. Following revision, the media proceeded to stage trials, the results of which are presented in Table 8.

Table 8. Recapitulation of Practicality Test Results

Trial Stage	Mean Score	Percentage	Category
Individual (n = 6)	3.24	81%	Very practical
Small group (n = 20)	3.48	87%	Very practical
Large group (n = 60)	3.47	87%	Very practical
Teacher response (n = 12)	3.58	90%	Very practical

The empirical findings from the multi-stage implementation phases rigorously demonstrate the high operational viability and systemic efficiency of the finalized product, as summarized in Table 8. The scalability of the application's usability is clearly reflected in the progressive increase in student feedback metrics, rising from a mean score of 3.24 (81%) in the individual trials (n = 6) to highly stable ratings of 3.48 (87%) and 3.47 (87%) in the small group (n = 20) and large group (n = 60) trials, respectively, all of which fall squarely within the "Very Practical" category. This exceptional baseline is further reinforced by the exemplary evaluation from educators (n = 12), who yielded the highest rating with a mean score of 3.58 (90%), thereby confirming that the media satisfies both instructional demands and pedagogical usability constraints. From a functional perspective, this strong practicality is directly attributable to the robust architecture of the final product, which seamlessly integrates structural features such as a functional splash screen, a comprehensive main menu with seven navigation systems, explicit curriculum-achievement (CP/TP) mappings, and multi-modal instructional delivery channels, including eight core topic pages, dedicated educational videos, automated feedback quiz interfaces, and four interactive gaming modules.

Analysis, Revision, and Final Product

Effectiveness was evaluated through a pre-test/post-test design with 60 students, analyzed using a paired-sample t-test. Results are presented in Table 9.

Table 9. Effectiveness Test Results

Condition	Mean	N	SD
Pre-test	58.92	60	19.03
Post-test	85.83	60	11.76

To determine the empirical efficacy of the developed media, a pre-test/post-test experimental design was deployed among 60 students (N = 60) and analyzed using a paired-sample t-test, with the outcomes summarized in Table 9. The descriptive statistical analysis reveals a substantial upward trajectory in student learning performance, as evidenced by the shift from an initial baseline pre-test mean score of 58.92 (SD = 19.03) to a markedly higher post-test mean score of 85.83 (SD = 11.76). This notable growth in post-intervention scores—coupled with a tighter standard deviation that indicates reduced variance and more consistent learning gains across the cohort—strongly implies that the integration of the application significantly enhances cognitive outcomes. The clear differentiation between the pre-and post-test conditions confirms that the product serves as an effective instructional intervention capable of driving meaningful academic improvement.

Table 10. Paired-Sample T-Test

Comparison	Mean Difference	t-value	df	Sig. (2-tailed)	Significance
Between Conditions (Pre-test vs. Post-test)	-26.92	-10.91	59	0	Statistically Significant (p<.05)

The mean difference between conditions was -26.92, t (59) = -10.91, Sig. (2-tailed) = .000, p < .05, indicating a statistically significant improvement in learning outcomes following use of the media. As validity, practicality, and effectiveness results all fell within the very valid, very practical, and effective categories, no further revision was required. The finalized media was disseminated on a limited basis to Informatics teachers at both participating schools and through scientific publication.

Discussion

Media Validity

The developed media achieved a very valid rating from both subject-matter experts (82%) and media experts (85%). In terms of content validity, the material aligned with Phase D Informatics learning outcomes and was grounded in field-based needs identified during the investigation stage. In terms of construct validity, components such as display design, navigation, learning features, and evaluation tools were arranged coherently and mutually reinforcing. This finding is consistent with Van den Akker's view that validity concerns the alignment of a design with current knowledge and the internal consistency of its components (Van der Craats et al., 2026). The results also align with Mayefis et al. (2019), who reported valid material and media ratings for Android-based mobile learning, and with Syarifuddin and Dwiningsih (2020), who found content validity of 91.85% and construct validity of 89.61% for Android-based interactive multimedia. Similar patterns were reported by Mahmudah et al. (2018), Izhar

et al. (2023), and Putra et al. (2024), reinforcing the broader consistency of these findings across Android-based learning media developed for different subject areas.

Media Practicality

Practicality scores increased progressively across trial stages-from individual trials (81%) to small-group (87%), large-group (87%), and teacher-response (90%) trials-all within the very practical category. This upward trend suggests that user-experience quality was increasingly confirmed as the trial scale expanded. Practicality was evidenced by ease of operation on Android devices already familiar to students, a simple interface with clear navigation, and the media's capacity to help teachers deliver material in a more structured and engaging manner. Nieveen emphasized that a product is practical when it can be applied by users as intended (Wang, 2025). These findings correspond with Huda et al. (2020), who reported 85% practicality for Android-based media; Hasna et al. (2021), who found Android-based interactive media practical among junior-secondary students; and Latifatus et al. (2025), who obtained a practicality score of 90.66%. Yuniar et al. (2025) similarly confirmed the practicality of Android-based interactive learning media for Informatics instruction.

Media Effectiveness

The increase in mean scores from pre-test (58.92) to post-test (85.83)—a difference of 26.92 points—provides concrete evidence that the Android-based interactive media effectively improved student learning outcomes. A significance value of .000, well below the .05 threshold, confirms that this improvement was unlikely to have occurred by chance. This effectiveness can be attributed to the media's integration of multiple instructional modes—text, video, self-paced navigation, automated-feedback practice questions, and interactive games—which together fostered more active student engagement than conventional print media. Van den Akker notes that effectiveness reflects the extent to which users' experience with a product aligns with its intended goals (Gomes et al., 2025). These findings correspond with Huda et al. (2020), who reported a significance value of .000 in an effectiveness test of Android-based media; Anggraini et al. (2024), who demonstrated the effectiveness of interactive Android multimedia via t-test, and Latifatus et al. (2025), who obtained an N-Gain value of 0.58, indicating an effective category. Muharraran et al. (2025) similarly confirmed that Android-based interactive media improved learning achievement in a senior-secondary informatics course.

Implications and Limitations

Beyond confirming feasibility, these findings suggest that embedding an educational-game component within Android-based interactive media offers an additional motivational mechanism not fully explored in prior studies on Informatics-focused mobile learning, which have concentrated primarily on multimedia presentation and general mobile-learning formats. This positions game-enhanced interactive media as a promising direction for future instructional-design research in computing education.

Nevertheless, several limitations should be acknowledged. The study was conducted at only two schools within a single city, and the pre-test/post-test design without a control group limits causal inference regarding effectiveness relative to conventional instruction. Future research employing quasi-experimental designs with control groups, larger and more geographically diverse samples, and longer implementation periods would strengthen the generalizability of these findings.

4. CONCLUSION

This study successfully developed Android-based interactive media as a learning tool for Informatics education in junior high school through a five-stage combined development model. The resulting media met three quality criteria comprehensively. First, in terms of validity, the media achieved a very valid category, with 82% from subject-matter experts and 85% from media experts, indicating that its content and construction align with Informatics learning outcomes and curriculum requirements. Second, in terms of practicality, the media achieved a very practical category at every trial stage, with the highest ratings from teacher responses (90%) and large-group trials (87%), demonstrating ease of use and benefit for both students and teachers under real classroom conditions. Third, in terms of effectiveness, use of the media was statistically shown to significantly improve student learning outcomes, as reflected in the increase in mean scores from 58.92 at pre-test to 85.83 at post-test, $t(59) = -10.91$, $p < .001$.

These findings support recommending that schools facilitate the use of Android-based interactive media by providing adequate supporting infrastructure and encouraging teachers to sustain technology-based instruction. For future research, this study may serve as a reference for developing similar learning media with broader content coverage, more advanced features, application at different educational levels, and evaluation through quasi-experimental designs with control groups, larger samples, and longer implementation periods to more comprehensively assess the effectiveness of such media across diverse learning contexts.

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