Jupiter: Jurnal Pendidikan Terapan
Homepage : https://journal.diginus.id/jupiter/index
Email: jurnalpendidikanterapan@gmail.com

p-ISSN : 2985-3214; e-ISSN : 2964-3171
Jupiter, Vol. 4, No. 5, November 2026
Page 391-402

Development of MORFDIGI SPEKAR: A Digital Module for Indonesian Morphology in Higher Education

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ARTICLE INFO

Article history:
Submitted: July 30, 2026
Final Revised: October 19, 2026
Accepted: October 29, 2026
Published: November 21, 2026

Keywords:
Indonesian Morphology; Digital Module; Higher Education; SPEKAR.

ABSTRACT

Purpose: This study aimed to develop and evaluate MORFDIGI SPEKAR, a digital teaching module for Indonesian Morphology in higher education, by examining its validity, practicality, and effectiveness. **Methods:** This study employed a Research and Development (R&D) approach using the Four-D (4D) model, consisting of define, design, develop, and disseminate stages. The participants included one subject-matter expert, one media expert, two Indonesian Morphology lecturers, 37 students in the experimental group, and 35 students in the control group. Data were collected through needs analysis, expert validation, lecturer and student practicality questionnaires, and pretest-posttest learning assessments. Validity and practicality data were analyzed descriptively, while learning effectiveness was examined using change-score analysis and N-Gain. ANCOVA was conducted as a supplementary analysis. **Findings:** The developed MORFDIGI SPEKAR module integrated the SPEKAR learning syntax (Stimulation, Problem, Exploration, Construction, Application, and Reflection) into Indonesian Morphology learning. The material and media validation results were 91.30% and 90.00%, respectively, both categorized as very valid. The overall practicality scores were 87.50% from lecturers and 91.26% from students, both categorized as very practical. For effectiveness, the experimental group showed a mean improvement of 18.54 points from pretest to posttest, compared with 11.11 points in the control group. The difference in mean change scores was statistically significant, $t(52.29) = 9.37$, $p < .001$, with a Hedges' g of approximately 2.15. N-Gain analysis also indicated greater learning improvement in the experimental group ($M = 0.457$) than in the control group ($M = 0.273$). **Research Implications:** The findings indicate that MORFDIGI SPEKAR can serve as a practical digital instructional resource for Indonesian Morphology courses in higher education. Its structured learning activities and interactive features may provide lecturers with an alternative way to organize morphology learning beyond conventional content presentation. **Originality:** The originality of this study lies in the development of MORFDIGI SPEKAR, which integrates the SPEKAR learning syntax (Stimulation, Problem, Exploration, Construction, Application, and Reflection) into a digital Indonesian Morphology module. The integration positions the module not merely as a digital presentation of instructional content but as a structured learning resource that operationalizes deep learning pedagogy through sequential learning activities.

Doi: https://doi.org/10.61255/jupiter.v4i5.1736

INTRODUCTION

Digital transformation has increasingly influenced teaching and learning practices in higher education, creating a need for learning resources that are accessible, interactive, and pedagogically meaningful. Digital practices in higher education are expected not merely to introduce technological tools but also to support student-centered learning environments and meaningful learning experiences (Otto et al., 2024). Therefore, the development of digital teaching materials needs to consider not only technological accessibility but also the pedagogical processes through which students engage with and construct knowledge.

Digital teaching modules provide opportunities to integrate text, visual materials, hyperlinks, multimedia resources, and interactive learning activities within a single learning environment. Digital learning resources can also support more flexible learning arrangements by providing access to instructional materials beyond the constraints of conventional classroom delivery (Munir, 2017). The integration of multiple forms of representation can support learning when multimedia elements are appropriately organized according to principles of learning and cognitive processing (Mayer, 2020). However, the availability of multimedia features alone does not guarantee meaningful learning. Learning activities need to be deliberately aligned with intended learning outcomes and assessment so that students are actively engaged in constructing knowledge (Biggs & Tang, 2011).

This need is particularly relevant to Indonesian Morphology, a core course in Indonesian Language Education. Morphological analysis involves examining word structure, the organization of morphemes, and the processes through which words are formed (Katamba, 1993). Accordingly, learning Indonesian Morphology requires students to move beyond memorizing terminology and to analyze the forms and structures of words in linguistic contexts. Morphology requires students to understand the structure of words and the processes involved in their formation, including morphemes, morphophonemics, affixation, reduplication, and composition. These topics require students not only to understand linguistic concepts but also to identify morphological forms, analyze morphological processes, interpret their functions, and apply concepts to linguistic data. Consequently, morphology learning requires learning activities that enable students to move from conceptual information toward analysis and application.

The need for improved learning resources was identified through the needs analysis conducted in this study. Of the 104 students involved in the analysis, 92 students (88.9%) indicated that the existing Indonesian Morphology learning materials needed further development. Composition was identified as the topic most in need of development by 47 students (45.2%), followed by affixation, identified by 42 students (40.4%). In addition, 93 students (89.4%) indicated a need for a digital module that could provide more flexible and accessible learning support. These findings indicate that the development of learning materials for Indonesian Morphology needs to address both the availability of digital resources and the learning processes through which students engage with morphological concepts.

Curriculum analysis further indicated that the Indonesian Morphology course had incorporated active learning methods, including project-based learning, small-group discussion, and case methods. However, these activities had not yet been systematically organized into a coherent learning sequence that consistently guided students from the observation of linguistic phenomena to conceptual construction, application, and reflection. Digital learning platforms were also used primarily for distributing materials and submitting assignments. This condition indicates the need for a digital learning resource that integrates digital affordances with a structured pedagogical sequence.

The pedagogical foundation of this study is the concept of *deep learning*. In this study, *deep learning* refers to a pedagogical approach rather than artificial intelligence or machine learning. The pedagogical concept of deep learning is grounded in the distinction between deep-level and surface-level processing described by Marton and Säljö (1976). Their study demonstrated qualitative differences in how students approach learning, particularly between approaches directed toward understanding meaning and approaches focused primarily on reproducing information. A deep approach to learning therefore emphasizes understanding the meaning of what is learned rather than merely memorizing or reproducing information (Marton & Säljö, 1976).

This perspective is particularly relevant to morphology learning because understanding morphological concepts requires students to go beyond the recall of definitions. Students need to examine linguistic forms, identify patterns, relate linguistic phenomena to conceptual knowledge, and apply their understanding to different language contexts. Such learning requires students to engage with content at a level that emphasizes understanding and meaningful connections rather than simple reproduction of information.

The application of deep learning in higher education requires learning activities that provide opportunities for students to actively engage with knowledge. Biggs & Tang (2011) emphasize the importance of learning activities that encourage students to construct meaning and achieve intended learning outcomes through appropriately designed learning experiences. This perspective supports the need for a pedagogical sequence that translates the principles of deep learning into concrete learning activities.

Previous research has shown that educational technologies can facilitate student-centered learning when they support active participation, collaboration, and knowledge construction. Shehata et al. (2024) found that educational technology can support student-centered learning when technology is integrated with learning activities that actively involve students in the learning process. This finding suggests that digital modules need to be designed not only to provide access to content but also to structure meaningful learning activities.

Research in Indonesian language education has also demonstrated the growing importance of digital learning in higher education. Kaunang et al. (2026) reported that digital-based Indonesian language learning has developed alongside increasing demands for flexibility, independent learning, and the use of emerging technologies. Research on digital pedagogies in higher education highlights the importance of examining not only the use of digital technologies but also the pedagogical approaches through which they shape teaching and learning practices (Santoveña-Casal & López, 2024). This perspective supports the development of digital learning resources in which technological features are aligned with explicit learning activities and instructional purposes. However, the development of digital learning resources still requires attention to the pedagogical structures that guide students' learning processes. Previous research at Universitas Negeri Makassar has also examined the development of digital learning modules in higher education. Ahyadin & Arnidah (2024) developed a digital module for a Curriculum Evaluation course and evaluated its validity and practicality. While this study provides a relevant example of digital module development in a higher education context, MORFDIGI SPEKAR extends this line of development by integrating a structured pedagogical sequence specifically designed for Indonesian Morphology.

The literature therefore indicates a need to strengthen the connection between digital learning resources and pedagogical frameworks that promote deeper engagement with learning content. In Indonesian Morphology, this need is particularly important because students are expected to analyze linguistic forms and processes rather than merely recall morphological terminology. Although digital learning materials and student-centered approaches have been increasingly developed, the integration of a structured deep-learning pedagogical sequence into a digital Indonesian Morphology module in higher education remains insufficiently explored.

To address this need, this study developed MORFDIGI SPEKAR, a digital teaching module for Indonesian Morphology that integrates the SPEKAR instructional syntax: Stimulation, Problem, Exploration, Construction, Application, and Reflection. The six stages were designed to provide a progressive learning experience. Stimulation introduces students to relevant linguistic phenomena; Problem directs students to identify and formulate morphological problems; Exploration guides students in observing and examining linguistic data; Construction facilitates the development of morphological concepts; Application requires students to apply the concepts to new linguistic cases; and Reflection provides an opportunity to evaluate and consolidate their learning.

The Reflection stage is particularly important because reflective learning provides students with opportunities to reconsider their learning experiences and evaluate their understanding. Herdiani & Dewi (2026) emphasize the role of reflective learning in supporting students' learning processes through reflection on what has been learned. Reflection in higher education requires more than asking students to recall what they have learned; it involves guiding them to examine their learning experiences and develop reasoned interpretations of their learning (Ryan, 2013). In MORFDIGI SPEKAR, the Reflection stage is intended to provide this opportunity by encouraging students to review their understanding of morphological concepts and identify aspects of their learning that require further development. Accordingly, reflection in SPEKAR is intended to help students consolidate the concepts developed during the preceding learning stages.

The development of MORFDIGI SPEKAR combines two complementary frameworks. The Four-D (4D) model functions as the product-development framework, consisting of Define, Design, Develop, and Disseminate stages (Thiagarajan et al., 1974). In contrast, SPEKAR functions as the pedagogical framework embedded within the module. Thus, SPEKAR is not an additional stage of the 4D development model but a structured sequence of learning activities implemented within the product.

The novelty of the present study lies in the integration of the SPEKAR pedagogical sequence into a digital teaching module specifically designed for Indonesian Morphology in higher education. Rather than treating the digital module merely as a medium for presenting morphological content, MORFDIGI SPEKAR organizes students' learning experiences through a sequence that moves from stimulation and problem identification toward exploration, conceptual construction, application, and reflection.

Accordingly, this study aimed to develop MORFDIGI SPEKAR as a digital teaching module for Indonesian Morphology in higher education and to evaluate its validity, practicality, and effectiveness. The study is expected to contribute to the development of digital teaching materials in Indonesian language education by demonstrating how a structured deep-learning pedagogical framework can be embedded within a digital morphology module developed through a systematic research-and-development process.

METHOD

This study employed a Research and Development (R&D) design to develop a digital teaching module for Indonesian Morphology based on deep-learning pedagogy. The development process followed the Four-D (4D) model proposed by Thiagarajan et al. (1974), consisting of four stages: Define, Design, Develop, and Disseminate.

The Define stage involved curriculum analysis, learner needs analysis, concept analysis, and formulation of learning objectives. The Design stage involved designing the module structure, learning activities, digital interface, assessment instruments, and learning tasks. The Develop stage consisted of prototype development, expert validation, revision, and classroom implementation. The Disseminate stage was conducted on a limited scale through implementation of the developed module in the Indonesian Morphology course and dissemination through scientific publication.

The 4D model functioned as the product-development framework, whereas SPEKAR functioned as the pedagogical framework embedded in the module. The learning activities were organized into six stages: Stimulation, Problem, Exploration, Construction, Application, and Reflection. Thus, the deep-learning pedagogy was integrated into the learning activities rather than treated as an additional stage of the 4D development model.

The study was conducted in the Indonesian Language Education Study Program, Faculty of Languages and Literature, Universitas Negeri Makassar. The participants consisted of one material expert, one media expert, two lecturers who taught Indonesian Morphology, and 37 undergraduate students. The material and media experts evaluated the quality and validity of the developed module, while the lecturers and students evaluated its practicality during classroom implementation.

For the effectiveness analysis, two naturally formed classes enrolled in the Indonesian Morphology course were involved. The classes were retained as intact classes to reflect the actual classroom setting and to avoid disrupting the existing course organization. One class, consisting of 37 students, was assigned as the experimental group and received instruction using the MORFDIGI SPEKAR module, while the other class, consisting of 35 students, served as the control group and received the regular instructional treatment used in the course. The effectiveness test employed a pretest–posttest control-group design. Because the groups were naturally formed rather than randomly assigned at the individual level, baseline equivalence was examined using students' pretest scores before the effectiveness analysis.

During the classroom implementation, both groups received the same Indonesian Morphology content and learning objectives over four meetings each. The experimental group received instruction using the revised MORFDIGI SPEKAR module, whereas the control group received the regular instructional treatment used in the course. Thus, the total implementation comprised eight classroom meetings across the two groups. The main difference between the groups was the instructional treatment. In the experimental group, learning activities were organized according to the six SPEKAR stages: Stimulation, Problem, Exploration, Construction, Application, and Reflection. Both groups completed equivalent pretest and posttest assessments to measure learning outcomes.

Data were collected using needs-analysis questionnaires, expert validation sheets, practicality questionnaires, and learning-outcome tests. The material-validation instrument consisted of 23 items covering five aspects: content appropriateness, integration of deep-learning principles, language, presentation, and graphics. The media-validation instrument consisted of 6 items covering visual design, aesthetics, and usability. The practicality questionnaire consisted of 8 items covering three aspects: ease of use, attractiveness, and usefulness. All questionnaire items were assessed using a five-point Likert scale. The eight-item student practicality questionnaire covered the following indicators: ease of module use, suitability of the material to learning needs, suitability of presentation to students' cognitive abilities, communicative language, concise presentation, conformity with Indonesian language conventions, time efficiency, and support for understanding Indonesian Morphology.

The learning-outcome instrument consisted of eight analytical essay items designed to assess students' ability to analyze Indonesian morphological phenomena, particularly affixation and composition. The items were developed at cognitive levels C4–C6 and were administered as pretest and posttest. The two tests assessed equivalent competencies and cognitive levels while using different linguistic contexts to reduce the possibility of a testing effect. Each item was scored from 0 to 4 based on the accuracy of the student's answer, resulting in a total possible score ranging from 0 to 32. The scoring focused on the accuracy of students' responses in analyzing the morphological phenomena presented in each item.

The learning-outcome test was used to measure students' achievement before and after the instructional intervention. Expert validation in this study was conducted for the MORFDIGI SPEKAR digital module, particularly its content and graphical aspects, rather than for the learning-outcome test. The available learning-outcome dataset consisted of students' total pretest and posttest scores; therefore, separate empirical item-validity and internal-consistency reliability analyses of the test were not conducted.

The empirical validity and internal consistency of the student practicality questionnaire were examined using the raw responses from 37 students. Item validity was assessed using corrected item-total correlations, in which each item score was correlated with the total questionnaire score after excluding the respective item. Pearson's product-moment correlation was used for this analysis. With 37 respondents, the critical correlation coefficient at the 0.05 significance level was 0.325. An item was considered empirically valid when its corrected item-total correlation exceeded the critical value and its corresponding *p*-value was below 0.05. Internal consistency was examined using Cronbach's alpha.

Because the material and media validation involved only one expert for each area, inter-rater reliability could not be meaningfully estimated. Similarly, the lecturer practicality assessment involved only two lecturers; therefore, internal-consistency reliability was not estimated for the lecturer responses. These data were instead treated as expert and user judgments for product evaluation. Data collection was conducted in several stages. First, curriculum and needs analyses were conducted during the Define stage to identify students' learning needs, learning difficulties, and characteristics of the existing Indonesian Morphology learning process. Second, the initial module prototype was developed based on the findings of the Define stage and the SPEKAR pedagogical framework.

Third, the prototype was evaluated by the material and media experts. The validation results and qualitative comments were used to revise the module before classroom implementation. The revised module was subsequently implemented in the Indonesian Morphology course.

During implementation, the lecturers and students used the module and completed the practicality questionnaires. The students' learning outcomes were measured through pretest and posttest administration in the experimental and control groups. Qualitative data were obtained from comments and suggestions provided by the validators and users and were used as a basis for product revision. The quantitative data from the expert validation and practicality questionnaires were analyzed descriptively by converting the obtained scores into percentages. The percentage score was calculated using the following formula:

$$P = \frac{n}{N} \times 100\%$$

where *P* represents the percentage score, *n* represents the obtained score, and *N* represents the maximum possible score.

The resulting percentages were interpreted according to the validity and practicality criteria established in the study. Expert validation scores were used to determine the validity of the material and media components, whereas lecturer and student responses were used to determine the practicality of the module. The student practicality questionnaire was first examined for empirical validity and internal consistency. Corrected item-total correlations were calculated for the eight questionnaire items, followed by Cronbach's alpha to examine internal consistency. These analyses were conducted before interpreting the student practicality results. For the effectiveness analysis, learning gains were examined using N-Gain to compare improvement in learning outcomes between the experimental and control groups. In addition, Analysis of Covariance (ANCOVA) was conducted to examine differences in posttest scores between the groups while controlling for pretest scores. Statistical analyses were conducted using JASP.

Before interpreting the ANCOVA results, relevant assumptions were examined, including the distribution of residuals, homogeneity of variance, and the relationship between the covariate and the dependent variable. Levene's test indicated a violation of the homogeneity-of-variance assumption ($p = .002$). The homogeneity-of-regression-slopes assumption was also examined by testing the interaction between group and pretest scores. The ANCOVA findings were therefore interpreted with appropriate caution.

Before examining the effectiveness of the instructional treatment, baseline equivalence between the experimental and control groups was examined using an independent-samples Welch t-test on the pretest scores. This analysis was conducted because the two groups consisted of naturally formed classes rather than individually randomized students. To examine the effectiveness of the intervention, change scores were calculated by subtracting each student's pretest score from the corresponding posttest score. The mean change scores of the experimental and control groups were then compared using an independent-samples Welch t-test. The analysis was accompanied by a 95% confidence interval for the mean difference and Hedges' *g* as an estimate of effect size. N-Gain scores were also analyzed as a supporting measure of learning improvement.

An ANCOVA was initially conducted with posttest scores as the dependent variable, group as the independent variable, and pretest scores as the covariate. However, because the assumption tests indicated unequal variances and a significant group-by-pretest interaction, the ANCOVA results were treated as supplementary rather than as the primary basis for evaluating instructional effectiveness.

RESULTS

Development of MORFDIGI SPEKAR

The development process resulted in MORFDIGI SPEKAR, a digital teaching module for Indonesian Morphology incorporating the SPEKAR pedagogical syntax. The module was developed through the four stages of the 4D model: Define, Design, Develop, and Disseminate.

The final product was designed in a flipbook format and included learning materials, concept maps, interactive navigation, hyperlinks, illustrations, learning activities, exercises, reflection activities, evaluation tasks, references, and QR-code access. The learning materials covered fundamental topics in Indonesian Morphology, including morphemes, morphophonemics, affixation, reduplication, and composition. The learning activities were organized according to six SPEKAR stages: Stimulation, Problem, Exploration, Construction, Application, and Reflection. The product underwent expert validation before classroom implementation. The material expert evaluated the content and pedagogical components, while the media expert evaluated the visual and usability components. The recommendations obtained from the validation process were used to revise the module before its implementation.

Instrument Validity and Reliability

Before interpreting the student practicality responses, the eight-item practicality questionnaire was examined for empirical validity and internal consistency using responses from 37 students. The corrected item-total correlation coefficients ranged from 0.735 to 0.841, exceeding the critical correlation value of 0.325 at the 0.05 significance level. All eight items also showed statistically significant correlations with the total score ($p < .001$). Therefore, all items were retained for the practicality analysis.

Table 1. Validity and Reliability of the Student Practicality Questionnaire

Item	Indicator	Corrected item-total *r*	*p*	Decision
P1	Ease of module use	.830	< .001	Valid
P2	Suitability to learning needs	.778	< .001	Valid
K1	Cognitive appropriateness	.841	< .001	Valid
K2	Communicative language	.809	< .001	Valid
K3	Clarity of presentation	.783	< .001	Valid
K4	Indonesian language conventions	.735	< .001	Valid
M1	Time efficiency	.822	< .001	Valid
M2	Support for understanding morphology	.806	< .001	Valid
Cronbach's alpha	**Overall reliability**	**.943**	-	**Reliable**

The internal consistency analysis produced a Cronbach's alpha coefficient of 0.943, indicating that the eight items demonstrated high internal consistency. These results provide empirical support for the use of the student practicality questionnaire in evaluating the practicality of MORFDIGI SPEKAR.

Content and Media Validity

The validity of MORFDIGI SPEKAR was assessed by one material expert and one media expert. The material-validation instrument consisted of 23 indicators covering five aspects: content appropriateness, deep-learning integration, language, presentation, and graphics. The material expert awarded a total score of 105 out of 115, corresponding to 91.30%. The highest score was obtained for the language aspect (95.00%), followed by graphics (93.33%), while content appropriateness, deep-learning integration, and presentation each obtained 90.00%. The overall result was categorized as very valid.

Table 2. Material Validation Results

Aspect	Obtained Score	Maximum Score	Percentage
Content appropriateness	27	30	90.00%
Deep-learning integration	27	30	90.00%
Language	19	20	95.00%
Presentation	18	20	90.00%
Graphics	14	15	93.33%
Total	**105**	**115**	**91.30%**

The media expert evaluated six indicators covering visual appearance, aesthetics, and usability. The module obtained a total score of 27 out of 30, corresponding to 90.00%. Visual appearance obtained 100.00%, usability 90.00%, and aesthetics 80.00%.

Table 3. Media Validation Results

Aspect	Obtained Score	Maximum Score	Percentage
Visual appearance	10	10	100.00%
Aesthetics	8	10	80.00%
Usability	9	10	90.00%
Total	**27**	**30**	**90.00%**

The media expert recommended improving the navigation system by adding hyperlinks to navigation icons such as *Home* and *Exit.* The module was subsequently revised by adding hyperlink-based navigation icons to facilitate movement between pages. No substantive revision was required for the content component. The material expert considered the content consistent with the established learning outcomes and objectives.

Practicality of MORFDIGI SPEKAR

The practicality evaluation involved two lecturers and 37 students. Practicality was assessed across three aspects: ease of use, attractiveness, and usefulness.

Lecturer Responses

The lecturers' overall practicality score was 87.50%. The highest score was obtained for ease of use (95.00%), followed by attractiveness (87.50%), while usefulness obtained 80.00%.

Table 4. Lecturer Practicality Evaluation

Aspect	Percentage	Category
Ease of use	95.00%	Very practical
Attractiveness	87.50%	Very practical
Usefulness	80.00%	Practical
Average	**87.50%**	**Very practical**

The results indicate that the lecturers particularly perceived the module as easy to use. The lower score for usefulness compared with ease of use suggests that perceptions of broader instructional benefits were less pronounced during the limited implementation.

Student Responses

The 37 students also reported positive responses toward the developed module. The percentage for ease of use was 93.52%, attractiveness was 90.54%, and usefulness was 89.73%. The average of the three aspect percentages was 91.26%, which was categorized as very practical. These values are consistent with the item-level response data.

Table 5. Student Practicality Evaluation

Aspect	Percentage	Category
Ease of use	93.52%	Very practical
Attractiveness	90.54%	Very practical
Usefulness	89.73%	Very practical
Average	**91.26%**	**Very practical**

The student responses therefore indicate that MORFDIGI SPEKAR was perceived as practical in terms of usability, attractiveness, and usefulness during the implementation.

Effectiveness of MORFDIGI SPEKAR

Before comparing learning gains between the two groups, baseline equivalence was examined using the pretest scores. The experimental group (n = 37) had a mean pretest score of 58.84 (SD = 2.39), whereas the control group (n = 35) had a mean pretest score of 58.80 (SD = 2.42). A Welch independent-samples t-test indicated no statistically significant difference between the groups, $t(69.64) = 0.067$, $p = .947$, with a negligible effect size (Cohen's $d = 0.016$). These results indicate that the two groups had comparable initial learning outcomes before the intervention.

The effectiveness analysis involved 37 students in the experimental group and 35 students in the control group. Posttest descriptive statistics showed that the experimental group obtained a mean score of 77.38 (SD = 6.40), whereas the control group obtained a mean score of 69.91 (SD = 4.30).

The mean improvement from pretest to posttest was 18.54 points in the experimental group and 11.11 points in the control group. The difference in mean change scores was 7.43 points. A Welch independent-samples *t*-test indicated a statistically significant difference in learning improvement between the groups, $t(52.29) = 9.37$, $p < .001$, 95% CI [5.84, 9.02]. The corresponding Hedges' g was approximately 2.15, indicating a large effect. Thus, students who received instruction using MORFDIGI SPEKAR demonstrated substantially greater improvement in learning outcomes than students in the control group.

The N-Gain analysis provided additional evidence of learning improvement. The experimental group obtained a mean N-Gain score of 0.457 (SD = 0.128), whereas the control group obtained a mean of 0.273 (SD = 0.064). A Welch independent-samples *t*-test showed a statistically significant difference between the groups, $t(53.45) = 7.74$, $p < .001$. The mean difference was 0.184, with a 95% CI ranging from 0.136 to 0.231, and the Hedges' g was approximately 1.78. These findings provide supporting evidence that the experimental group achieved greater learning gains than the control group.

ANCOVA was conducted to examine posttest differences while controlling for pretest scores. The analysis showed a statistically significant group effect, $F(1, 69) = 199.0$, $p < .001$. Pretest scores were also a significant covariate, $F(1, 69) = 357.7$, $p < .001$. However, Levene's test indicated that the homogeneity-of-variance assumption was not satisfied, $F(1, 70) = 9.872$, $p = .002$. In addition, the group-by-pretest interaction was statistically significant, $F(1, 68) = 13.41$, $p < .001$, indicating that the relationship between pretest and posttest scores differed between groups. Therefore, the ANCOVA results were not used as the sole basis for determining instructional effectiveness. Instead, the change-score analysis using Welch's *t*-test was treated as the primary inferential analysis, while the ANCOVA results were retained as supplementary evidence.

Table 6. Pretest and Posttest Descriptive Statistics

Group	n	Pretest M	Pretest SD	Posttest M	Posttest SD
Experimental	37	58.84	2.39	77.38	6.40
Control	35	58.80	2.42	69.91	4.30

Table 7. ANCOVA Results for Posttest Scores

Source	*F*	*p*
Group	199.0	< .001
Pretest	357.7	< .001
Residuals	-	-

Assumption check: Levene's test: F(1, 70) = 9.872, p = .002.

DISCUSSION

The development process produced MORFDIGI SPEKAR, a digital teaching module for Indonesian Morphology that integrates digital learning features with the SPEKAR pedagogical sequence. The module was developed through the Four-D (4D) model consisting of Define, Design, Develop, and Disseminate stages. The resulting product contains learning materials, concept maps, multimedia elements, hyperlinks, interactive navigation, exercises, reflection activities, and evaluation. The learning activities are organized into six SPEKAR stages: Stimulation, Problem, Exploration, Construction, Application, and Reflection.

The use of the 4D model provided a systematic structure for transforming the identified learning needs into an instructional product. In this study, the 4D model functioned as the product-development framework, whereas SPEKAR functioned as the pedagogical framework embedded in the module. This distinction is important because SPEKAR was not treated as an additional stage of product development but as the learning sequence used within the developed module. The use of the 4D model is consistent with its original purpose as a systematic framework for instructional development (Thiagarajan et al., 1974).

The distinctive feature of MORFDIGI SPEKAR lies in the integration of the six SPEKAR stages into Indonesian Morphology learning. The sequence begins with Stimulation, in which students encounter a linguistic phenomenon, followed by Problem, where they identify or formulate a morphological problem. In Exploration, students examine linguistic data before constructing concepts in the Construction stage. The exploration and construction activities in MORFDIGI SPEKAR are also compatible with social constructivist perspectives, which emphasize learners' active

engagement in knowledge construction and the role of interaction and scaffolding in learning (Nithideechaiwarachok & Chano, 2024). In the context of Indonesian Morphology, these activities encourage students to examine linguistic data and develop explanations of morphological phenomena. The Application stage then requires students to apply the constructed concepts to new morphological cases, while Reflection provides an opportunity to review the learning process and understanding. This sequence is consistent with the distinction between surface and deep approaches to learning (Marton & Säljö, 1976), particularly the emphasis on understanding meaning and relationships rather than merely reproducing information.

The Reflection stage is also an important component of the pedagogical sequence because students are encouraged to reconsider what they have learned, identify difficulties, and evaluate their learning process. Reflection therefore functions as part of the learning cycle rather than as an additional activity at the end of the module. This orientation is consistent with the view that reflective learning can support students in examining and giving meaning to their learning experiences (Herdiani & Dewi, 2026).

The development of MORFDIGI SPEKAR was also grounded in the learning needs identified during the development process. The needs analysis indicated that 92 of 104 students (88.9%) considered the existing learning materials in need of development, while 93 students (89.4%) indicated a need for digital learning materials. These findings provided an empirical basis for developing a digital module in response to students' learning needs. The product therefore represents not only a change in instructional format but also an attempt to address the identified need for accessible and structured learning materials in Indonesian Morphology.

The expert validation results indicated that MORFDIGI SPEKAR obtained a score of 91.30% from the material expert and 90.00% from the media expert. The material evaluation covered content appropriateness, integration of deep-learning principles, language, presentation, and graphics, while the media evaluation addressed visual design, aesthetics, and usability. The results indicate that the developed module met the predetermined criteria for validity in both its instructional content and digital presentation.

The material evaluation showed relatively high scores across the assessed dimensions. The language aspect obtained the highest score at 95.00%, followed by graphics at 93.33%, while content, integration of deep-learning principles, and presentation each obtained 90.00%. This pattern indicates that the module was considered linguistically appropriate and visually supportive while maintaining alignment between the learning content and the pedagogical approach. The media expert evaluation produced an overall score of 90.00%, with the visual aspect receiving the highest score of 100.00%. These results indicate that the digital presentation was considered appropriate for the intended learning context.

The numerical validation results were complemented by qualitative feedback from the validators. The material expert did not identify substantive problems requiring content revision, whereas the media expert recommended improvements to navigation. In response, hyperlink-based navigation icons were added to facilitate movement between sections of the digital module. This revision demonstrates that expert validation functioned not only as a mechanism for assigning a numerical validity score but also as a process for identifying specific aspects of the product that could be improved before classroom implementation. Nevertheless, the validity findings should be interpreted in light of the number of validators. Because the study involved only one material expert and one media expert, the results represent expert judgment of the developed product rather than evidence of agreement among multiple validators.

The additional analysis of the student practicality questionnaire showed that all eight items demonstrated positive and statistically significant corrected item-total correlations. The coefficients ranged from 0.735 to 0.841, exceeding the critical value of 0.325 at the 0.05 significance level, with all p-values below 0.001. Thus, all items were retained for the practicality analysis. The internal consistency analysis produced a Cronbach's alpha coefficient of 0.943, indicating a high level of internal consistency among the eight items. These findings provide empirical support for interpreting the subsequent student practicality responses. However, the analysis was conducted using responses from 37 students; the lecturer questionnaire involved only two respondents, so internal consistency statistics were not considered meaningful for that group.

The practicality results showed that lecturers gave an overall score of 87.50%, whereas students gave an average score of 91.26%. These results indicate that both groups generally perceived MORFDIGI SPEKAR as practical for Indonesian Morphology learning. The lecturers' responses showed that ease of use obtained the highest score at 95.00%, followed by attractiveness at 87.50% and usefulness at 80.00%. The relatively high score for ease of use suggests that lecturers could use and implement the module without substantial difficulty, while the attractiveness score indicates a positive perception of its presentation and organization.

An important finding is that usefulness received the lowest lecturer score, at 80.00%. This difference should not be interpreted as evidence that the module was ineffective for lecturers. Rather, it may indicate that ease of operation and presentation quality were more immediately observable during the limited implementation, whereas broader instructional benefits may require longer and repeated use to become more evident. This distinction is important because perceived usability and perceived instructional benefit do not necessarily emerge at the same time.

Students also provided positive responses toward the developed module. Ease of use obtained 93.52%, attractiveness 90.54%, and usefulness 89.73%, producing an overall average of 91.26%. The relatively consistent scores across the three dimensions indicate that students generally perceived the module as accessible, appropriately presented, and useful for their learning activities. The practicality findings can also be considered in relation to the digital features incorporated into the module, including hyperlinks, interactive navigation, illustrations, exercises, and reflection activities. Multimedia learning principles emphasize the organization of verbal and visual information to support learners' cognitive processing (Mayer, 2020). However, the practicality findings in this study should primarily be interpreted as evidence of perceived usability and acceptability rather than as direct evidence that particular multimedia features caused improvements in learning.

The effectiveness analysis provided evidence of greater learning improvement in the experimental group. The mean improvement from pretest to posttest was 18.54 points in the experimental group, compared with 11.11 points in the control group. The difference in mean change scores was statistically significant based on Welch's independent-samples t-test, $t(52.29) = 9.37$, $p < .001$, with a 95% CI of [5.84, 9.02] and a Hedges' g of approximately 2.15, indicating a large effect. These findings suggest that students who received instruction using MORFDIGI SPEKAR demonstrated substantially greater improvement in learning outcomes than those who received the regular instructional treatment.

The N-Gain analysis provided supporting evidence, with a mean N-Gain of 0.457 (SD = 0.128) in the experimental group and 0.273 (SD = 0.064) in the control group. The difference was statistically significant, $t(53.45) = 7.74$, $p < .001$, with a Hedges' g of approximately 1.78. Thus, both the change-score analysis and the N-Gain analysis consistently indicated greater learning improvement in the experimental group.

The ANCOVA results were interpreted as supplementary evidence rather than as the primary basis for determining effectiveness. Although the group effect was statistically significant, $F(1, 69) = 199.0$, $p < .001$, the assumptions of homogeneity of variance and homogeneity of regression slopes were violated. Levene's test was significant, $F(1, 70) = 9.872$, $p = .002$, and the group-by-pretest interaction was also significant, $F(1, 68) = 13.41$, $p < .001$. Therefore, the ANCOVA findings should be interpreted cautiously and should not be regarded as unequivocal evidence of causal effectiveness.

The learning-outcome findings are nevertheless relevant to the pedagogical design of MORFDIGI SPEKAR. The module requires students to examine morphological data, construct explanations, apply concepts to new cases, and reflect on their learning. These activities are compatible with a deep-learning orientation that emphasizes understanding and meaning rather than simple reproduction of information (Marton & Säljö, 1976). At the same time, stronger claims concerning improvements in higher-order thinking, conceptual understanding, or long-term learning would require further investigation using larger samples, stronger experimental controls, and longer implementation periods.

Taken together, the findings suggest that the contribution of MORFDIGI SPEKAR lies in connecting digital instructional materials with an explicit pedagogical sequence. The module does not merely convert conventional morphology materials into digital form but organizes learning experiences through a sequence that moves from encountering linguistic phenomena to identifying problems, exploring data, constructing concepts, applying knowledge, and reflecting on learning. For Indonesian Morphology instruction, this approach is relevant because morphological learning requires students to analyze linguistic forms and processes rather than merely memorize definitions. The integration of linguistic data, analytical activities, application, and reflection provides a structured way of connecting morphological concepts with learning activities.

Overall, the findings indicate that MORFDIGI SPEKAR met the predefined validity and practicality criteria for the Indonesian Morphology course, while the learning-outcome findings provide a basis for further investigation of its effectiveness. The contribution of the study therefore lies not only in producing a digital instructional product but also in embedding the SPEKAR pedagogical sequence within a structured digital learning environment.

This study has several limitations that should be considered when interpreting the findings. First, the validation of MORFDIGI SPEKAR involved only one material expert and one media expert. Therefore, the validity results represent individual expert judgments rather than evidence of agreement among multiple validators. Second, the effectiveness analysis involved naturally formed classes from one Indonesian Morphology course at one university. The classes were not randomly assigned at the individual level, and the study was conducted within a single

institutional context. Therefore, the findings should be interpreted within the context of the participating classes and should not be generalized broadly without further investigation. Third, the learning-outcome test consisted of eight analytical essay items, but the available dataset contained only students' total pretest and posttest scores rather than item-level responses. Consequently, separate empirical item-validity and internal-consistency reliability analyses of the learning-outcome test could not be conducted retrospectively. Future studies should involve multiple validators, larger and more diverse samples across institutions, and retain item-level response data so that the learning-outcome instrument can be subjected to empirical validity and reliability analyses before implementation.

CONCLUSION

This study developed MORFDIGI SPEKAR, a digital teaching module for Indonesian Morphology based on the SPEKAR syntax (Stimulation, Problem, Exploration, Construction, Application, and Reflection), using the Four-D (4D) development model. The development process resulted in a digital module that integrates structured learning activities with deep-learning pedagogy for Indonesian Morphology in higher education.

The validation results indicate that MORFDIGI SPEKAR has a high level of content and media validity. The practicality evaluation also indicates that the module is easy to use, attractive, and perceived as useful by lecturers and students in the Indonesian Morphology learning context.

The learning-outcome analysis showed significantly greater improvement in the experimental group than in the control group, as indicated by the change-score analysis and supported by the N-Gain results. The experimental group showed a mean improvement of 18.54 points compared with 11.11 points in the control group, with a large effect size. The initial ANCOVA also showed a statistically significant group difference after controlling for pretest scores. However, the violation of the homogeneity-of-variance and homogeneity-of-regression-slopes assumptions requires the adjusted group effect to be interpreted cautiously. Therefore, the learning-outcome findings provide promising evidence of the potential contribution of MORFDIGI SPEKAR but should not be interpreted as unequivocal evidence of causal effectiveness.

The novelty of this study lies in the integration of the SPEKAR syntax into a digital Indonesian Morphology teaching module, providing a structured pedagogical framework for organizing learning activities beyond the presentation of instructional content. Future research should examine the effectiveness of MORFDIGI SPEKAR through experimental or quasi-experimental designs involving larger and multi-institutional samples to provide stronger empirical evidence regarding its effects on students' conceptual understanding, higher-order thinking skills, and learning outcomes.

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ACKNOWLEDGEMENT

The author would like to express sincere gratitude to the Graduate School of Universitas Negeri Makassar for facilitating this doctoral research. Appreciation is also extended to the material expert, media expert, lecturers, and students of the Indonesian Language Education Study Program, Faculty of Languages and Literature, Universitas Negeri Makassar, for their valuable contributions during the validation and implementation of the developed module.

AUTHOR CONTRIBUTION STATEMENT

RH conceived and designed the study, developed the digital teaching module, collected and analyzed the data, interpreted the findings, and drafted the manuscript. AN supervised the research, contributed to the research design, validated the academic content, and critically reviewed the manuscript. MS contributed to the methodological development, data interpretation, and critical revision of the manuscript. All authors read and approved the final version of the manuscript.

AI DISCLOSURE STATEMENT

The authors used ChatGPT (OpenAI) and Grammarly during the preparation of this manuscript for language refinement, grammar improvement, and manuscript organization. After using the tool, the authors thoroughly reviewed, revised, and verified the content. All research design, data collection, data analysis, interpretation of findings, and final editorial decisions were performed by the authors, who take full responsibility for the content of this publication.

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