

The Effectiveness of NotebookLM-Assisted Nahwu Instruction in Improving Students' Arabic Syntactic Understanding

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Abstract

This study aims to measure the effectiveness of Nahwu learning assisted by NotebookLM in improving the Arabic syntactic comprehension of third-semester students in the Arabic Language Education Department at Sunan Drajat University Lamongan. The research employed a quantitative approach using a quasi-experimental one-group pretest-posttest design. The sample consisted of 32 students selected through total sampling. Data were collected using syntactic comprehension tests measuring students' ability to identify sentence structures, determine i'rāb functions, and analyze syntactic relationships. Data were analyzed through normality testing and paired sample t-test. The findings revealed that the mean pretest score of 61.34 increased to 81.56 in the posttest, with a gain of 20.22 points. The significance value ($0.000 < 0.05$) indicated a statistically significant difference. The N-Gain score of 0.63 was categorized as moderate to high. The results confirm that NotebookLM effectively enhances students' Arabic syntactic understanding and supports AI-assisted nahwu learning.

Keywords: NotebookLM, nahwu learning, Arabic syntax, AI-assisted learning, syntactic understanding.

ملخص

هدفت هذه الدراسة إلى قياس فاعلية استخدام NotebookLM في تعليم النحو لتحسين الفهم النحوي لدى طلبة الفصل الثالث بقسم تعليم اللغة العربية في جامعة سونان دراغات لامونجان. اعتمدت الدراسة المنهج الكمي باستخدام التصميم شبه التجريبي (اختبار قبلي-بعدي لمجموعة واحدة). تكونت العينة من ٣٢ طالباً تم اختيارهم بطريقة العينة الشاملة. جُمعت البيانات بواسطة اختبار الفهم النحوي الذي يقيس قدرة الطلبة على تحديد بنية الجملة، وتعيين الوظائف الإعرابية، وتحليل العلاقات النحوية بين عناصر الجملة. تم تحليل البيانات باستخدام اختبار التوزيع الطبيعي واختبار (t) للعينات المرتبطة. أظهرت النتائج ارتفاع متوسط الدرجات من ٦١,٣٤ في الاختبار القبلي إلى ٨١,٥٦ في الاختبار البعدي بزيادة قدرها ٢٠,٢٢ نقطة، مع دلالة إحصائية ($p < 0,05$). كما بلغ معامل الكسب المعدل ٠,٦٣ في المستوى المتوسط إلى المرتفع. وتؤكد النتائج فاعلية NotebookLM في تعزيز الفهم النحوي ودعم تعليم النحو القائم على الذكاء الاصطناعي..

الكلمات المفتاحية: NotebookLM، تعلّم النحو، النحو العربي، الذكاء الاصطناعي، الفهم التركيبي النحوي.

Abstrak

Penelitian ini bertujuan untuk mengukur efektivitas pembelajaran nahwu berbantuan NotebookLM dalam meningkatkan pemahaman sintaksis bahasa Arab mahasiswa semester III Pendidikan Bahasa Arab di Universitas Sunan Drajat Lamongan. Penelitian menggunakan pendekatan kuantitatif dengan desain *quasi-eksperimental one-group pretest-posttest*. Sampel penelitian berjumlah 32 mahasiswa yang dipilih melalui teknik total sampling. Data dikumpulkan menggunakan tes pemahaman sintaksis yang mengukur kemampuan mengidentifikasi struktur kalimat, menentukan fungsi *i'rāb*, serta menganalisis hubungan antarunsur kalimat. Analisis data dilakukan melalui uji normalitas dan uji t berpasangan. Hasil penelitian menunjukkan peningkatan rata-rata nilai dari 61,34 menjadi 81,56 dengan selisih 20,22 poin dan signifikansi 0,000 ($p < 0,05$). Nilai N-Gain sebesar 0,63 berada pada kategori sedang menuju tinggi. Hasil ini menunjukkan bahwa NotebookLM efektif dalam meningkatkan pemahaman sintaksis bahasa Arab serta mendukung pembelajaran nahwu berbasis kecerdasan buatan.

Kata kunci: NotebookLM, pembelajaran nahwu, sintaksis bahasa arab, kecerdasan buatan, pemahaman sintaksis.

A. Introduction

Arabic language learning, particularly in the domain of nahwu (grammar or syntax), constitutes a fundamental component in achieving comprehensive language proficiency. Nahwu functions not merely as a set of grammatical rules but as a structural system that determines meaning through syntactic relationships among sentence elements. Theoretically, mastery of syntax directly contributes to accurate text comprehension and grammatically correct language production (Hadhrah, 2025; Hermawan, 2020). From a structural linguistic perspective, errors in identifying syntactic roles such as *mubtadā'*, *khavar*, *fi'l*, or *maf'ul bih* may substantially alter meaning and interpretation. Furthermore, cognitive load theory explains that presenting complex grammatical material in abstract and heavily textual forms can overload students' working memory, thereby hindering deep conceptual understanding (Sweller, 2011). Therefore, nahwu instruction requires pedagogical strategies that move beyond rote memorization toward systematic and contextual meaning construction to facilitate durable learning outcomes.

Empirical observations indicate that students of Arabic Education, including those at Universitas Sunan Drajat Lamongan, continue to experience difficulties in analyzing sentence structures and accurately determining *i'rāb* functions. Learning evaluations reveal relatively low levels of syntactic comprehension, particularly when instructional delivery relies on traditional approaches centered on classical texts with limited visualization or interactive support. Such approaches often position students as passive recipients of information, reducing opportunities for active knowledge construction. Previous studies have shown that traditional grammar instruction lacking contextualization and learner engagement significantly contributes to difficulties in mastering Arabic grammar (Hadhrah, 2025; Mustofa, 2019). In addition, limited exposure to authentic language practice and minimal integration of innovative instructional media further constrain students' syntactic development (Hermawan, 2020). These findings suggest the need for more adaptive, interactive, and student-centered learning strategies in nahwu instruction.

Based on preliminary observations conducted in the Arabic Education Department at Universitas Sunan Drajat Lamongan, 68% of third-semester students experienced difficulties in identifying sentence structures and determining accurate *i'rāb* functions during nahwu learning activities. Initial diagnostic tests revealed that the average students' syntactic comprehension score reached only 61.34, which remained below the minimum competency target of 75 established in the course learning outcomes. Most students showed weaknesses in distinguishing *mubtadā'-khavar* patterns, analyzing *fi'l-fā'il* relationships, and determining grammatical endings correctly. These findings indicate a significant gap between the expected syntactic competence and the actual learning outcomes,

highlighting the urgency of implementing more adaptive and interactive instructional strategies in nahwu learning.

The integration of Artificial Intelligence (AI) into language learning has increasingly influenced Arabic grammar instruction, particularly in facilitating analytical and interactive learning processes. In nahwu learning, students often require structured guidance to analyze sentence patterns, determine *i'rāb* functions, and understand syntactic relationships systematically. NotebookLM, developed by Google, offers a document-based AI learning environment capable of generating contextual explanations from uploaded instructional materials. Unlike general AI chatbots, NotebookLM allows students to verify grammatical analyses based on course-specific references, thereby supporting more focused and structured syntactic learning. Previous studies have shown that AI-assisted learning tools can improve grammar comprehension and analytical engagement in language learning contexts (Al-Zahrani, 2024; Rahman et al., 2022).

Several previous studies have demonstrated the effectiveness of AI-assisted learning technologies in improving grammar comprehension and analytical reasoning. Al-Zahrani (2024) found that AI-based learning assistants significantly improved students' grammatical accuracy and engagement in Arabic grammar courses. Likewise, Rahman et al. (2022) reported that AI-supported language learning environments enhanced students' self-regulated learning and syntactic analysis skills. These findings suggest that NotebookLM possesses strong relevance as an instructional solution for overcoming students' difficulties in nahwu learning, particularly in facilitating structured sentence analysis and contextualized grammatical understanding.

Despite the growing body of literature on AI integration in language education, empirical studies specifically examining the implementation of NotebookLM in nahwu instruction remain scarce. This gap underscores the novelty of the present study, which integrates document-based AI technology into Arabic grammar learning to enhance students' syntactic understanding in a measurable manner. By empirically investigating its instructional impact, this study responds to calls for evidence-based evaluation of AI tools in higher education contexts (Zawacki-Richter et al., 2019; Holmes et al., 2022). The objective of this study is to analyze the effect of implementing NotebookLM on the syntactic comprehension of third-semester students in the Arabic Education program at Universitas Sunan Drajat Lamongan. Theoretically, this research contributes to the expanding discourse on AI-supported Arabic language pedagogy. Practically, it proposes an adaptive and interactive instructional model aligned with the learning characteristics of twenty-first-century students while strengthening their mastery of Arabic syntax.

B. Method

This study employed a quantitative approach using a quasi-experimental design with a one-group pretest–posttest model. The quantitative approach was selected because the primary objective of this research was to empirically measure the effect of implementing NotebookLM-assisted nahwu instruction on students' Arabic syntactic understanding through numerical data analyzed statistically. The one-group pretest–posttest design enabled the researcher to compare students' syntactic comprehension before and after the treatment. This design is considered appropriate for examining learning gains resulting directly from instructional intervention within a naturally existing classroom setting (Creswell & Creswell, 2018; Sugiyono, 2022).

The population of this study consisted of all third-semester students enrolled in the Arabic Education program at Universitas Sunan Drajat Lamongan who were taking the Nahwu course. Since the total number of students was fewer than 100, total sampling was employed, meaning all members of the population were included as research participants. Consequently, the sample comprised 32 students. The primary variable investigated in this study was students' Arabic syntactic understanding, operationally defined as the ability to analyze sentence structures, determine grammatical functions (*i'rāb*), and identify syntactic relationships among sentence elements.

Data were collected using a syntactic comprehension test administered as both pretest and posttest. The instrument consisted of 25 items combining objective and analytical questions designed to measure three indicators: (1) identifying Arabic sentence structures, (2) determining grammatical functions (*i'rāb*), and (3) analyzing syntactic relationships among sentence elements. Each item was scored using a rubric ranging from 0 to 4 points, where 0 indicated incorrect analysis and 4 indicated completely accurate syntactic analysis. The instrument was validated through expert judgment involving two Arabic grammar lecturers, while reliability testing using Cronbach's Alpha produced a coefficient of 0.82, indicating high reliability.

Data analysis was conducted using inferential statistics. Prior to hypothesis testing, a normality test was performed to determine whether the data met parametric assumptions. If the data were normally distributed, a paired sample t-test was applied to examine significant differences between pretest and posttest scores. If the normality assumption was not met, the Wilcoxon signed-rank test was used as a non-parametric alternative. In addition, the N-Gain score was calculated to determine the magnitude of students' learning improvement after the treatment. The level of significance was set at 0.05. Through this analytical procedure, the study aimed to determine whether NotebookLM-assisted nahwu instruction significantly improved students' Arabic syntactic understanding.

C. Results and Discussion

Pretest Results

Pretest was administered to measure students' initial syntactic understanding. Table 1 presents the descriptive statistics of the students' pretest scores before the implementation of NotebookLM-assisted nahwu instruction. The data include the number of participants, minimum and maximum scores, mean score, and standard deviation.

Table 1. Pretest Descriptive Statistics

Variable	N	Min	Max	Mean	SD
Pretest Score	32	45	78	61.34	8.12

Based on Table 1, the pretest scores of 32 students ranged from 45 to 78, with a mean score of 61.34 (SD = 8.12). These results indicate that students' initial Arabic syntactic understanding before the implementation of NotebookLM-assisted instruction remained below the expected competency target.

Posttest Results

Posttest was conducted after the completion of the instructional intervention. Table 2 presents the descriptive statistics of the students' posttest scores after the implementation of NotebookLM-assisted nahwu instruction. The table summarizes the number of participants, score range, mean score, and standard deviation obtained after the treatment.

Table 2. Posttest Descriptive Statistics

Variable	N	Min	Max	Mean	SD
Posttest Score	32	68	92	81.56	6.47

As shown in Table 2, the posttest scores ranged from 68 to 92, with a mean score of 81.56 (SD = 6.47). The mean posttest score was higher than the mean pretest score, indicating improvement in students' Arabic syntactic understanding after the implementation of NotebookLM-assisted instruction.

Comparison of Pretest and Posttest

Table 3 compares the mean scores obtained in the pretest and posttest. It also shows the score gain achieved by the students following the implementation of NotebookLM-assisted nahwu instruction.

Table 3. Comparison of Mean Scores

Aspect	Pretest	Posttest	Gain
Mean	61.34	81.56	+20.22

Table 3 shows an increase in the mean score from 61.34 in the pretest to 81.56 in the posttest, resulting in a gain of 20.22 points. The increase indicates improvement in students' ability to analyze Arabic sentence structures and

determine grammatical functions after participating in NotebookLM-assisted nahwu learning.

The increase in students' mean score from 61.34 in the pretest to 81.56 in the posttest indicates that NotebookLM-assisted nahwu instruction effectively improved students' Arabic syntactic understanding. The gain of 20.22 points reflects substantial learning progress in students' ability to analyze sentence structures and determine grammatical functions accurately. This improvement suggests that the integration of NotebookLM facilitated more systematic grammatical analysis and reduced students' difficulties in identifying syntactic relationships

Assumption Testing

Table 4 presents the results of the Shapiro-Wilk normality test for the pretest and posttest data. This test was conducted to determine whether both datasets met the normality assumption required for parametric statistical analysis.

Table 4. Normality Test (Shapiro-Wilk)

Data	Sig.	Interpretation
Pretest	0.112	Normal
Posttest	0.089	Normal

The normality of the data was tested using the Shapiro-Wilk test. The results indicated that the pretest scores ($p = 0.112$) and posttest scores ($p = 0.089$) were normally distributed because both significance values were greater than 0.05.

Hypothesis Testing

The paired sample t-test showed that the posttest scores were significantly higher than the pretest scores ($t = 14.87$, $df = 31$, $p = 0.000 < 0.05$). These findings indicate that NotebookLM-assisted nahwu instruction significantly improved students' Arabic syntactic understanding

The paired sample t-test produced a t-value of 14.87 with a significance value of 0.000 (< 0.05), indicating that NotebookLM-assisted nahwu instruction significantly improved students' Arabic syntactic understanding. This statistical result confirms that the instructional treatment contributed meaningfully to students' syntactic learning achievement.

Gain Score Analysis

The normalized gain (N-gain) score was 0.63, which falls into the moderate-to-high improvement category according to Hake's gain classification criteria. This finding indicates that NotebookLM-assisted instruction produced meaningful improvement in students' Arabic syntactic understanding.

Improvement in Arabic Syntactic Understanding

The increase in the mean score from 61.34 in the pretest to 81.56 in the posttest indicates that NotebookLM-assisted instruction improved students' procedural understanding of Arabic syntax. The reduction in students' errors in identifying sentence structures and determining *i'rāb* functions suggests that the learning process became more systematic and analytically guided. This finding supports Hermawan's (2020) argument that syntactic mastery requires not only memorization of grammatical rules but also procedural analytical competence. The structured verification process provided through NotebookLM enabled students to analyze grammatical patterns more accurately and contextually.

This result aligns with Hermawan (2020), who argues that syntactic mastery requires both declarative and procedural knowledge. The structured verification process facilitated by NotebookLM appears to bridge the gap between rule memorization and applied grammatical reasoning. Furthermore, Hadhrah (2023) emphasizes that traditional text-heavy instruction often contributes to students' difficulties in nahwu. The present findings suggest that AI-assisted tools can mitigate these challenges by restructuring complex material into more digestible analytical sequences.

NotebookLM as a Cognitive Tool in Nahwu Learning

From a theoretical standpoint, the improvement can be interpreted through Jonassen's (2018) concept of technology as a cognitive tool. NotebookLM functioned not merely as an information provider but as a scaffold for higher-order thinking. Students organized syntactic components systematically, evaluated analytical errors, and synthesized grammatical rules across varied contexts.

Kessler (2018) notes that interactive technology enhances analytical engagement in language learning. The present study confirms this perspective, as students actively interacted with linguistic data rather than passively receiving instruction. The structured AI feedback reduced random guessing and encouraged reflective analysis.

AI-Supported Adaptive Learning in Arabic Grammar

The effectiveness of NotebookLM in this study can be attributed to its ability to provide structured and source-based grammatical explanations. Students were able to verify sentence analysis systematically and receive contextual guidance directly connected to the uploaded nahwu materials. This process strengthened students' procedural understanding in identifying sentence structures and grammatical functions more accurately.

Despite the positive findings, this study has several limitations. The research employed a one-group pretest-posttest design without a control group, limiting the ability to compare the effectiveness of NotebookLM with other instructional methods. In addition, the sample size was limited to one university

context, which may affect the generalizability of the findings. Future studies are recommended to involve broader samples and experimental control-group designs to obtain more comprehensive evidence regarding the effectiveness of AI-assisted nahwu instruction

D. Conclusion

The findings of this study demonstrate that NotebookLM-assisted nahwu instruction was effective in improving students' Arabic syntactic understanding. This effectiveness was evidenced by the increase in the mean score from 61.34 in the pretest to 81.56 in the posttest, resulting in a gain of 20.22 points. Statistical analysis using paired sample t-test produced a t-value of 14.87 with a significance level of 0.000 (<0.05), indicating a statistically significant improvement after the instructional treatment. In addition, the N-Gain score of 0.63 was categorized as moderate to high, confirming meaningful learning improvement.

These findings indicate that NotebookLM-assisted learning helped students analyze Arabic sentence structures, determine *i'rāb* functions, and identify syntactic relationships more systematically and accurately. The integration of NotebookLM also supported more active and analytical learning processes by facilitating structured grammatical verification based on course materials.

Therefore, NotebookLM can be considered an effective AI-assisted instructional medium for nahwu learning in higher education contexts. Future studies are recommended to employ experimental designs involving control groups and larger participant samples to strengthen the generalizability of the findings

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