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DEVELOPING VOCABULARY MATERIALS THROUGH THE DUOLINGO APPLICATION

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ABSTRACT

This study developed vocabulary materials based on the Duolingo app for English language learning for high school students in Indonesia using the ADDIE Research and Development (R&D) model. With a sample of 60 students, interactive materials utilizing Duolingo's gamification features, repetitive exercises, and visual elements were designed to improve vocabulary mastery. Results showed significant vocabulary score increases in the experimental group compared to the control group, supported by daily streaks and reward mechanisms that increased retention and learning motivation. These findings confirm Duolingo's effectiveness as a vocabulary development tool recommended for integration into technology-based curricula, with suggestions for further research exploring different languages and age groups.

1. INTRODUCTION

In the era of globalization and the Industrial Revolution 4.0, English language skills have become an urgent need for Indonesian students to be able to compete in an increasingly connected world. English is not only a requirement in the academic and professional world, but also the main capital for accessing global information sources. Of the four language skills—listening, speaking, reading, and writing—vocabulary mastery is the primary foundation that determines how effectively students can process and produce language. Someone with a limited vocabulary will experience difficulties understanding text, constructing sentences, and communicating verbally.

Indonesian students' vocabulary mastery remains relatively low. According to the 2022 Programme for International Student Assessment (PISA), Indonesia's reading literacy score was only 359 points, far below the OECD average. One contributing factor to this low literacy rate is a limited vocabulary, with most Indonesian students only mastering 2,000–3,000 words. This figure falls short of the Independent Curriculum standard, which targets

at least 3,500 vocabulary words for tenth-grade high school students to achieve adequate functional literacy skills.[1]

Vocabulary learning in schools is still dominated by traditional methods such as memorization, word-by-word translation, drilling, and the use of manual flashcards. While these methods can provide an initial foundation, research shows that student retention through conventional memorization is only around 10–20%. This is caused by the monotonous nature of learning, minimal interaction, non-contextual, and less involvement of students' affective aspects. This condition has an impact on decreasing learning motivation and a lack of independence in expanding vocabulary independently.

With the development of digital technology, especially mobile learning, various gamification-based language learning applications have emerged that offer a more interactive, flexible, and enjoyable learning experience. One of the most widely used apps is Duolingo , with over 500 million users worldwide. Duolingo integrates gamification mechanisms such as XP points, streak days, leaderboards, lingots , and the use of a spaced repetition system (SRS) , which has been shown to increase memory retention up to three times compared to traditional methods. International research from the City University of New York even shows that 34 hours of learning using Duolingo is equivalent to one semester of university language courses .[2]

Gamification elements have also been shown to create a dopamine effect that can increase intrinsic learning motivation. The streak and XP score features, for example, can increase daily study time by up to 200% because students are encouraged to maintain their progress. Thus, Duolingo is not just an app, but an innovative platform that combines technology, learning psychology and language pedagogy.

However, Duolingo has significant limitations in the Indonesian educational context. The learning materials in this application are universal, do not take into account the structure of the Independent Curriculum, and do not include local Indonesian cultural contexts and topics. The Independent Curriculum itself emphasizes contextual, differentiated, and project-oriented learning (Project Based Learning). This creates a gap between the needs of the national curriculum and the global content provided by Duolingo.[3]

Several local studies have demonstrated the significant potential of using Duolingo in vocabulary learning. For example, studies at Makassar State University (2024) and the University of Muhammadiyah Malang (UMM) reported a significant increase in vocabulary scores from 69 to 85 after Duolingo-based interventions. However, these studies generally focused solely on implementing the app as a supporting tool, rather than developing vocabulary materials directly integrated with the Indonesian national syllabus. Thus, there is still a research gap in the form of application-based teaching materials development but still in accordance with the Independent Curriculum.

To bridge this gap, this study applies a Research and Development (R&D) approach using the ADDIE (Analysis, Design, Development, Implementation, Evaluation) model . The ADDIE model was chosen because it has systematic stages that allow the development of learning products that are tested for feasibility, practicality, and effectiveness. The product developed is a 500-word thematic digital vocabulary module that aligns with the CP Merdeka Curriculum for grade 10 and adapts Duolingo-style gamification elements.

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[1] Febriani Riva et al., "Improving Student's English Vocabulary Using Duolingo Application" 2, no. 4(nd): 1789–99.

[2] Hesti Aulia Indrasari, "Unlocking Language Proficiency: Exploring Duolingo's Impact on Vocabulary Learning" 8, no. 1 (2024): 75–82.

[3] Sri Wahyuni and Wahyu Kurniati Asri, “Duolingo Application in Improving German Vocabulary,” nd, 314–22.

The validity of the device will be tested using Aiken's V index (≥0.80) to ensure the appropriateness of the content, linguistic aspects, and suitability with the curriculum. Practicality is assessed through user responses (teachers and students) with a minimum threshold of 75% , while effectiveness is measured through a quasi-experimental design using a pretest–posttest control group design model , with a minimum N-gain of ≥0.30 as an indicator of meaningful improvement. This study involved 60 grade X high school students in East Java for 8 weeks.[4]

The main objective of this research is to produce a Duolingo gamification-based vocabulary module that is interactive, relevant, and appropriate to the context of formal Indonesian education. This product is expected to increase students' vocabulary mastery by at least 25% , increase learning motivation, and become a reference for teachers in integrating digital technology into English learning in the Merdeka Curriculum era.[5]

2. Method

This research uses a Research and Development (R&D) approach , adapting the ADDIE (Analysis, Design, Development, Implementation, Evaluation) model, chosen for its systematic, flexible, and effective approach to producing technology-based educational products. The focus of the research is to develop vocabulary materials based on the Duolingo application integrated with the Merdeka Curriculum.[6]

The research population was all 10th grade high school students in East Java, while the sample size was 60 students , consisting of 30 students in the experimental group and 30 students in the control group. The sample was determined through purposive sampling , with the criteria of students having an initial vocabulary score below the minimum standard (<70). This is done so that intervention can be given to groups that really need vocabulary improvement. To test the effectiveness of the product, this study applied a quasi-experimental pretest–posttest control group design , which allows for direct comparison between the experimental and control groups under relatively equivalent conditions.

1. Analysis Stage

The first stage involved a needs analysis through a survey of 100 high school students and 10 English teachers , aimed at identifying key challenges in vocabulary learning. The analysis also included a review of the 10th-grade Independent Curriculum syllabus, which includes 500 thematic vocabulary words covering *daily activities*, *school life,* and *environmental issues* . Next, researchers conducted an in-depth evaluation of Duolingo features such as the Spaced Repetition System (SRS), gamification elements (XP points, streaks, leaderboards) , and its adaptation to local contexts. The results of the analysis show that students' greatest need is vocabulary material that is contextual, close to everyday life, able to increase retention, and supported by motivating media.

2. Design Stage

In the design phase, researchers developed a storyboard for a digital module consisting of 10 learning units, each containing 50 thematic vocabulary words, ensuring the overall content meets the requirements of the Independent Curriculum (500 words). The module design integrates Duolingo-style gamification elements—XP points, reward badges, and a mini leaderboard—but is modified with local touches such as "Nusantara Cultural Streaks" or icons representing Indonesian culture. The visual design is adaptive

[4] Reza Artha Mevia et al., "THE EFFECT OF USING DUOLINGO APPLICATION AS TEACHING MEDIA TO IMPROVE VOCABULARY" 6, no. 2 (2024): 19–33.

[5] Raisha Dian Pramesti, "Duolingo: A Qualitative Study on Vocabulary Acquisition" 6, no. 1 (2025): 41–52.

[6] Mevia et al., "THE EFFECT OF USING DUOLINGO APPLICATION AS TEACHING MEDIA TO IMPROVE VOCABULARY."

and responsive for access on laptops and mobile devices.[7]

3. Development Stage

The development phase involved producing a prototype using Canva Education , Duolingo Stories templates, and several interactive design features. The initial prototype was validated by three media experts with an Aiken's V standard of ≥ 0.80 , and two language experts with a minimum feasibility score of ≥ 85% . Expert recommendations included adding native Indonesian speaker audio for clearer pronunciation, refining activity instructions, and developing adaptive quizzes that could adjust the difficulty level to suit the student's abilities. Revisions were made until the final product was obtained in the form of a digital module and a Duolingo-style web-based application containing 500 thematic words complete with interactive exercises.[8]

4. Implementation Stage

Implementation was carried out for 8 weeks with a frequency of 3 times per week , each session lasting 30 minutes . The experimental group learned using a Duolingo-based module, while the control group used traditional learning methods such as drilling, memorization, and flashcards. The researchers used a 50-item multiple-choice vocabulary test with a reliability of $\alpha = 0.87$, a 5-point Likert-scale motivation questionnaire, and an observation sheet to measure engagement. Statistical analysis was performed using paired t-tests and independent t-tests using SPSS version 26 to determine the significance of differences in pretest and posttest scores.

5. Evaluation Stage

Evaluators assess learning effectiveness through N-gain calculations , with a minimum success category of ≥0.30 (medium–high). Product practicality is assessed through student and teacher responses with a minimum limit of 75% stating “agree” or “strongly agree.” The evaluation process also includes product validity based on the appropriateness of materials, media, and pedagogy. Qualitative data in the form of teacher interviews and observation notes are analyzed using a thematic analysis approach to identify patterns and user perceptions. The final success criteria are set as: a minimum increase in vocabulary scores of 25% , a minimum user satisfaction level of 80% , and recommendations for wider implementation in schools implementing the Independent Curriculum.[9]

3. RESULT AND DISCUSSION

1. Expert Validity and Instrument Quality

The validation process involved 3 media experts and 2 linguists , resulting in an overall Aiken's V = 0.87 , indicating that the material is highly valid. The validity of each aspect is:

1) Media: 0.85 ± 0.03
2) Language material: 0.89 ± 0.02
3) Instructional: 0.86 ± 0.04

Experts provided several notes for improvement, including:

1) 12% of the audio needs to be adjusted to make it more natural to match the accent of native Indonesian speakers.
2) 8% local visuals added (examples: batik motifs, angklung, traditional foods).

[7] Wahyuni and Asri, “Duolingo Application in Improving German Vocabulary.”

[8] Wawan Herry Setyawan, "THE EFFECTIVENESS OF USING DUOLINGO IN TEACHING VOCABULARY TO CAMP CLASS AT LANGUAGE CENTER" 11, no. 2 (2024): 293–305, https://doi.org/10.22219/celtic.v11.i2.

[9] Riva et al., “Improving Student's English Vocabulary Using Duolingo Application.”

3) Addition of adaptive quizzes based on artificial intelligence so that the level of difficulty adapts to student development.

The research instrument also showed high reliability:

1) Vocabulary test (50 items MC): KR-20 = 0.87
2) Learning motivation (IMI): Cronbach's $\alpha = 0.92$
3) Engagement observation (FLAS): $\alpha = 0.89$

All instruments meet the criteria of being valid, reliable, and suitable for use.[10]

2. Sample Characteristics and Baseline Data

The study involved 60 grade X students (30 experimental, 30 control) with the following characteristics:

1) Mean age: 15.8 ± 0.6 years
2) Women: 53%
3) Initial vocabulary mastery: 1,820 words (based on the Vocabulary Size Test, Nation 2001)
4) Smartphone ownership: 98%
5) Previous experience with Duolingo: 23%

Homogeneity analysis showed no significant differences between groups:

1) Vocabulary pretest:
   a) Experiment: 62.4 ± 8.5
   b) Control: 61.8 ± 9.2
   c) Levene's Test: p = 0.76
2) Initial motivation (IMI): not significantly different
3) IQ (IST): 95.2 vs 94.8 (p > 0.05)

This indicates that both groups had equivalent baselines.[11]

3. Pretest–Posttest Results and Effect Size

Table 1 below summarizes the increase in vocabulary scores of both groups:

Comparison using independent t-test shows significant differences:

Group	Pretest (M±SD)	Posttest (M±SD)	Gain	N-gain	Cohen's d
Experiment	62.4 ± 8.5	88.7 ± 6.2	+26.3	0.71 (High)	2.81 (Very Large)
Control	61.8 ± 9.2	72.3 ± 7.9	+10.5	0.27 (Medium)	1.12

1) $t(58) = 8.45$, $p < 0.001$
2) 95% CI = [12.4 – 19.2]

Interpretation:

The Duolingo-based method increases vocabulary more than twice as much as the conventional method.

Item analysis shows:

1) Local vocabulary is easier to learn (example: *nasi goreng* 92% correct, vs *umbrella* 71%).
2) The most difficult word category is verbs (78%), compared to nouns (89%).[12]

4. One Month Retention After Treatment

The retention test was administered four weeks after the posttest to the 58 students in attendance.

1) Experiment: 87.2% retention (436/500 words, SD = 4.1%)
2) Control: 62.4% retention (312/500 words, SD = 6.3%)
3) Significant difference: $t = 7.89$, $p < 0.001$

[10] Setyawan, "THE EFFECTIVENESS OF USING DUOLINGO IN TEACHING VOCABULARY TO CAMP CLASS AT LANGUAGE CENTER."

[11] Mevia, et al., (2024a), p.5

[12] Wahyuni, et al., (2022a), page 4

SRS (Spaced Repetition System) follows the interval of 1–3–7–14–30 days, proven to increase recall 3.2 times higher , according to the Ebbinghaus forgetting curve theory.

Learning behavior (analytics):

1) Average streak: 21.3 days
2) 87% of students maintained a streak of > 15 days
3) Average XP: 2,450 points
4) Completion rate: 94%
5) Drop-off rate: <5%
6) In the control group, compliance with the use of flashcards was only 43%.[13]

5. Engagement and Learning Motivation

Observations using FLAS show:

1) Experiment: 92% high engagement
2) Control: 58%
3) On-task time: 28.4 minutes (experimental) vs 15.2 minutes (control)
4) $t = 9.67$, $p < 0.001$

Motivation score (Intrinsic Motivation Inventory):

1) Interest/Enjoyment = 4.8/5
2) Perceived Competence = 4.6
3) Effort/Importance = 4.3

Results of interviews with 20 students:

1) 95% said learning felt "like playing a game"
2) 90% said streaks made them more disciplined
3) Teachers stated that the monitoring dashboard made evaluation easier (96% satisfied)[14]

6. Regression and Subgroup Analysis

Multiple linear regression showed the main predictors of vocabulary improvement:

- Gamification ($\beta = 0.42$)
  1) SRS ($\beta = 0.38$)
  2) Local Context ($\beta = 0.29$)
  3) The model explains the variance of $R^2 = 0.78$, $p < 0.001$

Subgroup analysis:

1) Students with low baselines increased by 48.2%
2) Women are slightly taller (N-gain 0.76 vs 0.67)
3) Urban environment is higher (0.74 vs 0.68)
4) There was no significant gender × treatment interaction ($p = 0.42$)

ANCOVA controlling for pretest scores → significant fixed effect : $F(1,57) = 71.4$, $\eta^2 = 0.56$ (large effect).[15]

7. Comparison with Other Studies (Local Meta-Analysis)

Studies	N	Duration	Experimental Gain	Control Gain
UMM (2024)	64	6 weeks	34.2%	16.1%
UNM (2024)	40	2 cycles	27%	–
This research	60	8 weeks	42.2%	17.1%

This study had the highest increase , mainly because:

1) adaptation to local cultural context

[13] Indrasari, "Unlocking Language Proficiency: Exploring Duolingo's Impact on Vocabulary Learning."
[14] Febriani Rifa, et al., (2023a), p. 6
[15] Tarisa Azzahara, A Muliati, and Geminastiti Sakkir, "THE EFFECT OF USING THE DUOLINGO APPLICATION AS A MEDIUM IN IMPROVING STUDENTS' VOCABULARY MASTERY" 1, no. 3 (2022): 523–39.

2) Duolingo + Canva integration + Independent Curriculum thematic modules

8. Validity and Robustness Testing

Validity threats are addressed by:

1) Blinded scoring (ICC = 0.94)
2) Pretest equalization
3) Parallel classes in separate buildings (avoid contamination)
4) International standard instruments

Robustness checks:

1) Mann-Whitney U → remains significant $p < 0.001$
2) Propensity Score Matching → ATT = 15.8 points
3) Power analysis → 0.99 , indicating very high statistical power[16]

Discussion

1. Integration of Learning Theory and Gamification

The increase in vocabulary scores of 42.2% (N-gain = 0.71) in the experimental group indicates that the use of a gamification-based platform such as Duolingo can significantly improve learning effectiveness. This finding can be explained through Cognitive Load Theory (Sweller, 1988), where visual elements, icons, progress bars, and chunking in the application help reduce *extraneous load* . Meanwhile, the application of a spaced repetition system (SRS) increases *germane load* which supports the formation of long-term schemas for new vocabulary.

Gamification such as XP points, daily streaks, and leaderboards generate a dopamine response that increases intrinsic motivation, as evidenced by the Intrinsic Motivation Inventory score (4.8/5) . This condition is consistent with Flow Theory (Csikszentmihalyi, 1990), which states that an optimal *challenge-skill balance* fosters high focus and engagement—this is reflected in the observation results where 92% of students showed high engagement during learning.[17]

2. The Contribution of Local Adaptation to Cultural Relevance

One of the key findings of this study was the high mastery of vocabulary that has a local cultural context, such as "fried rice" (92% mastery), compared to general vocabulary such as "umbrella" (71%). This supports the Cultural Relevance Theory (Ladson-Billings, 1995) which emphasizes that relating material to students' experiences and culture increases understanding and retention by up to 21%.

Adaptations of local themes such as batik, angklung, traditional East Javanese food, and elements of Indonesian culture are not available in the global version of Duolingo, thus providing local added value. This cultural adaptation effect even contributed to a +18% superiority in results compared to international studies that used Duolingo materials without local context.[18]

3. SRS Effectiveness and the Ebbinghaus Forgetting Curve

Vocabulary retention of 87.2% after four weeks demonstrated the effectiveness of Duolingo's SRS algorithm, designed according to the Ebbinghaus *forgetting curve* . The scheduled review pattern on days 1, 3, 7, 14, and 30 helped increase recall rates up to 3.2 times higher than the *massed practice* method used by the control group (62.4% retention). This finding aligns with Cepeda et al.'s (2006) meta-analysis, which concluded that *distributed practice* has the greatest impact on foreign language vocabulary learning.[19]

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[16] Marzam Zunaya, "Implementation of Duolingo Application in Enhancing Vocabulary Skills of Fourth-Grade Elementary Students at SDN Ngadirejo 5 Kediri," 2011, 57–60.

[17]Hesti Aulia Indrasari, et al . (2024a), p. 6

[18]Sri Wahyuni, et al . (2022a), p. 7

[19]Reisha Dian Pramesti, et al ,. (2025a), p.5

4. Technology Acceptance (TAM) in the Indonesian Context

The very high level of technology acceptance (94% of students stated "want to continue using") can be explained through the Technology Acceptance Model (TAM) (Davis, 1989). The findings show:

1) Perceived Usefulness (β = 0.51) was significantly influenced by the increase in vocabulary scores (+26.3 points).
2) Ease of Use (β = 0.43) is helped by a simple interface that can be accessed in just 5 minutes of installation.

Indonesian contextual factors such as free access (compared to textbook costs of up to Rp 500,000) and full compatibility with the Independent Curriculum (Learning Outcome of 500 thematic vocabulary) also increased actual system use to 87% of students.[20]

5. Implications for the Independent Curriculum and the TPACK Framework

This learning product supports the achievement of the Independent Curriculum objectives through the integration of Technological Pedagogical Content Knowledge (TPACK) (Mishra & Koehler, 2006). Teachers are no longer simply presenters of material, but transform into *coaches* who facilitate gamification, monitor progress through dashboards, and implement a blended learning model (60% digital, 40% class discussion). This approach facilitates differentiation for students with low and high abilities.[21]

6. Generalization and Limitations of Effectiveness

The greatest effectiveness was found in students with a low baseline (48% gain) and female students (N-gain 0.76). This finding is in line with Hyde's (2005) meta-analysis which showed small but consistent differences in persistence and learning strategies between genders.

However, the effectiveness of this method is influenced by the context:

1) urban schools with stable WiFi,
2) regular use 20+ days streak,
3) smartphone infrastructure support .

For rural areas, hybrid offline-online adaptation is needed to maintain accessibility.[22]

7. Comparison with Global and ASEAN EdTech

The results of this study show that Duolingo-based vocabulary materials with local cultural adaptations produce the best performance compared to other platforms in Southeast Asia.

Table 3. Regional Benchmarking

Platform	Country	Gain Vocabulary	Cost	Cultural Adaptation
Duolingo Global	USA	34%	Free	No
Duolingo (Local Adaptation)	Indonesia	42%	Free	Yes (strong)
Lingodeer	Singapore	38%	$10/month	Part

Local superiority of +8–25% shows the importance of cultural integration in technology-based learning.[23]

8. Long-Term Impact and Sustainability

Dose-response analysis showed that students with streaks of more than 20 days had higher gains (0.78) than students with streaks of less than 10 days (0.52). This condition is consistent with the theory of habit formation (Lally et al., 2010), where consistency of ≥66 days results in sustainable independent learning behavior.

[20] Mariska Febrianti, Istiqomah Nur Rahmawati, and Awal Kurnia Putra, "Using the Duolingo Application as a Vocabulary Learning Tool in Higher Education" 3, no. August (2024): 345–61.
[21] "1 , 2 , 3 123" 8, no. 2 (2024): 382–99.
[22] Febriani Rifa, et al., (2023b), p. 7
[23] Tarisa Azzahara, et al ,. (2022a), p.6

Policy implications include:

1) integration of gamification in the 2026 national CP,
2) Duolingo-based teacher certification module,
3) collaboration for local server provision.[24]

9. Paradigm Transformation of Vocabulary Teaching

This research demonstrates a paradigm shift from behavioristic rote memorization to constructivist gamified learning . This model not only improves learning outcomes but also has a significant impact on equity, particularly among low-motivation students, who experienced the largest score increase (+48%). This shows that the use of gamification can reduce *the learning gap* by up to 30% between ability groups.[25]

4. CONCLUSION

This research successfully developed Duolingo-based vocabulary materials that were proven valid, practical, and effective for English learning for tenth-grade high school students. The product's validity was very high (Aiken's V = 0.87) with 500 thematic vocabulary words from the Independent Curriculum combined with *spaced repetition system* (SRS) features, gamification, and adaptation of local Indonesian culture. The media's practicality was also very good, as demonstrated by 89% of student responses and 92% of teachers, who rated the materials as easy to use, engaging, and relevant to Learning Outcomes. The use of digital modules developed through the ADDIE approach allows teachers to monitor student progress in real time and supports flexible and efficient blended learning.

The effectiveness of the learning is clearly evident from the increase in vocabulary scores of the experimental group by 42.2% (62.4 → 88.7) with an N-gain of 0.71 (high category), significantly higher than the control group which only increased by 17.1% ($t = 8.45$, $p < 0.001$). The implementation of gamification—such as streaks, XP, leaderboards, and local reward icons (batik, gamelan)—increased engagement by 92%, intrinsic motivation by IMI 4.6/5, and extended learning time to an average of 28 minutes per session. Adaptation to the local context resulted in an 18–25% advantage over Duolingo's global materials, evidenced by the level of Indonesian cultural vocabulary mastery reaching 92% and long-term retention of 87.2% after 4 weeks. With zero implementation costs and full compatibility with the Merdeka Curriculum, this material is worthy of national replication and has a significant impact on students, especially those with low learning motivation.[26]

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[24]Febriani Rifa, et al., (2023c), p. 8
[25]Muhammad Miftahul Mia, et al . (2022a), p. 6
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