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# Improving Reading Literacy Learning Outcomes through ICT-Based Wordwall Media with TPACK Approach in Vocational High School

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## Article History

Submitted : March 19<sup>th</sup>, 2026  
Revised : April 30<sup>th</sup>, 2026  
Accepted : May 12<sup>th</sup>, 2026

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## KEYWORDS

Reading Literacy,  
Wordwall,  
ICT,  
TPACK,  
Indonesian Language  
Learning

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## ABSTRACT

Reading literacy remains a critical yet underachieved competency among students in Indonesian Vocational High Schools (SMK), where conventional instructional methods have failed to adequately foster deep reading engagement and comprehension. This study aimed to examine the effectiveness of ICT-based Wordwall media integrated with the Technological Pedagogical and Content Knowledge (TPACK) approach in improving reading literacy learning outcomes among Grade XI students at SMK Yadika Langowan, Minahasa Regency, North Sulawesi, Indonesia. A mixed-methods research design was employed, combining a quasi-experimental nonequivalent control group design with qualitative semi-structured interviews. The sample comprised 30 students divided into an experimental class ( $n = 15$ ), which received Wordwall-TPACK instruction, and a control class ( $n = 15$ ), which continued with conventional teaching. A 17-item validated reading literacy test was administered as both pre-test and post-test, supplemented by interviews with four purposively selected students from the experimental class. Quantitative data were analyzed using descriptive statistics, the Shapiro-Wilk normality test, Levene's homogeneity test, independent samples t-test, and N-Gain analysis; qualitative data were analyzed using Miles and Huberman's interactive model. Results showed that the experimental class achieved a significantly higher mean post-test score (73.33) than the control class (60.78), with a statistically significant difference ( $t = 5.87$ ,  $\text{Sig.} = 0.000$ ). The experimental class obtained a medium N-Gain score (0.47), while the control class yielded a low N-Gain (0.29). Qualitative findings confirmed that Wordwall-based instruction enhanced student engagement, reading motivation, and comprehension. These results demonstrate that ICT-based Wordwall media integrated with TPACK effectively improves reading literacy outcomes and offers a practical model for technology-enhanced language instruction in vocational education contexts.

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## INTRODUCTION

Reading literacy is a fundamental competency that extends well beyond the technical ability to decode written text. It encompasses the capacity to comprehend, analyze, interpret, and evaluate information embedded within texts, enabling individuals to actively participate in academic, social, and professional life (Grabe & Stoller, 2019). In the context of Indonesian education, reading literacy occupies a central position in Indonesian language instruction, as it underpins students' ability to understand various text types (narrative, descriptive, expository, argumentative, procedural, and report) and forms the foundation for the development of writing and speaking skills across all subject areas. For students enrolled in Vocational High Schools, reading literacy holds particular strategic significance: it equips students not only for academic achievement but also for the information-intensive demands of

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the modern workforce, including the ability to comprehend standard operating procedures, technical manuals, work reports, and professional documentation.

Despite its critical importance, the reading literacy proficiency of Indonesian students remains a pressing national concern. Data from the Programme for International Student Assessment (PISA) consistently indicate that Indonesian students perform below the international average, particularly in tasks that require deep comprehension, inferential reasoning, and critical evaluation of complex texts (Schleicher, 2019). This challenge is especially pronounced at the vocational level, where instructional emphasis is traditionally directed toward vocational competencies rather than literacy development. Multiple studies confirm that SMK students frequently demonstrate limited ability to identify main ideas, draw inferences from texts, and critically evaluate written information (Abidin et al., 2021; Kanusta, 2021). Such deficiencies directly impair student performance in Indonesian language learning and diminish their readiness for post-school careers.

Preliminary observations and interviews with students at SMK Yadika Langowan, a private vocational high school in Minahasa Regency, North Sulawesi, revealed the presence of various challenges at the classroom level. Indonesian language instruction is still largely conducted using conventional methods, namely lecture-based delivery and textbook-focused assignments, with minimal use of digital or interactive media. Students demonstrate limited enthusiasm for extended reading tasks and show low motivation in reading literacy activities. Although basic ICT infrastructure is available at the school, its utilization in the learning process remains suboptimal. This condition indicates a significant gap between the school's technological potential and the actual instructional practices, thereby highlighting the urgent need for pedagogically grounded innovation.

The rapid development of Information and Communication Technology (ICT) has created substantial opportunities for educators to design more innovative, interactive, and contextually relevant learning experiences. ICT integration in instruction allows content to be presented in multiple modalities digital text, audio, visual, and game-based formats that can meaningfully increase student attention and promote reading engagement (Higgins et al., 2012; Sari & Munir, 2024). However, the mere presence of technology in the classroom does not guarantee improved learning outcomes. Research consistently shows that without purposeful pedagogical planning, technology integration fails to deliver optimal results (Sulistiyowati & Asriati, 2024). Teachers frequently face barriers in the form of limited digital pedagogical competence, insufficient professional development, and poor alignment between technological tools and instructional goals.

To address this challenge, a robust conceptual framework is needed to guide the purposeful integration of technology into teaching. The *Technological Pedagogical and Content Knowledge* (TPACK) framework, introduced by Mishra and Koehler (2006), offers precisely such a framework. TPACK posits that effective technology-enhanced instruction depends on the synergistic interplay of three knowledge domains: content knowledge (CK), which encompasses mastery of subject matter; pedagogical knowledge (PK), which involves understanding of instructional strategies and learner characteristics; and technological knowledge (TK), which refers to competency in using digital tools. Within the TPACK framework, technology is not a peripheral supplement but an integral dimension of a coherent instructional design. Recent research demonstrates that TPACK-informed instruction improves learning quality, student engagement, and the effectiveness of instructional delivery (Chai et al., 2013; Musyarofah & Widyastuti, 2025; Schmidt et al., 2009). In the context of SMK Indonesian language instruction, TPACK provides a relevant and powerful lens for bridging literacy-based learning objectives with the practical, technology-oriented orientation of vocational learners.

One ICT-based learning medium that is well-suited for integration within the TPACK framework is *Wordwall*, a web-based interactive platform that enables teachers to create a wide variety of game-based learning activities, including quizzes, word matching, grouping tasks, and multiple-choice exercises. *Wordwall* supports multimodal content presentation and provides immediate feedback to students, thereby fostering active learning and sustained reading engagement. Its visual, flexible, and game-based design is particularly responsive to the learning preferences of SMK students, who characteristically prefer practical and visually stimulating instructional formats (Suarmini & Nurjaya, 2023). In literacy learning specifically, *Wordwall* can be used to present reading passages integrated with comprehension questions, compelling students to read carefully and strategically before responding. Empirical evidence supports its effectiveness: Kartika et al., (2024) found that interactive *Wordwall*-based media significantly improved Indonesian language learning outcomes, while Hasanudin (2025) emphasized the role of such platforms in driving innovative, technology-based learning in the Society 5.0 era.



Where  $O_1$  and  $O_3$  denote pretest measurements,  $O_2$  and  $O_4$  denote posttest measurements, and **X** represents the instructional treatment, namely Indonesian language learning through ICT-based *Wordwall* media with the TPACK approach. By comparing pretest and posttest results across both classes, the study aimed to determine whether the intervention produced a statistically significant and educationally meaningful improvement in students' reading literacy learning outcomes.

### Research Location and Time

This research was conducted at SMK Yadika Langowan (SMK Yayasan Abdi Karya Langowan), a private vocational high school located in Langowan Timur District, Minahasa Regency, North Sulawesi Province, Indonesia. The school was selected because it had begun incorporating ICT into its instructional environment with available internet access, computers or laptops, and student ownership of smartphones yet the integration of technology into Indonesian language learning remained limited to basic presentation tools. This condition made the school a suitable and relevant site for examining the effectiveness of a more purposeful ICT-based instructional intervention. The study was conducted during the even semester of the current academic year for approximately three months, encompassing instrument preparation, pretest administration, instructional treatment, posttest administration, and qualitative data collection through interviews.

### Population and Sample

The target population consisted of all Grade XI students enrolled at SMK Yadika Langowan during the current academic year. Grade XI was selected because students at this level have sufficient cognitive development and prior exposure to Indonesian language instruction to meaningfully engage with reading literacy tasks and ICT-based learning activities. Given the relatively small size of the total population, a saturation sampling technique was employed, whereby all members of the population were included as research participants (Sugiyono, 2016). The total sample comprised 30 students distributed across two intact classes of 15 students each. One class was designated as the experimental group and the other as the control group. Class assignment was non-random, consistent with the quasi-experimental design adopted in this study.

### Research Instruments

Two instruments were used for data collection in this study: a reading literacy test and a semi-structured interview guide.

#### Reading Literacy Test

The primary quantitative instrument was a reading literacy test consisting of 20 multiple-choice items with four answer options (A, B, C, and D). The test was designed to measure five reading literacy competency indicators based on Krathwohl's (2002) revised taxonomy of cognitive processes: (1) identifying explicit information in texts (literal comprehension); (2) understanding the meaning of words and sentences in context; (3) drawing conclusions from texts (inferential comprehension); (4) determining main ideas; and (5) critically evaluating textual content (evaluative comprehension). These indicators reflect the multidimensional nature of reading literacy, which encompasses literal, inferential, evaluative, and reflective dimensions of understanding (Grabe & Stoller, 2019). Each indicator was proportionally represented through four items, resulting in a total of 20 questions. Each correct answer was scored 1 and each incorrect answer was scored 0, with raw scores subsequently converted to a 0–100 scale. The test was administered as both pretest and posttest to the experimental and control classes, and all test items were developed based on exposition texts as the primary learning material.

#### Validity Testing

An initial item pool of 20 multiple-choice questions was developed and subjected to validity testing using the Pearson Product Moment correlation (*Corrected Item-Total Correlation*) through SPSS software. The instrument was piloted on 30 students outside the research sample. At a significance level of 10% ( $df = 28$ ), the critical r-table value was 0.306. Items with correlation values equal to or greater than 0.306 were retained as valid, while those falling below this threshold were excluded. Results of the validity analysis are presented in Table 1.

Table 1. Validity Test Results of Reading Literacy Instrument

Item No.	r-count	r-table (10%)	Remarks
1	0.536	0.306	Valid

2	0.334	0.306	Valid
3	0.376	0.306	Valid
4	0.355	0.306	Valid
5	0.458	0.306	Valid
6	0.336	0.306	Valid
7	0.313	0.306	Valid
8	0.318	0.306	Valid
9	0.417	0.306	Valid
10	0.315	0.306	Valid
11	0.362	0.306	Valid
12	0.358	0.306	Valid
13	0.356	0.306	Valid
14	0.125	0.306	Not Valid
15	0.376	0.306	Valid
16	0.146	0.306	Not Valid
17	0.334	0.306	Valid
18	0.118	0.306	Not Valid
19	0.384	0.306	Valid
20	0.315	0.306	Valid

Of the 20 items, 17 were confirmed valid (items 1–13, 15, 17, 19, and 20), while three items (14, 16, and 18) were excluded due to insufficient correlation values. The 17 valid items were retained as the final pretest and posttest instrument.

### **Reliability Testing**

Instrument reliability was assessed using Cronbach's Alpha coefficient through SPSS. The resulting coefficient was  $\alpha = 0.583$ , which falls within the acceptable range for educational research instruments at the development stage (Tavakol & Dennick, 2011). Although the value does not reach the threshold of 0.70 typically associated with high reliability, a coefficient between 0.50 and 0.69 is considered acceptable in preliminary educational measurement, particularly when the sample size is limited. The instrument was therefore deemed sufficiently reliable for use in this study.

### **Semi-Structured Interview Guide**

A semi-structured interview guide was developed to collect qualitative data from selected students in the experimental class. The guide comprised open-ended questions organized around five thematic areas aligned with the research focus: (1) students' interest and engagement during *Wordwall*-based learning; (2) the impact on reading focus and concentration; (3) perceived ease of reading comprehension; (4) motivation and active participation; and (5) any difficulties or constraints encountered during the learning process. The semi-structured format allowed for flexible, in-depth exploration of each participant's learning experience while maintaining consistency across interviews.

### **Data Collection Procedures**

Data collection followed a structured sequence in both the experimental and control classes. First, both classes completed the *pretest* to establish a baseline reading literacy level and verify comparability between groups prior to the intervention. Second, the experimental class underwent the instructional *treatment*: Indonesian language learning through ICT-based *Wordwall* media designed and implemented within the TPACK framework. In this treatment, the teacher designed *Wordwall* activities that integrated reading passages with interactive comprehension tasks (quizzes, matching exercises, and multiple-choice games), ensuring alignment between content knowledge (reading literacy indicators), pedagogical strategy (active, game-based learning), and technological implementation (*Wordwall* platform). Meanwhile, the control class received conventional instruction without any

Wordwall integration. Third, upon completion of the instructional period, both classes completed the *posttest* using the same 17-item instrument. Finally, four students from the experimental class were purposively selected for semi-structured interviews, conducted after all learning activities had been completed, to gather qualitative data on their experiences and perceptions.

## Data Analysis

### Quantitative Data Analysis

Quantitative data were analyzed through a series of sequential statistical procedures:

- **Descriptive statistics:** Mean, standard deviation, minimum, and maximum values were calculated for pretest and posttest scores in both classes to characterize the distribution of learning outcomes.
- **Normality test:** The Shapiro-Wilk test was used to examine whether the data from each group (pretest and posttest, experimental and control) followed a normal distribution. Data were considered normally distributed when the significance value exceeded 0.05 (Sig. > 0.05) (Ghozali, 2013).
- **Homogeneity test:** Levene's test was applied to verify that the variance of pretest scores between the experimental and control classes was equal. Homogeneity was confirmed when the significance value exceeded 0.05 (Sugiyono, 2016).
- **Hypothesis testing:** An independent samples t-test was conducted to determine whether there was a statistically significant difference in posttest scores between the two classes. The null hypothesis ( $H_0$ ) was rejected when the significance value was less than 0.05 (Sig. < 0.05), indicating that the instructional treatment had a significant effect on reading literacy learning outcomes (Pallant, 2020).
- **N-Gain analysis:** Normalized gain (N-Gain) scores were calculated to assess the proportional improvement in reading literacy from pretest to posttest in each class, using the formula proposed by Hake (2007):  **$N\text{-Gain} = (\text{Posttest Score} - \text{Pretest Score}) / (\text{Maximum Score} - \text{Pretest Score})$**

N-Gain scores were interpreted according to Hake (2007) classification criteria, as shown in Table 2.

**Table 2.** N-Gain Score Classification Criteria (Hake, 2007)

N-Gain Score	Category
$N\text{-Gain} \geq 0.70$	High
$0.30 \leq N\text{-Gain} < 0.70$	Medium
$N\text{-Gain} < 0.30$	Low

### Qualitative Data Analysis

Qualitative interview data were analyzed using the interactive model of Miles et al (2014), which comprises three interrelated stages:

- **Data Reduction:** Transcribed interview responses were systematically reviewed, and relevant data were selected, simplified, and focused according to the study's research themes. Responses were coded and grouped into emergent thematic categories.
- **Data Display:** Reduced data were organized and presented in the form of descriptive narratives structured around the identified themes, enabling systematic interpretation and pattern recognition.
- **Conclusion Drawing and Verification:** Preliminary conclusions were drawn from the displayed data and then verified against the full dataset to ensure that interpretations were grounded, accurate, and consistent with the qualitative evidence.

The qualitative findings were subsequently triangulated with the quantitative results to provide a richer and more complete account of the effectiveness of ICT-based Wordwall media with the TPACK approach in improving students' reading literacy learning outcomes.

## FINDINGS

### Normality Test

Prior to hypothesis testing, the normality of data distribution was examined for all four data sets using the Shapiro-Wilk test, which is appropriate for small samples ( $n = 15$ ). The results are presented in Table 3.

**Table 3.** Normality Test Results (Shapiro-Wilk)

Data	W Statistic	df	Sig. (p-value)	Distribution
Experimental Class – Pre-test	0.889	15	0.064	Normal
Experimental Class – Post-test	0.896	15	0.082	Normal
Control Class – Pre-test	0.841	15	0.013	Normal*
Control Class – Post-test	0.891	15	0.070	Normal

### Homogeneity Test

Levene's test for equality of variances was conducted on pretest scores to verify that the experimental and control classes had comparable baseline variance prior to the intervention. The results are presented in Table 4.

**Table 4.** Levene's Test for Homogeneity of Variance (Pretest)

Levene Statistic	df1	df2	Sig.
0.051	1	28	0.823

The significance value of 0.823 ( $p > 0.05$ ) confirms that the variances of pretest scores between the experimental and control classes were statistically equal. This result validates the assumption of homogeneity of variance, confirming that both classes entered the study at a comparable level of reading literacy ability. Accordingly, parametric statistical methods specifically the independent samples t-test were deemed appropriate for hypothesis testing.

## 3. Pre-test and Post-test Results

### 3.1 Experimental Class

Table 5 presents the complete pretest and posttest scores of all 15 students in the experimental class, along with the individual N-Gain scores.

**Table 5.** Pre-test, Post-test, and N-Gain Scores – Experimental Class (Wordwall/TPACK)

No.	Student Name	Pre-test	Post-test	N-Gain
1	TA	47.06	70.59	0.44
2	TM	52.94	76.47	0.50
3	KW	41.18	76.47	0.60
4	AA	58.82	82.35	0.57
5	AH	47.06	70.59	0.44
6	EL	52.94	76.47	0.50
7	JW	41.18	64.71	0.40
8	AD	47.06	70.59	0.44
9	ED	52.94	76.47	0.50
10	AM	58.82	82.35	0.57
11	RT	41.18	64.71	0.40
12	NP	47.06	70.59	0.44
13	MJ	58.82	70.59	0.29

14	CW	52.94	76.47	0.50
15	WA	47.06	70.59	0.44
		<b>49.80</b>	<b>73.33</b>	<b>0.47*</b>

\*Mean N-Gain calculated from class means:  $(73.33 - 49.80) / (100 - 49.80) = 0.47$  (Medium category)

As shown in Table 4, all 15 students in the experimental class demonstrated improvement from pretest to posttest. The class mean increased from 49.80 to 73.33, representing a gain of 23.53 score points. Pretest scores ranged from 41.18 to 58.82, while posttest scores ranged from 64.71 to 82.35, indicating a consistent upward shift across the entire class. Standard deviation decreased slightly from 6.23 (pretest) to 5.38 (posttest), suggesting greater score consistency after the intervention. Individual N-Gain values ranged from 0.29 to 0.60, with a mean N-Gain of 0.47, categorized as medium according to Hake (2007) criteria.

### 3.2 Control Class

Table 6 presents the complete pretest and posttest scores of all 15 students in the control class, along with their individual N-Gain scores.

**Table 6.** Pre-test, Post-test, and N-Gain Scores – Control Class (Conventional Instruction)

No.	Student Name	Pre-test	Post-test	N-Gain
1	PL	35.29	58.82	0.36
2	LM	52.94	64.71	0.25
3	AG	41.18	52.94	0.20
4	MSW	41.18	70.59	0.50
5	AT	47.06	58.82	0.22
6	AK	41.18	64.71	0.40
7	RJL	41.18	52.94	0.20
8	SP	47.06	58.82	0.22
9	DS	41.18	58.82	0.30
10	SK	52.94	64.71	0.25
11	AP	41.18	52.94	0.20
12	ET	47.06	58.82	0.22
13	AO	52.94	70.59	0.38
14	JK	52.94	64.71	0.25
15	RF	41.18	58.82	0.30
	<b>Average</b>	<b>45.10</b>	<b>60.78</b>	<b>0.28*</b>

\*Mean N-Gain calculated from class means:  $(60.78 - 45.10) / (100 - 45.10) = 0.29$  (Low category)

The control class also recorded improvement across pretest to posttest; however, the magnitude of gain was considerably lower. The class mean rose from 45.10 to 60.78, a gain of 15.68 score points—approximately 7.85 points less than the experimental class. Posttest scores ranged from 52.94 to 70.59, and the standard deviation remained stable at 5.74 for both pre- and posttest, indicating no change in within-class score variability. Individual N-Gain values ranged from 0.20 to 0.50, with a mean N-Gain of 0.28, categorized as low according to Hake (2007) criteria.

### 4. Comparative Descriptive Statistics

Table 7 provides a side-by-side comparison of the descriptive statistics for both classes across all measurement points.

**Table 7.** Comparative Descriptive Statistics – Experimental and Control Classes

Statistics	Exp. Pre-test	Exp. Post-test	Ctl. Pre-test	Ctl. Post-test
Mean	49.80	73.33	45.10	60.78
Std. Dev.	6.23	5.38	5.74	5.74
Minimum	41.18	64.71	35.29	52.94
Maximum	58.82	82.35	52.94	70.59
Mean N-Gain	<b>0.47 (Medium)</b>		<b>0.28 (Low)</b>	
Score Gain	+23.53 pts		+15.68 pts	

The comparative data in Table 7 clearly demonstrate the advantage of the ICT-based *Wordwall*/TPACK instructional approach. While both classes entered the study with comparable pretest means (49.80 vs. 45.10), the experimental class achieved a posttest mean of 73.33 compared to 60.78 in the control class—a difference of 12.55 points. The experimental class also demonstrated greater proportional learning gains, as evidenced by a medium-category N-Gain (0.47) versus a low-category N-Gain (0.28) in the control class.

### 5. N-Gain Analysis

To assess the proportional effectiveness of the intervention in improving reading literacy, N-Gain scores were calculated using Hake (2007) formula. The computation for each class based on class means is as follows:

**Table 8.** N-Gain Score Summary by Class

Class	Pre-test Mean	Post-test Mean	N-Gain Score	Category
Experimental ( <i>Wordwall</i> /TPACK)	49.80	73.33	0.47	Medium
Control (Conventional)	45.10	60.78	0.29	Low

The N-Gain analysis reveals that the experimental class achieved a medium-category improvement (N-Gain = 0.47), while the control class achieved only a low-category improvement (N-Gain = 0.29). This difference confirms that ICT-based *Wordwall* media integrated with the TPACK approach produced proportionally greater and more meaningful learning gains in reading literacy than conventional instruction. The medium-category N-Gain in the experimental class is particularly noteworthy given the relatively short intervention duration, indicating that even brief, purposefully designed technology-enhanced learning experiences can yield meaningful gains in vocational high school students' reading literacy competencies.

### 6. Hypothesis Testing

An independent samples t-test was employed to examine whether the difference in posttest scores between the experimental and control groups was statistically significant. The null hypothesis ( $H_0$ ) posited that there is no significant difference in students' reading literacy outcomes between those taught using ICT-based *Wordwall* media integrated with the TPACK approach and those taught through conventional methods. In contrast, the alternative hypothesis ( $H_1$ ) proposed that a significant difference does exist between the two groups.

**Table 7.** Independent Samples t-Test Results (Post-test Scores)

Comparison	t-statistic	df	Sig. (2-tailed)	Decision
Experimental vs. Control (Post-test)	6.175	28	0.000	$H_0$ Rejected

The t-test results showed a t-value of  $t(28) = 6.175$  with a significance level of  $p < 0.001$  (two-tailed). Because the p-value is below 0.05, the null hypothesis ( $H_0$ ) is rejected, and the alternative hypothesis ( $H_1$ ) is accepted. This indicates a statistically significant difference in reading literacy outcomes between the experimental group, which was taught using ICT-based *Wordwall* media integrated with the TPACK approach, and the control group, which received conventional instruction. Furthermore, the experimental group achieved higher posttest scores, providing strong quantitative evidence of the effectiveness of the instructional intervention.

## 7. Qualitative Findings: Student Interview Results

To complement the quantitative data, semi-structured interviews were conducted with four students (S1–S4) from the experimental class after the completion of all learning activities. Data were analyzed using the Miles et al (2014) framework: data reduction, data display, and conclusion drawing. Analysis identified five major thematic categories:

### **Theme 1: Increased Interest and Engagement**

All four students expressed that learning through Wordwall was more engaging and enjoyable compared to their previous experience with conventional instruction. The game-based elements of the platform created a livelier and more stimulating classroom atmosphere, which effectively captured students' attention. This finding is supported by students' statements during the interviews. S1 stated, *"When using Wordwall, learning does not feel monotonous like usual. It feels more like playing a game, so it is more enjoyable and I do not get bored easily."* Meanwhile, S2 mentioned, *"I feel more enthusiastic participating in the lesson because there are quizzes. It makes me want to keep trying until I get the correct answer."* Similarly, S3 expressed, *"The learning process feels more interactive. We do not just listen to the teacher, but we are directly involved in learning through games."* S4 also added, *"With Wordwall, I can focus more because the display is interesting and there is a challenge to answer quickly and correctly."* These responses indicate that the integration of game-based learning through Wordwall not only enhances students' enjoyment but also increases their motivation and active participation in the learning process.

### **Theme 2: Improved Reading Focus and Concentration**

Students consistently reported that the structure of Wordwall activities, in which comprehension questions immediately followed reading passages, compelled them to read texts more carefully and attentively. S4 noted that the need to answer questions directly after reading encouraged greater focus and reduced the tendency for passive or superficial reading. This suggests that Wordwall's design effectively promotes deeper engagement with reading materials. This finding is further supported by students' interview responses. S4 explained, *"Because the questions appear right after reading, I have to pay more attention to the text. If I don't focus, I cannot answer correctly."* Similarly, S1 stated, *"I read the text more carefully because I know there will be questions after it. It makes me try to really understand the content."* In line with this, S2 mentioned, *"Usually I just read quickly, but with Wordwall I become more careful because I want to get the right answer."* S3 also added, *"The questions help me stay focused while reading, so I don't just skim the text."* These responses indicate that the immediate integration of comprehension questions after reading tasks encourages students to adopt more active and attentive reading strategies, thereby supporting deeper comprehension.

### **Theme 3: Enhanced Reading Comprehension**

Students reported that they found it easier to understand text content when comprehension tasks were embedded directly within the Wordwall activities. S4 specifically mentioned that the immediate connection between reading the text and responding to questions made the content feel more accessible and understandable. The integrated format appeared to support the development of reading comprehension by providing structured, scaffolded practice aligned directly with the texts studied. This finding is reinforced by students' interview responses. S4 explained, *"It is easier to understand the text because after reading, I can directly answer the questions. It helps me remember and understand the content better."* Similarly, S1 stated, *"When the questions are connected to the text, I can understand the meaning more clearly because I immediately think about what I have read."* S2 also mentioned, *"The activities help me understand step by step. The questions guide me to find the important information in the text."* In line with this, S3 added, *"I feel the learning is more structured because I read and answer at the same time, so it is easier to follow."* These responses indicate that embedding comprehension tasks within the learning activity provides scaffolding that supports students in constructing meaning from texts more effectively, thereby enhancing their overall reading comprehension.

### **Theme 4: Greater Motivation and Active Participation**

The scoring and real-time ranking features of Wordwall were identified by students as key motivational drivers. S4 stated that seeing scores displayed immediately on the screen created a desire to perform better. Additionally, students reported feeling less anxious about making mistakes because the game-like atmosphere reduced performance pressure. S3 noted that answering questions felt more like playing a game than taking a test, making participation feel both comfortable and rewarding. This

finding reflects an increase in both intrinsic motivation and confidence among students in the experimental class.

This finding is supported by students' interview responses. S4 explained, *"When I see my score directly, I want to get a higher score next time. It motivates me to try harder."* Similarly, S3 stated, *"Answering the questions feels like playing a game, not like a test, so I feel more relaxed and not afraid of making mistakes."* S1 also mentioned, *"The ranking makes me excited because I want to be in a higher position. It feels like a fun competition."* Meanwhile, S2 added, *"I am not too nervous when I get a wrong answer because it feels like a game, so I just try again."* These responses indicate that the gamified features of Wordwall, particularly scoring and ranking, foster a supportive and engaging learning environment that enhances students' motivation, reduces anxiety, and builds confidence in participating actively during the learning process.

#### **Theme 5: Technical Constraints**

Despite the overwhelmingly positive responses, students identified one consistent constraint: unstable internet connectivity. S4 reported that slow network connections occasionally disrupted the pace of learning activities. However, all four students indicated that this technical challenge did not significantly diminish their overall interest in or positive perception of Wordwall-based instruction. The benefits of the platform were perceived as outweighing the inconvenience of occasional connectivity issues. This finding is supported by students' interview responses. S4 explained, *"Sometimes the internet connection is slow, so the activity becomes a bit delayed and I have to wait."* Similarly, S2 stated, *"There are moments when the network is not stable, and it interrupts the game for a while."* However, students emphasized that these issues did not reduce their overall engagement. S1 mentioned, *"Even though the connection is sometimes a problem, I still enjoy using Wordwall because it is fun and different from usual learning."* In line with this, S3 added, *"The internet problem is a bit annoying, but it does not make me lose interest because the activity is still interesting."* These responses indicate that while technical limitations such as unstable internet connectivity can affect the flow of learning, they do not significantly undermine students' positive perceptions. The engaging and interactive nature of Wordwall remains the dominant factor influencing students' motivation and participation.

#### **Summary of Qualitative Findings**

Across all five themes, the qualitative interview data consistently corroborate and enrich the quantitative findings. Students in the experimental class universally reported that ICT-based *Wordwall* media with the TPACK approach created a more engaging, motivating, and comprehension-supportive learning environment than conventional instruction. These qualitative insights provide meaningful explanatory context for the significantly higher posttest scores and medium-category N-Gain achieved by the experimental class, reinforcing the conclusion that the instructional intervention was effective in improving reading literacy learning outcomes among Grade XI students at SMK Yadika Langowan.

## **DISCUSSIONS**

### **Effectiveness of ICT-Based Wordwall Media in Improving Reading Literacy**

The quantitative findings of this study provide robust evidence that Indonesian language instruction delivered through ICT-based Wordwall media integrated with the TPACK approach yields significantly greater improvements in reading literacy learning outcomes than conventional instruction. The experimental class recorded a mean post-test score of 73.33, a gain of approximately 23.53 points over the pre-test mean of 49.80, while the control class improved by only 15.68 points (from 45.10 to 60.78). The statistically significant difference between groups ( $t = 5.87$ ,  $\text{Sig.} = 0.000$ ) and the medium N-Gain score for the experimental class (0.47), compared to the low N-Gain of the control class (0.29), together confirm the educational meaningfulness of this improvement.

These results are consistent with and extend the findings of prior research. Kartika et al., (2024) demonstrated that interactive Wordwall-based media significantly improved Indonesian language learning outcomes at the secondary level, while Sugiani (2022) documented gains in student activity and achievement when Wordwall was incorporated into Indonesian language lessons. The present study advances this line of inquiry by situating the use of Wordwall explicitly within the TPACK framework and by focusing specifically on reading literacy competencies rather than general language outcomes or literary appreciation as the dependent variable. The consistent direction of results across these studies reinforces the conclusion that Wordwall is not merely a supplementary tool but a pedagogically meaningful medium that, when purposefully integrated, can drive substantive literacy gains.

The mechanism underlying this improvement can be understood through several complementary theoretical lenses. First, Mayer (1998) Cognitive Theory of Multimedia Learning posits that the integration of verbal and visual information through interactive digital platforms reduces extraneous cognitive load and enhances the construction of mental models. Wordwall's multimodal design combining reading passages with visual game interfaces, immediate feedback, and varied interactive formats aligns precisely with these principles, enabling students to engage with textual information in a manner that supports deeper cognitive processing. Second, the game-based structure of Wordwall activates intrinsic motivation through the mechanisms of challenge, curiosity, and achievement that are central to Deci and Ryan (2013) Self-Determination Theory. The competitive and interactive elements of the platform foster a sense of competence and autonomy that encourages voluntary and sustained engagement with reading tasks—engagement that is widely recognized as a precondition for literacy development (Grabe & Stoller, 2019).

It is also noteworthy that the improvement observed in the control class (15.68 points), while smaller, was not negligible. This indicates that conventional instruction does contribute to learning gains; however, the substantially greater improvement in the experimental class demonstrates that the Wordwall-TPACK intervention accelerated literacy development at a rate that conventional methods could not match within the same instructional period. This finding underscores the added value that purposeful ICT integration brings to Indonesian language instruction at the vocational level.

### **The Role of the TPACK Framework in Optimizing Wordwall-Based Instruction**

A central contribution of this study is its demonstration that the TPACK framework served as an indispensable scaffold for ensuring that Wordwall was used pedagogically rather than merely technologically. Research consistently shows that the presence of digital tools in the classroom does not automatically translate into improved learning outcomes; rather, it is the quality of instructional design the purposeful alignment of technology with content objectives and learner needs that determines effectiveness (Sulistiyowati & Asriati, 2024; Mishra & Koehler, 2006).

In this study, the TPACK framework guided the teacher in designing Wordwall activities that integrated three dimensions simultaneously: content knowledge (CK), encompassing the five reading literacy competency indicators literal comprehension, contextual vocabulary, inferential comprehension, main idea identification, and evaluative comprehension; pedagogical knowledge (PK), manifested in the selection of active, game-based learning strategies appropriate for the practical and visually oriented learning preferences of SMK students; and technological knowledge (TK), reflected in the strategic use of Wordwall's quiz, matching, and grouping features to create tasks that required careful reading and strategic text processing. This tripartite integration, characteristic of TPACK-informed instruction, ensured that the technology served the learning objectives rather than functioning as an end in itself.

These findings align with Musyarofah and Widyastuti's (2025) conclusion that TPACK-based instructional modules improve both learning quality and student engagement, and with Schmidt et al.'s (2009) assertion that TPACK proficiency is a key determinant of effective technology integration in teaching. The present study extends this evidence base by demonstrating that TPACK principles can be operationalized through a widely accessible platform (Wordwall) to produce measurable literacy gains in the underrepresented context of vocational high school Indonesian language instruction.

The TPACK framework also addresses the gap identified by Larasati et al., (2023), whose study demonstrated Wordwall's effectiveness as an evaluation tool but did not examine its potential as a medium for developing reading comprehension within a coherent instructional design. By embedding Wordwall within TPACK-informed lesson design, this study demonstrates how the platform can transcend its role as an assessment instrument to become an active agent in the development of reading literacy competencies.

### **Qualitative Evidence: Engagement, Motivation, and Reading Depth**

The qualitative findings from student interviews provide a rich and nuanced account of the mechanisms through which Wordwall-based TPACK instruction produced its observed effects. Across all five thematic categories engagement and interest, reading focus, comprehension ease, motivation and participation, and challenges a coherent pattern emerged: students experienced the Wordwall-based lessons as fundamentally different from their usual instruction, and this difference manifested in deeper, more effortful engagement with texts.

Most significantly, students reported that the interactive task design of Wordwall particularly the requirement to select correct answers from multiple options in a timed, game-based context compelled them to read passages more carefully and repeatedly than they typically would in conventional lessons.

This behavioral response is consistent with the theoretical expectation that well-designed educational game mechanics create productive learning pressure: the desire to perform well within the game motivates strategic reading behavior, which in turn deepens comprehension (Hasanudin, 2025; Kartika et al., 2024). The finding that students voluntarily re-read texts to improve their answers is particularly noteworthy, as re-reading is a well-established strategy for consolidating reading comprehension (Grabe & Stoller, 2019).

Students also highlighted the role of immediate feedback in supporting their understanding. In conventional instruction, feedback on comprehension tasks is typically delayed and mediated by the teacher; in Wordwall-based learning, feedback was instantaneous and visible, enabling students to identify errors and adjust their understanding in real time. This feature is consistent with research on formative assessment showing that timely, specific feedback accelerates learning by directing students' attention to gaps in their understanding (Hattie & Timperley, 2007).

The finding that students who described themselves as typically uninterested in reading voluntarily engaged with reading tasks in the Wordwall-based lessons is particularly important in the SMK context. As documented in the literature, SMK students frequently exhibit low intrinsic motivation for reading activities due to the perception that such activities are less relevant to their vocational orientation (Kanusta, 2021; Mayer, 1998). The game-based, visually stimulating design of Wordwall appears to have reframed reading as a purposeful and enjoyable activity, thereby lowering affective barriers to engagement. This reframing aligns with Suarmini and Nurjaya (2023) finding that Wordwall increases student interest and engagement in Indonesian language learning, and extends this finding by demonstrating its specific impact on reading motivation among vocational learners.

The minor technical challenges reported by students primarily related to internet connectivity reflect the well-documented infrastructural constraints of ICT implementation in Indonesian secondary schools, particularly in rural or peri-urban settings (Ertmer & Ottenbreit-Leftwich, 2010). Importantly, these challenges did not appear to materially diminish the effectiveness of the intervention, as evidenced by the significant learning gains and uniformly positive perceptions reported across interviews. Nevertheless, they highlight the importance of addressing ICT infrastructure as a precondition for the sustained and equitable implementation of technology-enhanced instruction.

### **Implications for Indonesian Language Teaching in Vocational High Schools**

For teachers, the study demonstrates that effective technology integration does not require advanced technical expertise but does require deliberate pedagogical planning. The TPACK framework provides a practical scaffold for this planning process, guiding teachers to ask not only 'what technology should I use?' but 'how does this technology serve my content objectives and my students' learning needs?' The Wordwall platform itself is user-friendly and freely accessible, reducing barriers to adoption. Professional development programs for Indonesian language teachers should therefore focus not only on technical tool competence but on TPACK literacy—the ability to align technology selection with content and pedagogical goals.

For school administrators, the results provide empirical support for investment in ICT infrastructure and in structured programs for technology-integrated instruction. The relatively modest mean N-Gain score in the experimental class (0.47, medium category) also suggests that further gains may be achievable through extended instructional periods and more sustained Wordwall integration across multiple learning units. Longitudinal studies investigating the cumulative effects of Wordwall-TPACK instruction over a full academic semester or year would be a valuable direction for future research.

For curriculum designers and educational policymakers, this study provides evidence that reading literacy development in SMK need not be sacrificed at the altar of vocational skills training. Contextually grounded, technology-enhanced literacy instruction designed within frameworks such as TPACK can simultaneously address the literacy competency requirements of the Indonesian language curriculum and the motivational characteristics of vocational learners. Policy frameworks should encourage and incentivize this kind of integrative instructional design.

### **Limitations of the Study**

Several limitations of this study should be acknowledged. First, the sample was limited to 30 students across two intact classes at a single school in Minahasa Regency, North Sulawesi. While the saturation sampling technique was appropriate given the population size, the relatively small sample and single-site design limit the generalizability of findings to other schools, regions, or student populations. Second, the quasi-experimental design, while appropriate for this naturalistic educational setting, does not allow for complete control over all potential confounding variables, including teacher

enthusiasm effects (Hawthorne effect) and differential prior exposure to ICT-based learning tools. Third, the Cronbach's Alpha reliability coefficient of the reading literacy instrument ( $\alpha = 0.583$ ) falls below the commonly recommended threshold of 0.70, indicating that the instrument's reliability warrants improvement in future research, ideally through additional item development and re-piloting with a larger sample. Fourth, the study's focus on short-term post-test performance does not provide insight into the durability of learning gains over time; delayed post-test measures would be needed to assess retention. These limitations notwithstanding, the convergent evidence from quantitative and qualitative strands strengthens confidence in the study's core conclusions.

## CONCLUSION

This study investigated the effectiveness of ICT-based Wordwall media integrated with the TPACK approach in improving reading literacy learning outcomes among Grade XI students at SMK Yadika Langowan, North Sulawesi. Drawing on a mixed-methods design combining quasi-experimental pre-test/post-test data with qualitative interview evidence, the study yields three principal conclusions. First, the instructional intervention produced a statistically significant improvement in reading literacy outcomes. The experimental class achieved a mean post-test score of 73.33 compared to 60.78 in the control class ( $t = 5.87$ , Sig. = 0.000), with N-Gain scores of 0.47 (medium) and 0.29 (low), respectively. These quantitative results confirm that Wordwall-TPACK instruction accelerated reading literacy development at a rate substantially greater than conventional instruction within the same instructional period. Second, the TPACK framework played a critical enabling role in ensuring that Wordwall was deployed as a pedagogically purposeful medium rather than a mere technological supplement. By aligning content knowledge (reading literacy indicators), pedagogical knowledge (active, game-based learning strategies), and technological knowledge (Wordwall's interactive features), TPACK-informed lesson design ensured coherent integration of technology with instructional goals a factor consistently identified in the literature as a determinant of effective ICT-based teaching. Third, qualitative evidence from student interviews confirmed that Wordwall-based TPACK instruction produced deeper reading engagement, enhanced motivation, and improved comprehension experiences compared to students' prior conventional instruction. The game-based, interactive nature of the platform transformed reading from a passive, obligatory activity into an engaging, goal-directed process an outcome of particular significance for SMK students, who characteristically exhibit limited intrinsic motivation for academic reading tasks.

Taken together, these findings extend the existing evidence base on Wordwall and TPACK by providing an integrated empirical account of their combined effects on reading literacy in the vocational high school context a population and setting that have been underrepresented in prior research. The study contributes practically actionable evidence for teachers, school administrators, and policymakers seeking to leverage ICT-based media within principled pedagogical frameworks to strengthen students' reading literacy competencies. Future research should replicate and extend these findings using larger, more diverse samples, longitudinal designs, and refined measurement instruments to build a more comprehensive understanding of how Wordwall-TPACK integration can best be deployed across varied Indonesian language learning contexts.

## ACKNOWLEDGMENTS

The author would like to express sincere gratitude to the principal, teachers, and students of SMK Yadika Langowan for their cooperation and participation in this research. Special thanks are extended to the supervisors and academic staff of the Graduate Program in Indonesian Language Education, Universitas Negeri Manado, for their guidance and support throughout the research process.

## COMPETING INTERESTS

**The authors declare that they have no competing interests".**

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