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Changes in Students' Learning Motivation after Using Wordwall Educational Games in Integrated Natural and Social Sciences at Elementary School

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Abstract*. Learning motivation helps sustain students' attention, persistence, and engagement during instruction. This study examined changes in students' learning motivation after using Wordwall educational games in integrated natural and social sciences (IPAS). A quantitative pre-experimental one-group pretest-posttest design was employed. Saturated sampling included all 29 fourth-grade students at UPTD SDN 2 Rambatan Kulon, comprising 14 boys and 15 girls. Motivation was measured before and after instruction using a 20-item, four-point Likert questionnaire covering five indicators. Data were analyzed using descriptive statistics, a Shapiro-Wilk test of difference scores, a paired-samples t-test, a confidence interval, Cohen's dz, and normalized gain. The mean motivation score increased from 52.59 (SD = 4.49) to 67.10 (SD = 5.58), representing a mean increase of 14.52 points. The paired-samples test indicated a significant change, t(28) = 13.919, p < .001, 95% CI [12.38, 16.65], with Cohen's dz = 2.58. The normalized gain was 0.5286, categorized as moderate. These findings indicate a positive change in motivation following Wordwall use. However, because the study did not include a control group, the observed change cannot be attributed exclusively to Wordwall. Future studies should use a comparison group, document the intervention more comprehensively, and include follow-up measurements.*

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Introduction

Elementary education is directed not only toward knowledge acquisition but also toward developing the psychological readiness that enables students to participate actively and consistently in learning. One important aspect of this readiness is learning motivation. Motivation influences why students initiate learning activities, how much effort they invest, how persistent they remain when encountering difficulties, and which strategies they select to achieve learning goals. Within self-determination theory, the quality of motivation is differentiated according to the degree of autonomy underlying behavior; more autonomous motivation tends to be associated with more adaptive engagement, well-being, and learning outcomes than motivation primarily controlled by external pressure (Ryan & Deci, 2020). The meta-analysis by the previous studied reinforces this perspective by demonstrating that different forms of motivation are associated differently with persistence, engagement, achievement, and student well-

being. Learning motivation should therefore be understood not merely as high or low, but as a process shaped by students' experiences during instruction (Howard et al., 2021). Motivation develops through interactions between individual characteristics and the learning environment.

Autonomy support, clear instructional structure, informative feedback, perceived competence, and positive social relationships can strengthen more adaptive forms of motivation. Identified support for basic psychological needs as an important antecedent of autonomous motivation (Bureau et al., 2022). While emphasized that teachers can learn and implement autonomy-supportive practices (Reeve and Cheon, 2021). These conditions are particularly important in elementary school because students are still developing learning habits and may easily lose attention when classroom activities become monotonous. The ARCS-V model likewise explains that motivating instruction should capture attention, establish relevance, build confidence, produce satisfaction, and sustain volition. Consequently, instructional media and learning activities can form part of the environment that shapes students' motivation.

The need to foster motivation is also relevant to integrated natural and social sciences, known in the Indonesian curriculum as IPAS. IPAS requires students to connect concepts with environmental phenomena, observe causal relationships, and use knowledge to explain everyday experiences. In a unit on energy in daily life, for example, students are expected to identify forms, sources, transformations, and uses of energy through concrete examples. Instruction relying primarily on verbal explanation may limit opportunities for students to respond, test their understanding, and receive feedback. In contrast, activities that provide structured challenges and immediate responses may help students sustain attention and monitor their progress. Research on digital games indicates that instructional benefits do not arise simply from the presence of a game; rather, they depend on alignment among learning objectives, game mechanics, content representations, and the cognitive activities required of students (Malihatin et al., 2026).

Gamification and digital game-based learning are increasingly used to create such activities. Gamification refers to the use of game-design elements in non-game contexts, whereas game-based learning uses games as the principal learning environment or activity. Both may incorporate explicit goals, challenges, scores, time limits, levels, competition, feedback, and repetition. Cautioned that gamification cannot be assumed to be automatically effective because its outcomes depend on design, context, duration, and participant characteristics (Dichev & Dicheva, 2017). Nevertheless, research syntheses generally report favorable tendencies. Meta-analyses by the previous studied (Sailer & Homner, 2020). The gamification can support cognitive, motivational, and behavioral outcomes, although effect sizes vary across studies (Huang et al., 2020; Bai et al., 2020). Feedback, challenge, interaction, and reward systems as mechanisms frequently associated with learner engagement (Zainuddin et al., 2020). Consistent with this pattern, studies conducted in Indonesian elementary classrooms have shown that interactive digital media whether presentation based or game based evaluation tools can improve student learning outcomes (Sefina et al., 2024; Nurhabibah et al., 2021).

These findings are consistent with research focusing more specifically on game-based learning. The previous studied showed that digital games can improve learning outcomes when game design and instructional support are properly aligned. The cognitive benefits from serious games, although motivational benefits were not consistently observed. The previous studied reported positive effects of game-based learning on mathematics achievement (Tokac et al., 2019).while the another studied found that digital game-based

STEM education supported learning achievement (Wang et al., 2022). In science education, showed that gamification has frequently been used to enhance engagement, motivation, and conceptual understanding (Kalogiannakis et al., 2021). The effects of games in STEM education may differ according to students' backgrounds (Arztmann et al., 2023). The potential of game-based learning in early childhood and the early grades, while emphasizing the need for developmentally appropriate design and teacher guidance (Alotaibi, 2024).

Despite these generally positive findings, the motivational mechanisms of gamification are complex. The gamification was particularly associated with increased intrinsic motivation and perceptions of autonomy and relatedness, whereas its effect on competence was more limited (Li et al., 2024). That points, leaderboards, and levels may improve performance without necessarily strengthening intrinsic motivation (Mekler et al., 2017). Similarly found that badges did not always produce the expected changes in motivation or performance (Kyewski & Krämer, 2018). Students' responses may vary according to personality and preferences, meaning that the same design may not be equally effective for all learners (Buckley & Doyle, 2017; Smiderle et al., 2020). The motivational power of gamification as ambivalent: game elements may increase engagement for some participants but may be perceived as external control by others (Van Roy & Zaman, 2018). Therefore recommended tailoring gamification to user needs, learning objectives, and implementation contexts (Oliveira et al., 2023).

Wordwall is a platform that enables teachers to present questions and instructional content through interactive formats such as quizzes, matching, grouping, random wheels, and open-the-box activities. In this study, Wordwall was positioned as an educational game medium that transformed practice or assessment into an activity offering immediate responses and a game-like display. Theoretically, varied displays can attract attention, clearly defined tasks can support perceived competence, and immediate feedback can help students recognize their progress. Research on similar game-based response platforms suggests that ease of interaction, rapid feedback, and appropriately managed competition may support classroom engagement, although the benefits continue to depend on teacher strategy and question quality (Wang & Tahir, 2020). The longitudinal study by the previous studied showed that gamification can support knowledge retention and engagement when it is deliberately planned rather than used merely as an occasional diversion (Putz et al., 2020).

Empirical studies of Wordwall in Indonesian elementary schools have produced promising findings. The previous studied found an association between Wordwall use and fourth-grade students' motivation in social studies (Permana & Kasriman, 2022). The increased interest and motivation in IPAS learning (Hidayah & Andriani, 2023). Thepositive changes in motivation or learning outcomes following Wordwall use (Hafinda et al., 2025; Juraidah et al., 2025; Zahroh & Sutriyani, 2025). The provided additional evidence from IPAS classrooms (Israwaty et al., 2025;Siagian et al., 2026). Similar gains have been reported in other subjects and grade levels, including fifth-grade language learning (Hastuti et al., 2024). Tifth-grade mathematics, and fourth-grade civics education (Julianti et al., 2025; Nurjanah et al., 2025). Nevertheless, most of these studies were conducted in local contexts, involved relatively small samples, and did not always explain the mechanisms underlying motivational change. Learning achievement and motivation are also distinct constructs; improvements in achievement therefore cannot automatically be interpreted as evidence of increased motivation.

Initial responses to digital media may also be influenced by a novelty effect.

Responses to gamification may change through familiarization: initial enthusiasm can diminish, while participants' understanding of game mechanics may develop with repeated use (Rodrigues et al., 2022). This finding is important for short-term pretest-posttest studies because post-intervention changes may reflect a combination of instructional benefits, novel experiences, teacher-student interaction, and time-related factors. Interpretations must therefore distinguish between evidence of score change and certainty that the change was produced exclusively by the medium. The literature further indicates that many gamification studies focus on learning achievement, general engagement, or secondary and higher education, whereas evidence concerning motivational change among elementary students in integrated subjects remains comparatively limited. Meta-analytic findings cannot be transferred directly to every classroom because gamification encompasses widely varying combinations of elements, ranging from simple points to complex game environments. Furthermore, an immediate increase in motivation scores does not necessarily represent a stable increase in intrinsic motivation. Differences in constructs, age groups, subject matter, game formats, and implementation duration must be considered. Classroom-based studies are therefore still needed to document patterns of change while explicitly acknowledging the limits of the inferences that can be drawn.

Preliminary observations of 29 fourth-grade students at UPTD SDN 2 Rambatan Kulon indicated that motivation in IPAS learning required strengthening. The observed patterns included easily diverted attention, limited participation in question-and-answer activities, and boredom during instruction. These observations provided a practical basis for introducing a medium that offered students more opportunities to respond actively. However, the observations were not treated as evidence that the preceding instructional method was the sole cause of limited motivation. Students' motivation may also be influenced by family factors such as parental involvement in fostering motivation as well as previous learning experiences, classroom conditions, relationships with teachers, and individual characteristics (Afendi & Rahayu, 2023).

The research gap concerns the need for empirical evidence specifically describing changes in fourth-grade students' motivation after Wordwall use in an elementary IPAS classroom. Unlike studies limited to students' perceptions or learning achievement, this study measured motivation before and after Wordwall use and reported statistical significance, a confidence interval, an effect size, and normalized gain. Because only one group was involved, however, the study was designed to identify within-group change rather than establish causal effectiveness relative to another instructional condition. Within this limitation, the study aimed to (1) describe students' motivation before Wordwall use, (2) describe their motivation after Wordwall use, and (3) analyze the magnitude and statistical significance of the change. The research question was: Is there a significant change in students' learning motivation after using Wordwall educational games in elementary IPAS instruction?

Method

Design and Participants

This quantitative study employed a pre-experimental one-group pretest-posttest design. The design was selected because the fourth grade at the research site consisted of only one class, and no parallel class was available as a comparison group. The same group was measured before the intervention (O_1), participated in IPAS instruction using

Wordwall educational games (X), and was measured again after the intervention (O_2). The design can therefore be represented as O_1-X-O_2. Because the study did not employ randomization or a control group, it was intended to identify within-group change rather than establish the causal effectiveness of Wordwall relative to another instructional condition.

The population comprised all fourth-grade students at UPTD SDN 2 Rambatan Kulon. All members of the population were included through total population sampling (Sugiyono, 2023), resulting in a sample of 29 students: 14 boys (48.28%) and 15 girls (51.72%). All participants belonged to the same class and learning environment and completed both measurements. The unit of analysis was the individual student, and paired observations were formed from each student's pretest and posttest scores. No participant attrition or missing paired observations was reported; the 28 degrees of freedom in the paired-samples test likewise indicate that all 29 pairs were analyzed.

***Table 1**. Research design, participants, and measurement sequence*

Component	Specification
Design	Pre-experimental one-group pretest-posttest (O_1-X-O_2)
Site	UPTD SDN 2 Rambatan Kulon
Participants	29 fourth-grade students
Gender	14 boys (48.28%); 15 girls (51.72%)
Sampling technique	Total population sampling
Unit of analysis	Students with paired pretest-posttest scores
Outcome variable	Motivation in IPAS learning
Comparison condition	No control group was available

As shown in Table 1, both measurements were obtained from the same group. Score changes were therefore analyzed as paired differences rather than differences between independent groups.

Intervention and Research Procedures

The study comprised preparation, implementation, and data-processing stages. Preparation included preliminary observation, identification of the motivational problem, selection of the design and participants, development of the indicators and questionnaire, instrument testing, and research authorization. During implementation, students first completed the motivation pretest. They then participated in an IPAS unit on energy in everyday life in which Wordwall was used for interactive practice and assessment. The same questionnaire was administered as a posttest after the intervention. The final stage included checking response completeness, reverse-scoring negative items, calculating total scores, performing the statistical analyses, and interpreting the results.

Wordwall was operationalized as a digital educational game medium presenting IPAS questions through interactive activities. The available research documentation identifies its use for practice and assessment and lists quizzes, matching activities, and multiple-choice questions as examples. The records, however, do not provide consistent details regarding the number and duration of sessions, the template used in each session, device configuration, individual or group access, or game-scoring rules. These undocumented specifications limit the procedural replicability of the intervention. An observation sheet was prepared as a supporting instrument to examine media use, student involvement, responses to questions, active participation, and classroom continuity. Complete observation scores were not available in the records examined. The observation sheet is therefore described as part of the data-collection design but was not used to support quantitative claims about intervention fidelity.

Measures and Data Collection

The outcome variable was students' motivation in IPAS learning. The primary instrument was a 20-item closed-response questionnaire using four response options: Strongly Agree, Agree, Disagree, and Strongly Disagree. The questionnaire was developed from five learning-motivation indicators: desire to succeed, learning persistence, interest and attention, positive responses to learning, and external encouragement. Each indicator was represented by four items, as summarized in Table 2.

***Table 2**. Blueprint of the learning-motivation questionnaire*

No.	Indicator	Operational description	Items
1	Desire to succeed	Effort to understand the material and complete tasks	1–4
2	Learning persistence	Diligence and persistence when encountering difficulties	5–8
3	Interest and attention	Interest, focus, and attention in IPAS learning	9–12
4	Positive responses	Enjoyment, enthusiasm, and active engagement	13–16
5	External encouragement	Responses to praise, grades, and teacher reinforcement	17–20

The blueprint in Table 2 provides balanced coverage because each indicator contains the same number of items. Nevertheless, the five indicators are treated as operational dimensions of the researcher-developed questionnaire rather than evidence that a five-factor structure has been confirmed through factor analysis. Ten items were positively worded (Items 1, 2, 5, 6, 9, 10, 13, 14, 17, and 18), and the other ten were negatively worded (Items 3, 4, 7, 8, 11, 12, 15, 16, 19, and 20). Negatively worded items were reverse-scored before computing the total. The scoring rules are presented in Table 3.

***Table 3.** Questionnaire scoring rules*

Response option	Positive items	Negative items
Strongly Agree (SA)	4	1
Agree (A)	3	2
Disagree (D)	2	3
Strongly Disagree (SD)	1	4
Total score range	20–80	20–80

Based on Table 3, the theoretical total score ranged from 20 to 80, with higher scores indicating stronger learning motivation. The same questionnaire was administered at pretest and posttest to ensure that change was measured on an identical scale. Although using the same instrument improves comparability, it may introduce a testing effect because students have already encountered the questionnaire at the second measurement.

The research records report a Pearson item-total correlation analysis involving 29 students, with a reference value of .367. The 20 items had observed coefficients ranging from .371 to .708. Internal consistency was assessed using Cronbach's alpha, which was .860. Table 4 summarizes the item analysis. Because the instrument-testing sample appears to have been the same size as the main sample and no independent validation sample was documented, these results are interpreted as preliminary internal evidence requiring confirmation in a larger independent sample.

***Table 4.** Item-total correlations and internal consistency*

Item	Observed r	Reference r	Decision
X01	0.708	0.367	Criterion met
X02	0.656	0.367	Criterion met
X03	0.596	0.367	Criterion met
X04	0.611	0.367	Criterion met
X05	0.603	0.367	Criterion met
X06	0.540	0.367	Criterion met

Item	Observed r	Reference r	Decision
X07	0.381	0.367	Criterion met
X08	0.507	0.367	Criterion met
X09	0.471	0.367	Criterion met
X10	0.480	0.367	Criterion met
X11	0.492	0.367	Criterion met
X12	0.445	0.367	Criterion met
X13	0.442	0.367	Criterion met
X14	0.427	0.367	Criterion met
X15	0.470	0.367	Criterion met
X16	0.587	0.367	Criterion met
X17	0.371	0.367	Criterion met
X18	0.408	0.367	Criterion met
X19	0.667	0.367	Criterion met
X20	0.614	0.367	Criterion met
20 items	Cronbach's alpha = 0.860	—	Good internal consistency

As Table 4 shows, the lowest coefficient was only slightly above the reference value. It is therefore more accurate to state that all items met the specified correlation criterion than to claim that the instrument's construct validity was comprehensively established. Cronbach's alpha indicates internal score consistency but does not replace examination of factor structure, expert evaluation of content validity, or cross-group validation.

Data Analysis

The analyses were conducted on total motivation scores. Descriptive statistics included the number of participants, mean, standard deviation, percentage of the maximum score, and score change. Percentages for the five indicators were reported to describe their patterns of change. The primary inferential analysis was based on the difference score D = posttest - pretest. Normality of the difference scores was examined using the Shapiro-Wilk test because the paired-samples t-test assumes that these differences are approximately normally distributed. The decision was not based solely on the separate distributions of pretest and posttest scores.

A paired-samples t-test evaluated the null hypothesis that the mean difference was zero at the .05 significance level. The results were reported using t, degrees of freedom, p value, and a 95% confidence interval for the mean difference. The difference was defined as posttest minus pretest, so a positive value indicated an increase. Cohen's dz was calculated by dividing the mean difference by the standard deviation of the difference scores. Reporting an effect size follows the principle that a p value should be accompanied by an estimate of the magnitude of change.

Normalized gain was calculated as g = (posttest score - pretest score)/(maximum score - pretest score) and then averaged across participants. Values below .30 were categorized as low, values from .30 to below .70 as moderate, and values of .70 or above as high. Because normalized gain was originally used primarily for mastery scores with a defined maximum, its application to motivation scores was interpreted cautiously and treated as a supplementary analysis rather than the sole evidence of change. The analysis plan is summarized in Table 5.

Table 5. *Statistical analysis plan and decision criteria*

Purpose	Analysis	Statistic/criterion
Describe scores	Descriptive statistics	n, mean, SD, percentage
Check assumption	Shapiro-Wilk test of difference scores	p > .05: assumption not rejected
Test change	Paired-samples t-test	α = .05; 95% CI

Purpose	Analysis	Statistic/criterion
Estimate magnitude of change	Cohen's dz	Mean difference/SD of differences
Estimate relative improvement	Normalized gain	< .30 low; .30-< .70 moderate; ≥ .70 high

The sequence in Table 5 ensured that the conclusion did not depend only on categories or p values. The mean and confidence interval expressed change in score units, Cohen's dz represented standardized change, and normalized gain indicated improvement relative to the available room for improvement. Analyses were conducted using SPSS version 25, and the statistical summaries were checked for consistency across the manuscript.

Ethical Considerations

The study was conducted under institutional authorization from the Faculty of Teacher Training and Education, Universitas Muhammadiyah Cirebon, through Letter No. 115/2.a/UMC-FKIP-D/V/2026. Implementation at the research site was authorized by UPTD SDN 2 Rambatan Kulon through Letter No. 421.2/018-SD, dated June 12, 2026. These documents constituted institutional and site permissions and are not described as approval from a research ethics committee. Student identities were omitted from the analysis and reporting; data were presented using codes or aggregate summaries and were used for academic purposes. The manuscript does not claim that additional consent procedures were obtained when they were not documented.

Results and Discussion

Results

Data Characteristics and Changes in Total Scores

Complete paired pretest and posttest scores were available for all 29 students. Table 6 summarizes motivation scores before and after Wordwall use and the corresponding change scores. Decimal values were reported consistently across the abstract, results, discussion, and conclusion.

Table 6. *Descriptive statistics for learning-motivation scores*

Measurement	n	Mean	SD	Percentage
Pretest	29	52.59	4.49	65.74%
Posttest	29	67.10	5.58	83.88%
Change	29	14.52	5.62	18.15 percentage points

As shown in Table 6, the mean score increased from 52.59 to 67.10. The mean difference of 14.52 points indicates that posttest scores were higher, on average, than pretest scores. The posttest standard deviation was slightly larger than the pretest standard deviation, indicating a modest increase in between-student variability at the final measurement. The standard deviation of the difference scores, 5.62, was used as the denominator in the calculation of Cohen's dz.

Changes across Motivation Indicators

In addition to the total score, changes across the five indicators were examined descriptively. Table 7 compares pretest and posttest percentages and reports change in percentage points.

Table 7. *Changes across learning-motivation indicators*

Indicator	Pretest	Posttest	Change
Desire to succeed	72%	89%	+17
Learning persistence	61%	83%	+22

Indicator	Pretest	Posttest	Change
Interest and attention	65%	83%	+18
Positive responses	65%	83%	+18
External encouragement	64%	81%	+17

Table 7 shows positive movement across all indicators. The largest increase occurred in learning persistence (22 percentage points), followed by positive responses (18 points), interest and attention (18 points), desire to succeed (17 points), and external encouragement (17 points). Desire to succeed had the highest percentage at both measurements. Because item-level indicator data and corresponding standard deviations were unavailable, differences among indicators were not tested inferentially and cannot be interpreted as evidence that one indicator changed significantly more than another.

Assumption Testing and Paired Change

Normality was assessed for the difference scores, calculated as posttest minus pretest. The Shapiro-Wilk test yielded $W = .953$ and $p = .218$. Because p exceeded .05, there was insufficient evidence to reject the normality assumption for the difference scores. The paired-samples t-test was subsequently conducted, and the complete results are presented in Table 8.

Table 8. *Assumption test, paired change, and effect size*

Analysis	Estimate	p value	Interpretation
Shapiro-Wilk test of difference scores	$W = .953$	.218	Normality assumption not rejected
Paired-samples t-test	$t(28) = 13.919$	$< .001$	Significant change
Mean change	14.52; 95% CI [12.38, 16.65]	—	Positive direction
Cohen's dz	2.58	—	Very large standardized change

Table 8 shows a mean increase of 14.52 points, $t(28) = 13.919$, $p < .001$. The 95% confidence interval [12.38, 16.65] excluded zero, supporting a positive within-group change. Cohen's dz = 2.58 indicates a very large standardized change in this sample. This large effect size does not eliminate internal-validity threats arising from the absence of a control group; it represents the magnitude of paired change, not the proportion of change that was necessarily caused by Wordwall.

Normalized Gain and Reporting Consistency

As a supplementary analysis, normalized gain was used to represent improvement relative to the maximum score. The classification criteria and observed result are presented in Table 9.

Table 9. *Normalized-gain criteria and study result*

Range	Category	Study result
$g < .30$	Low	
$.30 \leq g < .70$	Moderate	.5286 (52.86%)
$g \geq .70$	High	

Table 9 shows a mean normalized gain of .5286, or 52.86%, categorized as moderate. This value indicates that the observed increase occupied approximately half of the potential improvement according to the normalized-gain formula. It should not be interpreted as the percentage of students who improved or as a percentage of the medium's causal effectiveness. Descriptive statistics, the confidence interval, paired-samples test, effect size, and normalized gain consistently indicate that motivation scores were higher after Wordwall use than before it.

Discussion

Changes in Motivation after Wordwall Use

Students' learning-motivation scores were higher after Wordwall use than before it. The 14.52-point mean increase, a confidence interval entirely above zero, and a large within-sample effect size indicate that the observed change was not merely a trivial numerical difference. Nevertheless, the finding must be described as change following the intervention rather than proof that Wordwall was its sole cause. A one-group design cannot separate intervention effects from history, maturation, repeated testing, regression to the mean, or other concurrent changes. Emphasized that one-group pretest-posttest designs can document within-group change but cannot establish causal relationships without an appropriate comparison (Bierer et al., 2025).

Theoretically, the increase may be explained by the quality of the learning experience created during media use. Varied displays and challenges can attract attention, explicit goals and game rules can provide structure, and immediate responses can inform students about success. These features align with the ARCS-V framework, which identifies attention, relevance, confidence, satisfaction, and volition as conditions for sustaining motivation. From the perspective of self-determination theory, opportunities to respond, observe progress, and interact may support competence, autonomy, and relatedness, provided that the game is not used in an excessively controlling manner Ryan & Deci, 2020). Teacher autonomy support remains important because media cannot replace teachers' provision of choice, meaningful rationale, assistance, and informative feedback (Reeve & Cheon, 2021).

This interpretation is consistent with syntheses of gamification research. The previous studied found positive cognitive, motivational, and behavioral effects (Sailer & Homner, 2020). Generally favorable but heterogeneous learning outcomes (Huang et al., 2020; Bai et al., 2020). More specifically identified increases in intrinsic motivation and perceptions of autonomy and relatedness, but a more limited effect on competence (Li et al., 2024). The increases observed here in interest, attention, positive responses, and persistence are compatible with these mechanisms. However, because the questionnaire did not directly measure basic psychological needs or each ARCS-V component, this explanation is theoretical rather than the result of a mediation analysis.

Relevance to IPAS Learning and Previous Findings

In IPAS instruction, game media may transform conceptual practice into a responsive activity. The previous studied showed that gamification in science education is frequently used to support motivation, engagement, and conceptual understanding (Kalogiannakis et al., 2021). Identified benefits of game-based learning in STEM education while emphasizing variation according to design and participant characteristics (Wang et al., 2022; Arztmann et al., 2023). Wordwall may therefore be useful when its questions align closely with the objectives of the energy unit, the difficulty is appropriate, and feedback assists students' understanding rather than merely encouraging them to pursue game scores.

The results align with Indonesian studies of Wordwall. The previous reported increased motivation among fourth-grade students in social studies (Permana & Kasriman, 2022).Likewise reported positive findings in IPAS learning (Hidayah and Andriani, 2023; Israwaty et al., 2025; Siagian et al., 2026). While identified changes in motivation or learning outcomes in elementary-school contexts (Hafinda et al., 2025;

Juraidah et al., 2025; Zahroh & Sutriyani, 2025). The consistent direction of these findings strengthens the proposition that Wordwall's interactive features can support learning experiences. Nevertheless, differences in design, content, duration, instruments, and school characteristics preclude treating effect estimates across these studies as fully equivalent.

Evidence from the broader digital-game literature provides further context. Emphasized that instructional design quality determines whether game elements contribute to meaningful learning (Clark et al., 2016). Showed that cognitive benefits are not always accompanied by equally strong motivational benefits. The previous studied found positive effects in particular populations and subjects, but these results cannot be generalized without considering developmental stage and implementation context (Tokac et al., 2019; Alotaibi, 2024). The observed motivational change should therefore be associated with the complete learning experience including IPAS content, classroom management, teacher involvement, peer interaction, and Wordwall use rather than with the platform as an independently operating technology.

Variation in Responses and Sustainability of Effects

An increased mean score does not imply that every student responded in the same way. The previous studied demonstrated that preferences, personality, and interpretations of game elements may produce different motivational responses (Buckley & Doyle, 2017; Van Roy and Zaman, 2018;Smiderle et al., 2020). That points and leaderboards may improve performance without necessarily increasing intrinsic motivation, while cautioned that badges do not automatically strengthen motivation or participation (Kyewski & Krämer2018). Competition, scores, and rewards should therefore be used proportionately so that students do not become focused solely on winning. Tailoring gamification to user needs, as recommended by the previous studied may reduce undesirable responses (Oliveira et al., 2023).

The sustainability of the change cannot be determined from a single posttest. The previous studied found that gamification benefits may persist when implementation is consistently designed (Putz et al., 2020). Whereas identified novelty and familiarization effects that change responses over time (Rodrigues et al., 2022). Students' enthusiasm in this study may partly reflect the novelty of the medium, while repeated use may produce a different pattern. In the absence of follow-up measurement, the results represent students' immediate condition after Wordwall use and do not establish long-term motivational stability.

Practical Implications

For teachers, the findings support the use of Wordwall as a supplement to IPAS instruction, particularly for eliciting student responses, providing practice, and delivering rapid feedback. Wordwall should be integrated into a sequence of conceptual explanation or exploration, discussion, game activity, and reflection. Teachers should ensure question readability, adequate time, equitable opportunities to participate, and explanation of incorrect answers. Evidence on game-based response systems indicates that classroom benefits depend on question design and facilitation strategy rather than application use alone (Wang & Tahir, 2020). Gamification should not replace experiments, environmental observations, or conceptual discussions that are central to IPAS learning.

Teachers should also monitor whether game elements produce meaningful engagement or only momentary excitement. Identified challenge, feedback, interaction,

and rewards as elements frequently supporting learning (Zainuddin et al., 2020). But the previous studied cautioned that evidence for gamification depends strongly on implementation quality (Dichev & Dicheva, 2017). Wordwall templates should therefore be selected according to purpose: matching activities for connecting concepts, grouping activities for classification, and quizzes for checking understanding. Multiple formats need not be used simultaneously when doing so would increase cognitive load or distract attention from the content.

Limitations

First, the pre-experimental design without a control group limits causal attribution. Second, the study involved only 29 students from one class and one school, precluding statistical generalization to a broader population. Third, motivation was measured through self-report, which may be influenced by socially desirable responding or students' comprehension of the statements. Fourth, the available documentation did not provide sufficiently complete evidence concerning the original item-development source, expert content validation, or confirmation of the questionnaire's factor structure. The item-total correlation and internal-consistency estimates offer preliminary evidence but do not constitute comprehensive construct validation. Fifth, details concerning session duration, Wordwall templates, device configuration, and intervention-fidelity scores were not comprehensively documented. Sixth, the lack of follow-up measurement prevented examination of whether the change persisted beyond students' initial response to the medium.

Future research should employ a comparison group, stronger allocation procedures where feasible, samples from several schools, and follow-up measurement. Motivation instruments should report their development source, blueprint, sample items, scoring rules, validity evidence, and reliability in the study sample. Quantitative data may be supplemented with engagement observations, student and teacher interviews, Wordwall usage logs, and intervention-fidelity assessment. Such designs would help determine not only whether scores change, but also the underlying mechanisms, variation among students, and sustainability of motivational change.

Conclusion

The learning motivation of the 29 fourth-grade students increased after Wordwall educational games were used in IPAS instruction. The mean score changed from 52.59 (SD = 4.49) at pretest to 67.10 (SD = 5.58) at posttest, representing a mean increase of 14.52 points. This change was statistically significant, $t(28) = 13.919$, $p < .001$, 95% CI [12.38, 16.65], with Cohen's $dz = 2.58$ and a moderate normalized gain of .5286. These findings demonstrate a positive within-group change after Wordwall use but do not establish that the change was caused exclusively by the medium. The principal limitations were the absence of a control group, a sample drawn from a single class, reliance on self-report, incomplete intervention documentation, and the absence of follow-up measurement. Future research should include a comparison group, multiple schools, detailed records of intervention duration and fidelity, validation of the instrument in an independent sample, and follow-up measurement. Questionnaire data should also be complemented by observations, interviews, and media-usage logs to clarify the mechanisms and sustainability of motivational change.

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