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Effectiveness of Online Physics Learning Platforms in Improving Students' Learning Motivation

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Abstract – *This study explores ongoing motivation challenges in junior high school physics, where abstract concepts and teacher-centered methods often diminish student engagement. It aims to compare six online learning platforms Google Classroom, Canvas, Padlet, Nearpod, Genially, and Kahoot! in boosting students' physics motivation using the ARCS framework (Attention, Relevance, Confidence, Satisfaction). A quasi-experimental, non-equivalent group pretest–posttest design was conducted across six junior high schools in Ngada Regency, Indonesia, involving 120 eighth-grade students (one intact class per school). Motivation was assessed with a validated 20-item ARCS-based questionnaire on a five-point Likert scale, complemented by classroom observations and teacher interviews for contextual insights. Data analysis included descriptive statistics, assumption tests (normality and homogeneity), paired-sample t-tests, one-way ANOVA, and Tukey HSD post hoc analysis. Results revealed significant increases in motivation from pretest to posttest for all platforms ($p < 0.001$), suggesting that platform-supported physics instruction can effectively boost student motivation. Notably, motivational improvements varied significantly across platforms ($F = 9.400$, $p < 0.001$): interactive and gamified platforms, especially Kahoot! and Nearpod, yielded higher gains than more text- and task-focused platforms such as Google Classroom and Padlet. The unique contribution of this study lies in its systematic comparison of multiple platforms within the same grade level and physics topic in a non-urban setting, interpreted explicitly through ARCS. The findings highlight that interactivity and immediate feedback are crucial for motivating students and offer evidence-based guidance for physics teachers and schools in choosing and integrating digital platforms to create more motivationally engaging instruction and professional development for technology-enhanced physics education.*

Keywords: *ARCS model; gamification; learning motivation; online platforms; physics education*

I. INTRODUCTION

Physics is frequently regarded as a difficult subject by junior high school (SMP) students because understanding physical phenomena often requires abstract reasoning alongside mathematical representations. When students fail to develop a solid understanding of basic physics concepts, their interest in learning tends to decline, thereby weakening intrinsic motivation (Pols et al., 2021). Reduced motivation negatively affects students' active engagement in classroom activities and ultimately impacts learning outcomes (Shin & Bolkan, 2021). These conditions indicate that conceptual difficulty and motivational issues in physics learning are closely interconnected and require targeted pedagogical attention.

Conventional instructional practices commonly found in junior high schools, such as teacher-centered lectures and rote memorization, are often ineffective in fostering students' curiosity, exploration, and conceptual understanding in physics (Al-Kamzari & Alias, 2025; Banda & Nzabahimana, 2021; Verawati & Nisrina, 2025). Consequently, there is a growing need to integrate digital technology into physics instruction to support more engaging, contextual, and student-centered learning experiences. Previous studies suggest that digital learning platforms can enhance physics learning by providing visual representations, interactive activities, and flexible access to learning resources, which are particularly beneficial for abstract scientific concepts (Chang et al., 2023; Dominguez et al., 2023; Kotsis, 2024; Kotsis & Vakarou, 2025).

Various online learning platforms, including Google Classroom, Canvas, Padlet, Kahoot!, Genially, and Nearpod, have been increasingly adopted in science and physics education to support digital learning environments. Prior research indicates that platforms incorporating interactive and gamified features, such as Kahoot!, can enhance students' learning motivation through competition, feedback, and active participation (Astuti et al., 2021; Ghawail & Yahia, 2022; Lashari et al., 2024; Meulenbroeks, 2024; Rayan & Watted, 2024). Meanwhile, platforms such as Nearpod and Genially emphasize visualization and interactivity to help students better understand abstract physics concepts (Maison et al., 2025; Muzakki et al., 2025). In contrast, learning management systems such as Google Classroom and Canvas primarily function as tools for organizing materials and assignments, supporting self-regulated learning rather than direct motivational engagement (Furqon et al., 2024; Magalong & Palomar, 2019; Schumacher & Ifenthaler, 2021; Widiyatmoko, 2021). These differences suggest that each platform may influence students' learning motivation in distinct ways.

However, despite the increasing adoption of digital learning platforms in physics education, systematic comparative studies evaluating their effectiveness at the junior high school level remain limited. Most existing studies tend to focus on the implementation and impact of a single platform rather than examining how different platform characteristics influence learning motivation in comparative settings. As emphasized by Wong & Hughes (2023), the effectiveness of learning media is not determined solely by technological features, but also by how well the media address students' cognitive and affective needs. In this regard, although interactive technologies have been shown to support conceptual understanding (Alhadlaq, 2023), evidence comparing multiple platforms within the same instructional context is still insufficient.

This study focuses on students' learning motivation as a central indicator of effective physics instruction. Motivation plays a crucial role in determining students' engagement, persistence, and achievement in learning science. The ARCS model proposed by Keller (2010) conceptualizes learning motivation through four dimensions: Attention, Relevance, Confidence, and Satisfaction. From this perspective, an effective digital learning platform should not only deliver content efficiently but also be able to attract students' attention, connect learning materials to meaningful contexts, build learners' confidence, and provide a sense of satisfaction during the learning process (Cai et al., 2021; Tuveri et al., 2022). Therefore, the ARCS framework offers a systematic lens for examining how different online platforms influence students' motivational experiences in physics learning.

Although previous studies have demonstrated that well-designed digital platforms can support the motivational dimensions of the ARCS model, their effectiveness depends heavily on contextual factors such as technological infrastructure, teacher readiness, and student characteristics (Sofi-Karim et al., 2023). This issue becomes particularly relevant in non-urban, resource-limited educational settings, where variations across schools may shape how digital platforms are implemented and experienced by learners. Based on the identified research gap, this study aims to systematically compare the effectiveness of six online learning platforms, Google Classroom, Canvas, Padlet, Nearpod, Genially, and Kahoot! in enhancing junior high school students' motivation in physics learning. Specifically, the study examines changes in students' learning motivation before and after the implementation of each platform, as measured through the four dimensions of the ARCS model: attention, relevance, confidence, and satisfaction. By adopting a comparative perspective, this research moves beyond single-platform evaluations. It provides a more comprehensive understanding of how different platform features relate to students' motivational responses in physics classrooms and after using these platforms (Fajri et al., 2021; Kua et al., 2022; Keller, 2010; Veermans et al., 2022).

Therefore, this study aims to evaluate and compare the effectiveness of these six platforms in enhancing Grade VIII students' motivation in physics through a quasi-experimental non-equivalent group pretest–posttest design involving six junior high schools in Ngada Regency, Indonesia. Motivational changes will be measured using a validated ARCS-based questionnaire and validated through classroom observations and teacher interviews. The novelty of this work lies in (1) providing a head-to-head comparison of multiple mainstream platforms under a common curricular topic and standardized instructional sequence, enabling more reliable cross-platform interpretation than single-platform studies; (2) combining ARCS-based quantitative gains with qualitative classroom evidence to clarify not only whether motivation increases but also how engagement patterns differ by platform; and (3) offering context-specific evidence from a non-urban, resource-limited setting to better guide schools in selecting platforms to strengthen motivation in physics learning.

II. METHODS

This study employed a quasi-experimental design with a non-equivalent group pretest–posttest approach. Six intact groups from different junior high schools participated, each using a specific online learning platform for physics instruction. Randomly assigning students to platforms was not feasible within the schools; thus, each school acted as one experimental group. This setup allowed the study to examine changes in students' motivation before and after the platform intervention while acknowledging differences among groups at baseline.

Each school used a designated learning platform during their regular physics lessons: Google Classroom (SMP Citra Bakti), Canvas (SMPN 1 Golewa), Padlet (SMPN 1 Golewa Barat), Nearpod (SMPN 1 Bajawa), Genially (SMPN 2 Bajawa), and Kahoot! (SMPS Soegija Pranata Mataloko). Platform assignment was based on each school's readiness and prior adoption, not researcher preference, to preserve ecological validity and prevent instructional disruption. This approach reflects authentic classroom conditions and realistic scenarios of digital platform use in junior high school physics classes.

Because the interventions took place in different schools, potential confounding factors—such as teachers' instructional styles, school infrastructure, and learning culture—could impact motivation outcomes. To control for these, several measures were taken. First, all schools covered the same physics topic, with similar learning objectives and instructional durations. Second, learning activities followed a comparable instructional sequence: introduction, guided practice, and formative assessment across all platforms. Third, pretest motivation scores were analyzed to ensure baseline equivalence before conducting further analyses. These steps helped strengthen comparisons across platforms while maintaining the natural classroom environment.

The participants included 120 eighth-grade students from six junior high schools in Ngada Regency, Indonesia. Each school contributed one intact class, forming six non-equivalent groups corresponding to the platforms used. Participants were selected through purposive sampling based on school availability, platform readiness, and administrative approval. This method aligned with the quasi-experimental design and the practical realities of implementing interventions in real classroom settings. Figure 1 shows the quasi-experimental design for online learning platforms in this study.

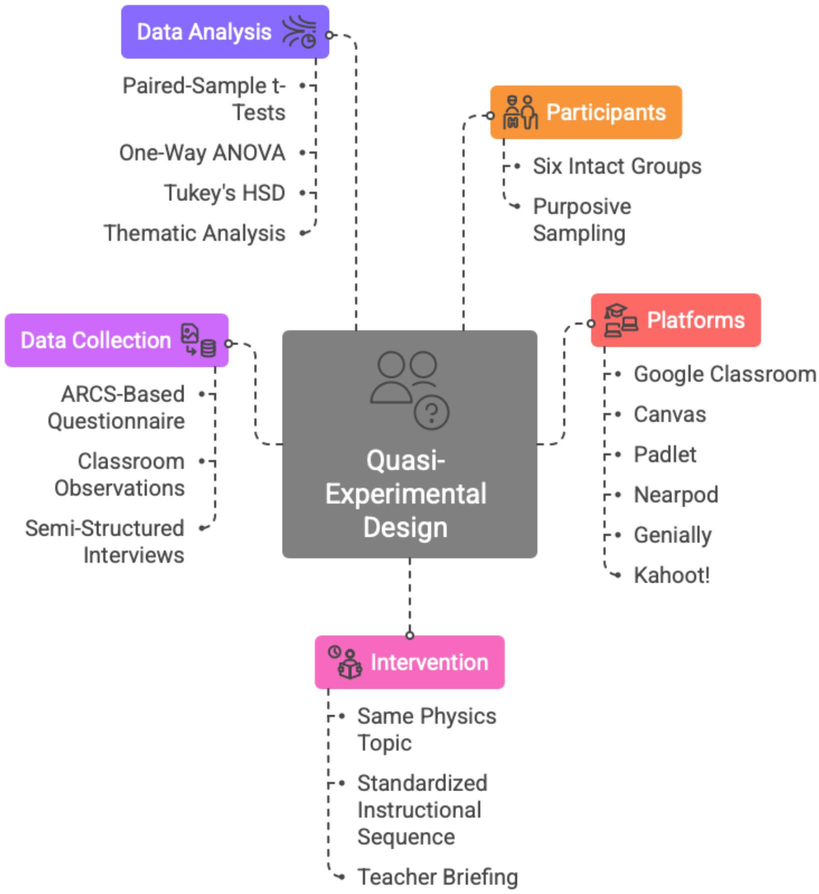

Figure 1. Quasi-experimental design for online learning platforms

Students' learning motivation was measured using an ARCS-based questionnaire derived from Keller's model (Keller, 2010), which comprises four dimensions: Attention, Relevance, Confidence, and Satisfaction. The instrument included 20 items rated on a five-point Likert scale (strongly disagree to agree), with five items per dimension. Before use, the questionnaire was reviewed by experts in physics education and educational measurement to confirm content relevance and alignment with the research objectives. The instrument grid (dimensions, indicators, and number of items) is presented in Table 1.

Instrument quality was confirmed before collecting data. Content validity was assessed through expert judgment by physics education lecturers and experienced junior high school teachers. Reliability testing with Cronbach's alpha resulted in a coefficient of 0.87, indicating strong internal consistency. Based on these results, the instrument was deemed suitable for evaluating students' learning motivation across different platforms. It was administered as both a pretest and a posttest to measure changes after the intervention.

Table 1. ARCS Model learning motivation scale instrument grid

No	ARCS dimension	Indicator	Example statement	Number of grains
1	Attention	Interest in media displays and activities	The media used made me interested in taking physics lessons	5
2	Relevance	Suitability of material to real life	The physics material delivered through this platform is relevant to my life	5
3	Confidence	Students' confidence in understanding the material	I feel more confident when learning physics with this platform.	5
4	Satisfaction	Satisfaction after the learning process with the platform	I feel satisfied after learning physics using this media	5
	Total			**20**

The intervention was conducted over four consecutive weeks during regular physics lessons. To ensure comparability across groups, all schools implemented the same physics topic, learning objectives, and instructional time allocation. Each platform was utilized according to its core features while adhering to a standardized instructional sequence: (1) concept introduction, (2) guided learning activities, (3) student interaction/practice, and (4) formative assessment. Before implementation, participating teachers received a briefing on the instructional sequence to reduce variation in classroom delivery across schools.

In addition to quantitative measures, qualitative data were collected through classroom observations and semi-structured interviews with physics teachers. Observations focused on indicators of student engagement, including participation, task responsiveness, and interaction with the digital platform. Interviews followed a guided protocol to capture teachers' perceptions of student motivation and platform usability. Qualitative data were analyzed using thematic analysis (data reduction, coding, and theme development). The qualitative findings were used to contextualize and support the quantitative results rather than to generate independent claims.

Quantitative analyses included descriptive statistics and inferential testing. Normality and homogeneity tests were conducted as prerequisites for parametric analyses. Paired-sample t-tests examined pretest–posttest changes in learning motivation within each platform group. One-way ANOVA, followed by Tukey's HSD post hoc test, compared motivational gains across platforms. Effect sizes were also reported using Cohen's d and eta squared (η^2) to interpret the magnitude of observed differences. Qualitative insights were integrated into the discussion to enrich the interpretation of the statistical findings.

III. RESULTS

This study compared the effectiveness of six online physics learning platforms in enhancing junior high school students' motivation to learn. The analysis comprised three stages: pretest, platform-supported instruction, and posttest. It integrated quantitative statistics with qualitative evidence from classroom observations and teacher interviews to contextualize the numerical patterns. Students' learning motivation was assessed before and after the intervention for each platform group. Descriptive statistics summarizing pretest scores, posttest scores, gain scores, and standard deviations are presented in Table 2. Overall, all groups exhibited higher posttest motivation scores compared to pretest scores, indicating an improvement in motivation following the platform intervention implementation.

Table 2. Average score of student learning motivation before and after the intervention

Platform	Average pretest	Average posttest	Improvement	Standard deviation
Kahoot!	62.12	71.98	9.86	3.56
Nearpod	59.43	68.58	9.14	2.71
Genially	61.71	69.08	7.37	2.20
Canvas	59.87	66.77	6.91	3.34
Padlet	59.88	66.01	6.13	3.07
Google Classroom	60.23	65.53	5.30	3.22

The largest mean gains were observed for platforms with strong interactive features (notably Kahoot!, Nearpod, and Genially). In contrast, relatively smaller gains were observed for platforms that are more text- and task-oriented. The overall pretest–posttest pattern across platforms is visualized in Figure 2.

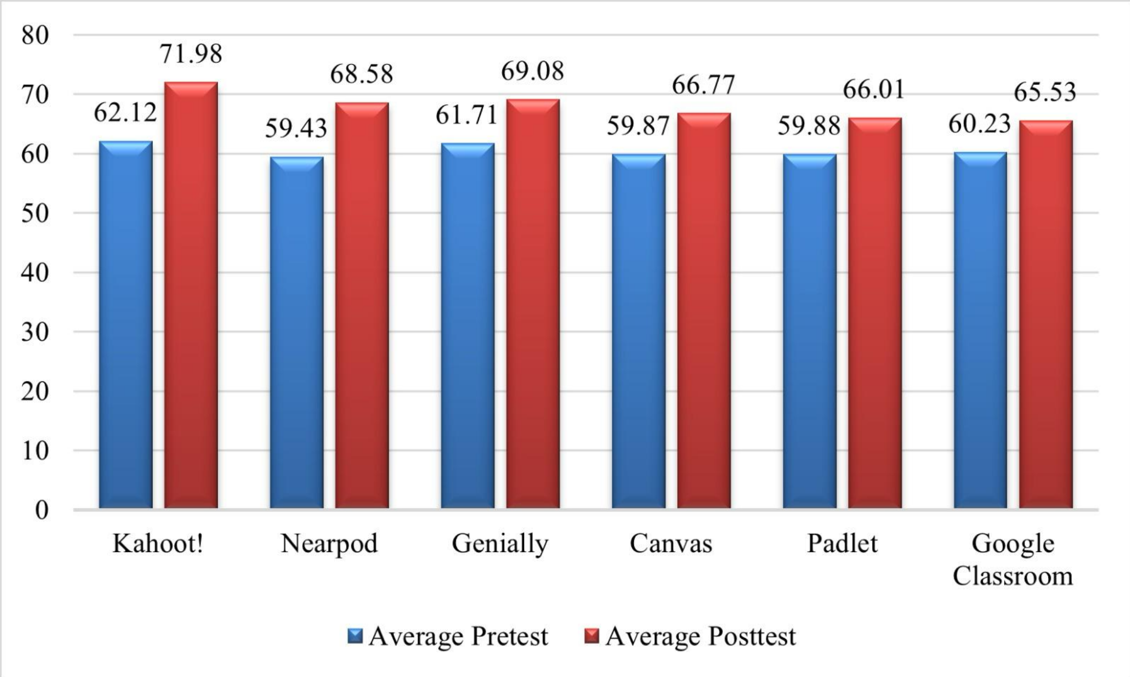

Figure 2. Comparison of students' average pretest and posttest motivation scores across platforms

Before performing inferential analyses, statistical assumptions were checked using gain (difference) scores. Normality was tested with the Shapiro–Wilk test (Table 3), which showed that the gain-score distributions across all platforms did not significantly deviate from normality ($p > 0.05$). The Shapiro–Wilk W statistics ranged from 0.768 to 0.964, and all platform-specific p-values—Google Classroom ($p = 0.7676$), Canvas ($p = 0.4833$), Padlet ($p = 0.4156$), Nearpod ($p = 0.1019$), Genially ($p = 0.1720$), and Kahoot! ($p = 0.6940$)—were above the 0.05 threshold. Thus, the gain scores for each platform were normally distributed, supporting the assumption of normality needed for parametric tests procedures.

Table 3. Normality test (Shapiro-Wilk) per platform

Platform	Statistik W	p-value	Conclusion
Google classroom	0.768	0.7676	Normal
Canvas	0.905	0.4833	Normal
Padlet	0.945	0.4156	Normal
Nearpod	0.943	0.1019	Normal
Genially	0.964	0.1720	Normal
Kahoot!	0.947	0.6940	Normal

Homogeneity of variance across groups was subsequently assessed using Levene's test (table 4). The results yielded a test statistic of 0.691 with a p-value of 0.6315 ($p > 0.05$), indicating no statistically significant differences in variances among the platform groups. Thus, the variances of the gain scores are homogeneous across platforms, satisfying the equal-variance assumption for parametric analysis. Taken together, the findings in tables 3 and 4 confirm that both normality and homogeneity assumptions were met, providing an objective basis for proceeding with parametric inferential tests.

Table 4. Test of homogeneity of variance (Levene's test)

Test	Statistics	p-value	Conclusion
Levene's test	0.691	0.6315	Homogeneous

To assess whether each platform significantly improved learning motivation, paired-sample t-tests were conducted within each group, comparing pretest and posttest scores. The results in Table 5 indicate that all six platforms produced statistically significant increases in students' learning motivation ($p < 0.001$). This finding confirms that using digital learning platforms in physics instruction was linked to meaningful motivational gains across all groups.

Table 5. Paired sample t-test

Platform	t-statistics	p-value	Conclusion
Google classroom	6.471	<0.001	Significant
Canvas	9.257	<0.001	Significant
Padlet	8.939	<0.001	Significant
Nearpod	15.090	<0.001	Significant
Genially	14.959	<0.001	Significant
Kahoot!	12.398	<0.001	Significant

While each platform yielded notable improvements, the study further investigated whether the extent of these enhancements varied among the different platforms. A one-way ANOVA was performed on motivation gain scores. As shown in Table 6, there was a statistically significant variation in motivational improvement across the six platforms ($F = 9.400$, $p < 0.001$), suggesting that the platforms did not demonstrate uniform effectiveness. For more explicit comparison, Figure 3 illustrates the mean gain scores for each platform.

Table 6. ANOVA test results

Variable	Sum of squares	df	F	p-value	Conclusion
Platform	421.746	5	9.400	1.60×10^{-7}	Significant

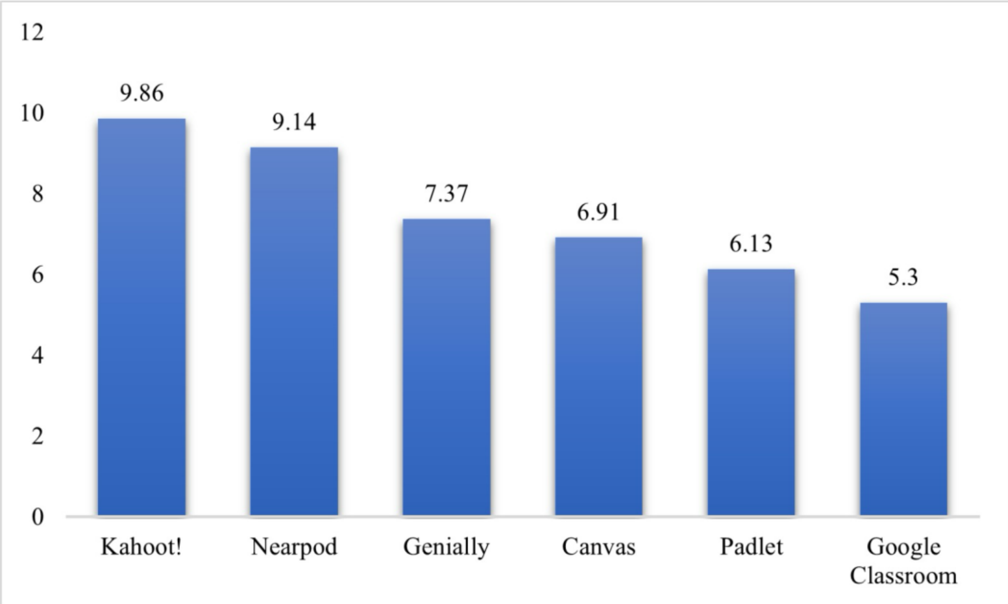

Figure 3. Mean gain scores of students' learning motivation across online learning platforms

To determine which platforms differed significantly from each other, a Tukey HSD post-hoc analysis was performed. The significant pairwise comparisons are summarized in Table 7 ($p < 0.05$ only). The results show that Kahoot! and Nearpod consistently outperformed several other platforms, especially Google Classroom and Padlet. Specifically, Kahoot! produced significantly higher motivation gains than Google Classroom ($p < 0.001$) and Padlet ($p = 0.0025$), while Nearpod also showed a significant advantage over Padlet ($p = 0.0287$). Overall, these findings indicate that although all platforms improved motivation, those emphasizing interactivity and gamification, particularly Kahoot! and Nearpod, generated larger motivational gains than platforms primarily designed for content delivery and task management.

Table 7. Tukey HSD test results

Platform 1	Platform 2	Mean difference	P-adj	Lower limit	Upper limit	Significant
Canvas	Kahoot!	2.96	0.0268	0.21	5.70	Yes
Genially	Google Classroom	-3.17	0.0086	-5.91	-0.42	Yes
Google Classroom	Kahoot!	5.66	0.0000	2.91	8.40	Yes
Google Classroom	Nearpod	4.94	0.0002	2.19	7.68	Yes
Kahoot!	Padlet	-3.72	0.0025	-6.47	-0.98	Yes
Nearpod	Padlet	-3.00	0.0287	-5.74	-0.25	Yes

IV. DISCUSSION

This study examined how six online learning platforms influenced junior high school students' motivation in physics learning, using the ARCS framework (Keller, 2010) as an interpretive lens. The results highlight two main points. First, across all platforms, learning motivation increased significantly from pretest to posttest. Second, the degree of improvement varied across platforms, suggesting that specific platform features likely shaped students' motivational experiences differently. The significant pretest–posttest increases across all groups imply that integrating online platforms into physics lessons can boost students' motivation compared to traditional methods. This aligns with previous research indicating that digital learning environments can enhance engagement by offering flexible access to materials, structured activities, and technology-supported interaction (Chang et al., 2023; Dominguez et al., 2023; Kotsis, 2024; Kotsis & Vakarou, 2025). In this study's context, digital platforms may have reduced monotony and increased novelty in classroom learning, supporting students' overall motivation. Importantly, the observed improvements across groups also show that even platforms mainly designed for content management can promote motivation when used with clear learning goals and structured instructional sequences.

However, the significant ANOVA results indicate that platforms were not equally effective in increasing motivation. Platforms with stronger interactive and gamified components, particularly Kahoot! Nearpod produced greater motivational gains than Google Classroom and Padlet. This pattern supports the argument that the presence of technology alone does not determine motivational improvement in digital learning, but rather that platform features address students' cognitive and affective needs (Wong & Hughes, 2023). In physics learning, where students often encounter abstract concepts and feel less confident, platforms that provide immediate feedback, competition, and engaging interactions may strengthen students' willingness to participate and persist.

From an ARCS perspective, Kahoot! and Nearpod may have been particularly effective in fostering attention through interactive prompts, game-like tasks, and real-time engagement. These features are consistent with prior studies showing that gamified learning environments can sustain students' attention and promote active participation (Astuti et al., 2021; Ghawail & Yahia, 2022; Lashari et al., 2024; Rayan & Watted, 2024). In addition, real-time response systems and multimedia delivery may have improved relevance by linking physics content to contextual representations and interactive tasks, helping students perceive the learning activities as meaningful and accessible (Maison et al., 2025; Muzakki et al., 2025). Such relevance is particularly important in physics learning because students' motivation often declines when they perceive concepts as disconnected from everyday experience.

The larger gains observed for Kahoot! and Nearpod may also reflect improvements in confidence and satisfaction. Immediate feedback and incremental success in interactive tasks can help students evaluate their progress, reduce uncertainty, and develop a sense of competence. This mechanism is consistent with Keller's (2010) emphasis that confidence grows when learners experience structured opportunities for success. Moreover, when students receive prompt feedback and see their performance outcomes clearly, satisfaction may increase because the learning experience becomes more rewarding and transparent. These interpretations are supported by evidence that interactive technologies can improve learning experiences by making abstract concepts more concrete and by strengthening students' perceived control and achievement during learning activities (Alhadlaq, 2023).

In contrast, platforms such as Google Classroom and Padlet showed smaller motivational gains. This does not indicate that these platforms are ineffective, but rather that their primary functions, organizing materials, distributing tasks, and facilitating asynchronous discussion, may contribute less directly to the motivational dimensions emphasized in the ARCS model. Prior research suggests that learning management systems support self-regulated learning and structured content delivery (Furqon et al., 2024; Magalong & Palomar, 2019; Schumacher & Ifenthaler, 2021; Widiyatmoko, 2021), but they do not inherently provide the immediate stimulation, feedback, or competitive elements that intensify attention and satisfaction. Consequently, motivational improvement may depend more strongly on teachers' instructional design when using such platforms, particularly in physics contexts that require high engagement.

Qualitative findings from classroom observations and teacher interviews helped explain these quantitative trends. Teachers reported that students were more enthusiastic and visibly engaged when lessons involved interactive activities and immediate responses, especially during platform-based quizzes and collaborative tasks. Observations also indicated that students tended to participate more actively when the platform provided real-time prompts and instant feedback. In contrast, when activities relied heavily on reading instructions, uploading tasks, or responding asynchronously, students' engagement was less consistent and required stronger teacher facilitation. These findings reinforce the view that technological affordances interact with pedagogical implementation. That platform effectiveness depends not only on the tool itself but also on its integration into classroom instruction (Sofi-Karim et al., 2023).

The results are particularly relevant for non-urban contexts such as Ngada Regency, where infrastructure, teacher readiness, and students' prior exposure to digital learning may vary across schools. Although the study standardized the topic, objectives, and duration, contextual differences likely influenced how students experienced each platform. This contextual dimension is important because digital learning interventions may produce different motivational effects depending on local conditions and implementation fidelity (Sofi-Karim et al., 2023). Therefore, platform selection should consider not only the technology's features but also the practicality of implementation within school constraints.

V. CONCLUSION AND SUGGESTION

This study shows that using online learning platforms in junior high school physics lessons greatly boosts students' motivation to learn. All six groups showed higher posttest motivation scores compared to their pretest scores, suggesting that integrating digital platforms can help develop motivation in physics education. However, the level of improvement varied across different platforms. Platforms that emphasize interactivity and real-time engagement, especially Kahoot! and Nearpod, produced higher motivational gains than platforms mainly focused on content management and task sharing (such as Google Classroom and Padlet). Viewing these results through the ARCS framework indicates that interactive features are more effective in enhancing key motivational elements, particularly attention and satisfaction. Still, all platforms can have positive effects when used with clear learning goals and structured instruction.

Nonetheless, some limitations should be noted. First, the quasi-experimental design involved non-equivalent groups from different schools, which may introduce external influences (like teaching style, school facilities, and student backgrounds) that are hard to control. Second, the intervention was relatively short, and the assessment of motivational change was limited; thus, the long-term persistence of motivation improvements remains unknown. Third, motivation was mainly measured through self-report data, which may be affected by response bias. Future research should consider longer implementation periods, more rigorous controls (or matched comparison methods), and additional measures—such as learning analytics, performance data, and classroom interaction observations—to verify the motivational results. Despite these limitations, this study adds valuable insights to physics education by providing comparative evidence on how various online platforms influence students' motivation using the ARCS model. It also offers practical advice for teachers and schools, especially in resource-limited settings, on selecting and using digital platforms to foster motivated physics learning.

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