



The Effect of Android-Based Learning and Learning Motivation on Learning Outcomes in Computer Science in the 10th Grade at SMK Negeri 1 Sumatera Barat

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Abstract: This study aims to analyze the effects of Android-based learning and learning motivation on the Informatics learning outcomes of tenth-grade students at SMK Negeri 1 Sumatera Barat. Android-based learning is increasingly important in vocational education because it supports the development of digital competencies and independent learning skills required in the digital era. Previous studies have generally examined Android-based learning and learning motivation separately, while evidence regarding their interaction remains limited. This study employed a quasi-experimental method with a 2 × 3 factorial design involving 84 students in experimental and control classes. Data were collected using a learning motivation questionnaire and a learning outcomes test and analyzed through descriptive statistics and Two-Way ANOVA. The results showed that the experimental class achieved a higher mean posttest score (78.61) than the control class (68.33). The N-Gain score was also higher in the experimental class (0.55) than in the control class (0.34). Two-Way ANOVA revealed significant effects of the learning model ($F = 32.47, p < 0.05$), learning motivation ($F = 22.86, p < 0.05$), and their interaction ($F = 6.43, p < 0.05$) on learning outcomes. These findings indicate that Android-based learning is more effective when supported by high student motivation. This study provides empirical evidence for integrating technology-enhanced learning and motivational factors in vocational Informatics education.

Keywords: Android-based learning; Informatics; Learning motivation; Learning outcomes; Vocational high school

Introduction

Learning is a communication process between The rapid development of information and communication technology (ICT) has brought profound changes to the education sector, particularly at the vocational secondary school (Sekolah Menengah Kejuruan/SMK) level. Informatics is one of the subjects that is most directly affected by this technological shift, as it demands not only conceptual understanding but also the practical application of digital skills. Ideally, Informatics instruction should leverage digital

technology optimally to create engaging and effective learning experiences aligned with the characteristics of today's digital learners (Lubis et al., 2024).

The rapid development of digital technology has transformed educational practices, requiring schools to adopt innovative learning approaches that promote students' digital literacy and independent learning skills. In vocational education, particularly in Informatics subjects, students are expected not only to understand theoretical concepts but also to develop practical competencies that align with the demands of the digital era. Therefore, learning models that integrate technology into the instructional process have become

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increasingly important to support effective and meaningful learning experiences (Sumardi et al., 2024).

In Indonesia, the implementation of the Merdeka Curriculum emphasizes student-centered learning and the integration of digital technology into classroom activities. However, the successful realization of these objectives remains challenging in many vocational schools. Learning activities are often still dominated by teacher-centered approaches, limiting students' opportunities to actively engage in the learning process and develop higher-order thinking skills. Consequently, students may experience difficulties in achieving the expected learning outcomes (Fransisca et al., 2025).

Observational data from Class X of SMK Negeri 1 Sumatera Barat revealed that Informatics instruction was still primarily conducted through lectures, note-taking activities, and written assignments. Such conventional practices tend to reduce student participation and learning engagement. As shown in Table 1, the average Informatics achievement score across four Electronics concentration classes was only 70.5, which was below the school's Minimum Competency Criterion (KKTP) of 75. Furthermore, 43% of students failed to achieve mastery learning. These findings indicate the need for more innovative instructional approaches that can improve both student engagement and academic performance (Miranda et al., 2026).

One promising alternative is Android-based learning, which utilizes mobile devices as learning media. Android-based learning enables students to access learning materials, assignments, and assessments anytime and anywhere, thereby extending learning opportunities beyond the classroom. Given the widespread ownership and use of smartphones among vocational students, Android-based learning offers a practical and accessible solution for supporting flexible and technology-enhanced learning environments (Putra et al., 2017; Susilawati et al., 2025).

Previous studies have reported positive effects of Android-based learning on student achievement and engagement. Husnulwati et al. (2019) found that Android-based learning media significantly improved students' learning outcomes compared to conventional instruction. Similarly, Putritama et al. (2026) reported that mobile learning environments increased students' motivation and participation in classroom activities. These findings suggest that Android-based learning has considerable potential to enhance the effectiveness of Informatics education.

Nevertheless, the success of technology-based learning is not determined solely by the learning platform itself. Learning motivation remains a critical factor influencing how students interact with educational technology and engage in learning

activities. According to Self-Determination Theory proposed by Irawan et al. (2025), students are more likely to achieve positive learning outcomes when their needs for competence, autonomy, and relatedness are fulfilled. Students with high motivation generally demonstrate greater persistence, engagement, and willingness to utilize digital learning resources effectively.

Although numerous studies have examined the effects of Android-based learning and learning motivation on learning outcomes, these variables have predominantly been investigated separately. Limited empirical evidence is available regarding how learning motivation interacts with Android-based learning in influencing students' academic achievement, particularly in vocational Informatics education. This limitation creates a significant research gap because educational technology may not produce optimal outcomes when students' motivational characteristics are overlooked. Understanding this interaction is essential for designing learning environments that effectively support diverse learner needs (Krisdiantoro et al., 2024).

The novelty of this study lies in examining the interaction effect between Android-based learning and different levels of learning motivation using a 2×3 factorial design. Unlike previous studies that focused primarily on direct effects, this research investigates how technological and psychological factors jointly influence Informatics learning outcomes. The findings are expected to contribute both theoretically and practically by providing empirical evidence regarding the effectiveness of Android-based learning across different motivational levels and offering recommendations for designing more adaptive and effective learning strategies in vocational education. Therefore, this study aims to examine the effects of Android-based learning, learning motivation, and their interaction on the Informatics learning outcomes of tenth-grade students at SMK Negeri 1 Sumatera Barat.

Method

This study employs a quantitative approach using a quasi-experimental method. The design applied is a 2×3 factorial design, where the first factor is the learning model (Android-based learning and conventional learning) and the second factor is learning motivation (high, moderate, and low) (Desky, et al., 2025). This design allows for the simultaneous testing of the main effects of each factor as well as the interaction effects of both factors on learning outcomes (Gustina et al., 2024).

Figure 1 illustrates the 2×3 factorial research design employed in this study. The first factor was the learning model (Factor A), consisting of two levels:

Android-based learning (A1) and conventional learning (A2). The second factor was learning motivation (Factor B), which was categorized into three levels based on the results of the motivation questionnaire: high motivation (B1), moderate motivation (B2), and low motivation (B3). The dependent variable was students' Informatics learning outcomes (Y).

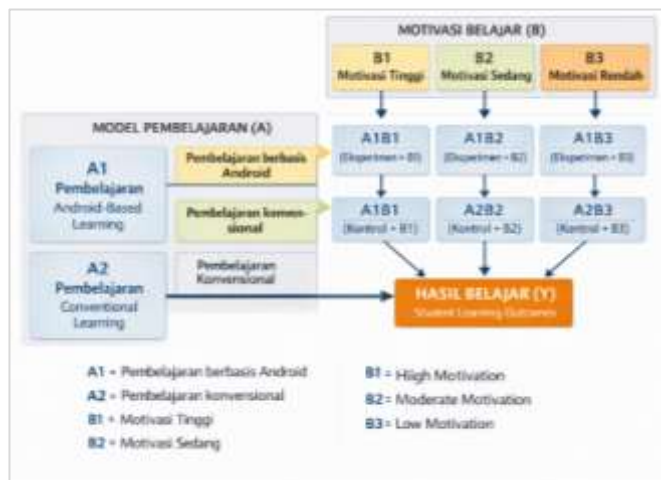


Figure 1. Illustrates the 2 × 3 factorial research design

The study was conducted at SMK Negeri 1 Sumatera Barat during the second semester of the 2025/2026 academic year, from January to April 2026. The population consisted of approximately 120 tenth-grade students enrolled in the Informatics subject. Using purposive sampling based on the equivalence of pretest scores, two classes were selected: Class X TAV (42 students) as the experimental group and Class X Mechatronics (42 students) as the control group, resulting in a total sample of 84 students.

Before the intervention, all students completed a pretest to measure their initial knowledge and a learning motivation questionnaire. Based on the questionnaire results, students in each group were classified into three motivation categories: high (B1), moderate (B2), and low (B3). Consequently, six treatment combinations were formed: A1B1, A1B2, and A1B3 for students receiving Android-based learning with different motivation levels, and A2B1, A2B2, and A2B3 for students receiving conventional learning with different motivation levels.

The experimental group received Android-based learning through Google Classroom and Quizizz for eight instructional sessions (Taali et al., 2024). Google Classroom was used to distribute learning materials, manage assignments, and facilitate discussions, while Quizizz was employed to provide interactive assessments with immediate feedback and automatic scoring. In contrast, the control group received conventional instruction consisting of teacher explanations, printed learning materials, and written exercises.

Following the intervention, all students completed a posttest to measure their learning outcomes. The factorial design enabled the researcher to examine not only the main effect of the learning model and learning motivation on learning outcomes but also the interaction effect between both variables. Data were analyzed using descriptive statistics and Two-Way Analysis of Variance (ANOVA) at a significance level of $\alpha = 0.05$.

Students' levels of learning motivation were measured using a Likert-scale questionnaire (1-5) consisting of 40 items covering eight aspects: interest, intrinsic motivation, extrinsic motivation, perseverance, self-confidence, independent learning, affective aspects, and goal orientation. Students were classified into three motivation categories (high, moderate, low) based on questionnaire scores prior to the implementation of the learning process. The learning outcome assessment instrument consisted of multiple-choice and essay questions at cognitive levels C2-C5 according to the revised Bloom's Taxonomy (Anderson et al., 2001).

The validity of the instrument was assessed using construct validity by subject matter experts and educational experts. Reliability was measured using Cronbach's Alpha coefficient, with a value of ≥ 0.70 as the acceptability threshold. The research procedure consisted of three stages: (a) the preparation stage (development of teaching modules, instruments, and class selection); (b) the implementation stage (pretest, intervention delivery over eight sessions, and posttest); and (c) the data analysis stage.

Learning outcome data were analyzed through several stages: (1) calculation of the N-Gain Score to determine improvements in learning outcomes; (2) normality test using the Kolmogorov-Smirnov test; (3) homogeneity of variance test using Levene's test; and (4) hypothesis testing using Two-Way ANOVA. If significant differences were found, a Tukey Post Hoc test was conducted to determine differences between groups. All analyses were performed using SPSS software with a significance level of $\alpha = 0.05$.

Result and Discussion

Result

Data Description and Analysis Prerequisite Tests

This study employed a quantitative quasi-experimental approach with a 2x2 factorial design (Elida et al., 2025). The two independent variables were learning model (Android-based vs. conventional) and learning motivation level (high vs. low), while the dependent variable was the learning outcome in Informatics. The factorial design allowed simultaneous examination of main effects and the interaction effect between the two independent variables (Risna et al., 2026).

Before the treatment was administered, a pretest was conducted on both groups to ensure equivalence in initial ability. The mean pretest score for the experimental group was 58.4 (SD=8.2) and for the control group 57.9 (SD=7.8). An independent t-test showed no significant difference between the two groups ($t=0.312$; $p=0.756$), so the two groups were deemed equivalent. Based on the results of the motivation questionnaire, the distribution of students in the experimental group was as follows: high motivation in 12 students (33.3%), moderate motivation in 15 students (41.7%), and low motivation in 9 students (25%). A similar distribution was found in the control group.

The Kolmogorov-Smirnov normality test showed that the posttest data for the experimental group were normally distributed ($p = 0.142 > 0.05$) and that the control group's data were also normally distributed ($p = 0.186 > 0.05$). The Levene's test for homogeneity of variances yielded an F-value of 1.247 with a significance of 0.298 ($p > 0.05$), indicating that the assumption of homogeneity of variances is met. Since all prerequisite assumptions are met, the hypothesis testing using a Two-Way ANOVA can proceed.

Gain Score

When pretest and posttest results are compared using the N-Gain or gain score, the effectiveness of the learning media can be observed through improvements in student learning outcomes, as these scores indicate the extent to which students have progressed after using the media. If the gain score achieved by students reaches a minimum threshold of ≥ 0.3 , which falls into the moderate category, the learning media is then considered effective in enhancing student understanding and performance (Handoyo et al., 2025).

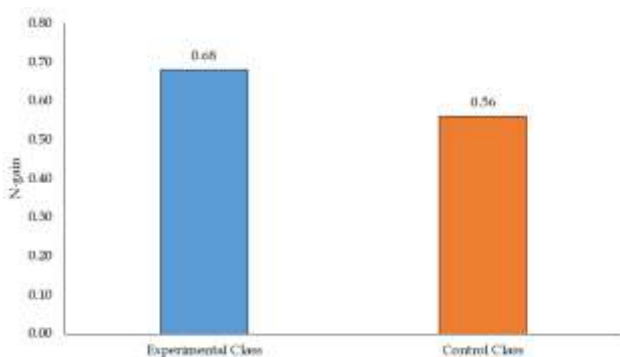


Figure 2. Effectiveness test analysis of gain score value

Based on the results of the analysis, it can be shown that the gain score in the experiment group was higher than the control group, with a value of 0.68 in the medium category. Meanwhile, the control group's gain score is 0.56 in this category as well. It may be inferred

from the data on the gain score on the above graph that android app-based interactive learning media can be considered effective.

Table 1. Normality Test of Pre-test and Post

Class	Data	Statistic	Shapiro-Wilk	
			df	Sig
Experimental	Pre Test	.946	32	.111
	Post Test	.935	32	.053
Control	Pre Test	.952	31	.175
	Post Test	.964	31	.371

Based on the variance normality test that using the Shapiro-Wilk test was used to analyze the pretest-posttest results in the experimental and control classes. The results showed that the experimental class pretest data had a Sig. value of 0.111, while the control posttest data had a Sig. value of 0.053. Meanwhile, for the experimental class pretest data, the Sig. value was 0.175 and for the control class posttest data, the Sig. value was 0.371. Because the significance value of both classes is more than 0.05, it can be said that the experimental class and control class are normally distributed and can be continued with the next analysis.

Table 2. Homogeneity Test of Experimental Class and Control Class Pre-test and Post- test

Value	Levene Statistic	df1	df2	Sig.
Pre-test	.923	1	42	.341
Post-test	.126	1	42	.724

Based on data analysis, the Sig (Based on Mean) value of the pretest results is 0.341 and the posttest value is 0.724 greater than 0.05. This indicates that the research data has a homogeneously distributed variation, thus fulfilling the necessary requirements to conduct an independent sample t-test.

Table 3. Homogeneity Test of Experimental Class and Control Class Pre-test and Post-test

Levene's Test for Equality of Variances	Independent Samples Test			
	t- Test for Equality of Means		T	Df
	F	Sig.(2-tailed)		
Equal Variances Assumed	.126	0.00	4.075	61
Equal Variances Assumed		0.00	4.086	59.859

Discussion

This interaction finding extends prior literature by empirically demonstrating that media effectiveness is conditional on motivational context, consistent with Hazar et al. (2025) argument that appropriate media combined with strong motivation optimises learning efficacy. From a theoretical standpoint, the interaction supports Self-Determination Theory (Ningsih et al., 2025), which posits that the educational environment can nurture intrinsic motivation through features that

support student autonomy, competence, and relatedness—all of which Android learning platforms are structurally positioned to provide through self-paced access, immediate performance feedback, and collaborative discussion features (Sudianti et al., 2025).

These findings collectively indicate that Android-based learning is most transformative when students enter the learning environment with high intrinsic motivation, but that even motivationally disadvantaged students benefit from the enhanced accessibility and interactivity of Android platforms relative to purely conventional instruction (Vaesar et al., 2026).

Conclusion

This study demonstrates that the effectiveness of Android-based learning in Informatics education is influenced not only by the integration of digital technology but also by students' learning motivation. The findings indicate that Android-based learning provides a more flexible, interactive, and learner-centered learning environment than conventional instruction, leading to improved student achievement. Furthermore, students with higher levels of learning motivation benefited more from the Android-based learning environment, indicating that motivational factors play a crucial role in maximizing the impact of educational technology. The significant interaction between learning model and motivation suggests that technology-enhanced learning is most effective when accompanied by strong student engagement and motivation. The findings imply that the successful implementation of digital learning in vocational education requires a balanced integration of technological innovation and motivational support. Therefore, teachers should not only utilize Android-based learning platforms but also design learning experiences that encourage active participation, self-regulated learning, collaboration, and sustained engagement. Unlike previous studies that primarily examined the direct effects of Android-based learning or learning motivation separately, this study provides empirical evidence regarding their combined and interactive influence on students' Informatics learning outcomes. Despite its contributions, this study has several limitations. The sample was limited to 84 students from a single vocational high school, which may restrict the generalizability of the findings. In addition, the intervention was conducted over only eight instructional sessions, limiting the observation of long-term effects. The study also focused solely on learning motivation without considering other factors such as digital literacy, prior technology experience, socioeconomic background, or parental support. Nevertheless, this study contributes to the growing body

of technology-enhanced learning research by demonstrating that the effectiveness of Android-based learning depends on students' motivational characteristics, thereby providing valuable insights for advancing digital learning practices and supporting the transformation of vocational education in the digital era.

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Author Contributions

Conceptualization and methodology, H. L. B.; software, validation, formal analysis, and investigation, H. L. B. and A.; data curation, H. L. B. and A.; writing—original draft preparation, H. L. B., A. and R.; writing—review and editing, R.

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Conflicts of Interest

There is no conflict of interest.

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