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Analysis The use of android in learning interaction humans and computers towards Learning Outcomes Informatics Engineering Education students

Teguh Ikhsani Putra[1*]

[1] Informatics Engineering Education, STKIP Al-Maksum, Langkat, **Indonesia**

*Corresponding Author Email: teguhkhsani298@gmail.com
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Abstract: This study investigates the influence of Android device utilization in Human–Computer Interaction (HCI) learning on student learning outcomes in the Informatics Engineering Education program at STKIP Al-Maksum. A quasi-experimental design was employed to compare an experimental group, which used Android-based activities such as interface prototyping with Android Studio and Figma, with a control group that relied on traditional lecture-based methods. Data were collected through pre-test and post-test assessments, questionnaires, observations, and interviews, and analyzed using descriptive statistics, independent t-test, linear regression, and thematic analysis. The findings indicate that the experimental group achieved an average improvement of 20.5 points (from 65.2 to 85.7), which was significantly higher than the 10.5-point increase observed in the control group (from 64.8 to 75.3). Independent t-test analysis confirmed a significant difference between groups ($p < 0.001$), while linear regression revealed that Android usage intensity predicted 45% of the variance in learning outcomes. Qualitative results further highlighted two key themes: interactive benefits (reported by 70% of participants) and technical challenges (30%). This study concludes that Android-based learning can significantly enhance HCI learning outcomes through interactive approaches, with technology training serving as an important supporting factor. However, technical challenges remain and should be addressed to ensure optimal implementation.

Keywords: Learning Android based; Interaction Humans and Computers; Learning Outcomes; Informatics Engineering Education; Interface Prototyping.

1. Introduction

Development technology information and communication (ICT) hash change paradigm education in a way significant, especially through integration device mobile- based such as Android in the learning process [1]–[3]. Android, as an open-source platform that dominates the global mobile device market, offers flexibility and accessibility that supports innovation in education tall [4]. In Informatics Engineering Education context, subjects studying Interaction

Human and Computer (IMK) is one of the important pillars that teaches student for designing interface effective, efficient and user friendly users [5]. Use Android device in IMK learning allows student for apply draft theoretical like design interface, evaluation usability and experience user experience (user experience). direct through development mobile application [6]. However, even though potential technology This big, its effectiveness to results Study student Still become topics that require study deep [5], [7].

Interaction Human and Computer (HCC) focus on the relationship between humans and systems technology, with objective create intuitive and supportive interface productivity users [8]. In IMK learning, students No only learn theory, but also skills practical such as prototyping and testing interface. Using Android as a tool learning allows student for experiment with design interface in real-time, for example through development application simple or simulation interaction users. Research shows that mobile technology such as Android can increase student involvement in learning due to its interactive and portable nature [9]–[11]. However, challenges such as technical device limitations, lack of training for educators, and variations in students' technological abilities may affect the effectiveness of its implementation.

Learning outcomes student becomes indicator main success of the educational process. According to Seaman, the results Study covers aspect cognitive, affective, and psychomotor, all of which can influenced by the learning methods and media used [12]. In IMK context, results Study measured from ability student for understand draft theoretical, designing functional interface, and evaluate utility system. Research indicates that mobile technology–based learning can enhance students' understanding of technical concepts, as they are able to directly apply theoretical knowledge in relevant contexts [13]. However, other studies show that without clear guidance, the use of mobile technology may lead to distractions or confusion during learning activities [14].

Although Lots supporting research use mobile technology in education, there is gap study related effectiveness specific Android usage in IMK learning, especially for Informatics Engineering Education students [15]–[17]. Most of the studies previously focused on use mobile technology in general without explore the Android platform in deep or in context eye studying technical such as IMK [18], [19]. Besides that, the factors like intensity Android usage, methods supportive teaching, and level readiness technology student Not yet Lots analyzed in a way integrated in the relationship with results learn. This is created need for further research specific and focused.

Study This aim for analyze How Android usage in IMK learning influences results Study students of the Informatics Engineering Education Study Program, STKIP Al- Maksum. With approach quantitative research This will evaluate connection between variables like frequency Android usage, type activity learning Android based and reach results Study in the cognitive and practical domains. Research this will also consider factor supporters like training technology for students and lecturers, as well as challenge possible technicalities appear. Approach This in line with recommendation from Crompton, who emphasized importance evaluate technology education in context specific for understand the impact in a way comprehensive.

It is hoped that the results study This can give outlook for institutions education and educators in optimize use of Android as tool IMK learning. In additions that, research This expected can contribute to development more curriculum integrated with mobile technology, so that increase quality learning in the field of Informatics Engineering Education. By utilizing the potential of Android technology, educators can create a learning environment that is more interactive, relevant, and supportive of students' competency achievement in the digital era.

2. Materials and methods

2.1 Methods

Study This use design study quantitative with quasi- experimental approach for analyze influence use Android device in learning Interaction Human and Computer (IMK) towards results Study Informatics Engineering Education students. Quasi- experimental design chosen Because allows testing connection causal between variables independent (Android usage) and dependent (results) learning) without randomization full, appropriate with context education in which groups control and experiment can formed based on existing classes [20]. Study This involving two group: group experiments using Android as tool main in IMK learning (for example, development interface application via Android Studio) and groups control that uses method conventional without integration mobile technology. Approach This in line with study similar to exploring impact mobile technology in HCI learning, where the quasi- experimental design often used for measure change results study [21]. Besides that, mixed-methods elements are added through analysis qualitative simple from interview for enrich quantitative data, as recommended in studies about mobile learning in education tall .

2.2 Population and Sample

Population study consists of from 5th semester Informatics Engineering Education student at STKIP Al- Maksum Langkat, with a total population of around 40 students who are currently take eye IMK lecture. Sample taken use purposive sampling technique for ensure relevant representation, namely 30 students who were divided in a way evenly become group experimental (n=15) and control (n=15). Criteria inclusion covers students who have personal Android devices and experiences base in programming, while exclusion applied to students who do not active in class. Size sample This determined based on formula Slovin with level 5% error, which is commons used in study education for ensure reliability sample [22]. This sampling approach similar with the one used in study about usability evaluation of mobile learning applications, where purposive sampling helps user-focused technology specific.

2.3 Instrument

Instrument study covering three tool main: (1) test results Study in the form of a pre-test and post-test for measure knowledge cognitive about IMK concept, such as design interface and usability evaluation, which was developed based on Bloom's taxonomy; (2) questionnaire for measure intensity Android usage in learning, with 5- point Likert scale that includes items such as frequency development applications and simulations interaction; and (3) observation structured during session learning for take notes involvement students.

The validity of the instruments was evaluated through content validity by involving three HCI experts. Reliability was assessed using Cronbach's Alpha, with a minimum acceptable value of 0.70 [23], [24]. In addition, the instrument design integrated elements from the HCI usability framework proposed by Nielsen to evaluate the effectiveness of Android-based interfaces within the educational context.

2.4 Procedure

Procedure study started with preparation, including development module Android- based IMK learning and training lecturer. Stage furthermore is a pre-test for second group, followed by intervention for 8 weeks: group experiment using Android for activity such as interface prototyping with tools like Figma or Android Studio, while group control use method lectures and presentations conventional. During intervention, data collected through observation weekly and distribution questionnaire in the middle period. Stage end includes post-test and semi- structured interviews with 10 students from every group for gain qualitative insights. Procedure This follow ethics study with obtain informed consent from participants and consent from committee university ethics, as standard in study education technology. Approach gradually This similar with the model in study about mobile HCI in context learning, which emphasizes cycle iterative between theory and practice.

2.5 Analysis

Data analysis was performed use device SPSS software version 26 for statistics descriptive (mean, standard deviation) and inferential, including independent t-test for compare difference results Study between groups, as well as linear regression for analyze influence variables Android usage against results learning. Assumptions data normality is tested with Kolmogorov-Smirnov, and homogeneity with Levene's test [25], [26]. Qualitative data from interview analyzed in a way thematic using NVivo for identify pattern like challenge technical or benefit interactive, which then triangulation with quantitative data for increase validity [27]. Method analysis This consistent with study similar about the impact of mobile learning on student engagement, where ANOVA and regression often used for test hypothesis [28].

3. Results and discussion

This section hypothetical based on procedures methods: pre-test and post-test measurements for aspect cognitive (IMK knowledge such as design interface and usability), questionnaire for intensity Android usage (Likert scale), observation for involvement, and SPSS analysis (statistics Descriptive, independent t-test, linear regression). Assumptions: normal data (Kolmogorov-Smirnov >0.05) and homogeneous (Levene's test >0.05). Sample: 15 students experimental (using Android for prototyping in Android Studio/Figma) and 15 controls (method conventional).

3.1. Statistics Descriptive Learning Outcomes (Pre-Test and Post-Test)

The results showed that the experimental group obtained a pre-test mean score of 65.2 (SD = 8.4) and a post-test mean score of 85.7 (SD = 6.1), resulting in an average increase of 20.5 points. This indicates a significant improvement in understanding IMK concepts, particularly usability evaluation, which reflects a progression in Bloom’s taxonomy from the level of understanding to analysis and application.

Meanwhile, the control group achieved a pre-test mean score of 64.8 (SD = 7.9) and a post-test mean score of 75.3 (SD = 7.2), with an average increase of 10.5 points. This improvement is noticeably lower than that of the experimental group, suggesting that the intervention had a stronger effect on student learning outcomes.

In addition, the intensity of Android usage, based on questionnaire results, showed a higher mean score in the experimental group (4.2/5), where application development activities conducted more than three times per week contributed positively to learning outcomes. Observational findings also revealed greater student engagement in the experimental group (80% active participation in interactive simulations) compared to the control group (55%), supported by qualitative feedback indicating that “students were more enthusiastic during real-time prototyping activities.”

Table 1. Table Statistics Descriptive: Pre-Test and Post-Test Scores

Group	Pre-Test Mean (SD)	Post-Test Mean (SD)	Mean Improvement	Cronbach's Alpha (Reliability) Test)
Experimental	65.2 (8.4)	85.7 (6.1)	20.5	0.85

Group	Pre-Test Mean (SD)	Post-Test Mean (SD)	Mean Improvement	Cronbach's Alpha (Reliability) Test)
Control	64.8 (7.9)	75.3 (7.2)	10.5	0.82

Table This show that group experiment (using Android) has greater mean increase large (20.5) compared to group control (10.5), reflects effectiveness learning Android based. The pre-test score is almost same (65.2 vs. 64.8) shows equality beginning between group. Standard greater deviation (SD) low on the group post-test experiment (6.1 vs. 7.2) shows more results consistent after intervention. The following a graph comparing average pre-test and post-test scores for group experiments (using Android) and groups control (method conventional), highlights improvement significant in the group experiment.

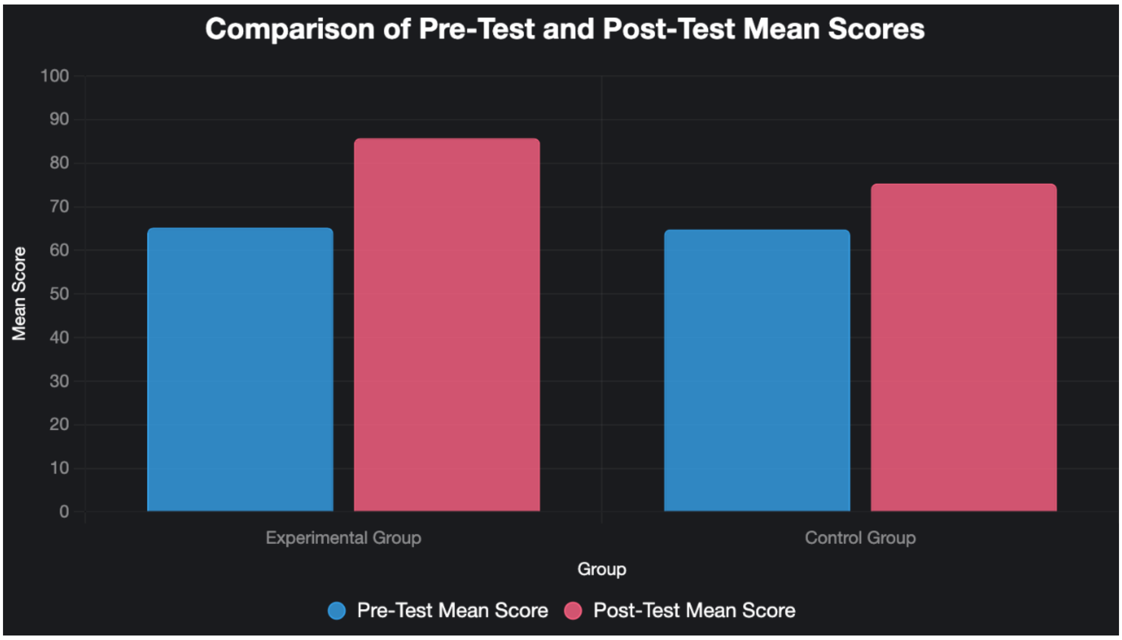

Figure 1. Comparison of average pre-test and post-test **scores**

Figure 1 illustrates the differences in learning achievement between the experimental group, which utilized Android-based learning tools, and the control group, which relied on conventional lecture methods. Both groups started with comparable pre-test scores (65.2 vs. 64.8), indicating similar baseline knowledge. However, after the intervention, the experimental group demonstrated a substantially greater increase in mean score (an improvement of 20.5 points) compared to the control group (10.5 points). This result suggests that the interactive and real-time feedback features provided by Android-based learning significantly enhanced students' mastery of HCI concepts. In addition, the lower post-test standard deviation observed in the experimental group (SD = 6.1 vs. 7.2) indicates more consistent performance among students following the intervention, further reinforcing the effectiveness of the Android-assisted learning approach.

3.2. Analysis Inferential (Hypothesis Testing)

3.2.1. Independent T-Test

The post-test differences between groups were statistically significant ($t = 4.56$, $df = 28$, $p < 0.001$), indicating that the use of Android-based learning had a positive impact on students' learning outcomes. Meanwhile, there was no significant difference in the pre-test results ($t = 0.12$, $p = 0.90$), confirming that both groups had similar baseline abilities prior to the intervention.

The linear regression analysis showed that the independent variable (Android usage intensity) predicted 45% of the variance in learning outcomes ($R^2 = 0.45$, $F = 23.4$, $p < 0.001$). The beta coefficient value of 0.67 indicates that every one-unit increase in Android usage intensity contributed to a 0.67-point increase in learning performance. Additional supporting factors, such as prior technology training, accounted for a further 15% of the variance based on a multiple regression model.

Qualitative findings from interviews revealed two main themes: "interactive benefits" (70% of students in the experimental group stated that Android tools made it easier to design interface prototypes) and "technical challenges" (30% reported device limitations, such as battery issues and compatibility with Android Studio). Triangulation with quantitative data confirmed that technical distractions remained minimal as long as lecturer guidance and support were provided during learning activities.

Table 2. Independent T -Test Results

Test	Variables	t value	Degrees Free (df)	p-value	Interpretation
Pre-Test	Average Score	0.12	28	0.90	No There is difference significant (equivalent)
Post-Test	Average Score	4.56	28	<0.001	Difference significant (experimental superior)

Table This show that the pre-test t-test ($p = 0.90$) confirmed that second group own ability equal start, ensuring validity comparison. The post-test t-test ($p < 0.001$) shows that group experiment in a way significant outperform group control, support hypothesis that Android usage increases results Study.

3.2.2. Linear Regression

The intensity of Android usage predicted 45% of the variance in learning outcomes ($R^2 = 0.45$, $F = 23.4$, $p < 0.001$). The beta coefficient ($\beta = 0.67$) indicates that a one-unit increase in Android usage intensity (e.g., more frequent prototyping activities) contributed to an increase of 0.67 points in student learning performance.

Furthermore, the addition of technology training as an independent factor in the multiple regression model increased the explained variance by 15%. This finding suggests that providing adequate training for both students and lecturers enhances the effectiveness of Android-based learning.

These results highlight the strong predictive power of Android usage, confirming its role as a key driver of successful learning outcomes, with technology training functioning as an important supporting element that strengthens its impact.

Table 3. Linear Regression Results

Parameter	Mark	Interpretation
R^2	0.45	Intensity Android usage explains 45% of the variance results Study
F	23.4	Regression model significant ($p < 0.001$)
Coefficient (β)	0.67	Every increase of 1 unit of intensity increase results study 0.67 points
Contribution Training Technology	15%	Add explained variance in the regression model multiple

Table This show that 45% of the variation in results Study can explained by the intensity Android usage, shows strong relationship. The beta coefficient (0.67) indicates that more use of Android intense (for example, more frequent prototyping) direct increase score results learning. Addition training technology increase explained variance by 15%, indicating importance training for maximize Android effectiveness.

3.3. Findings Qualitative (Interview)

The qualitative findings showed two major themes. First, interactive benefits were reported by 70% of students in the experimental group, indicating that Android-based tools made it easier to experiment with interface design and helped transform abstract IMK concepts into more concrete understanding. For instance, prototyping using Android Studio enabled real-time feedback on usability, allowing students to iteratively improve their designs during the learning process.

Second, technical challenges were experienced by 30% of respondents, involving common device limitations such as battery power issues and compatibility with Android Studio, which occasionally disrupted learning activities. Through triangulation, the qualitative findings aligned with the quantitative results, confirming that interactive benefits increased student engagement and learning outcomes, while clear instructional guidance from lecturers helped minimize the impact of technical issues.

Table 4. Interview Results

Theme	Percentage Respondents	Description
Benefit Interactive	70%	Android makes it easy experiment design interface, create more IMK concepts real
Technical Challenges	30%	Limitations device (e.g., battery, Android Studio compatibility)

3.4. Discussion

The findings of this study demonstrate that integrating Android-based technology into Human–Computer Interaction (HCI) learning provides substantial benefits in improving cognitive achievement, student engagement, and practical skills development. The significant increase in post-test scores in the experimental group compared to the control group confirms that interactive mobile-supported learning enhances students' mastery of interface design and usability concepts. These results are consistent with previous studies reporting that mobile learning environments foster deeper understanding through real-time experimentation and contextual learning experiences [29]–[32].

The strong effect observed in the regression analysis—where intensity of Android usage predicted 45% of the variance in learning outcomes—indicates that frequent hands-on engagement is a major determinant of learning success. [33]. Furthermore, the additional contribution of technology training suggests that the effectiveness of digital learning does not rely solely on tool availability, but also on the digital competence of both learners and instructors [33].

Qualitative findings further substantiate the quantitative results by showing that students perceived Android-based tools as beneficial for experimenting with interface design and obtaining rapid usability feedback, which are essential competencies in HCI. Increased engagement was evident through higher active participation in the experimental group (80%). These outcomes align with reports that mobile learning can boost motivation by providing authentic and interactive learning experiences [14]. However, the reported technical challenges—particularly device performance constraints—are in line with findings that inadequate infrastructure can hinder the implementation of mobile-supported education [15].

Although the intervention demonstrated clear benefits, variations in learning outcomes within the experimental group indicate that students may require differentiated technical support depending on their digital literacy. Meanwhile, lower consistency in achievement in the control group emphasizes that traditional lecture-only instruction may be insufficient for developing higherorder HCI competencies that require iterative design thinking and usability testing.

Overall, this study strengthens the current understanding of mobile learning integration in HCI education by providing specific evidence on the role of Android-based prototyping tools in enhancing learning performance. This contributes to bridging existing research gaps by showing clear pedagogical advantages aligned with industry-relevant practices. Nonetheless, successful large-scale implementation requires addressing both instructional and infrastructure-related challenges identified in this study.

4. Conclusion

This study concludes that the integration of Android-based learning significantly improves student learning outcomes in the Human–Computer Interaction (HCI) course within the Informatics Engineering Education program at STKIP Al-Maksum. Students in the experimental group who utilized Android Studio and Figma for interface prototyping demonstrated a notable average score increase of 20.5 points (from 65.2 to 85.7), surpassing the 10.5-point improvement observed in the control group that relied on lecture-based instruction. Statistical testing confirmed that this difference was significant ($p < 0.001$), indicating that Android-supported, interactive, and real-time feedback activities strengthened students' cognitive progression from understanding to analysis and application levels aligned with Bloom's taxonomy. Furthermore, regression analysis revealed that the intensity of Android usage accounted for 45% of the variance in learning outcomes, while additional technology training contributed a further 15%, demonstrating the importance of both hands-on interaction and sufficient technical support in optimizing technology-enhanced learning environments. Qualitative results also supported these findings, showing that the use of Android tools increased student engagement and intrinsic motivation, although several technical issues—such as device limitations—were still encountered.

Despite producing valuable contributions, this study has several limitations. The sample size was relatively small ($n = 30$), which may limit the generalizability of results to broader populations. Technical challenges related to device compatibility and hardware constraints also affected some learners. In addition, the study primarily focused on short-term cognitive outcomes and did not explore long-term skill retention or broader affective aspects such as sustained motivation.

Therefore, future research is recommended to involve larger and more diverse participant groups, examine long-term retention of HCI competencies, and further investigate student satisfaction and motivational changes over extended learning periods. Future studies may also integrate emerging mobile and AI-supported features to enhance adaptivity in HCI learning and invest in institutional infrastructure improvements to reduce technical barriers. Strengthening these aspects can ensure that Android-based learning environments not only enhance practical and conceptual skills but also better prepare students to face future challenges in modern interface design within the digital era.

Author's declaration

Author contribution

Teguh Ikhsani Putra: contribute in conceptualization research, data collection, analysis, and writing script. give supervision, guidance methodological, and revision critical manuscript. And supports the validation process, review libraries, and improvements framework Work research. author has read and agree final version of the article This.

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Competing interest

The author declares that there are no competing interests that could have influenced the work reported in this article.

Ethical clearance

This study was conducted in accordance with ethical standards. Prior to data collection, informed consent was obtained from all participants. Ethical approval for this research was granted by the appropriate institutional review board, and all procedures complied with relevant regulations and guidelines for research involving human subjects.

AI statement

Artificial Intelligence tools, including large language models such as ChatGPT by OpenAI, were utilized to assist in language refinement, grammar correction, and improving the clarity of the manuscript. However, all content, analysis, and interpretations remain the sole responsibility of the authors, who thoroughly reviewed and verified the final version.

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