Effectiveness of Android-Based Mobile Learning in Graphic Design Course for Digital Learning: The Development Research Study

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***Abstract*—This research spearheads the development and evaluation of an Android-based mobile learning platform specifically designed for graphic design education, using the 4-D model (Define, Design, Develop, Disseminate). The key findings indicate a substantial and statistically significant improvement in learning outcomes (t-count = −15.453, t-table = 2.019), highlighting the positive impact of the platform. Moreover, the Android-based learning platform proves highly effective in enhancing student motivation, with an average learning motivation score of 85.86%. The novelty of this research lies in its focus on a specific application of mobile learning technology in graphic design education, offering valuable insights for educational institutions navigating digital challenges. The platform not only contributes to improved learning quality but also fosters a creative mobile development environment, encouraging further research for its optimization in diverse educational contexts. Limitations include the need for ongoing technological updates and potential variations in device accessibility. Recommendations encompass continuous research for platform optimization, integration into broader educational settings, and adapting to evolving technological landscapes.**

***Keywords*—development, android-based mobile learning, learning effectiveness, graphic design subject, digital learning**

I. Introduction

In today's digital age, android-based mobile devices have become an integral part of everyday life [1, 2] revolutionizing the way we communicate, work, and learn [3]. With the increasing popularity and widespread use of mobile technology, it is imperative for educational institutions to harness the potential of these devices as powerful tools to enrich their learning experience [4–6]. Mobile learning platforms offer exciting opportunities to engage students in self-directed learning as a basis for improving learning outcomes and increasing learning motivation [7, 8] in the context of android-based mobile learning for graphic design.

In recognizing the importance of android-based mobile device integration, especially in the field of graphic design education, it is essential to initiate this research with a meticulous analysis of students' needs [9, 10]. The omnipresence of mobile devices in contemporary society has significantly transformed communication, work processes, and learning methodologies [11, 12]. Acknowledging this paradigm shift, educational institutions must harness the potential of mobile technology to enrich students' learning experiences. The increasing popularity of mobile learning platforms, particularly in the context of Android-based mobile learning for graphic design, provides a distinctive opportunity to involve students in self-directed learning, thereby fostering advancements in learning outcomes and heightened motivation [13, 14]. This research is based on the recognition of the important role that mobile learning plays as an indispensable skill in the modern digital landscape. Considering the continuous evolution of mobile devices, which incorporate new graphic designs and features, it becomes imperative for students to acquire proficiency in this domain. By empowering students to develop their graphic design skills through Android-based mobile learning, this research aims to enhance their technological literacy, enabling them to proficiently navigate the challenges presented by the digital age.

This research has a dual purpose within the realm of Android-based mobile learning. Firstly, it strives to develop an efficient platform tailored for mobile graphic design education on Android devices. This comprehensive platform integrates interactive materials, video tutorials, practical exercises, and features like discussion forums and gamification elements, aiming to enhance student motivation and guide them seamlessly through the Android-based learning journey. Secondly, the research aims to investigate the impact of this Android-based mobile learning platform on students' learning outcomes and intrinsic motivation in graphic design education. By evaluating learning achievements and measuring motivation levels through questionnaires, the study seeks to understand how the platform influences students' intrinsic motivation, self-efficacy, and enthusiasm for the subject matter within the Android learning environment.

This research, framed in the context of Android-based mobile learning for graphic design, recognizes the important role of mobile learning as an essential skill in the contemporary digital landscape. Given the continuous evolution of mobile devices with new graphic designs and features, it is imperative that students develop proficiency in

this domain. Empowering students to enhance their graphic design skills through Android-based mobile learning, this research enables them to elevate their technological literacy, equipping them to effectively tackle the challenges of the digital age [15, 16]. This study aims to address three primary research questions focused on the development and evaluation of an effective Android-based mobile learning platform for graphic design education: 1) How can a comprehensive educational experience for mobile graphic design be achieved through the design of an effective Android-based mobile learning platform? 2) What is the impact of implementing an Android-based mobile learning platform on improving students' learning outcomes in the field of graphic design education? This question seeks to assess the effectiveness of the platform in enhancing students' understanding of graphic design concepts and their practical application. 3) How does the utilization of an Android-based mobile learning platform affect students' intrinsic motivation to learn graphic design?

Overall, this research aims to contribute to the expanding field of knowledge regarding android-based mobile learning platforms in the digital age, specifically designed for graphic design education. By evaluating the efficacy of Android-based mobile learning platforms, our research seeks to shed light on the various benefits of such platforms in improving learning outcomes and encouraging student learning motivation in the context of Android-based mobile learning for graphic design. The insights gained from this research are poised to resonate with educational institutions, curriculum developers, and technology educators, offering valuable guidance for the design and implementation of effective android-based mobile learning strategies in the digital age.

II. Literature Review

The theoretical framework underpinning android-based mobile learning centers on its ability to revolutionize educational practice, especially within the context of graphic design education [17, 18]. This literature review explores key themes and findings related to android-based mobile learning, emphasizing its relevance and transformative impact. Often referred to as "m-learning," this approach leverages mobile devices, such as smartphones and tablets, for various educational practices [19, 20]. The flexibility, accessibility, and widespread potential of Android-based mobile learning has made it a dynamic force in education [21, 22]. Numerous studies have emphasized its advantages, including enhanced student engagement, anytime-anywhere learning, and catering to diverse learning styles [23, 24].

In line with previous studies, researchers demonstrated the profound impact of Android-based mobile learning on education, affecting student learning outcomes and motivation [25, 26]. The interactive and multimedia-rich nature of Android-based mobile devices contributes to a more engaging learning experience. Empowering students to access learning materials through Android-based mobile devices allows for personalized education, fostering autonomy and customization [27, 28]. Graphic design, situated at the intersection of technology and creativity, is an ideal domain for innovative educational approaches. The integration of Android-based mobile learning into graphic design education provides hands-on experience and exposure to the latest design trends [29–31].

Android-based mobile learning platforms offer a myriad of features, including interactive modules, video tutorials, social learning components, and gamification elements [32, 33]. These platforms empower students to access course materials, collaborate with peers, and receive real-time feedback [34, 35]. Motivation, a crucial determinant of learning outcomes, is enhanced through Android-based mobile learning, providing autonomy, relevance, and opportunities for mastery [36, 37]. The flexibility inherent in this approach allows students to take ownership of their learning journey, setting their pace and objectives [38, 39]. Gamification elements incorporated into these platforms heighten motivation through elements of competition and achievement [30, 40].

Despite the evident benefits, challenges persist, such as device compatibility, digital literacy, and equitable access [41, 42]. Addressing these challenges is paramount to ensuring effective utilization of Android-based mobile learning benefits for all students. Educators must adapt their teaching methods to seamlessly integrate Android-based mobile learning into curricula [43, 44]. Android-based mobile learning significantly enhances learning outcomes and motivation across disciplines, including graphic design [45]. This literature review underscores its importance in graphic design education, calling for further research to explore implications and best practices in the evolving digital design landscape. Challenges, including device accessibility gaps, content availability, and data security, necessitate attention. Recommendations include prioritizing device accessibility, providing relevant content, integrating interactive learning, offering instructor support, and implementing thorough evaluation for improved graphic design learning outcomes and student motivation. Ongoing research is crucial for fully realizing the potential of the Android platform in innovative and effective graphic design education.

III. Method

This research adopts a Research and Development (R&D) approach with the objective of crafting mobile learning solutions tailored for graphic design courses, employing the 4-D (Define, Design, Develop, Disseminate) development model [46]. This model, comprising four distinct stages (define, design, develop, and disseminate) provides a structured framework for the creation of learning tools. The selection of this model is justified by its appropriateness for learning tool development, offering a comprehensive and systematic description of the developmental process. One of the key advantages lies in the iterative nature of the model, allowing for revisions and expert consultations prior to testing the developed learning media. This approach ensures that the final product aligns effectively with the needs of learners and achieves optimal functionality in enhancing graphic design education.

A. Research Variables

This research design utilized the well-established 4-D model (Define, Design, Develop, Disseminate) as its basic framework. The 4-D model guided the development of this research, structuring it into distinct sequential stages that

collectively shaped the research methodology and outcomes.

Fig. 1. Mobile learning development procedure.

- **Define.** During the initial phase, problem identification is executed as expounded in the background. This is followed by an analysis of field conditions encompassing the determination of research samples, examination of student characteristics, exploration of graphic design learning concepts, scrutiny of tasks to be undertaken during mobile learning development, and formulation of precise graphic design learning objectives.
- **Design.** This stage encompasses the compilation of media design users, material design, and research instrument design. It involves designing the learning media's development, which encompasses activities such as reviewing media development criteria, selecting appropriate media and applications for graphic design lessons, choosing mobile learning media formats, compiling material scope, formulating re-search validity instruments, and creating the initial media design for mobile learning platforms.
- **Develop.** During this phase, the development of mobile learning platforms is initiated. This process begins by aligning the learning media with the curriculum and school syllabus, followed by the compilation of graphic design learning material content. Subsequently, instructional videos are created, and progress is propelled through engaging in discussions with experts in media and material validation.
- **Disseminate.** In the dissemination stage, simulations and initial trials of the media were conducted before implementation. Furthermore, comprehensive validation was carried out by media experts and material experts. After the media and materials are declared valid, they are considered ready to be integrated into the research, allowing for the collection of validity data through questionnaires given to media experts and material experts, who act as validators of mobile learning media.

The aspiration is that the successful development of this media can yield implications for other pertinent subjects. This, in turn, can lead to the creation of an effective learning platform capable of supporting students in their educational journey. Such a platform is expected to stimulate interest, enhance motivation to learn, and ultimately contribute to the improvement of overall learning outcomes.

B. Sample

This study used a simple random sampling method to select 43 students of the information technology education study program at Universitas Muhammadiyah Muara Bungo who were enrolled and taking graphic design courses. The use of this sampling method aims to ensure a representative and diverse group of participants for the research investigation.

C. Data Collection Instruments

The research instrument used in this study is the Effectiveness Instrument, which evaluates the effectiveness of mobile learning through learning test results and learning motivation. Test performance on mobile graphic design and student motivation measured through questionnaires were analyzed. The Effectiveness Instrument provides a comprehensive assessment of the impact of mobile learning on student outcomes and motivation, as follows:

- **Learning Outcome Aspects.** Effectiveness is obtained by using valid and reliable learning outcome tests. The learning outcome test was used to determine the percentage of student success after taking part in learning by using mobile learning. The preparation of learning outcome effectiveness instruments is presented in Table 1.

Table 1. Learning outcome effectiveness instrument grid

Learning Outcomes	Learning Experience	Materials
Students can understand the components of graphic design.	1. Understand the scope of graphic design. 2. Discuss applications and examples of graphic design.	1. Scope of graphic design. 2. Definition of graphic design. 3. Applications and examples of graphic design usage.
	1. Understand the components of graphic design. 2. Discuss the characteristics of graphic design components.	1. Characteristics of graphic design components 2. Basic principles of graphic design elements
Students can understand animation project planning.	1. Understand about design planning. 2. Discuss about design planning and animation.	1. Characteristics of design planning system 2. Working principle of design planning system and animation

- **Learning Motivation Aspect.** Effectiveness is seen from learning motivation using mobile learning. This learning motivation instrument was prepared using a Likert scale. The preparation of the learning motivation instrument is presented in Table 2.

Table 2. Learning motivation instrument grid

Aspect	Indicator
Intrinsic Motivation	Desire and desire to succeed The existence of encouragement and needs in learning The existence of future hopes and aspirations
Extrinsic Motivation	The existence of rewards in learning The existence of a conducive learning environment that allows learning well The existence of interesting activities in learning

D. Data Analysis Technique

To evaluate the effectiveness of the mobile learning platform, an analysis was conducted focusing on two factors: learning outcomes and student motivation. The analysis

assessed students' understanding and proficiency in mobile graphic design as indicators of the platform's effectiveness in facilitating knowledge acquisition and skill development. In addition, the impact of the mobile learning platform on student motivation, including engagement and interest, was also examined. This comprehensive assessment provides insight into the overall effectiveness of the platform in the learning process.

1) Effectiveness of learning outcomes in terms of classical completeness

Classical completeness is seen from the percentage of students who are complete after using mobile learning. The basis for determining classical completeness is if the presentation of ≥85% of students in a class has met the minimum completeness criteria [28]. Individual student learning outcomes are said to be complete if they reach the minimum completeness criteria that has been applied by Vocational High School 2 Yogyakarta, which is ≥75. The determination of the classical completeness value was analyzed using the formula proposed by.

$$Classical = \frac{many\ students\ who\ are\ complete}{number\ of\ students} \times 100\% \quad (1)$$

Based on the analysis of the number of students who reached the minimum completeness criteria, the percentage value of classical completeness was obtained. The percentage of classical completeness is an indicator in determining the effectiveness of learning media. If the percentage of students' classical completeness is ≥85% then mobile learning is said to be effective.

2) Effectiveness of learning outcomes in terms of pre-test and post-test

Learning analysis is reviewed from the pre-test and post-test to determine the difference in student learning outcomes before and after using mobile learning. The difference in question is the difference between pre-test and post-test learning outcomes, if the increase in post-test learning outcomes is higher than mobile learning can be said to be effective. For significant testing can be done with paired data t-test. Before conducting a paired data t-test, first conduct a normality and homogeneity test.

- **Normality test** is useful for determining whether the data that has been collected is normally distributed or taken from a normal population for the normality test using SPSS looking at the value of the significant Shapiro wilk, the decision making in the normality test is as follows: If the Sig. value >0.05, then the data is normally distributed; If the Sig. value <0.05, then the data is not normally distributed.
- **Homogeneity test** aims to find out whether several groups of research data have the same variance or not, to test homogeneity using SPSS see the value of significant homogeneity, decision making in the homogeneity test is as follows: If the Sig. value >0.05, then the data is homogeneous; If the Sig. value <0.05, then the data is not homogeneous.
- **Paired data t-test** serves to see the significant difference between learning outcomes before and after using the product. Paired sample t-test hypothesis testing uses the SPSS program. The decision criteria are if the Sig. value <0.05 then there is a significant difference in student learning outcomes before and after using mobile learning. If the Sig. value >0.05, it is stated that there is no significant difference in student learning outcomes before and after using mobile learning.

3) Learning motivation

The effectiveness of mobile learning through learning motivation is obtained with an instrument in the form of a checklist on a Likert scale, then analyzed into quantitative data. The data will be analyzed with descriptive statistics. Descriptive analysis was conducted to obtain scores about students' learning motivation using mobile learning. The steps to conduct the effectiveness of learning motivation are as follows:

a) Score the answers with the following criteria: 5 = Highly Effective; 4 = Effective; 3 = Moderately Effective; 2 = Less Effective; 1 = Not Effective.
b) Determining the average score obtained by summing the values obtained from many indicators.
c) Giving the value of learning motivation with the formula:

$$NA = \frac{S}{M} \times 100\% \quad (2)$$

NA = Percentage
S = Score obtained
SM = Maximum score

d) To determine the level of student learning motivation with the criteria shown in Table 3.

Table 3. Learning motivation category

No	Achievement level (%)	Category
1	85–100	Highly Effective
2	75–84	Effective
3	60–74	Moderately Effective
4	55–59	Less Effective
5	0–54	Not Effective

IV. Result and Discussion

A. Development

The development of mobile learning follows the 4-D development model, which consists of four main stages: define, design, develop, and disseminate. In this research, the focus is on creating mobile learning materials for graphic design courses. Before being implemented, the product was tested on students of the Information Technology Education study program at Muhammadiyah University Muara Bungo. The development stage involves research analysis, with the aim of describing the exact specifications of the program which includes the results of syllabus analysis, concept analysis results, and analysis of student characteristics. This analysis became the basis for mobile learning development by examining learning outcomes, competency standards, and learning strategies, identifying important graphic design concepts, and assessing students' backgrounds and abilities to customize learning media for college-level individuals. Next, the prototyping stage is conducted, where the mobile learning prototype is designed to incorporate images, animations, and videos that aim to improve students' understanding of the material. The format used follows the modified mobile learning systematics based on the guidelines of the Department of National Education (DEPDIKNAS),

which consists of a login page, material section, material presentation and video tutorial as well as an evaluation page consisting of pre and posttests. In more detail, the mobile learning development format is described as follows:

- **The login pages.** which is the page that appears when the learning media application is opened. This initial page contains animated icons that describe the material to be learned. Then on this opening page there is also a "login" button that will direct users to the material page. The login page display can be seen in Fig. 2.

Fig. 2. The login page.

- **The Material Page.** The materials page is a specialized section in the course curriculum that includes a carefully selected collection of graphic design learning materials, consisting of 16 different modules that are carefully designed to be absorbed by students throughout the course. Each of these modules is enriched with pretest and posttest menus, strategically incorporated to assess student understanding and progress. For a visual representation of the layout and organization of this educational resource, please refer to Fig. 3 presented below.

Fig. 3. The material page.

- **The Content Page.** This page will provide a detailed explanation of each graphic design learning material, complemented by a comprehensive collection of video tutorials carefully designed to help students understand the intricacies of graphic design concepts and techniques. The arrangement and presentation of the material content can be seen in Fig. 4.

Fig. 4. The content page.

- **The Evaluation Page.** is a page that contains questions that will test students' abilities. The evaluation presented in the form of objective questions consists of pretests, post-test, and evaluations on each learning material. The display of the evaluation page can be seen in the following Fig. 5.

Fig. 5. The evaluation page.

This integrated mobile learning format amalgamates various learning components into a single user-friendly platform, offering easy accessibility to users. By presenting content through a range of formats, it fosters interactivity and engagement among students, thereby enhancing learning effectiveness and motivation. Following the practical declaration of this mobile learning platform, it undergoes rigorous testing with students enrolled in the Information Technology Education program. The assessment phase serves as a critical evaluation of the designed learning

media's efficacy, focusing on its ability to effectively improve learning outcomes and student motivation. This evaluation process spans four sessions, and the effectiveness of the mobile learning design is determined by analyzing both learning outcome test results and student learning motivation questionnaire responses.

B. Research Results

The effectiveness of mobile learning is assessed in two ways: firstly, by examining the achievement of the minimum completion criteria through classical methods; and secondly, by calculating and analyzing pretest and posttest data using the paired sample t-test. These two evaluation approaches provide a comprehensive understanding of the impact and success of mobile learning interventions in improving learning outcomes and facilitating knowledge acquisition.

1) Effectiveness of learning outcomes

Classical completeness is assessed by evaluating the percentage of students who meet the completeness criteria (compared to the predetermined minimum completeness criteria value) after the implementation of mobile learning. The effectiveness of mobile learning is determined based on whether the percentage is equal to or more than 85%; if so, mobile learning is considered effective. Conversely, if the percentage of students who meet the classical completion criteria is below 85%, then the mobile learning is considered ineffective. The next section presents the average scores achieved by students in the graphic design subject, as detailed in Table 4.

Table 4. Effectiveness analysis results based on classical completeness

Item		Value	
Number	43	<75 (Not Completed)	2 (4.66%)
		≥75 (Completed)	41 (95.34%)
Max. Value		100	
Min. Value		50	

According to the findings presented in Table 4, it is evident that 41 students (95.34%) have successfully met the completion criteria. This outcome signifies the attainment of classical completeness, leading to the conclusion that the utilization of mobile learning is indeed effective in terms of classical completeness.

2) Effectiveness of pretest and posttest research results

- **Pretest result**. After administering the initial test to the students, the collected data underwent comprehensive analysis using the SPSS data processing application. This analysis aimed to assess various aspects of the data, including data distribution, mean values, and standard deviations. The outcomes of this rigorous analysis have been meticulously documented and are conveniently summarized in Table 5 for reference and further evaluation.

The results obtained from the data analysis, as depicted in Table 5, provide valuable insights into some key parameters: a) the mean score was 50.51; b) the highest score recorded was 80; c) the lowest score observed was 40; d) the standard deviation, which indicates the variability of the data, was calculated at 9.5. It is important to emphasize that these statistics relate to data collected prior to the implementation of mobile learning and form the basis for assessing its effective impact on learning outcomes.

Table 5. Pretest analysis results

		Pretest	Posttest
Mean		50.5116	81.4884
Std. Error of Mean		1.44878	1.68387
Median		48.0000	83.0000
Mode		46.00	85.00
Std. Deviation		9.50031	11.04185
Variance		90.256	121.922
Range		40.00	51.00
Minimum		40.00	45.00
Maximum		80.00	96.00
Sum		2172.00	3504.00
Percentiles	25	44.0000	78.0000
	50	48.0000	83.0000
	75	53.0000	90.0000

- **Posttest result.** Following the utilization of mobile learning by students, the data collected was subjected to analysis using the SPSS data processing application. This analysis aimed to discern the distribution of the data, calculate the mean value, and determine the standard deviation of the acquired data. The outcomes of this comprehensive analysis conducted via SPSS are meticulously detailed and presented in Table 5. These findings are instrumental in evaluating the impact of mobile learning on student performance and understanding the changes in data distribution, mean scores, and data variability post-implementation.

Data analysis provided the following results: a) the mean score was 81.49, b) the highest score was 96, c) the lowest score was 45, and d) the standard deviation was 11.04. It is important to note that these statistics relate to posttest data, which represents the final assessment after students have received the mobile learning treatment. This posttest was administered to a student group of 43 students, which provides important insight into the effectiveness of mobile learning in improving student performance.

- **Analysis of differences in pre-test and post-test results.** The data from both the pretest and posttest results underwent analysis using the paired data t-test formula. This analysis aimed to identify any significant differences between the pretest and posttest outcomes. Before conducting the t-test analysis, prerequisite assessments were performed, including a normality analysis to assess the data's normal distribution and a homogeneity analysis to determine whether the data variances were consistent. Both normality and homogeneity tests were executed utilizing SPSS software. The outcomes of the normality test for the pretest and posttest data are presented in Table 6.

Table 6. Analysis pretest and posttest normality test analysis results

		Pretest	Posttest
N		43	43
Normal Parameters	Mean	50.5116	81.4884
	Std. Deviation	9.50031	11.04185
Most Extreme Differences	Absolute	0.171	0.190
	Positive	0.171	0.125
	Negative	–0.134	–0.190
Shapiro-Wilk Z		1.119	1.246
Asymp. Sig. (2-tailed)		0.163	0.090

Based on the results of the pretest and posttest data analysis conducted at a significance level of 0.05, the normality value for the pretest data is 0.163, as indicated by the asymp Sig. (2-tailed) value. Since the normality value exceeds the significance threshold (0.163 > 0.05), the data is considered to follow a normal distribution. Similarly, for the post-test data, a normality value of 0.090 was obtained, as reflected in the asymp Sig. (2-tailed). Again, since this normality value surpasses the significance level (0.090 > 0.05), the data is deemed to exhibit a normal distribution, as shown in Table 7.

Table 7. Pretest and posttest homogeneity test analysis results

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	720.337	13	60.028	0.587	0.836
Within Groups	3070.407	30	102.347		
Total	3790.744	43			

The SPSS output in Tables 7 and 8 shows that the significance value for the pretest and posttest data is 0.836, which exceeds the 0.05 threshold. This indicates that the pretest and posttest data show homogeneous variance, so it can be continued with hypothesis testing, as presented in Table 8.

Table 8. T-test analysis results

	t	df	Sig. (2-tailed)
Pretest – Posttest	−15.453	43	0.000

Hypothesis testing was conducted using paired sample test analysis through the SPSS program. The decision criteria were established as follows: if the significance value is less than 0.05, it indicates a significant difference in student learning outcomes before and after the implementation of mobile learning. Conversely, if the significance value is greater than 0.05, there is no significant difference in student learning outcomes before and after mobile learning. The results of the test revealed a significance value of 0.000 (0.000 < 0.05), signifying a significant difference in student learning outcomes before and after the utilization of mobile learning. Additionally, when comparing the t-count and t-table values, if t-count is less than t-table, it indicates an improvement in learning outcomes after implementing mobile learning. Conversely, if t-count is greater than t-table, there is no enhancement in learning outcomes following mobile learning adoption. The analysis yielded a t-count value of −15.453, while the t-table value was 2.019. Since t-count is less than t-table (−15.453 < 2.019), it is affirmed that there is indeed an increase in learning outcomes between the period before and after the implementation of mobile learning.

3) Learning motivation

- **Validity of learning motivation instrument.** The analysis of the validity test for the learning motivation questionnaire, conducted using the SPSS 21 application, resulted in the validation of 13 out of the 15 questionnaire items initially provided. The validated questionnaire items were identified as follows: 1, 2, 3, 4, 6, 7, 8, 9, 10, 12, 13, 14, and 15. Additionally, two items were found to be invalid. Validity was established based on the criterion that r-count should be greater than r-table (where r-table = 0.444), considering a total of 20 student respondents participating in the questionnaire analysis.
- **Reliability test of learning motivation instrument.** The results of the analysis of the reliability test for the learning motivation questionnaire are presented in Table 9.

Table 9. Recapitulation of the learning motivation instrument reliability test

Cronbach's Alpha	Cronbach's Alpha Based on Standardized Items	N of Items
0.903	0.897	15

The analysis of the reliability test results in Table 10, conducted using the SPSS 21 program, yielded a Cronbach's Alpha value of 0.903, indicating a very high level of reliability. Consequently, it can be confidently concluded that the learning motivation questionnaire is highly reliable for measuring learning motivation through the perspective of students when using the mobile learning platform that has been developed.

- **Learning motivation.** The assessment of learning motivation was based on the data obtained from a motivation questionnaire administered during the fourth meeting after students had completed their learning using the mobile learning platform. The summarized outcomes regarding the effectiveness of learning motivation can be found in Table 10 and Fig. 6.

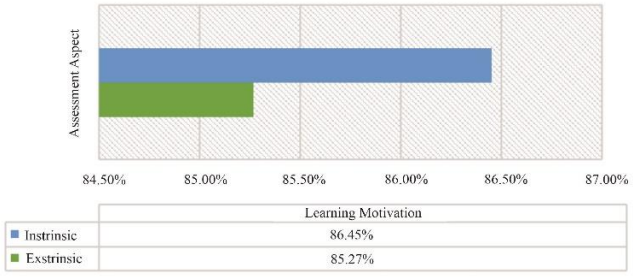

Fig. 6. Data recapitulation of learning motivation.

Table 10.Tabulation of learning motivation data

Description	Extrinsic motivation						Intrinsic motivation						
Score obtained (S)	177	188	186	185	173	191	177	181	201	183	186	195	178
Maximum score (SM)	215	215	215	215	215	215	215	215	215	215	215	215	215
Average	4.1	4.4	4.3	4.3	4	4.4	4.1	4.2	4.7	4.3	4.3	4.5	4.1
Percentage (NA)	82	87	87	86	80	89	82	84	93	85	87	91	83
(%) Aspect	85.27						86.45						
Category	Effective						Very Effective						
Average	85.86						Effective						

The data generated from the effectiveness analysis, as illustrated in Fig. 6, revealed important findings. Specifically, in terms of intrinsic motivation, the data showed a score of 86.45%, while extrinsic motivation of mobile learning reached 85.27%. Furthermore, the data of this study was further analyzed, focusing on the average results of learning motivation. It can be concluded that the implementation of the mobile learning platform has a significant positive impact

on increasing students' learning motivation, with the average learning motivation score reaching 85.86%, categorizing the mobile learning platform as "effective" for increasing students' learning motivation.

C. Discussion

The results of this study indicate that the development of an Android-based learning platform in graphic design education has great potential to improve learning outcomes and student motivation. The main finding that stands out is the significant improvement in learning outcomes, as evidenced by the t-test results (t-count = −15.453, t-table = 2.019), indicating a positive impact on students' academic performance. In addition, the platform proved to be highly effective in increasing students' learning motivation, with an average result of 85.86% in the learning motivation, making it "Effective" in terms of motivating students.

This research reinforces the understanding that the use of technology, such as Android-based platforms, has the potential to enrich students' learning experience and improve academic achievement [47]. Especially in the context of graphic design education, where practical proficiency in design software and student motivation are key to success, mobile learning platforms such as the one researched here can meet these needs [45].

However, there are several challenges that need to be overcome in adopting this technology more widely. One of the main challenges is the uneven accessibility of the devices [48]. Although the results are positive, not all students may have adequate Android devices, which may create inequality in learning opportunities. In addition, the availability of appropriate and curriculum-relevant content is also an important issue to be considered [45, 49]. To maximize the potential of this platform, it is important for platform developers and graphic design educators to ensure that the content provided supports the learning objectives.

In conclusion, this research provides valuable insights into how technology, particularly Android-based platforms, can be used to enhance graphic design education. The positive results achieved in terms of learning outcomes and student motivation suggest that investment in the development of this kind of platform can provide substantial benefits. However, challenges such as device accessibility and content availability should be taken seriously to continue the use of Android-based learning platforms in graphic design education.

V. Conclusion

This research is centered on the development and evaluation of a mobile graphic design learning platform aimed at enhancing learning outcomes and student motivation. The analysis conducted yielded significant findings regarding the platform's effectiveness in improving learning outcomes, as indicated by the t-test results (t-count = −15.453, t-table = 2.019), demonstrating a positive impact on student academic performance. Moreover, the study underscored the platform's high effectiveness in boosting students' learning motivation, with an average result of 85.86% in the learning motivation, categorizing it as "Effective" in terms of motivating students. This underscores the platform's capacity to capture students' interest and sustain their motivation in the graphic design subject. These findings highlight the substantial potential of mobile learning platforms, especially in graphic design education, as technology integration enriches the learning experience, enhances academic achievement, and sustains student engagement. The study's outcomes hold practical implications for educational institutions and curriculum designers, emphasizing the value of incorporating mobile learning platforms to optimize students' learning journeys. Leveraging mobile platform features, educators can enhance learning outcomes and nurture student motivation across various educational contexts, fostering a dynamic and effective learning environment.

Moving forward, the continual evolution and enhancement of the mobile graphic design learning platform should be a priority. This necessitates ongoing development efforts aimed at incorporating cutting-edge technologies and pedagogical advancements. Customization features should be introduced to personalize learning experiences, accommodating diverse learning styles and individual student needs. Additionally, providing pedagogical training and support for educators is crucial to ensure their effective utilization of the platform's features. Investing in educators' professional development will empower them to optimize the platform's capabilities, thereby maximizing its impact on student learning. Furthermore, expanding research endeavors in similar educational contexts or diverse academic disciplines is paramount. Longitudinal studies and comparative analyses can offer deeper insights into the sustained effectiveness and adaptability of mobile learning platforms. Collaboration with industry professionals in the graphic design field will ensure the platform aligns with current industry standards and practices. Lastly, establishing a feedback loop for continual improvement, incorporating user feedback from both students and educators, will be instrumental in shaping iterative enhancements that meet evolving educational needs.

Conflict of Interest

The authors declare no conflict of interest.

Author Contributions

Muhammad Hakiki: Conceptualization; methodology; project administration; writing-original draft; writing- review and editing. Herman D. Surjono: Formal analysis; validation; supervision. Wagiran: Formal analysis; validation; supervision. Radinal Fadli: Software; project administration; visualization. Agariadne D. Samala: Software; project administration; visualization. Fivia Eliza: Investigation; resources. Ade Fricticarani: Investigation; resources. Anis Suryaningsih: Data curation; formal analysis; writing - review and editing. Yayuk Hidayah: Data curation; formal analysis; writing—review and editing. all authors had approved the final version.

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