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The Implementation and Empirical Analysis of Android Learning Application toward Performance among Students Electronics Engineering Education

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***Abstract*—The integration of technology into the realm of education is experiencing exponential growth, and an ever-evolving selection of media formats is being created to facilitate teaching and learning in a more effective manner. The objective of this research endeavor is to ascertain the degree to which the implementation of learning applications influences the academic achievement of students enrolled in electrical engineering-related programs. To accomplish this objective, learning methodologies and self-directed learning must be implemented as variables that impact students' academic performance. To facilitate this inquiry, a total of 339 representative samples of participants were collected. The collected data were subjected to analysis using the SmartPLS 4.0 software and the Structural Equation Model (SEM) with partial least square (PLS) correction. Following a thorough analysis, it was determined that the data provided an accurate representation of the population. The findings of this study have practical implications-students who engage in self-directed learning and implement effective learning strategies will see a substantial improvement in their overall learning outcomes. Students desire easy access to a variety of educational resources and materials, according to the findings. This aspiration motivates the proliferation of mobile media devices. To facilitate students' access to a diverse range of learning strategies, instructors possess the ability to provide accommodation. These applications benefit students by streamlining the process of obtaining access to learning-supporting materials and resources.**

***Keywords*— Learning application; self-directed learning; learning strategies; performance.**

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I. INTRODUCTION

Mobile app technology for students has evolved rapidly and will likely continue to grow even further. Media-based learning methods are on the rise; therefore, it is necessary to study to understand how learners can accept and adapt to the rapidly improving mobile application learning environment [1]. User appreciation of renewable resources such as technology is strongly correlated with its ease of use [2]. The intense use of smartphones today can benefit education service providers to design applications that can be downloaded on smartphones. This can have an impact on students to open and access lessons through the application whenever they want [3]. Innovative and accessible teaching tools can increase student interest, easy access to learning, and skill development through real-world experiences that students can experience or see first-hand [4]. Learning outcomes that they can develop wherever and whenever needed. If students can have this kind of thinking, then the learning process using smartphone apps can have a good effect [5].

Learners find themselves on the app to be fun, intuitive, and interactive when using learning apps. It is a fact that learning apps can enrich learners' learning processes [6]. Learners can now continue their learning remotely thanks to learning systems, video conferencing tools, and collaboration platforms with adapted smartphone apps [7]. This increases the consistency and accessibility of their learning. Education providers today have access to the latest and cutting-edge instructional strategies due to the rapid advancement of technology.

Educational institutions can now create engaging and interactive lessons for their students through the use of digital platforms, multimedia presentations [8], and educational software. Technology has an essential influence on the advancement and ease of education in facilitating distance learning and by using smartphone apps [9]. Many universities in the world recognize the importance of problem-solving skills using the cultivation of computational thinking necessary for students to live in today's world [10]. The use of technology makes collaboration between students and teachers easier [11]. Students can work together, share ideas, and participate in group projects regardless of their physical location thanks to discussion forums through smartphone apps, video conferencing tools, and collaboration platforms [12].

Thanks to the internet, students and teachers now have access to a vast amount of previously inaccessible information. E-books, educational websites, and digital libraries are examples of resources that can be obtained on digital media that provide access to a wide variety of educational materials [13]. Smartphone technology is increasingly integrated into the educational experience of today's learners [14]. Technology has developed so rapidly that it is now possible to learn using smartphone applications containing courses and other learning resources that can be accessed at any time. The mobile tendency of students to rely heavily on their devices [3], has the potential to influence the development of apps for these devices positively. This is a support for students to be able to open the lessons they want wherever and whenever they want, to improve the way of thinking that is so important for them [15].

Technology has facilitated distance learning by providing digital platforms, multimedia presentations, and educational software that enable engaging and interactive lessons in schools [9]. Active learning technologies develop students' learning motivation, and to modernize education, the standards and the way students think must change. Students are motivated by educational quality and tools [16]. Learning management systems, video conferencing, and smartphone app collaboration platforms allow students to learn remotely [17]. Using Android technology, basic electronics practice learning can be simulated, and the learning can be measured to determine how this kind of learning can affect student performance and the factors that can impact the use of this simulation system. This ensures consistent education and easy access. Evaluating educational technology helps maintain the standard of student learning.

II. MATERIALS AND METHOD

In higher education, teachers must shift from lesson giver to lesson facilitator. This transition can be best reflected through self-directed learning. Any lingering confusion about the concept of self-directed learning must be cleared up if self-directed learning will be useful in the real world. People who emphasize their education are the kind of learners who direct their educational pursuits. Learners can determine their learning goals and the order in which they should be completed. It is possible to engage in self-directed learning within and beyond the confines of the conventional classroom (offline). The role of the teacher should be more of a facilitator of learning rather than a conveyor of information [18]. According to Garrison [11], most conceptualizations include the notion that the learner should have some level of control over either or both the planning (goals) and management (support) of the learning experience. While complete autonomy in learning is ideal, it is not always the ultimate goal of self-directed learning, as emphasized by Garrison [19]. The capacity to make decisions about one's education is as important as the availability of learning opportunities for successful self-directed learning. Therefore, self-direction is not just a matter of "technique"; the normative and knowledge aspects are also essential. If you are technically competent, you can take responsibility for your education without questioning the underlying norms. In the future, we need to make a distinction between self-directed learning strategies and shifts in perspective that can be referred to as self-direction [20].

Individuals will use various approaches to achieve their learning-related goals, and the collective name for these approaches is "Learning Strategies" [21]. Learning techniques, also sometimes referred to as cognitive strategies, are essential and beneficial, but one cannot make the same claim for the specific definition and classification of these methods [5]. Although academic research agrees on the importance and advantages of learning techniques, sometimes referred to as cognitive strategies. Learning strategies are defined as behaviors or thoughts that are expected to shape the process of acquiring knowledge, encoding it in memory, and re-accessing it when needed [1]. According to Weinstein and Mayer [22], learning strategies are behaviors or thoughts, learners can exhibit any of the behaviors mentioned above or thoughts when acquiring new knowledge. Weinstein and Mayer [22], define learning strategies as behaviors that shape the way learners process knowledge. Mayer calls these ways of behaving learning strategies. Based on these definitions, "learning strategies" most often refer to the methods learners use to find solutions to the problems they face or the procedures that enable learners to learn independently.

Learner performance can be defined and measured in various ways, including completing courses, receiving grades, and gaining new knowledge and skills, as stated by Picciano [23]. Whether or not differences between online and traditional course formats remain when students are broken down into high-performing and low-performing groups has been the subject of research in several studies. Bacolod et al. [24] supported the idea that online learning hurts both performance groups, with the most considerable differences observed in the low-performing learners' population. These results lend credence to the negative effects of online education on both performance groups. Research [25] shows that students with low grades perform less in online classes than in traditional courses. According to Johnson and Palmer [26], students with lower academic grades are likelier to take online courses than students with higher academic grades. According to Driscoll et al. [27], the various types of evaluations that teachers use to create variety in their lessons, such as exams, assignments, and final grades, may not always accurately reflect students' authentic learning abilities. This is because teachers use these evaluations to create variety in their lessons. On the other hand, such assessments are universally used to measure student performance and are frequently regarded as reliable indicators of the degree to which students have achieved learning goals [28].

Therefore, this study proposes the following hypotheses, as shown in Fig. 1:

- H1: Self-directed learning significantly influences Learning Strategy
- H2: Self-directed learning significantly affects Performance
- H3: Learning Strategy significantly influences Performance
- H4: Learning Strategies significantly mediate the relationship between Self-Directed Learning and Performance

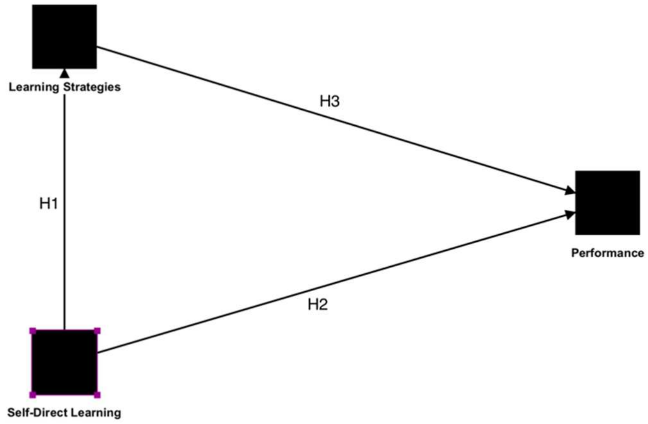

Fig. 1 Hypothesis

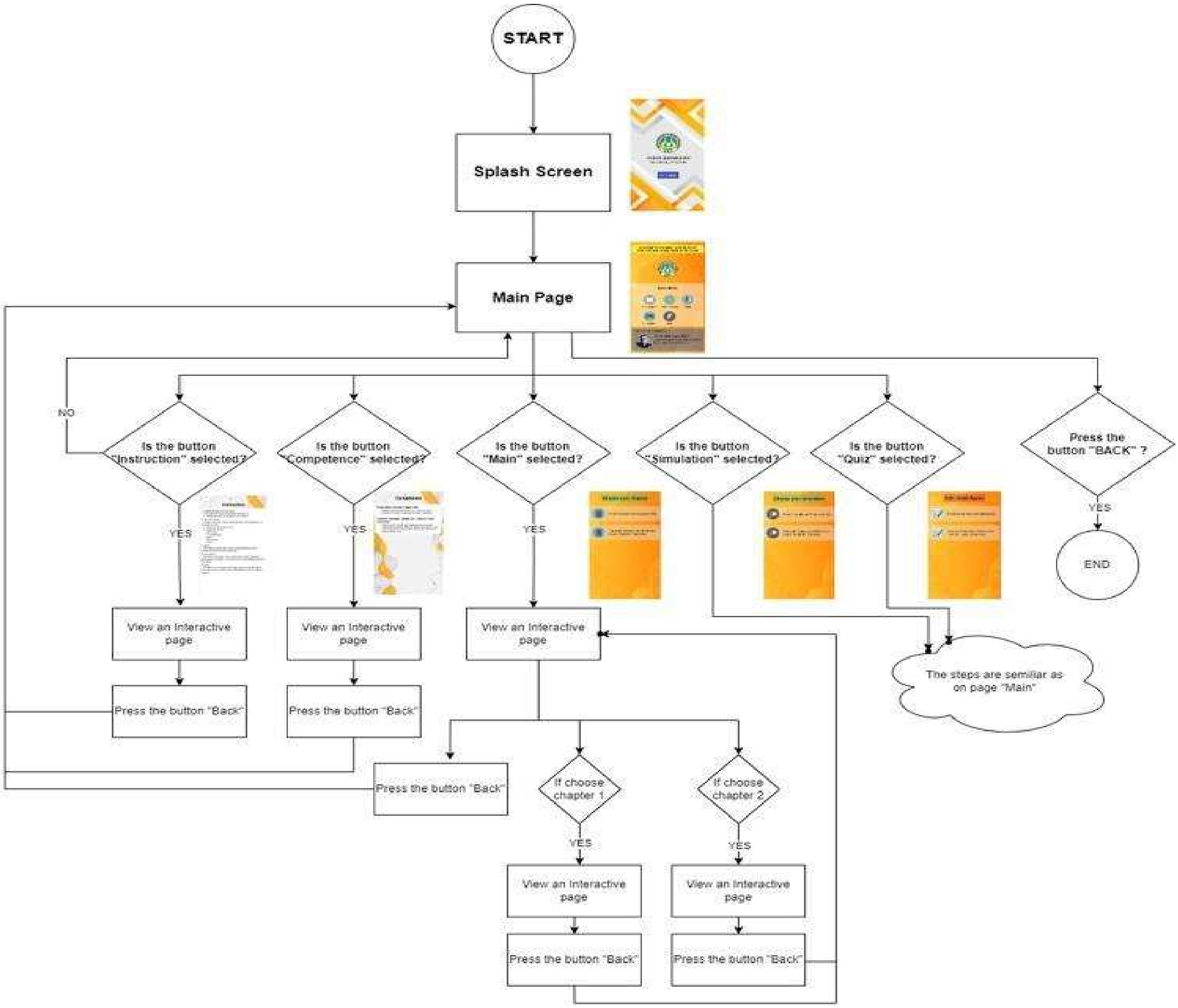

Fig. 2 Flowchart problem-based learning apps

This study focuses on a smartphone application that can be installed on a smartphone, which is based on Problem-based Learning and can be used by students to improve their skills. In Fig. 2, we can see the flowchart of the learning application provided, where students can choose several options, such as running simulations and quizzes in the application. Fig. 3 shows an image of the main page and simulations that can be selected by the learner. These simulations can be run by students to sharpen their understanding of the use of the material learned, as well as the practicum they can do with the theory. From Fig. 4, we can see the simulation that can be done by students in this problem-based learning application, making it easier for students to get a picture of the adjustments they can make in the field when they have to practice the teaching material directly, they get from the learning process.

A. Data Analysis

Most of the measurement items used in this study refer to research done in the past, but some modifications have been made to account for the context of this study. As a result, it was discovered that a Likert Scale was used to measure the items included in this study. On this scale, each item was given a score out of five points, ranging from 1 (strongly disagree) to 5 (strongly agree).

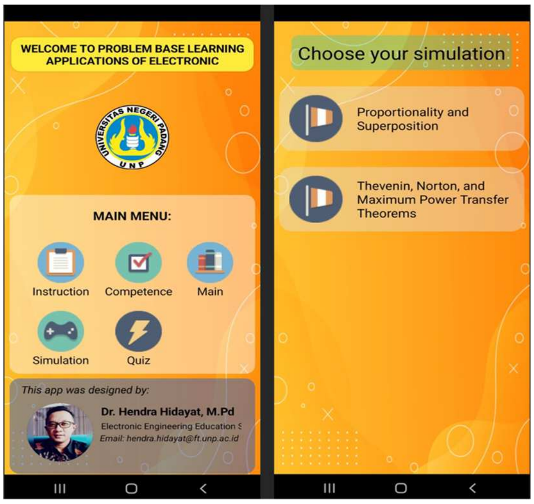

Fig. 3 The Main Page of the Android Learning Application

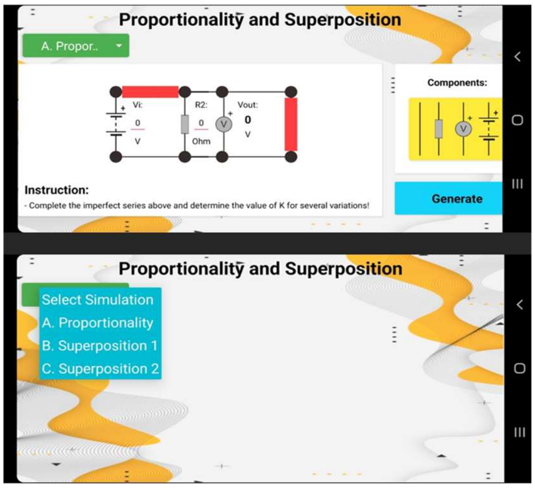

Fig. 4 The Simulation Test on The Apps

Partial Least Squares (PLS) is one of the alternative methods of variance-based Structural Equation Modeling (SEM) (VB-SEM), which was used to conduct data analysis. This analysis was carried out with the help of a Structural Equation Model (SEM) by employing the Partial Least Square (PLS) approach and SmartPLS version 4 as the software. According to Anderson and Garbing [29], a two-stage data analysis strategy was utilized in this study. The first stage consisted of assessing the validity and reliability of the research constructs against the measurement model. The structural model and data validity were also evaluated. Standard item loading and average variance extracted (AVE) were utilized to test convergent validity. On the other hand, the heterotrait-monotrait correlation ratio (HTMT) was used to test discriminant validity.

In addition, composite reliability (CR) and Cronbach's alpha were used to measure the internal consistency of the dependency of the research constructs. In the second stage, 5,000 bootstrap samples were generated to test the statistical significance of the structural relationships between the research components. This article provides an overview and discusses the value and level based on the importance-performance model (IPM) results of each research construct on satisfaction and competitive advantage, with an analysis model using Importance-performance Map Analysis (IPMA) from the SmartPLS application providing an overview of the importance and performance values of each construct.

III. Result and Discussion

The respondents in this study totaled 339 Electronics Engineering Education students who had experience using Android-based learning applications designed to help the learning process. These respondents were collected through online media, and then the participants filled out a questionnaire via the web-based that had been prepared. From 339 data obtained, 212 respondents, or equivalent to 62.54%, are male, and 127, or comparable to 37.46%, are female. And from the age group, more than 24 years of age, 4 people or 1.18%, 23-24 years of age, there were 12 participants or 3.54%. From the 21–22-year age group, 82 people participated, or 24.19% of the total respondents, while from the 19–20-year age group, 182 people, or 53.69% of the total respondents, and the 17–18-year age group participated, in this study were 59 people or 17.40%. In comparison, the use of smartphones per day in the group is more than 10 hours per day by 90 people or 26.55%, from the 7–9-hour group, 131 people or 38.64%. From the 4-6 hours per day group, there were 93 people or 27.43%; for 1-3 hours per day, there were 25 people or 7.37%.

TABLE I
Respondents Profile

Gender		Number	Percentage
Male		212	62,54%
Female		127	37,46%
	Total	339	100,00%
Age(Years Old)			
> 24		4	1,18%
17 - 18		59	17,40%
19 - 20		182	53,69%
21 - 22		82	24,19%
23 -24		12	3,54%
	Total	339	100,00%
Smartphone usage in a day (Hours)			
> 10		90	26,55%
1 - 3		25	7,37%
4 - 6		93	27,43%
7 - 9		131	38,64%
	Total	339	100,00%

Using the internal Variance Inflation Factor (VIF) and PLS-SEM method, a statistical technique was used to determine common bias [30]. The VIF values ranged from

1.565 to 2.773, which is below the 3.30 criterion suggested by Kock (2015) [31] for significance tests to be free from common method bias. The Heterotrait-monotrait ratio (HTMT) discriminant validity was performed with the expectation that the value of the HTMT would be lower than 0.9 to guarantee the existence of discriminant validity between the two reflective constructs [32]. The discriminant validity test results range from 0.445 to 0.502, which is still below the threshold of 0.9 recommended by professionals.

TABLE II
VIF, CRONBACH'S ALPHA, COMPOSITE RELIABILITY, AVERAGE VARIANCE EXTRACTED (AVE)

	VIF	alpha	CR	AVE
Learning Strategies		0.616	0.620	0.445
LS1	2.154			
LS2	2.282			
LS3	2.423			
LS4	2.313			
LS5	2.247			
LS6	1.565			
Performance		0.561	0.563	0.502
Pr1	1.855			
Pr2	2.025			
Pr3	1.575			
Self-Directed Learning		0.588	0.590	0.478
SDL1	1.615			
SDL2	2.299			
SDL3	2.773			
SDL4	1.708			

According to Table 2, all the values for Composite Reliability and Cronbach's alpha are higher than 0.70 [33]. In addition, the data were found to have convergent validity, as shown in Table 2, because all factor loadings for each indicator on the corresponding latent constructs exceeded the benchmark of 0.60, and the AVE for each construct exceeded the benchmark of 0.50 [33]. This was demonstrated by the fact that the data met both criteria.

TABLE III
HETEROTRAIT-MONOTRAIT RATIO OF CORRELATIONS (HTMT)

	Learning Strategies	Performance	Self-Directed Learning
Learning Strategies			
Performance	0,755		
Self-Directed Learning	0,852	0,685	

The results of the data filled in by respondents and analyzed using SmartPLS can be seen in Fig. 5 and Table 4, which shows the path of all hypotheses designed in this study. These results show that in hypothesis 1, the effect of self-directed learning on learning strategies is positive and significant ($\beta = 0.516$, $\rho = 0.000$). This relationship is also found in hypothesis 2, the effect of self-directed learning on performance ($\beta = 0.142$, $\rho = 0.004$).

In hypothesis 3, the effect of learning strategies on performance has a positive and significant relationship ($\beta = 0.340$, $\rho = 0.000$). Then, hypothesis 4 mediates the role of strategic learning on the relationship between self-directed learning and performance ($\beta = 0.252$, $\rho = 0.000$).

TABLE IV
HYPOTHESIS RESULT

Hypothesis	β	t	ρ	Results
H1	0.516	24.904	0.000	Accepted
H2	0.142	2.903	0.004	Accepted
H3	0.340	7.682	0.000	Accepted
H4	0.252	7.400	0.000	Accepted

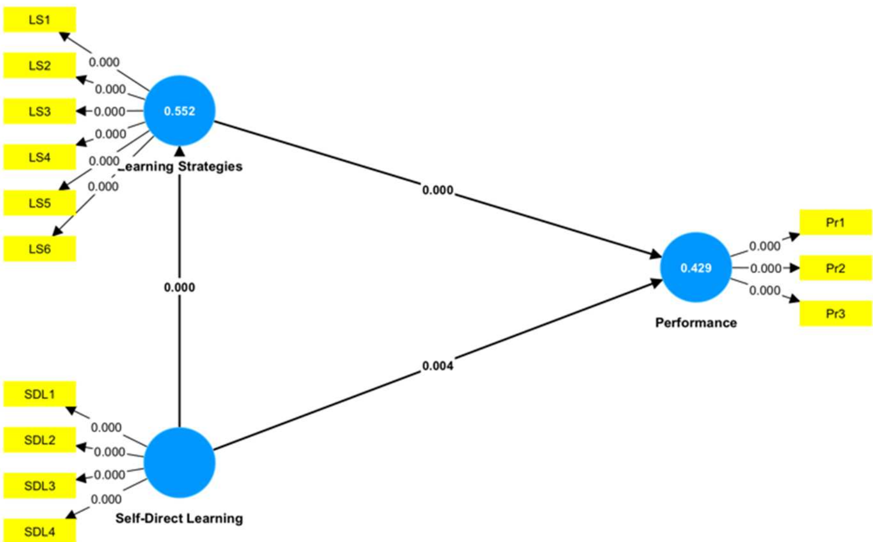

Fig. 5 Hypothesis Testing

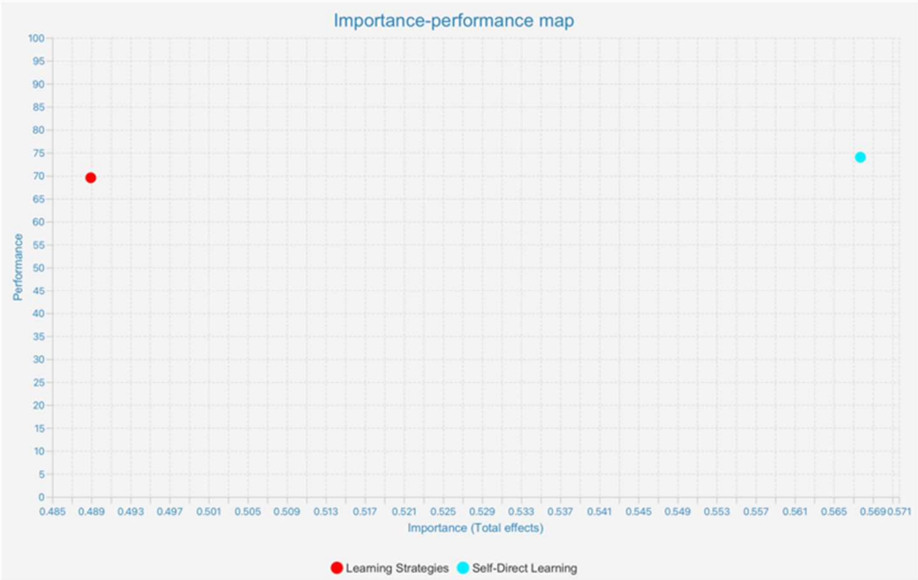

Fig. 6 Importance – Performance Map Analysis

This article provides an overview and discusses the value and level based on the results of the importance-performance model (IPM) of each research construct on satisfaction and competitive advantage, with an analysis model using Importance-Performance Map Analysis (IPMA) from the SmartPLS application providing an overview of the importance and performance value of each construct. These constructs have the potential to become driving factors in the process of improving student performance from self-directed learning and learning strategies. IPMA analysis is measured based on the structural model, the importance value is obtained from the total effect received by the construct, and the performance value is obtained from the variable score [34]. This study found that the most significant driving factor in learner performance was self-directed learning.

IV. Conclusion

Using learning apps on mobile phones is potentially a powerful tool to make education more accessible and engaging for students. Mobile apps can create practical learning experiences using various technologies and features, such as multimedia content, interactive elements, gamification, and mobile accessibility. All of these are accessible on mobile devices. Implement features that allow the app to modify itself based on each student's preferences and progress. The app's efficiency can be improved through personalized learning paths. Include mechanisms that will provide feedback to students on their performance so that they can improve. Learners are encouraged to improve through features that track their progress, which helps them understand their strengths and weaknesses.

Making consistent updates to the app based on user comments and suggestions and changing educational needs. Maintaining the app's currency requires keeping up with the latest developments in education and technology. Learners are said to be engaged in a process known as self-regulated learning when they are responsible for determining their educational requirements, formulating their own educational goals, selecting and practicing the most appropriate educational strategies, and evaluating their academic achievements. Due to its potential to assist students in developing their learning habits, the concept of students taking responsibility for their education is gaining traction not only in conventional teaching settings but also in research on online education and distance education [35]. This is because the idea of students taking charge of their education is gaining traction in conventional teaching settings and research on online and distance education.

Students taking part in self-regulated learning are given instruction, and their grades are determined by the collaborative teamwork process in which they take part. Behavioral assessment of self-regulated learning is a tool used worldwide to evaluate the capacity of learners to self-regulate during leisure time. Activation of several different dimensions of self-directed learning is necessary to determine the extent of things that can lead the learner to self-directed learning. The emotional component of self-directed learning has received less attention, although emotions can be an essential part of a learner [36], as evidenced by the research that has been conducted.

Regularly solicit feedback from app users, including students, teachers, and parents, to identify areas of the app that can be improved and update it accordingly. Teachers can provide resources and tools for other teachers to track student progress, create reports, and provide individualized assistance to students who may be struggling. The design and content of these apps should be based on tried-and-true educational strategies and research on efficient teaching techniques. The success of a learning app depends on its ease of use, efficiency, and ability to meet the specific needs of individual students. For continuous improvement and long-term success, it is crucial to regularly evaluate and improve the app based on user feedback.

Developing educational apps to improve students' academic performance can be a useful resource for both students and teachers. By catering to individual strengths, areas of improvement, and preferred modes of teaching, you can make each student's educational experience unique. You can also apply appropriate algorithmic methods to assess their performance and provide suggestions regarding appropriate educational materials or activities.

Include engaging and interactive content, such as videos, animations, quizzes, and games, to make the educational process more exciting and fun. Provide a detailed overview of student progress, including achievements and areas they can improve on. Students can find it easier to stay on track and set learning goals with the help of this feature. Implementing adaptive testing techniques, which adjust the difficulty of questions based on student performance to provide a more accurate assessment of knowledge and skills, is a must. Incorporate elements that encourage students to work together, such as discussion forums and group projects. Learning and problem-solving are two skills that can be enhanced through collaboration. Ensure the app complies with data privacy laws and takes appropriate precautions to protect student information. Make the app available to all students, including those with special needs, by including accessibility features such as text-to-speech, closed captions, and screen reader compatibility.

Based on the variables and items, applying technological advances to facilitate teaching and learning is crucial to achieving student learning outcomes. Due to the rapid advancement of technology, the education system should also continuously strive to develop more mobile teaching and learning methods. According to research conducted by [37], the findings are consistent with the observation that students want to be able to access learning materials and resources efficiently. This desire is the driving force behind the continued adoption of mobile media devices. Ease of access to learning strategies, a critical component for students, can be supported by accommodations that teachers can make. Learning apps such as these are excellent support for students as they allow students to easily access materials or resources that can make the learning process easier for students to complete.

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