

An Android e-Learning Application to Support Academic Learning: Design, Development, and Implementation of a Case Study

Neilcy Tjahjamoorniarasih¹, Leonardus Sandy Ade Putra^{1,*}, Eka Kusumawardhani¹, Suci Pramadita², and Vincentius Abdi Gunawan³

¹Department of Electrical Engineering, Universitas Tanjungpura, Indonesia

²Department of Environmental Engineering, Universitas Tanjungpura, Indonesia

³Department of Informatics Engineering, Universitas Palangka Raya, Indonesia

Email: neilcy.mooniarasih@ee.untan.ac.id (N.T.), leonardusandy@ee.untan.ac.id (L.S.A.P.), ekawardhani@ee.untan.ac.id (E.K.), suci.pramadita@gmail.com (S.P.), abdi.g05@gmail.com (V.A.G.)

Abstract—After the pandemic, Indonesia became one of the countries that imposed a new normal for all levels of society with various sectors of life. The education sector is one of the areas most highlighted in the new normal change. Various policies and learning methods have been attempted to implement distance education. In the current new normal, distance learning is a beneficial method in implementing education in Indonesia. The delivery of learning materials is carried out by sending materials and meeting face-to-face online using video conferencing applications and materials provided on online storage services. Both methods are now available on separate platforms and have not been integrated into one platform, making it difficult for users. It has shortcomings in terms of optimization in providing learning services. In addition, the method used today still has several weaknesses, such as adjusting the learning schedule, understanding that is more difficult to accept because it is done online and also not yet integrated between face-to-face materials and media on a mobile device. This study aims to design an Android-based e-learning application that can assist students' learning process and help distribute learning materials. The application is designed to meet the needs of students in understanding the material more optimally and can be done without being limited in time. The results of research that have been carried out on student satisfaction obtained a percentage level of 94% which stated satisfaction in the use of learning applications. Satisfaction with the help of the application says that e-learning applications can improve academic abilities and skills in the fields they study.

Index Terms—Applications of e-learning, android development, e-learning, Information and Communication Technologies (ICT), mobile application

I. INTRODUCTION

The development of digital technology is currently very advanced and cannot be separated from the influence of the Covid-19 pandemic, which requires all aspects of activities to be carried out by utilizing

technology. One of the applications of technology is in the field of education, which makes it possible to make learning content unique and attractive to users [1]. The supporting factors for the success of the learning process in higher education are the use of innovative, engaging, creative, and easily accessible learning media to increase students' ability to study an object and explore the field of expertise they are engaged in. Thus, the specific learning media must be able to assist students in increasing their understanding and knowledge of learning materials [2].

Currently, the learning process is carried out face-to-face online, as well as the distribution of materials using online media with limited resources such as the devices used. Mastery of the material and understanding a field of science is necessary for students to help understand the concepts and scientific fields they are engaged in.

The distribution of materials used at this time is still not supported by combining features in one platform that supports several different learning models such as the latest information, learning materials, learning evaluations, learning videos, and live chat. The use of learning media today must be supported by the availability of learning resources that are easily accessible and have content that supports interactive material. One of the learning media that can be developed to improve learning abilities at this time is to use e-learning which contains interactive learning materials.

Learning media with the application of current technology is the primary choice in developing learning models, which is currently known as e-learning [3]. E-learning is an alternative solution that can be used as a medium of learning in the field of education from various aspects and levels. E-learning allows students to be independent in controlling the success of learning according to the selected learning material. Learning with e-learning can be done by students anywhere and anytime without being limited by the time [4].

With the description of the problem above, it is necessary to have an Android-based learning media that can help students to understand learning materials

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*Corresponding author

independently. The designed application can be used on Android smartphones. The designed e-learning application has supporting features, including information features, learning features according to modules, learning video features, and learning evaluation features. All The development of digital technology is currently very advanced and cannot be separated from the influence of the Covid-19 pandemic, which requires all aspects of activities to be carried out using technology. One application of technology is in the field of education, which makes it possible to make learning content unique and attractive to users [1]. The supporting factors for the success of the learning process in tertiary institutions are the use of innovative, attractive, creative, and easily accessible learning media to increase students' ability to study an object and deepen the area of expertise they practice. Specifically, thus learning media must be able to assist students in increasing their understanding and knowledge of learning material [2].

Currently, the learning process is carried out face-to-face and online, as well as material distribution using online media with limited resources, such as the devices used. Mastery of material and understanding of a field of science is essential for students to help them understand the concepts and scientific fields they practice. The distribution of materials used at this time still needs to be supported by a combination of features in one platform that supports several different learning models, such as the latest information, learning materials, learning evaluations, learning videos, and live chat. In Indonesia, some teachers still use learning tools that still need to be digital in the teaching and learning process. So it is necessary to introduce learning media that are installed in various digital platforms that have many benefits [3, 4]. The use of learning media at this time must be supported by the availability of learning resources that are easily accessible and have content that supports interactive material. Cooperative learning that uses traditional learning media by teaching directly on the blackboard is mathematics. This material is one of the learning models with the old method, which has a level of understanding that is difficult for some students, so it needs to be updated so that it can attract students' desires to learn mathematics [5].

With the description of the problems above, it is necessary to have an electronic learning media or e-learning that can help students to understand learning material independently. One of the learning media that can be developed to improve learning abilities today is using e-learning which contains interactive learning materials. Learning media with the application of current technology is the main choice in developing electronic learning models.

E-learning is an alternative solution that can be used as a learning medium in education from various aspects and levels. E-learning provides opportunities for students to independently control the success of learning according to the selected learning material. Learning with e-learning can be done by students anywhere and anytime without being limited by time. Wibawa *et al.* have designed e-

learning by creating a speech recognition technology game for essential Japanese language learning [6].

Tariq Banday conducted a case study on e-learning applications used in technical education using e-learning by utilizing the web as a learning medium. The case studies show that online learning can increase the efficiency of Engineering Education, and various other resources can be applied [7]. The use of distance learning technology is utilized by Medical Education, which conducts observations on student behavior toward learning technology at Endeavor College of Natural Health [8]. From the 576 observations of these students, it was found that 96.2% had cell phones, 85.9% used laptops, and only 24.7% had desktop computers. With this data, it is known that 84% of students with smartphones access their email daily. It indicates that they have used information technology to obtain information. Currently, learning has increased to the stage of robotic learning aimed at young people [9]. Using games as learning media has also been widely used to improve students' abilities [10, 11].

By utilizing technology, educators can equalize perceptions and abilities among students by using e-learning as a modern learning application. This study designed an application that can be used on an Android smartphone. The e-learning application is designed to have supporting features, including information features, learning features according to modules, learning video features, and learning evaluation features. Students can later access all application features using student accounts registered at the school individually. In this study, the authors try to build Android applications with more complete learning features. So that all students in each school can use the developed application to obtain better information so that it can improve the academic abilities of each student.

II. RELATED WORK

Research in the field of electronic-based learning media is currently overgrowing. It is intended as an alternative learning with various interactive media for the education sector. Three essential components must be considered when designing learning-based learning media: container, context, and content. The container in question is a platform used for the designed application. Context and content are part of the content and format of using e-learning to the available features. The learning system is currently transitioning from traditional learning media to modern learning processes that utilize technology. Utilization of modern learning models based on programming has many options that students can use.

Papadakis [12] evaluated two programming learning models between Scratch and App Inventor for Android (AIA), which focused on forming attitudes, perceptions, beliefs, and knowledge for users. In this study, researchers divided into two groups: experimental and control groups (teaching with Scratch). The results showed that students improved their behavioral approaches and knowledge of programming. The use of AIA learning results in a better level and more positive

attitudes, perceptions, and motivation in programming engagement than students who get learning using scratch. The AIA program is used to carry out weather forecasts that are applied to learning projects for mathematics, science, and technology (STEM). This research focuses on presenting Education by combining the basic concepts of STEM programming and learning through smart mobile applications. The result is that the use of AIA with the MIT App Inventor 2 programming results in an increase in the ability of second-grade students in the knowledge of programming abilities that are applied to learning projects [13].

Sutrisni *et al.* [14] utilize learning media using Android applications in mind games. The game is designed based on SAC3, which aims to analyze the game's effectiveness in improving student learning outcomes. This study divided into pretest and posttest into several experimental groups and formed a group that does not play the game called the control group. After the pretest and posttest were carried out, it was found that the experimental group had an average value of 30.67 which could increase to 74.83. While the control group obtained an average value of 30.00 which increased to 50.00. The results show that the increase in the experimental group can be determined by the N-gain value of 64%.

One of the cooperative learning currently used in learning media is mathematics. In solving mathematical calculations, problems can now be solved using Android learning technology. Verawati *et al.* [15] designed an android learning media to improve mathematical problem-solving skills and seek validation of ratio calculations. This research refers to the development of 4D, which consists of four steps: defining, designing, developing, and disseminating. Data analysis techniques in this study used descriptive qualitative in the definition and design stages, and the development stage used quantitative descriptive analysis. This study found that the designed learning media prototype obtained a validation index of more than 0.75, with the average value obtained being a high level of validation, according to experts or experts.

The development of learning media is currently heavily influenced by the many technologies and methods of delivering learning materials that are more innovative and efficient. It was shown by Petousi & Sifaki who discussed in full the process of learning development published in scientific journal publication articles with reference to Pubmed, Scopus, and WOS. Challenges in using Artificial Intelligence (AI) are the main topic in discussing positive and negative impacts on students. The use of qualitative methods, expert interviews, and investigations was carried out to obtain perspectives on the use of technology in learning [16].

Research conducted by Samsul *et al.* [17], regarding the use of Android applications that are utilized as Telemedicine in hospitals in the concept of patient health as a choice in reducing treatment costs. Telemedicine is an application that has a concept in handling patients who have complaints about their health. They only need to have a smartphone to access health applications. Through

the application, patients can communicate directly to provide information on complaints that are felt and can then be responded to directly by specialist doctors according to the complaints that are felt. Research by building a campus information system designed with an Android application is used to provide more complete knowledge to students in obtaining information online [18].

Therefore, it is necessary to research learning media development for students using the Android platform, especially in electronics practicum. Therefore, this study aims to design learning applications in electronics to improve students' abilities in science independently and can be done anywhere. The designed application is expected to be used anywhere and anytime, has economic value, and efficiently utilizes technology.

III. METHODOLOGY

This research was conducted by applying a type of research and development (R&D) to develop android-based learning media for students studying lecture material. Research and development are a method used to produce specific products and has applications in testing the effectiveness of product design results. There are stages in designing Android-based applications to suit user needs.

The outline stages in this study are divided into three:

- 1) The stages in defining the student learning curriculum.
- 2) The stages in designing system applications.
- 3) The stages in conducting trials and validating the use of applications to experts and students as the main users.

A detailed discussion of the data collection and analysis of system usage has been described in Fig. 1, the process of system design and data processing stages.

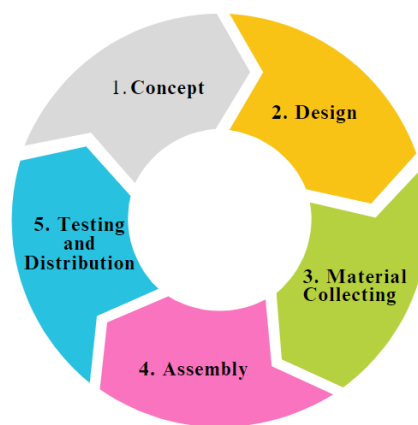


Fig. 1. Stages of system design and data processing.

- 1) Concept: This stage determines the goals and users of the Android application design.
- 2) Design: This stage is the process of designing an application by the underlying specifications in the program architecture, appearance, work system, and material requirements for the program.
- 3) Material collecting: This stage is collecting materials and the need for content in student

learning materials. These materials consist of audio, video, learning materials, and evaluation questions.

- 4) Assembly: This stage is the creation of all objects that are developed in the Android multimedia application.
- 5) Testing and Distribution: This stage is an application testing process intended for users and students to obtain initial conclusions about the use and detect errors in the program. This stage also becomes the final process in research by distributing applications to students to be used as alternative learning media.

A. E-Learning

E-learning or electronic learning is a form of information technology that is applied in a field of education with the help of the internet network to access websites that can be done anywhere.

The use of e-learning can shorten learning time and has a more economical cost [19]. E-learning is beneficial in the interaction between students and their learning materials or modules. Information exchange can also occur so that learning materials can be repeatedly accessed when they want to do independent learning.

B. Android Architecture

The Android architecture has four primary layers, which are divided into the application layer, framework layer, application layer, and library layer for the operating system, as shown in Fig. 2 [19]. Android is a Linux-based Operation System (OS) developed by Google based on IntelliJ IDEA [20]. This system is specifically designed to be able to run on smartphones and tablets with adjustments from low-end specifications to high-end specifications.

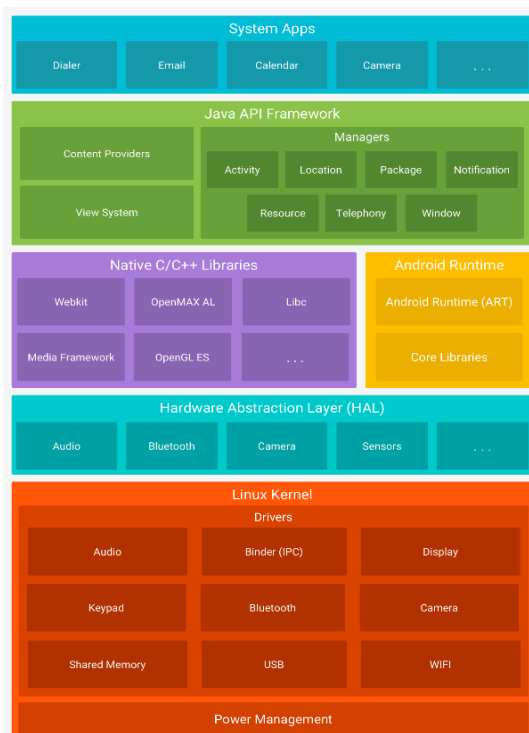


Fig. 2. Android software architecture [21].

The recommended library on Android defaults to using C and C++ languages, allowing the Java API framework to improve the performance of the Android system [22]. Android API development already has several libraries that use collaborative filtering technique development and development using different and more efficient languages [23].

All of the features on this android system are available through the API using the Java language. API as the formation of basic elements in service components on the system has a scope in system display, resource management, notifications, activation, and service providers.

C. Android SDK

Android Software Development Kit (SDK) is a kit that can be used to build android-based applications [24, 25]. The Android SDK has a tools section that includes software libraries, emulators, debuggers, documentation, and sample code. The use of the Android SDK can be combined with HTML, JavaScript, and other networks to display a WebView [19].

Research conducted on using the Android SDK was carried out by Hao *et al.* [26] in designing a UAV restriction on plants by utilizing the surrounding area. The designed system was developed with a diagrammatic interface and the use of 3D algorithms to solve 2D problems. The technology development carried out by Li and Huang [27] in data processing on a health platform at the university combining android and python programming in data processing has succeeded in working optimally and can manage data well.

D. Android SDK

Android Software Development Kit (SDK) is a tool that users can use to design learning applications. There are stages in application design to obtain an optimal system through needs analysis. The flow diagram for the stages of needs analysis is shown in Fig. 3.

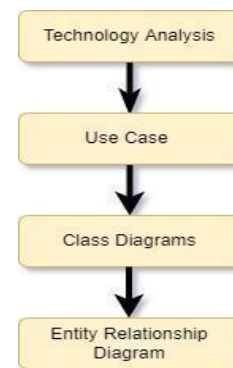


Fig. 3. Needs analysis flowchart.

1) Security Analysis

Security analysis was first carried out to prepare the design of an Android-based learning application. The most commonly used security layer is the Security Module Layer (SML) which serves to protect the system and application user privacy. This layer has several functions in its use, such as identifying the benefit of

learning applications made by users, checking static and dynamic attributes on the applications used, and activating and disabling policies that are approved or not approved by users in running applications.

The process of running the application must first check the security, which is done automatically by the system manager in providing information related to running the system. There are five types of EMS examination, namely [28]. First, context checks are related to checking temperature, light, geographic location, and system sensitivity [29]. Second, malware checks aim to identify malicious applications so mobile phones can install anti-malware to perform security and scan for malicious applications [30]. With the initial identification of malicious applications, it can provide information for users to prevent errors from occurring on higher android systems. Third, external checks function in identifying devices around the user that have direct connectivity using Bluetooth or Wi-Fi [31].

In this section, there is a policy regarding the security and privacy of users to connect available networks to communicate (send or receive data). Fourth, an installation check is a process of granting application permissions to be installed or withdrawing data owned by users on smartphones. These checks can be renewed to protect the user's privacy [28, 32]. This check will automatically activate if an unusual process is detected in the system. Fifth, the taint analyzer makes it possible to determine which applications use and retrieve sensitive user information. This analysis focuses on sensitive pieces of information that have malicious loopholes that malware can attack [33]. Static and dynamic analysis can be used to identify information leaks related to privacy and the system on the user's smartphone.

2) Use Case

Use Case represents the interaction between the system and its environment based on the requirements that have been defined, then described in the form of a use case diagram.

Fig. 4 shows a use case that explains the positions and duties of admins, teachers, and students in the e-learning system. Admin, as the system manager, is responsible for managing information, learning modules, user accounts, and learning classes held. Meanwhile, the teacher has the task of preparing learning modules in the system. Then students have a flow to use a system that can do evaluations, edit profiles, view schedules, and ask questions.

3) Class Diagram

Class diagrams, in general, are flow diagrams that can map a specific system structure by modeling classes, attributes, operations, and also the relationship between objects with each other. In the results of the analysis of the requirements that have been carried out, there are ten specified classes. Each data class has a relationship with each other with different functions. All data classes have additional data attributes according to the needs of the data content used. The system of the class diagram is shown in Fig. 5.

4) Entity Relationship Diagram (ERD)

Entity Relationship Diagram is a graphical representation of database tables, columns, and relations between tables in e-learning databases. In designing the e-learning database, there are four super-classes, namely Module, Evaluation, Data Questions, and User, with student, teacher, and admin subclasses. The presentation of ERD for e-learning can be seen in Fig. 6.

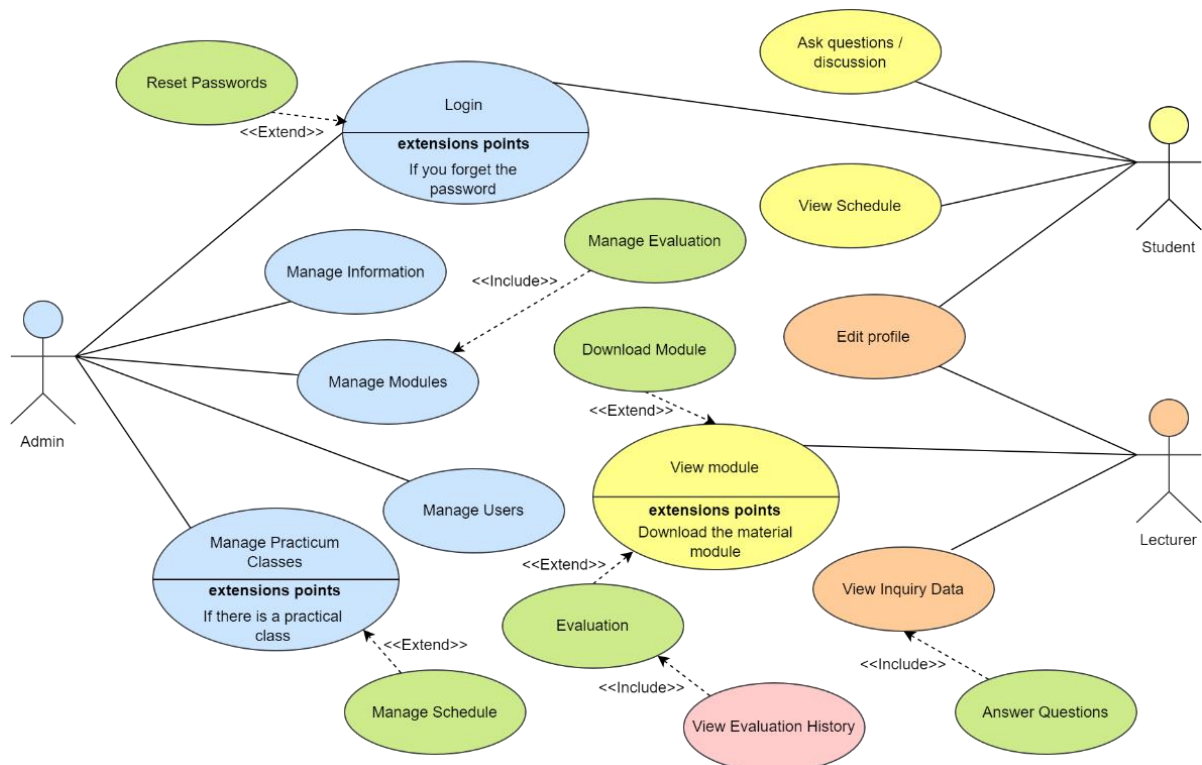


Fig. 4. Use case diagram of learning e-learning design.

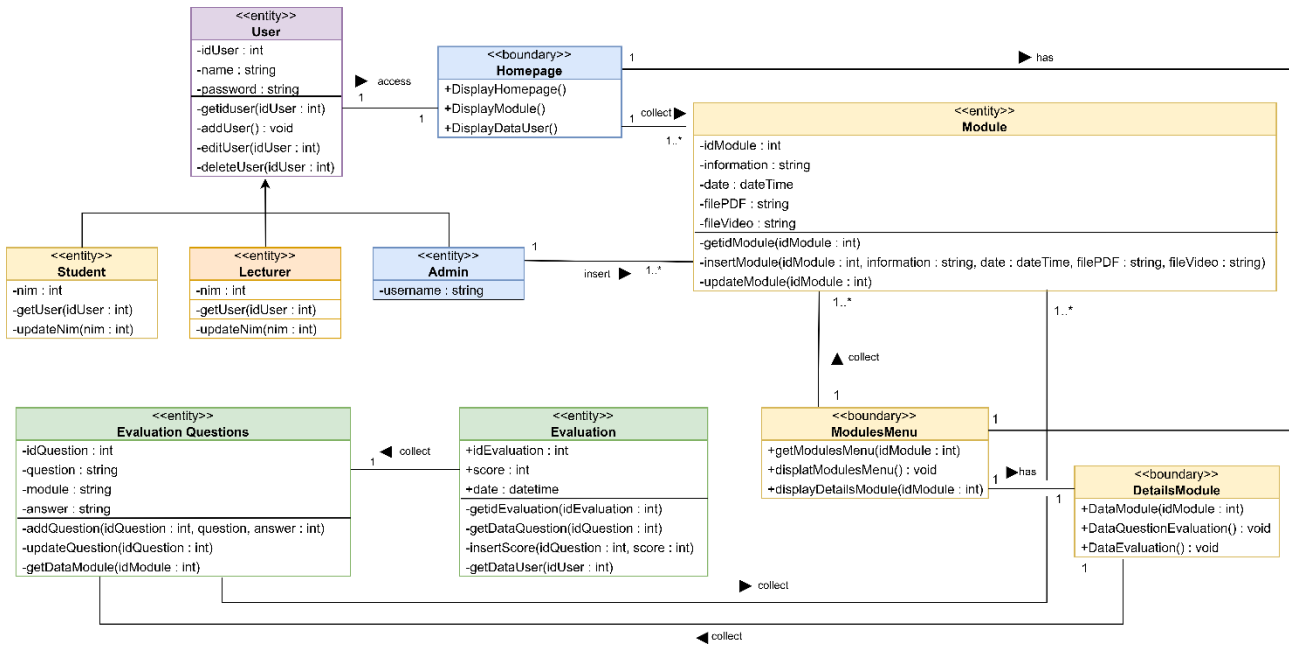


Fig. 5. Class diagram on e-learning system.

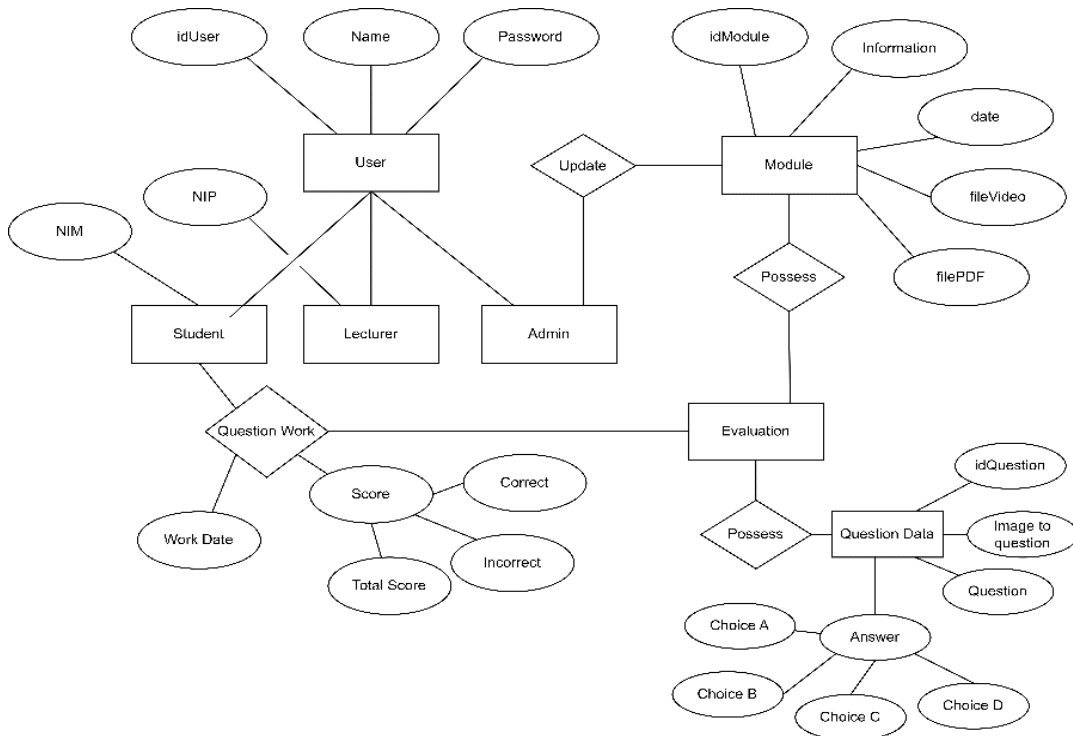


Fig. 6. ERD on the e-learning system.

IV. RESULT, ANALYSIS AND DISCUSSIONS

The application design is developed by utilizing the open-source android studio application as the main platform for building e-learning applications. This research has described the parts of the application design, which are described in detail as follows.

A. Login and Registration Features

The front view is the initial view of the designed application. This view also shows the login feature to

access the e-learning application. Users who can access the e-learning application are students, teachers, and admins of related study programs.

Student users need a Student Identification Number (NIS) as a username. Teacher users can be accessed by using the Employee Identification Number (NIP). Prodi admin users can access with Employee Number as username. Each user can also perform the forgot password feature if needed by clicking on “Forgot Password” then, the process to reset the password can be carried out. The front page view is shown in Fig. 7.

B. Home Feature

The home view is the initial view the user receives when successfully accessing the application using an account. In this home view, the user can see the biodata and choose the learning materials that they want to learn independently. Each learning material is shown here per the courses students take in the active semester. The appearance and features of the home section are shown in Fig. 8.

C. Learning Module

The learning module displays features for users, especially students, to do independent learning. After selecting learning materials, students are then presented with the e-learning feature, which consists of learning material features, material video features, and evaluation features. The display of the learning module is shown in Fig. 9.

D. Sub Learning Materials

This section is an e-learning display that presents sub-learning materials that students can choose to learn

according to their needs. Sub-learning materials can be selected and saved by pressing the “Save” button. Fig. 10 shows the sub-learning material section.

E. Learning Materials

Learning material is a feature that is displayed after students choose the sub-material to be studied. Students can read learning materials and can save lessons in PDF format. Students can choose video tutorials to explore related material. The display of learning materials is shown in Fig. 11.

F. Learning Video Features

This section displays the features of the learning videos found in the e-learning application. Students can choose video-based learning to obtain information about related materials. There is a feature to save videos with local storage. The display of the learning video is shown in Fig. 12.

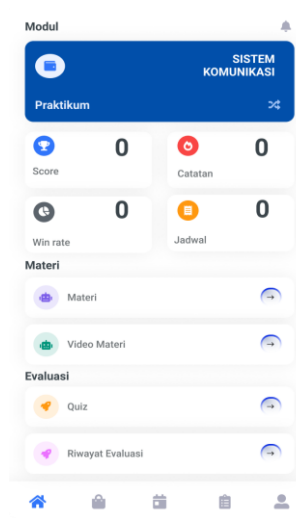
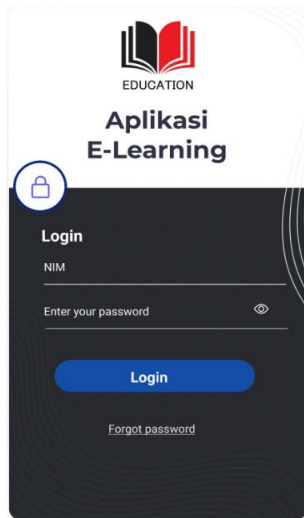


Fig. 7. Front view of e-learning application. Fig. 8. Home screen on e-learning application. Fig. 9. Student learning module display.

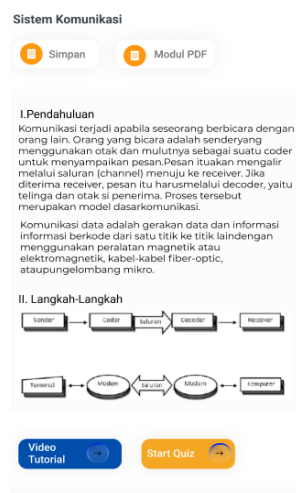
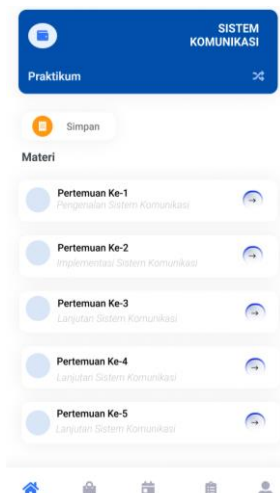


Fig. 10. Display of sub learning materials. Fig. 11. Display of learning materials. Fig. 12. Display of learning video features.

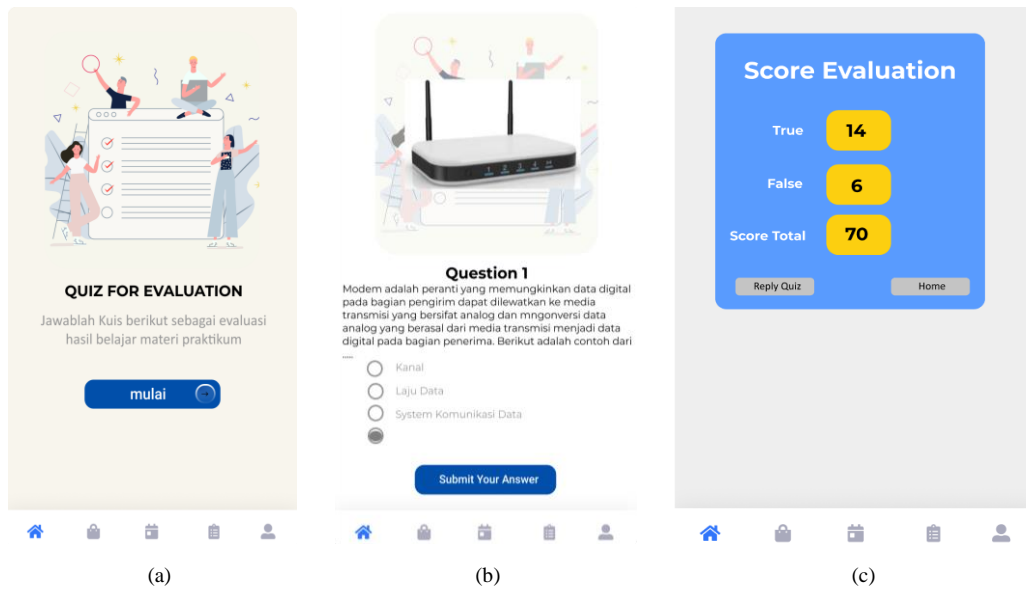


Fig. 13. Display evaluation features; (a) is a description of the evaluation to be carried out; (b) is the display of the evaluation questions; (c) is a display of the evaluation results in the form of scores.

G. Learning Video Features

Fig. 13 shows the evaluation features found in e-learning. Multiple-choice questions help understand students’ abilities in understanding the material. The results of the evaluation can be shown in the form of a score that will be displayed when the evaluation has been completed.

H. Survey of Design and Content Attractiveness to Learning Applications

Learning applications that are designed must have an attraction for students as users so that they can increase comfort in learning. In this study, responses regarding the use of applications regarding convenience and attractiveness were carried out by testing the application on 50 students as respondents. Tests are carried out to determine the reliability of the application as well as the design and features displayed. This survey is focused on respondents in assessing the features, colors, and design components in each layout and control components contained in the form of icons and text that are easy to understand.

The researcher provided 15 questions for surveying by dividing the response options into 5. The response options provided consisted of Strongly Agree (SS), Agree (S), Moderately Agree (CS), Disagree (TS), and Strongly Disagree (STS). The results of respondents’ responses to questions regarding the application and design reliability are shown in Table I.

Table I shows the results of a survey conducted to determine the reliability and attractiveness of the application to students as respondents. Each question is designed to determine the selected design’s appeal in each application layout. Reference to attractiveness is also obtained from each placement of buttons and icons used. Each respondent also responded to the

completeness of the features provided to measure the completeness of the learning application.

TABLE I: RESULT OF DESIGN, CONTENT AND RELIABILITY ATTRACTIVENESS

No	Question	Respondents Response				
		STS	TS	CS	S	SS
1	Attractive login display design	0	1	2	10	37
2	Attractive register display design	0	2	2	27	19
3	The choice of color for each item is correct.	0	0	3	34	13
4	The font used is attractive.	0	1	1	38	10
5	Attractive information display design	0	0	5	25	20
6	Attractive information display design	0	0	8	31	11
7	The voice control feature is appropriate.	0	0	2	26	22
8	The evaluation feature is appropriate.	0	1	3	25	21
9	The learning video feature is appropriate.	0	1	4	14	31
10	Content management features are complete.	0	2	5	19	24
11	The completeness of the features provided is complete.	0	0	2	12	36
12	High app access speed	0	0	7	15	28
13	The application has high responsiveness when used.	0	0	2	25	23
14	Easy to use the application on every feature	0	0	1	14	35
15	I am satisfied with the overall design, appearance, and features of the learning application.	0	0	0	3	47

The survey results on the attractiveness of the login design, register, color selection, font, and icon have

agreed to be used in the application. Then on the availability of features as learning support, the results strongly agree for each use of the features provided. Regarding the reliability of the application related to speed and convenience, the average response results agree and strongly agree with the help of the application as a whole. It is supported by the last question in the survey, which stated that they strongly agree this application is used, with a percentage reaching 94%.

I. Benefits of e-Learning Applications

The designed e-learning application can help students learn independently to improve their understanding of learning materials. Students can take advantage of the available features according to their learning needs. Each material will be updated by the study program admin and also regulate which users can access the application.

Each student can only view learning materials to which the admin has granted access rights according to the students' level of ability in the learning process so that not all learning materials can be accessed by all students freely. It applies so that students focus on studying the learning material being taken in the active semester.

Teachers as teaching staff also feel the benefits of the e-learning application to be more flexible in providing varied learning and teaching materials to improve student understanding. Teachers can provide material in the form of learning modules, videos of the learning process, and evaluation of material understanding. It can increase students' interest in learning independently and can be done anywhere and anytime.

IV. CONCLUSION

Based on the research that has been done, the Android-based e-learning application as an alternative to independent learning media has obtained satisfactory results, with an application user satisfaction level reaching 94%. This application communicates between the server and application users on smartphones in real time so that users can take advantage of the available multimedia features. The results of this study indicate that application design by utilizing learning module features, learning materials, learning video features, and evaluation features has an extraordinary appeal to students' interest in acquiring learning knowledge that can be done anywhere and anytime by utilizing efficient technology and reliable. To improve technology-based learning media, researchers plan to develop game and animation features in learning applications to increase students' knowledge more quickly.

CONFLICT OF INTEREST

The authors declare no conflict of interest.

AUTHOR CONTRIBUTIONS

Neilcy Tjahjamoornisih conceptualized the idea, conducted the research, and wrote the paper. The application and system testing were designed by Leonardus Sandy Ade Putra and Eka Kusumawardhani.

Suci Pramaditha was responsible for testing the system and writing the script. Vincentius Abdi Gunawan designed the application and tested the application.

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Neiley Tjahjamoonsih is lecturer from Universitas Tanjungpura. She received her bachelor degree in electrical engineering from Universitas Tanjungpura, Pontianak, Indonesia. She continued her master degree in Universitas Gadjah Mada, Yogyakarta, Indonesia. Her research is focused on telecommunications, signal processing, and communication systems.



Leonardus Sandy Ade Putra is a lecturer from Universitas Tanjungpura. He received his bachelor degree in electrical engineering from Sanata Dharma University, Yogyakarta, Indonesia. Then he continued his master degree in telecommunication engineering from Universitas Diponegoro, Semarang, Indonesia. His research is focused on telecommunication network, IoT, image and video processing, and

artificial intelligence.



Eka Kusumawardhani is working as a lecturer in Faculty of engineering, Universitas Tanjungpura. She received her bachelor degree in telecommunication engineering from Telkom University, Indonesia in 2015, and in 2016 She continued her study and received her master degree in electrical-telecommunication engineering from Telkom University, Indonesia. She is conducting research activities in the areas of wireless communication system, massive MIMO, and signal processing.



Suci Pramadita is a lecturer from Universitas Tanjungpura. She received her bachelor degree in environmental engineering from Universitas Tanjungpura, Pontianak, Indonesia. She continued her master degree in environmental engineering from Institut Teknologi Bandung, Bandung, Indonesia. Her research is focused on ecotoksikology, water pollution, public and environmental health.



Vincentius Abdi Gunawan is working as a lecturer in Faculty of Engineering, Universitas Palangka Raya. He earned a bachelor's degree in electrical engineering in 2003 from Sanata Dharma University. Then obtained a master's degree in 2006 in electrical engineering from the University of Indonesia. Areas of research interest studied include mobile development, image and video processing, artificial intelligence, and mobile telecommunications.