ISSN 2355-0082

Development of Learning Media in Fluids in Higher Education Based on Android

Boldson Herdianto Situmorang[1], Teguh Puja Negara[2], Muhammad Farhan Maulidan[3]
[1,3]Departement of Computer Sciences, Universitas Pakuan, Bogor, Indonesia
email: boldson.situmorang@unpak.ac.id, muhammad.065117054@unpak.ac.id
[2]Departement of Physics, IPB University, Bogor, Indonesia
email: teguhpuja@ipb.ac.id

Accepted 20 January 2023
Approved 20 December 2023

***Abstract*— Mobile learning is an alternative to developing learning media. The presence of mobile learning is intended as a complement to learning and practicum so that it can provide opportunities for students to learn material and practices that are not mastered anywhere and anytime. The purpose of this community service activity is to optimize the function of technology as a practicum learning medium on android-based fluid material at Pakuan University Laboratory, Bogor. The implementation of this activity is in three stages, namely the planning, implementation and evaluation stages. The planning stage is to create an Android-based learning media system using Frame by Frame, Low-poly modeling and Shader Graph techniques. The implementation stage is system testing, namely the validation test and system compatibility test. The validation test consists of: theory testing, simulated sample questions and quizzes whose results are in accordance with the theory, while in the compatibility test, the system runs well with a minimum HP RAM of 4GB and OS 6.0 (Marshmallow). The last stage is the evaluation stage, namely giving the feasibility test to experts at 90.95%, lecturers 96.13%, a comparison between online and offline testing systems 81.86%, and a comparison of written test post testing and post application test results in an average student get an increase of 20.66%.**

***Keywords*— Learning media; Multimedia Development Life Cycle; Fluids; Low-poly modeling; Shader graph**

I. INTRODUCTION

Technological developments have had a major impact in various fields, especially in education [1]. The development of computers in terms of hardware and software has improved the learning process in terms of learning methods. The classical learning method is still based on the lecture system, in which the teacher explains the materials and students listen passively and the teacher-student relationship must occur face-to-face [2]. The face-to-face learning system has several obstacles when students cannot go to learning places such as classes or laboratories and rely heavily on the ability of the teacher to explain the material [3]. In practicum learning, students are faced with mastering the material, using tools and calculating data. The limitations of practicum tools and mastery of practicum materials by practicum instructors cause students' understanding to be reduced [4].

To overcome problems with face-to-face learning systems, especially practicum learning, the development of computer science has made many breakthroughs in the form of learning media. According to the National Education Association (NEA), learning media are forms of communication, both printed and audiovisual, and their equipment [5]. The media should be manipulated, can be seen, heard, and read. Learning media can be understood as anything that can convey or convey messages from the source in a planned manner, thus forming a useful learning environment where recipients can carry out the learning process efficiently and effectively [6]. Learning media can overcome several problems in face-to-face learning, including the condition of the spread of the corona virus, which requires students not to be able to go to the laboratory, limited practicum facilities and infrastructure so that practicum activities are not optimal, or limited students' understanding of practicum material that is classified as difficult, such as Physics and Chemistry [7].

For physics subjects, learning media have been designed and implemented at the Physics Laboratory of Pakuan University, as a form of technology application and learning effectiveness. Multimedia learning systems are designed using Low-poly and Shader Graph modeling. The high-poly 3D model will be a reference for reconstructing the high-poly 3D model into a low-poly 3D model [8]. The advantage of using low poly is that it speeds up the process of creating 3D objects because it doesn't require excessive detail. Meanwhile, Shader Graph is a shader creation technique developed by Unity to visually create shaders using a node-based editor without the need to carry out the process of writing code which can later be applied to certain materials [9]. Making learning media using high-poly 3D models and Shader Graph is a breakthrough to provide students with a perfect understanding of Physics practicum learning in Fluid material, which connects it to practicum objects in 3D form

Testing of the multimedia system for fluid practicum materials using the Likert Scale has been carried out on students, experts, and lecturers, at the Physics Laboratory, Pakuan University. The Likert scale is a scale that can be used to measure attitudes, opinions, and perceptions of a person or group of people about an educational symptom or phenomenon [10, 11]. The feasibility test using a Likert Scale shows the feasibility of the system above 90% according to lecturers and media experts, and above 80% according to students.

II. Method

In the learning media design process, realistic 3D models are used keep an eye on performance optimization on device users, for 3D models used in lowpoly style coming from unity asset store, sketchfab and some of the assets created through unity. Several components in the system are also made, such as: back-sound, logo, icon and font Application development is based on the design stage. Making the application is based on storyboards and flowcharts. All objects or materials are created and combined into one complete application. In building this system is used several software such as Unity, Audacity and Inkscape. The stages of making learning media use low poly 3D as shown in Figure 1, namely:

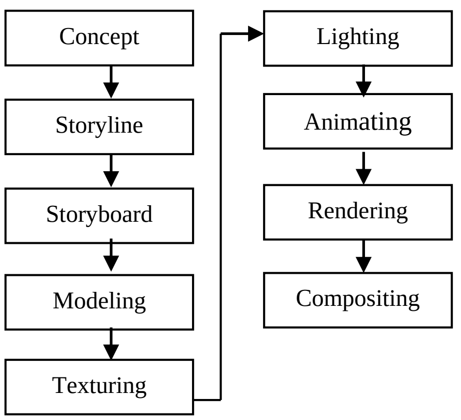


Fig. 1. Cart of design method

- Storyline is making grooves in the fluid chapter with animation
- Storyboard is the main guide of the animation production process in the form of panels that contain images of characters and their supporting environment
- Modeling is the process of digitizing the storyboard that was made later followed by making objects in 3D form
- Texturing is the process of giving color to the object that has been done previous modeling
- Lighting is the process of giving color to objects that have been modeled before
- Animating the process of making animation on characters, camera movements, and others
- Rendering is the process of calculating the 3D model and proceeding with the arrangement of camera angles
- Compositing is the process of combining image elements into one whole part, color correction, adding text and photos that are combined in the video

In using the Likert scale, there are two forms of questions, namely positive questions to measure positive scales, and negative questions to measure negative scales. Positive questions are scored 5, 4, 3, 2, and 1; while negative questions are given a score of 1, 2, 3, 4, and 5. Forms of Likert scale answers include: strongly agree, agree, undecided, disagree, and disagree. In addition, the answers to each instrument item using the Likert Scale can also have a graduation from very positive to very negative, which can be in the form of words including: Very Important (SP), Important (P), Undecided (R), Not Important (TP), Not Very Important (STP). The total score of each individual is the sum of the scores of each item from that individual. Responses were analyzed to find out which items had a very significant difference between high scores and low scores on the total scale.

$$T_S = T_R \times P_N \tag{1}$$

T_S is total score, T_R is total number of respondents who voted, and P_N is choice of numbers from Likert scores. The score interpretation criteria is based on the interval determined based on the lowest distance interval of 0%

$$I_S = 100 / N_L \tag{2}$$

N_L is total Score (Likert). Respondents interpretation of the feasibility of the system is the result of the value generated using the formula from Index %.

$$\%I = \frac{T_S}{Y} \times 100 \qquad (3)$$

$\%I = \frac{T_S}{Y} \times 100$ is the highest Likert score multiplied by the number of respondents. The interpretation criterion of $\%I$ is based on the interval determined through I_S, for example if N_L is worth 20, then the score interpretation criterion is based on the following interval:

TABLE I. SCORE INTERPRETATION CRITERIA

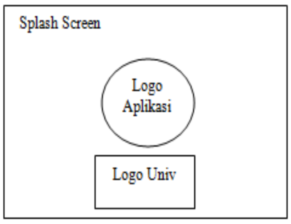
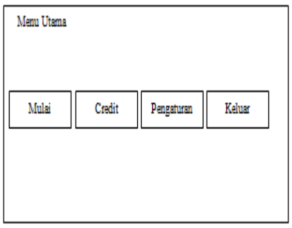
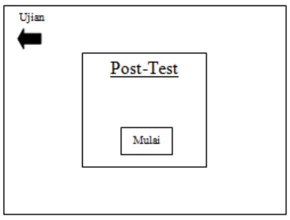
No	Interval	Criteria
1	$0\% < \%I < 20\%$	Strongly disagree / very bad / very poor.
2	$20\% \leq \%I < 40\%$	Disagree / Not good
3	$40\% \leq \%I < 60\%$	Fair / Neutral
4	$60\% \leq \%I < 80\%$	Agree/Good/like
5	$80\% \leq \%I < 100\%$	Totally agree/very good/like very much

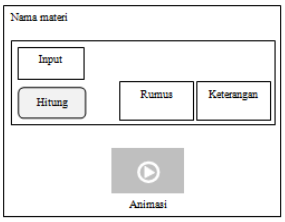
III. RESULT AND DISCUSSION

The results of the application development are the implementation of the interface design based on the story board, which can be seen in Table I. The interface design consists of opening pages, material pages, exam pages, and simulation pages

The Learning Media Application has the goal of developing fluid learning media for basic physics in Android-based universities. The learning media runs on an Android operating system device with a minimum version of 4.4 (KitKat), where in this application, after the user has done the post-test in writing, the user can access material about fluids starting from basic theory, interactive simulation and there are practice questions and post-test applications. When accessing each material, the user needs to enter the amount in the available input column so that the simulation can run. Then there is also a post-test where, after the user understands and tries all the simulations, he will be faced with practice questions to measure the learning outcome

TABLE II. USER-INTERFACE DESIGN

No	Design	Description
1		The opening page is used as a user intermediary on the main menu of the application. On the opening page there is the application logo and the unity logo.
2		On the main menu, there are 4 sub-menus, namely start, credit, settings and exit. The start menu functions to select simulation equipment, the credit menu functions to display asset use licenses, the settings menu to adjust music and sound effects, and the exit menu to end the application.
3		The exam page will provide several questions to test the ability to knowledge of fluid materials, and the user is given time to complete all questions.

4		The Simulation page displays a 3-dimensional. Users can access theory so they can understand the basic concepts of the material as well as help when having difficulties running the simulation. To carry out the simulation, the user needs to enter a magnitude value then press the calculate button to play the animation and display the result value, as well as to test the user's brief understanding of mastering the material provided by practice questions.

A. *Validation Test*

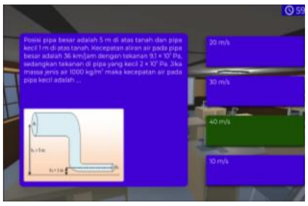
The system consists of theory, calculation simulation, and practice questions (quiz). In the theory section, the system covers the basic theory of fluid statics and dynamics. All theories in the system have been validated against the theories found in physics textbooks. Display in table 2 no.1 is one of the theories of static fluids, namely hydrostatic pressure, which is in accordance with an essay in Physics textbooks [11]. For simulation calculations, the user can fill in the input variables for each formulation in fluid. The output will appear according to the formulation accompanied by 3-dimensional animation to prove the theory. Displayed in table II no.2, is an example of calculating hydrostatic pressure, with the input variable being the height or distance from the water surface (h). The output pressure will adjust to the formula in theory, namely:

$$P = \rho g h \quad (4)$$

With P is hydrostatic pressure in Pa , ρ is density of water in kg/m^3, g is earth's gravitational acceleration in m/s^2, and h is the height or distance from the water surface in m. On the system (table 2), for $h = 5m$ the system outputs according to manual calculations, which produces an output value of hydrostatic pressure of $P = 49000$. In the simulation questions, the questions are in the form of multiple choices and the user can choose one answer with the correct answer indicator being a green button. One example in the display in table 2 no.3 is regarding Bernoulli's law with the correct answer and according to manual calculations. For theory, examples of questions and other quizzes, include static and dynamic fluid chapters, namely: Pascal's law. Archimedes' law, surface tension, viscosity, continuity principle, and Bernoulli's law. All calculations in the sample questions and quizzes are in International Standard units (SI). The addition of theory, sample questions, and quizzes can be done through source code in the systems, because the learning system is dynamic.

TABLE III. DESIGN SUB OF THE USER-INTERFACE

No	Interface	Validation Test
1		One of the theories in static fluid, which explains hydrostatic pressure, regarding the theory and formulation in hydrostatic theory .
2		$P = \rho g h$ $P = (1000)(9.8)(5)$ $P = 49000$

3		On the questions contained in the system, $P_1 = 9.1 \times 10^5\, Pa, v_1 = 36 km/jam$ $P_2 = 2 \times 10^5\, Pa, h_2 = 1m$ Answer in the system $40 m/s$

B. Compability Test

Compatibility testing is a trial conducted to determine application compatibility with several Android devices with different hardware and software specifications. The test results can be seen in table III. Applications can run at least the specifications of the Smartphone using Android 6.0 (Marshmallow), Resolution 1080x1920 pixels, ratio 16:9, CPU Deca core 2.1 GHz.

TABLE IV. COMPABILITY TEST

No	Interface	Compability Test
1	Chipset Qualcomm MSM8916 Snapdragon 410, CPU Quad-core 1.2 GHz Cortex-A53, GPU Adreno 306, Internal 8GB, RAM 1GB, OS Android 4.4.4 (KitKat), Resolution 720x1280 pixels, ratio 16:9	The Welcome Page does not appear. Water shaders like Liquid Wooble and Cartoon Water don't show up  .
2	Chipset Mediatek MT6797 Helio X20, CPU Deca-core 2.1 GHz, GPU Mali-T880 MP4, Internal 64 GB, RAM 3 GB, OS Android 6.0 (Marshmallow), Resolution 1080x1920 pixels, ratio 16:9	The application runs smoothly 
3	Chipset Qualcomm MSM8998 Snapdragon 835, CPU Octa-core (4x2.45 GHz Kryo& 4x1.9 GHz Kryo), GPU Adreno 540, Internal 64 GB, RAM 4 GB, OS Android 8.0 (Oreo), Resolution 1080 x 1920 pixels, ratio 16:9	The application runs smoothly. The colors in the water shader seem more vivid 

C. Feasibility Test

The feasibility test using a questionnaire is aimed at determining the quality or feasibility of fluid learning media applications. This test is carried out by one media expert, one materials expert or physics lecturer, as well as 30 students divided into 2 materials sessions, namely offline and online, based on the background of their respective areas of expertise. The feasibility test consists of two parts, namely the alpha test and beta test. Alpha test is a test performed by the user in the development environment. Alpha testing takes place on the developer site by an internal team, before release to external customers. So that later when users use the application they are not disappointed because of defects or application failures. Included in the alpha test is the results test from media experts and the results test from the Physics lecturer. Beta testing is a test where the developer gives access to users to use it and also many of the developers do not provide general access to users. Beta testing is also carried out so that users who use it can provide information about damage or errors that occur in the application made by the developer, as well as reports regarding errors or damage will be received for approximately until the completion of beta testing. That way the problems that occur in the application will be fixed. Included in the beta test is the test of results from students. The following are the results of the feasibility trials listed in table III, table IV, table V and table VII.

Based on the table IV, it can be concluded that media experts respond by answering each aspect on average 88.69%, namely the design feasibility aspect with 11 questions. The score is 92.73% including the very feasible category, linguistic aspects 3 questions with a score of 80% including the appropriate category, learning aspects 3 questions with a score of 93.33 %, is included in the very feasible category, and, for the feasibility results of the application including all aspects, it can be seen that the result is 90.59% which concludes that this application is very feasible to use. The questionnaire table for media experts can be seen in Appendix A.

Based on the table V, it can be concluded that respondents from lecturers for each aspect answered with an average score of 97.04%. In namely, the learning design aspect with 15 questions, the score was 93.33%, including the very feasible category, the design feasibility aspect, 7 questions with a score of 100%, the very feasible category, the learning aspect of 9 questions with a score of 97.78%, is included in the very feasible category, and, for, the results of the, feasibility of the application including all aspects it can be seen that the result is 96.13% which concludes that this application is very feasible to use. The questionnaire table for lecture can be seen in Appendix B.

The results of the application feasibility score were obtained with a score of 81.86% with a total of 30 student respondents who were divided into 2 forms of test, namely offline and online (table VI). And each test gets a score, namely an offline test with a score of 77.73% including the eligible category, an online test with a score of 85.98% including a very feasible category, and because of the feasibility results of the application including all tests, it can be seen that the result is 81.86%, which concludes that this application is feasible to use. The questionnaire table for post test and application pos test experts can be seen in Appendix C

The table VII below shows that the average student obtains an offline written post-test result of 75.63%, an offline application post-test result is 86.25%, the average score for the difference between the offline written post-test and the offline application post-test is 10.63%, the increase in the offline application test is 14.05% , while for the online written post-test students obtained an average of 65.71%, the results of the online application post-test were 84.29%, the average difference between the online written post-test and the online application post-test was 18.57%, the increase in the online application test was 28.26 % and it can be concluded that the average student gets a pretty good increase with a 20.66% increase as in the table VIII.

D. *EffectivenessTest*

This test was conducted on 30 computer science students in the form of post-test questions. Giving a post-test is to find out how effective the application is to support student learning, the results of the post-test can be seen in Table IX. The questions consist of a written post-test and an application post-test, where there is a positive difference in value, which means there is an increase.The average results of the post-test items showed an increase of 20.66%

TABLE V. FEASIBILITY TEST BY EXPERT

No	Aspect	Statement proof	Value result	Total maximum value	Feasibility
1	Feasibility aspects of design	1,2,3,4,5,6,7,8,9,10,11	51	55	92.73
2	Linguistic aspect	12,13,14	12	15	80
3	Learning aspects	15,16,17	14	15	93.33
		Number of results	77	85	90.95
		Overage amount	25.67	28.33	88.69

TABLE VI. FEASIBILITY TEST BY LECTURE

No	Aspect	Statement proof	Value result	Total maximum value	Feasibility
1	Feasibility aspects of design	16,17,18,19,20,21,22	35	35	100
2	Learning design aspects	1,2,3,4,5,6,7,8,9,10,11,12,13,14	70	75	93.33
3	Learning aspects	23,24,25,26,27,28,29,30,31	44	45	97.78
		Number of results	149	155	96.13
		Average amount	49.67	51.67	97.04

TABLE VII. FEASIBILITY TEST BY ONLINE AND OFFLINE

No	Test form	Statement proof	Value result	Total maximum value	Feasibility
1	Offline	1,2,3,4,5,6,7,8,9,10,11,12,13, 14,15	955	1280	77.73
2	Online	1,2,3,4,5,6,7,8,9,10,11,12,13, 14,15	963	1120	85.98
		Average amount	979	1200	81.86

TABLE VIII. FEASIBILITY TEST BY WRITTEN POS TEST AND APPLICATION POS TEST

No	Test form	Writen post tes	Application pos test	Score difference	Enhancement
1	Offline	75.63	86.25	10.63	14.05
2	Online	65.71	84.29	18.57	28.26
	Average amoun	70.67	85.27	14.60	20.66

TABLE IX. EFFECTIVENESS TEST

No	Name	NPM	Writing post test	Application post-test	Score difference	Enhancement (%)
1	Gugun Adiguna	065117010	90	80	10	11.11
2	Erlan Rifandi	065117012	70	80	10	14.29
3	Ditra Albar	065117017	70	90	20	28.57
4	Riski Suganda	065117018	80	90	10	12.50
5	Hendrik Sidarta	065117031	70	90	20	28.57
6	Galih Rakasiwi	065117035	80	90	10	12.50
7	Gozali	065117041	60	90	30	50.00
8	Ramdam Hidayat	065117042	80	90	10	12.50
9	Mohammad Ervin	065117043	80	90	10	12.50
10	Reusmana Sujani	065117046	80	90	10	12.50
11	Yudhi Pratama	065117047	80	90	10	12.50
12	Rico Saputra	065117048	70	80	10	14.29
13	Muzia Vandri	065117110	70	80	10	14.29
14	Abdu Muhammad	065117127	80	70	10	12.50
15	Wirawan	065117144	70	80	10	14.29
16	Ricky Wahyudi	065117150	80	100	20	25.00
17	Vicky Herdyan	065117005	70	80	10	14.29
18	Aji Saputro	065117013	70	90	20	28.57
19	Muhammad Latif	065117014	70	80	10	14.29
20	Agung Dwi	065117023	50	70	20	25.00
21	Wahyu Irawan	065117028	70	80	10	14.29
22	Fransiscus Xaverius	065117032	70	100	30	42.86
23	Raka Fachrurahman	065117033	50	70	20	40.00
24	Gustana Nurul	065117036	50	80	30	60.00
25	Ananda Dwi Laras	065117037	60	80	20	33.33
26	Anggiat Mora	065117038	70	100	30	42.86
27	Purnama	065117049	90	100	10	11.11
28	Rizqi Nur Aditya	065117051	70	80	10	14.29
29	Muhamad Recka	065117058	70	80	10	14.29
30	Atix Medixa	065117095	60	90	30	50.00
	AVERAGE		70.67	85.27	14.60	20.66

IV. Conclusion

After t Based on the results of the research that has been done, it can be concluded that the use of Learning Media applications can make it easier for students to understand material and basic fluid physics practicum with interactive 3D simulation models as well as theoretical explanations and exercises regarding the material being discussed. The application can be used on low-end Android devices with a minimum operating system of KitKat 4.4, 8 Gb of internal memory and 1 GB of RAM. This is evidenced by the results of compatibility trials on 3 different devices. There are deficiencies in the first device, including several shader effects that don't appear , the opening page that does not appear temporarily for the 3rd color shader device seems more vivid than the previous 2 devices. Application development applies two techniques, namely Low-Poly Modeling and Shader Graph.

The application of the Low-Poly Modeling technique is used to support universal device compatibility and minimize force closes while the application of the Shader Graph technique is used to give a realistic effect to the simulation even though the 3D model only uses a Low-Poly model. To test the feasibility of the application through a questionnaire to respondents, satisfactory results were obtained. For media experts, they responded with a value of 90.59 which was included in the very feasible category. For lecturers, they responded with a value of 96.13 which was included in the very feasible category, and students responded with a value of 81.86 which was included in the feasible category while testing the written post-test and application post-test resulted in a significant increase of 20.66% increase, given material in the form of interactive simulations and theory which was divided into 2 sessions, namely offline and online.

ACKNOWLEDGMENT

The The work is funded by the LPPM, Universitas Pakuan, though Internal Research in 2022

References

[1]. R. Raja, P. C. Nagasubramani, "Impact of Modern Technology in Education," *Journal of Applied and Advanced Research*, vol. 3, pp. S33-S35, 2018.

[2]. Sulandari, "Analisis terhadap Metoda Pembelajaran Klasikal dan Metoda Pembelajaran E-Learning di Lingkungan Badiklat Kemhan," *Jurnal Pendidikan Indonesia*, vol. 1, pp. 176-187, 2020.

[3]. T. A. Nengrum, N. Pettasolong, M. Nuriman, M, "Kelebihan dan Kekurangan Pembelajaran Luring dan Daring dalam Pencapaian Kompetensi Dasar Kurikulum Bahasa Arab di MadrasahIbtidaiyah 2 Kabupaten Gorontalo," *Jurnal Pendidikan*, vol. 30, pp. 1-12, 2021.

[4]. M. L. Ilhamdi, Sukib, J. Ardhuha, "Analisis Kesulitan Mahasiswa Dalam Kegiatan Praktikum Di Laboratorium," *Jurnal Pijar MIPA*, vol. 15, pp. 188-191, 2020.

[5]. A. S. Sadiman, R. Rahardjo, A. Haryono, Harjito, *Media pendidikan : Pengertian, Pengembangan, dan Pemanfaatannya*. Depok, Rajagrafindo Persada. 2018.

[6]. N. Nurmadiah, "Media Pendidikan," *Al-AfkarJurnal Keislaman & Peradaban*, vol. 5, pp. 43-62, 2016.

[7]. T. C. Putri, Y. Sugiarti, G. G. Suryadi, "Pengembangan Media Pembelajaran Video Praktikum Untuk Meningkatkan Hasil Belajar Peserta Didik," *Jurnal Edufortech*, vol. 6, pp. 99-108, 2021.

[8]. M. M. Kolesoglu, D. G. Ozer, "A Study on Digital Low Poly Modeling Methods as an Abstraction Tool in Design Processes," *Civil Engineering and Architecture*, vol 9, pp. 2569-2586, 2021.

[9]. D. F. Abdillah, A. Basuki, A, T. Harsono, "Optimization of Virtual Reality-Based Flood Simulation by Manipulating Particle System," *Jurnal Mantik*, vol. 5, pp. 2117-2126, 2022.

[10]. D. Taluke, R. S. Lakat, A. Sembel, "Analisis Preferensi Masyarakat Dalam Pengelolaan Ekosistem Mangrove Di Pesisir Pantai Kecamatan Loloda Kabupaten Halmahera Barat," *Jurnal Spasial*, vol. 6, pp. 531-540, 2019.

[11]. D. A. Setiawan, I. A. Husen, R. Yuliansyah, S. K. Wasit, "Pengaruh Promosi, Kualitas Pelayanan dan Nilai Pelanggan terhadap Kepuasan Konsumen Gojek," Jurnal Inovasi Penelitian, vol. 2, pp. 3131-3137, 2022.

[12]. D. C. Giancoli, *Fisika*. Jakarta, Erlangga, 2001.