

Development of Interactive Learning Media for Vocational High Schools in Basic Computer Network and Telecommunication Engineering Subjects

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ABSTRACT

The development of technology in the Industry 4.0 era has brought significant changes in many aspects of life, including our education. In the formal education system, teachers play a crucial role in creating an engaging and effective learning environment. This research aims to develop an interactive learning media called Comneter (Computer Network Learning) as a learning media to help students with their understanding of basic computer networks and telecommunication in vocational high schools. Comneter was developed using Unity software, a cross-platform game engine that enables us to create apps for both mobile and desktop platforms. The method used for this research is the Research and Development (R&D) method, with ADDIE (Dick et al., 1996) as the model of this development. This model consists of 5 main phases, including analysis, design, development, implementation, and evaluation. The results from this research show that Comneter received a feasibility assessment from a material expert, a media expert, students, and a teacher (as a respondent), with an average score of 3.96, categorizing Comneter as 'Good' or feasible. Therefore, it can be concluded that, based on this research, using computers can help enhance students' comprehension in basic computer network and telecommunications engineering subjects, and has the potential to be used in vocational high schools to create a more effective and engaging learning experience.

Keywords: Interactive learning media, R&D, ADDIE, Feasibility assessment, Computer network and telecommunications engineering, mobile application.

1. INTRODUCTION

The rapid advancement of technology in the Industry 4.0 era has significantly impacted various aspects of life, including the education system. Technology can be utilized as an essential tool for enhancing the learning process by providing interactive, engaging, and understandable learning media (Tjakraatmaja et al., 2002). In formal education, teachers play a crucial role in creating an effective learning environment. Therefore, adopting innovative teaching methods and interactive media is necessary to improve students' motivation to learn and understanding of the material subjects (Amaliyah et al., 2023). Despite technological advancements and the adoption of interactive media in education showing potential to enhance students' comprehension and motivation, interactive media such as Comneter are rarely used in practice. Teachers predominantly rely on textbook materials and sometimes use videos from social media platforms like YouTube as an alternative medium besides textbooks. The limitations of current learning media in optimally integrating interactive technology have resulted in teaching and learning processes that do not achieve the desired effectiveness. Therefore, developing interactive learning media such as Comneter may provide a viable solution to deliver a more engaging and effective learning experience for students.

Based on the writers' interview, one of the subjects that needs to be improved to create an effective and engaging learning method is the Basic Computer Network and Telecommunication Engineering Subject,

especially in the Orientation of Basic Computer Network and Telecommunication Engineering topic, which is often challenging for students. To address this issue, this research focuses on developing interactive learning media called Comneter (Computer Network Learning), using Unity software.

This research presented in this journal focuses on the development process of Comneter, an interactive learning media for the subject of Basic Computer Network and Telecommunications. The study is narrowed down to examine several key aspects: how the development of Comneter is carried out, how the validity testing of the instruments is conducted, and how the feasibility analysis of the media is performed. By addressing these issues, the research aims to create a comprehensive, valid, and effective learning tool using Unity for Smartphone users, ultimately supporting the improvement of teaching and learning in vocational schools specializing in Computer Network and Telecommunication Engineering. This research follows the R&D approach, using the ADDIE model (Analyze, Design, Development, Implementation, and Evaluation) to ensure the effectiveness of this learning media development (Branch, 2009). The goal of this development is to provide an innovative and engaging learning experience that can enhance student comprehension of Basic Computer Network and Telecommunication Engineering in the tenth grade of Vocational High Schools. By integrating interactive technology, Comneter aims to improve learning effectiveness, motivation, and students' overall understanding of basic Computer Network and Telecommunication concepts.

2. RESEARCH METHOD

Research method, this study employs the Research and Development (R&D) method, which focuses on developing new products or improving existing ones to ensure effectiveness and accountability. According to Nana Syaodih Sukmadinata (2009:164), R&D involves a series of steps to create and refine products, which can be either hardware (such as books, modules, and learning tools) or software (such as applications, educational videos, and interactive multimedia). R&D is descriptive in nature and emphasizes structured development steps.

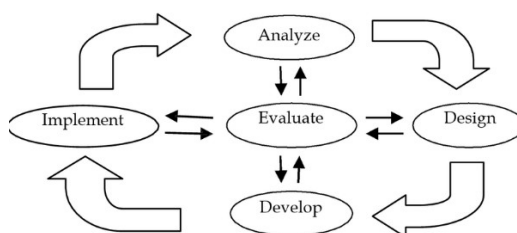


Figure 1. 5 phase of ADDIE model

Development model, in this study, researcher adopts the ADDIE model, developed by Dick and Carey (1996), which consists of five main phases: **analysis**, which identifies needs and problems. In the initial phase of development, a comprehensive needs analysis was conducted by observing classroom activities and reviewing Computer Network and Telecommunications materials from more than one sources, including books and online modules. The analysis also used to decide what platform will be used, and a quick survey revealed that out of 36 students, 34 out of 36 students use Android phones, while only 2 used iOS phones, leading to the decision to develop the application for an android based phone. Based on this analysis and validated source review, the researcher choose that the Orientation of Basic Computer Network and Telecommunications material as the main focus for the learning product. According to that, an interactive learning media product named Comneter (short for Computer Network Learning), was developed as an Android based phone application using Unity. Comneter combines text, images, and audio and includes features such as an introduction, learning materials, a summary, evaluations, quizzes, and source references, along with a developer profile.

Design, which plans the structure and components of the product. This phase begins by creating the application programs' flow, and put it out in a flowchart, it serves to show how the program operates within the application. Afterwards, the next step is designing the applications' interfaces by creating a storyboard, it manually drawn by hand on a sheet of paper and depict each scene of the application program. **Development**, which involves creating and refining the product. In this phase, the process is divided into 3 sub-stages. Starting from designing each scene, including the landing page, home page, material, quiz, etc., and making it able to

operate. Once this step is done, the next stage is testing. This testing was conducted to ensure that every button, scene, or program in the application works as expected without errors. This testing is conducted by using blackbox testing scenarios, and will be repeated in the event of any failures occurring, until the issues are resolved and Comneter performs as intended. The final step is publishing, exporting (build if in Unity) the program to produce an interactive learning media (Comneter) in the form of an Android-based mobile application.

Implementation is the phase where the product is applied in real learning environments. In the implementation phase, Comneter is applied directly in the classroom to assess its feasibility through instrument validation and testing by both experts and end-users. The process begins by creating a feasibility testing instrument, which is divided into four sections for content experts, media experts, students, and teachers as respondents. The instruments are based on the LORI v1.5 standard developed by Nesbit et al. Following this, the instruments are validated by one of the lecturers in the Computer and Informatics Education Program, Sebelas Maret University. At first, the results indicated that the instruments required revisions, and once it was improved, it was deemed suitable for use in data collection. Next, a feasibility test is conducted with content experts, who use Comneter for 15 minutes to evaluate its contents, alignment with learning objectives, and ability to motivate students.

This assessment is carried out by one of the teachers in the Computer Network and Telecommunications program at Vocational High School in Karanganyar Regency. To strengthen the validity of the content evaluation, a second material expert was engaged in the assessment process. The second evaluator was a lecturer specializing in Computer Network and Telecommunication Engineering, whose academic background provided a complementary theoretical perspective to the practical expertise of the first evaluator. The final content feasibility score was derived from the average of assessments provided by both material experts, ensuring a more balanced and credible evaluation of Comneter's instructional content. Similarly, a media expert conducts a test focusing on design, ease of use, accessibility, and reusability, with evaluations provided by the Vice Principal for Curriculum in Vocational High School. In addition, a second media expert was recruited to provide a more comprehensive evaluation of Comneter's technical and design qualities. The second evaluator was a lecturer in Educational Technology, with expertise in instructional media design and interface usability. The inclusion of two media experts allowed for cross-validation of the design assessment, reducing the risk of evaluator bias and increasing the reliability of the feasibility judgment. Finally, user testing is conducted with students and teachers in a tenth-grade networking class during a lesson, where participants are given a link to download and install Comneter, provided time to explore all features—including reading materials, summaries, evaluations, and quizzes—and then complete a questionnaire via Google Form by rating each statement on a scale of 1 to 5.

Evaluation, is the final phase of the ADDIE development model, carried out at the end of each development phase. During the **analysis** stage, the evaluation focused on selecting the appropriate platform. Although the learning media was initially planned as a desktop program, after the observations and a review of student needs, the researcher decided to develop Comneter as an Android mobile application. In the **design** phase, evaluations were conducted on the program's flowchart and storyboard. The initial flowchart, which inadequately depicted process flows and symbol usage, was revised based on expert feedback, and the storyboard was simplified for each menu or scene. During the **development** stage, evaluations focused on resolving errors in the scoring scheme within the evaluation menu and issues with the drag-and-drop feature in the quiz during blackbox testing. In the **implementation** phase, the validation instrument was first developed, divided into four sections for content experts, media experts, students, and teachers as respondents, and then validated by experts such as one of the lecturers in the Informatics Education Program, with several revisions made until the instruments were deemed suitable. The next step is testing the instruments' validity and reliability using IBM SPSS Statistics Software. Subsequent tests of validity and reliability using IBM SPSS Statistics confirmed that the instrument was both valid and reliable, eliminating the need for further evaluation.

Reliability Statistics	
Cronbach's Alpha	N of Items
.924	19

Figure 2. Reliability Test Result

Finally, overall evaluation was divided into three parts: (a) expert evaluation, which yielded average scores of 4.00 from content experts and 3.70 from media experts; (b) respondent evaluation, where 36 participants provided an average score of 4.20, resulting in a final combined average of 4.33, which places Comneter in the 'very feasible' category according to established criteria; and (c) the final product, which is the Comneter, media learning application for tenth-grade Computer Network and Telecommunications in vocational high schools, developed as an Android application..

Formula	Score Intervals	Categories
$X > \bar{X}_i + 1,8 \times sb_i$	> 4,2	Very Feasible
$\bar{X}_i + 0,6 \times sb_i < X \leq \bar{X}_i + 1,8 \times sb_i$	> 3,4 – 4,2	Feasible
$\bar{X}_i - 0,6 \times sb_i < X \leq \bar{X}_i + 0,6 \times sb_i$	> 2,6 – 3,4	Adequate
$\bar{X}_i - 1,8 \times sb_i < X \leq \bar{X}_i - 0,6 \times sb_i$	> 1,8 – 2,6	Not Suitable
$X \leq \bar{X}_i - 1,8 \times sb_i$	$\leq 1,8$	Very Unsuitable

Figure 3. Table of Score Conversion

The study focuses on developing interactive learning media using technology to enhance the teaching and learning process, particularly in basic computer network subjects at vocational high schools. The study population comprised all tenth-grade students enrolled in the Computer Network and Telecommunication Engineering program at vocational high schools in Karanganyar Regency. From this population, a sample of 36 students from one class was selected using purposive sampling, a non-probability sampling technique in which participants are chosen based on specific, predetermined criteria relevant to the research objectives (Sugiyono, 2019). The inclusion criteria applied in this study were as follows: (1) students actively enrolled in the tenth grade of the Computer Network and Telecommunication Engineering program; (2) students who owned or had regular access to an Android-based smartphone; and (3) students who had received instruction on the Basic Orientation of Computer Network and Telecommunication Engineering topic at the time of the study. These criteria were established to ensure that the selected participants possessed the prerequisite knowledge and technical access necessary to meaningfully evaluate Comneter as a learning medium. The process of data collection is conducted by using a questionnaire based on the Likert scale model. The data obtained from experts and respondents were used for evaluation and to determine the feasibility of Comneter.

3. RESULT AND ANALYSIS

This research was conducted at Vocational High School in Karanganyar Regency to develop and evaluate an Android-based multimedia learning application for the Basic Computer Network and Telecommunication Engineering course. The study followed the Research and Development (R&D) method using the ADDIE model, which includes Analyze, Design, Development, Implementation, and Evaluation stages. The developed application was tested in the learning process to assess its feasibility and effectiveness. Through this approach, researchers successfully integrated the collected learning materials into an interactive multimedia platform to enhance students' understanding and engagement.

3.1. RESULT

Analyze, the first phase of this development is conducting an analysis, including a needs assessment and an evaluation of student characteristics. This was done by observing the classroom learning environment, conducting some interviews, and reviewing the Computer Network and Telecommunication Engineering course materials from various sources, such as textbooks and online modules. Since the learning media would

be developed as a mobile application, the researcher also determined whether Comneter should be iOS-based or Android-based. Based on a quick survey, 34 out of 36 students used Android devices, leading to the decision to develop an Android-based application. Based on interview results, the topic that students find most difficult to understand is the Basic Orientation of Computer Network and Telecommunication Engineering. This is because the material discusses various objects, which would be easier to comprehend with illustrations. Therefore, the researcher chose to focus on the basic orientation of Computer and Network Engineering as the main topic for Comneter.

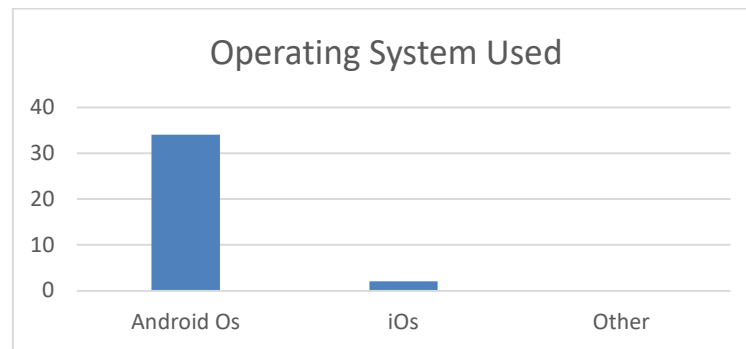


Figure 4. Chart of Smartphones' OS Used by Students

Design, the second phase, is designing a flowchart, as the main component to be used in this development, to illustrate the functional flow of Comneter. The illustration of the flowchart can be seen in the figure below.

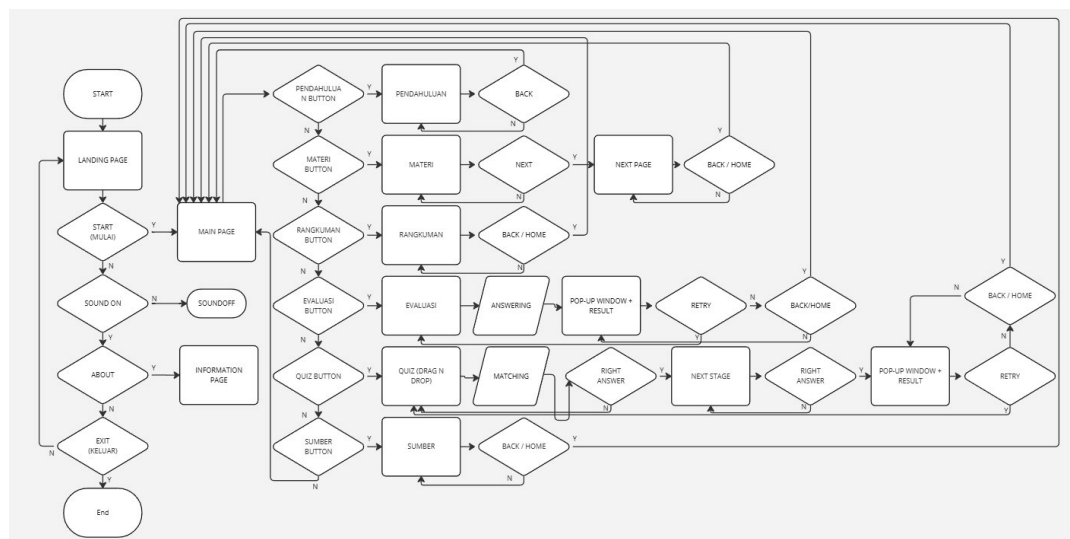


Figure 5. Comneters' Fowchart

Comneter consists of six menus, with functional flow as depicted above. The flowchart plays a crucial role as the foundation for Comneter's development. In addition to creating the flowchart, instrument design is also conducted, which will later be used to test the validity of the assessment instrument and evaluate the feasibility of Comneter. The feasibility testing instrument was developed in three distinct formats, customized for media experts, content experts, and respondents, each containing a set of evaluation criteria tailored to the evaluator's role and area of expertise. Derived from the LORI feasibility testing instrument developed by Nesbit et al., these instruments ensure a comprehensive assessment of the learning media. For a content expert, the instrument is focused on evaluating the quality of the material contents, the alignment of the content with the learning objectives, the effectiveness of feedback mechanisms and adaptation processes, as well as the overall motivational impact on learners. Otherwise, the instrument for media experts emphasizes the aesthetic

and functional aspects of the media by assessing the presentation design, ease of use, interaction, accessibility, and potential for reusability across different learning contexts. Finally, the instrument designed for respondents integrates criteria from both domains. The criteria embrace presentation design, user interaction, accessibility, content quality, alignment with learning objectives, feedback and adaptation, and motivational effectiveness. This structured, multi-perspective approach ensures that each aspect of the learning media is thoroughly evaluated from multiple perspectives, thus providing a strong assessment of the overall feasibility and suitability for enhancing the learning experience.

Development. Comneter was developed using Unity software. In addition to the observations and analysis of student needs, one of the reasons for developing Comneter as a mobile application is that, under the current curriculum, students are allowed to bring and use their mobile phones during the learning process for educational purposes. This policy not only facilitates a more dynamic and interactive learning environment but also allows both students and teachers to utilize available devices/technology fully. Among 36 students, 34 are Android users. Therefore, this learning media is designed to operate on Android-based mobile devices. By integrating mobile technology into the learning process, the learning process becomes more flexible and engaging. In the end, teachers and students can maximize the effectiveness of using media to enhance the learning experience using technology.

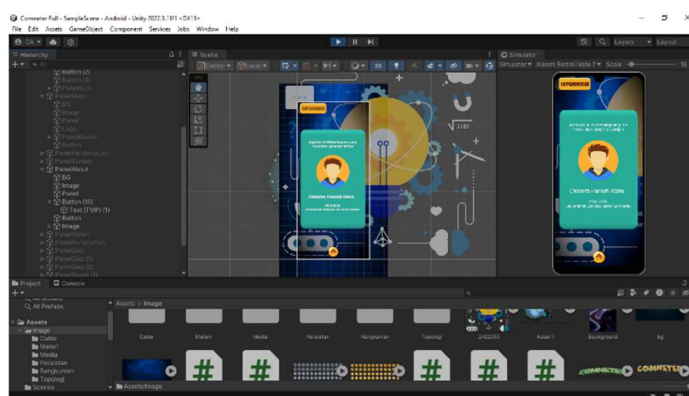


Figure 6. Comneters' Developing Porcess

This development process includes various processes, like designing the assets, creating app scenes, app scripts, and doing blackbox testing, etc. Functional testing of comneter also conducted in this development phase, using the black-box testing method, showing the main result as in the figure below.

Table 1 Blackbox testing scenes

No.	Scene	Expected Result	Summary
1.	Landing Page	All Suitable	Success
2.	Main Menu	All Suitable	Success
3.	Quiz	All Suitable	Success
4.	Evaluation	All Suitable	Success
5.	All Page Navigation Button	All Suitable	Success

After completing extensive blackbox testing, the results clearly indicate that Comneter operates exactly as expected, delivering smooth performance without any disruptions, lag, or errors. As we transition into the final stage of the development process, known as the publication phase, our primary objective is to produce a fully functional product that meets specific technical criteria. The final product is packaged as an APK application, optimized for use on a variety of devices running the Android operating system, and it boasts a compact final file size of 31.2 MB. Furthermore, it is engineered to operate independently without the need for an internet connection, ensuring reliable usage in diverse learning environments. With these specifications in place, we anticipate that the download and installation process on students' mobile phones will be smooth and largely issue-free. Once the final product, Comneter, is produced, it will undergo a comprehensive

feasibility evaluation by media experts, content experts, and end-users, as detailed in the subsequent implementation phase.

Implementation, the phase was conducted with 34 tenth-grade students at Vocational High School in Karanganyar. After explaining how to use Comneter, students were given time to explore the application on their own. This provided a different learning experience, as traditional learning media typically consist of textbooks. Comneter offers a more user-friendly approach with interactive quizzes inside this app, making the learning process more engaging and less monotonous for students. In this phase, the evaluation instrument underwent a thorough validation process. Once confirmed as valid, it was used to collect assessment data from content experts, media experts, and respondents. The data gathered from the experts was then organized into tables that clearly display the scores for each evaluated aspect. This systematic approach ensures that the evaluation results are well-documented and can be easily referenced in subsequent analysis.

Table 2 Table of Aspects Scores

No.	Expertise	Aspects	Score	Avg.	Categories
1	Material Expert	Content quality	4.00	4.00	Feasible
		Learning goal alignment	4.00		
		Feedback and adaptation	4.00		
		Motivation	4.00		
2	Media Expert	Presentation design	4.00	3.60	Feasible
		Interaction usability	4.00		
		Accessability	3.67		
		Reusability	3.00		
3	End-user	All Aspects	-	4.20	Feasible

Evaluation: This phase was carried out at the end of each development phase. During the analysis phase, the evaluation focused on adding more comprehensive and relevant materials to align with the learning objectives. In the design phase, the evaluation involved refining the application's functional flow, which was then illustrated through a flowchart. During the development phase, the evaluation aimed to improve the assessment system for evaluations and quizzes. Therefore, evaluations were conducted at the end of each phase to make necessary improvements before progressing to the next stage.

3.2. ANALYSIS

This research employed the Research and Development (R&D) methodology, utilizing the ADDIE development model. The study was conducted systematically following the five stages of ADDIE: Analyze, Design, Development, Implementation, and Evaluation.

Before proceeding to the feasibility validation of Comneter, a rigorous preliminary validation process was conducted on the evaluation instrument. This initial validation was essential to ensure that the instrument was both accurate and appropriate for use in data collection. In the first round of validation, the instrument was carefully reviewed, and several revisions were made to improve its grammar and refine the choice of words, thereby enhancing clarity and professionalism. Following these revisions, a second round of validation was performed, and the instrument was subsequently deemed acceptable based on the improved assessment results provided by the validators. To further confirm its robustness, the instrument's validity was statistically tested using IBM SPSS Statistics, with the resulting metrics presented in the table below. Additionally, a reliability test was conducted using the same software to verify the consistency of the instrument. The statistical analysis

confirmed that the instrument met the required standards for both validity and reliability. Once the instrument was fully validated, it was then employed to collect data, ensuring that the measurements were both dependable and precise for the study's subsequent phases.

The data collection was conducted through a Likert-scale questionnaire, which was first validated by experts before use. The feasibility testing of Comneter involved three groups of evaluators: subject matter experts, media experts, and respondents (teachers and students). The subject matter experts rated Comneter with a final score of 4.00 (feasible category), the media expert rated it with 3.70 (feasible category), and respondents with their average rating came to a 4.20 score (feasible category). Notably, the reusability aspect received the lowest score of 3.00 from the media expert, indicating that Comneter's content is narrowly tailored to one curriculum unit, which limits its broader applicability across different subjects or instructional contexts. This finding suggests that future development iterations should prioritize modular content architecture to enhance the application's reusability across the wider vocational curriculum. The final average of the feasibility score was 3.96, which falls under the feasible category based on Eko Putro Widoyoko's assessment criteria.

Table 3 Pearson Correlation

X01	Pearson Correlation	.592**	>	0.339	Valid
	Sig. (2-tailed)	0,000	<	0.05	Valid
X02	Pearson Correlation	.750**	>	0.339	Valid
	Sig. (2-tailed)	0,000	<	0.05	Valid
X03	Pearson Correlation	.674**	>	0.339	Valid
	Sig. (2-tailed)	0,000	<	0.05	Valid

The analysis phase involved three parties: subject matter expert, media expert, and respondents consisting of teachers and students. The feasibility analysis of Comneter was conducted based on the assessment guidelines proposed by Eko Putro Widoyoko (2009). The evaluation by the subject matter expert resulted in a score of 4.00, categorized as feasible. Media experts provided a score of 3.70, also classified as feasible. Meanwhile, the students' assessment yielded an average score of 4.20, it also categorized as feasible. Using the predetermined formula from the assessment guidelines, the overall average score was calculated to be 3.96. Based on Eko's assessment criteria, Comneter was deemed suitable for use and categorized as Feasible.

Table 4 Result of Feasibility Assessment

Subject	Score	Categories
Material Expert	4.00	Feasible
Media Expert	3.70	Feasible
Respondents	4.20	Feasible
End Result	3.96	Feasible

After the feasibility testing of Comneter was completed, the results confirmed that Comneter is valid and feasible for use. Following this, a data analysis was conducted to assess the improvement in students' learning motivation. The enhancement of students' material comprehension and motivation was evaluated based on responses collected through questionnaires distributed to the student respondents in this study. Specifically, regarding the statement "Comneter is capable of increasing students' motivation to learn," the analysis showed that 21 out of 36 students rated it 5, 9 rated it 4, 3 rated it 3, and 3 rated it 2. With a total of 36 responses, the average score was calculated using the formula $\bar{X} = (\sum X)/N = 156/36 = 4.33$. According to the rating criteria provided by Eko Putro Widoyoko, an average score of approximately 4.33 falls into the "very valid" category. Subsequently, for the second statement, "Comneter is capable of enhancing students' knowledge," the responses were: 23 out of 36 students rated it as 5, 9 out of 36 rated it as 4, 2 out of 36 rated it as 3, and 2 out of 36 rated it as 2. With a total of 36 respondents, the validity of these responses was calculated using the formula $\bar{X} = (\sum X)/N$, yielding an average score of $161/36 = 4.47$. According to the rating criteria provided by Eko Putro Widoyoko, an average score of 4.47 falls into the "very valid" category.

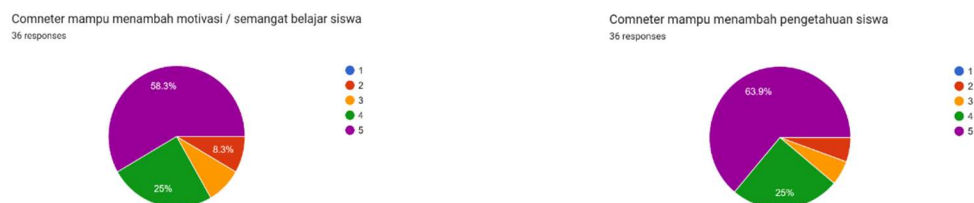


Figure 7. Student Motivations & Comprehensions' Increase Data by Students' Responses

Based on the analysis of the data presented above, it can be concluded that Comneter not only increases students' motivation to learn but also significantly enhances their understanding of the instructional material. The evaluation results indicate that the application effectively stimulates students' interest and engagement, leading to a deeper comprehension of the subject matter. These findings provide robust support for the claim that Comneter can serve as a powerful tool in boosting learning motivation while simultaneously improving academic performance. In essence, the evidence establishes a valid and reliable basis for asserting that Comneter is highly effective in both increasing student motivation and enhancing their overall understanding of the material. Students perceived Comneter as enhancing their understanding ($M=4.47$), suggesting its potential effectiveness. However, pre-post assessment is recommended to confirm actual learning gains.

4. CONCLUSION

The research resulted in the development of an interactive learning multimedia application named Comneter, an abbreviation for Computer Network and Telecommunication Learning. Comneter was developed using Unity and designed as an Android-based mobile application. The development process adhered to the five structured phases of the ADDIE model, starting from analysis of student needs and characteristics, followed by the design phase, which involved structuring the media flow and model. The development phase then focused on creating the application using Unity, leading to the implementation phase, where the application was tested in the learning environment. Finally, the evaluation phase was conducted at each phase before proceeding to the next phase.

Based on these findings, it can be concluded that Comneter, developed using Unity for 10th-grade students in the Computer Network and Telecommunication Engineering program at Vocational High Schools in Karanganyar Regency, has been evaluated and feasibility tests using validated assessment instruments. With an overall feasibility score of 3.96, Comneter is deemed suitable for use as an interactive learning medium, and Comneter not only increases students' motivation to learn but also significantly enhances their understanding of the instructional material. The evaluation results indicate that the application effectively stimulates students' interest and engagement, leading to a deeper comprehension of the subject matter. These findings provide robust support for the claim that Comneter can serve as a powerful tool in boosting learning motivation while simultaneously improving academic performance. In essence, the evidence establishes a valid and reliable basis for asserting that Comneter is highly effective in both increasing student motivation and enhancing their overall understanding of the material.

Despite its contributions, this study is subject to several limitations that should be acknowledged. First, the sample was confined to 36 tenth-grade students from a single vocational high school in Karanganyar Regency, which constrains the generalizability of the findings to broader populations across different institutional and geographical contexts in Indonesia. Second, the absence of a control group in the research design prevents any causal inference regarding the effectiveness of Comneter relative to conventional instructional methods. Third, as this study focused exclusively on feasibility assessment, no pre-posttest instrument was administered, meaning that actual learning gains — as opposed to perceived improvements reported through self-assessment questionnaires — remain empirically unmeasured. Fourth, the instructional content embedded within Comneter was limited to a single unit, namely the Basic Orientation of Computer

Network and Telecommunication Engineering, which restricts the applicability of the media to a narrow segment of the broader vocational curriculum.

Considering these limitations, several directions for future research are recommended. Subsequent studies should employ quasi-experimental or experimental designs incorporating control groups across multiple schools and regions to establish more robust evidence of Comneter's instructional effectiveness. Additionally, longitudinal assessments measuring long-term knowledge retention would provide deeper insight into the durability of learning outcomes facilitated by the application. Finally, future development efforts are encouraged to expand the content coverage of Comneter beyond the introductory unit to encompass the full scope of the Computer Network and Telecommunication Engineering curriculum, thereby enhancing its utility as a comprehensive learning tool for vocational students.

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