JURNAL INOVASI PENDIDIKAN DAN TEKNOLOGI INFORMASI

Volume 7 No. 1, April (2026)
E-ISSN: 2720-9725
P-ISSN: 2987-8462

SMART NETWORK REFERENCE DICTIONARY DEVELOPMENT USING WATERFALL FRAMEWORK MODEL TO IMPROVE LEARNING OUTCOMES

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Abstract

The purpose of this study is to develop a Smart Network Reference Dictionary using the Waterfall Framework Model to improve student learning outcomes. Information technology plays an essential role in enhancing student competence and expertise, especially in the Industrial Era 4.0, which demands skills aligned with the needs of industry and the business sector. Computer Networking is one of the subjects that requires strong mastery. Based on observations and interviews with lecturers at STMIK Methodist, out of 28 students, only seven passed with excellent categories, 11 with good categories, and ten did not pass, indicating the need for more effective learning support tools. This study developed the Smart Network Reference Dictionary using the SDLC approach with the Waterfall model and conducted validation through Black Box Testing and Alpha Testing, with Likert-scale analysis used to classify the results. The developed application achieved the Very Appropriate category, with assessment scores of 85.3%, 82.8%, and 86.0%, all of which fall under the Very Eligible classification. Furthermore, the learning outcomes of the experimental class improved significantly, as shown by the higher average pretest–posttest score range compared with the control class. Thus, the development of the Smart Network Reference Dictionary using the Waterfall Framework Model not only produces a high-quality application but also effectively enhances student learning outcomes in the Computer Networking course at STMIK Methodist.

Keywords: *Network Dictionary, Reference Subjects, Android Mobile, Waterfall, Learning Outcomes*

Submitted: *2026-02-27.* ***Revision:*** *2026-03-01.* ***Accepted:*** *2026-03-19.* ***Publish:*** *2026-04-01.*

Purba, R. A., Bukit, T. A., & Simanjuntak, M. S. (2026). SMART NETWORK REFERENCE DICTIONARY DEVELOPMENT USING WATERFALL FRAMEWORK MODEL TO IMPROVE LEARNING OUTCOMES. *Jurnal Inovasi Pendidikan dan Teknologi Informasi (JIPTI), 7(1), 65-78.* https://doi.org/10.52060/jipti.v7i1.4013

http://ejournal.ummuba.ac.id/index.php/JIPTI/

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INTRODUCTION

The development of information technology must be used as much as possible. One of them is to support learning activities. Information technology can be used to improve student competence and expertise (Sakibayeva & Sakibayev, 2025). For example, it is building an information technology-based means that effective and efficient (Alshuaybat, 2025). Effective and efficient means that the information technology that is built can be used anywhere, anytime, and can solve student problems when studying (Ramen Antonov Purba et al., 2024). Currently, it is called the Industrial Age 4.0 (Chasokela & Mangena, 2025). An era that requires students to have skills and competencies by the needs of the industry and business world (Li, 2024). One of the characteristics of this era, information technology based on IoT networks, has developed so rapidly (Ramen Antonov Purba et al., 2022).

Technological developments have resulted in several things being possible in terms of learning (Jaradat et al., 2025). The combination of the two can support learning to improve competence (Ambiyar et al., 2021). Where competence is really needed at this time (Ramen Antonov Purba, 2021b). With competence, someone will be accepted and ready to compete in anything (Pessot et al., 2025). Especially at this time the competition is very tight. So, ability or competence is really needed to be able to compete (Tantawi et al., 2025). One of the subjects that students must master to the maximum is Computer Networking. This course contains topics that aim to enable students to build networks, manage internet connections, manage IP addresses, build network material requirements and how they work, and the philosophy of LAN, MAN, WAN, and Network Topology. So important is this subject that in the Polytechnic curriculum, the weight is made of 8 Semester Credit Units (SKS).

When conducting direct observations and interviews with lecturers who teach computer networks at STMIK Methodist, most students taking computer network courses were poor. From 28 students, only seven students succeeded in graduating with good categories, 11 students with good categories, the remaining ten students, did not pass. The lecturer said that the cause was the limited learning time. The time provided is felt to be insufficient. When conducting interviews with students, students have the same reasons as lecturers, namely time. In addition, students also revealed that they lacked facilities that could be used as a

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reference for learning outside of lecture hours and outside the tertiary institution.

Products of technological sophistication can be developed into solutions to the problems that have been stated above, said that interactive and communicative-based technology collaborated with internet means crisscross or cyberspace would change people's perspectives and patterns in interacting and behaving. Werner (Werner & O'Dowd, 2025) agrees with this statement and confirms by saying that the virtual world, in this case, the use of the internet and its related components, can make humans see the world in an infinite, dynamic, and flexible way. This condition makes humans have broad and limitless insights. At the same time can interact widely and without limits as well. Wong (Wong & Yunus, 2021) and Gregory (IJOKO, 2025)**,** agree with Werner about the sophistication of network-based technology and the utilization of cyberspace capacity. Wagdi (Bin-Hady et al., 2025) and Lindner (Lindner & Schwab, 2025) specified their opinion by saying that such a context was synonymous with mobile learning. Mobile learning, namely mobile technology combined with a wireless concept internet network that allows everyone to access information from anywhere and anytime. Agha (Agha et al., 2025) stated that mobile learning is a concept that can be implemented so that humans can learn indefinitely and without boundaries. Gian (Giannakos et al., 2025) and Purba (R. A. Purba et al., 2019) emphasized that mobile learning is the best alternative as a substitute for learning models, which are essentially traditional and monotonous and boring.

Mauri (Mauri Medrano et al., 2023) said the context of mobile learning uses mobile media with an Android system. It was used as an option because most students use such media on their telecommunication technology devices. Based on the information (Ramen Antonov Purba, 2022)**,** there are 202.6 million Indonesians who are active internet users. There was an increase of 15.5% from January 2020. This percentage is equivalent to 27 million Indonesians. Based on HootSuite data in (Widyanti et al., 2020)**,** Indonesians with an age range of 16 to 64 years are active Android mobile users 195.3 million with a percentage of 96.4%. Of these, approximately 58 million are active Android mobile users, namely students, in this case, school children to university students. Sanjay (Rathod & Agal, 2023) revealed that mobile media with an Android system is excellent and powerful. Possesses the characteristics of portability and networking. Adesina (Azeez et al., 2025) has a similar view, that mobile media with an Android system has many services that will be very useful, especially in educational activities.

Criollo (Criollo-C et al., 2024) and Yuan (Yuan et al., 2025) argues**,** when viewed from the perspective of the effectiveness aspect related to the use of mobile media with the Android system for educational activities, it is sure that they can present new things, situations, and atmosphere in learning activities. It is believed that students will actively learn because there is a unique attraction in

mobile media with this Android system. Elvira (Elvira et al., 2025) and Purba (Ramen Antonov Purba & Sembiring, 2016) concludes that learning to use mobile media with an Android system can increase the ability and knowledge of students in digesting and interpreting the teaching material given and delivered. Hadiarto (Hadiarto et al., 2025), Xun (Xun et al., 2025), Haruna (Haruna et al., 2025), and de sales (de Sales & Oliveira, 2025) also have the same view regarding the use of mobile media with the Android system for educational activities. The maximum use of such media will also maximize student learning outcomes.

Purba (Ramen Antonov Purba & Sondang, 2022) in their research concluded that the use of mobile media with Android makes the desired process related to synonyms and antonyms faster. To test the application uses the Blackbox method as well as the Binary Search method. Moroki (Moroki, 2025) in their research that the use of an Android-based mobile device will help students achieve higher levels of achievement. Where the results when the initial test and the final test are carried out are different, this research uses experimental methods. Nuryana (Nuryana et al., 2024) in her research Dictionary Application Design Using an Android-Based Binary Search Method. It has been discovered that when the application is used, the results of the research topic will vanish. The study employs the SDLC methodology and the Blackbox test.

Sudarma (Sudarma et al., 2025) in his research was found that learning in Algorithm and Programming courses was more interactive and interesting with the use of Android-based mobile media. Using a development research philosophy with software development methods. Daniyal (Alghazzawi et al., 2021) in their research "Developing an Android-based Mobile Application Dictionary of Computer Terminology for New Students in the Field of Computer Science". It was concluded that an application built made it easier for students to understand the lessons presented, especially related to computer terms. Dewi (Dewi et al., 2025) in their research "Development of Android-based mobile learning applications for subjects related to software engineering at SMK Sultan Trenggono in Semarang City". It was found that the Android-based mobile application was straightforward to use in the learning activities carried out. Based on the distributed questionnaires, the results obtained were categorized as feasible for the applications that have been built.

Based on the explanation of the above problems and the results of the analysis of research that has been done before, research and development will be carried out related to the Design of an Effective and Efficient Network Reference Dictionary Design with the Waterfall, Black Box, and Alpha Methods. What distinguishes research carried out from previous research is the method and model of development and analysis of the effectiveness and efficiency of the application being built. In addition, the difference is that the application is built in the form of a dictionary whose content is

related to computer network learning. The hope is that by carrying out the development in this research, technology media for learning will be produced in a dictionary that can be opened and accessed anytime and anywhere. In addition, it is hoped that learning technology media will be obtained in the form of a dictionary which is essentially effective and efficient.

METHODS

The SDLC with the Waterfall method was used to solve the problems in this analysis. Namely, the context used to build and develop application software (Ramen Antonov Purba, 2021a). For the implementation of validation of software applications that are built using testing with the BlackBox method. Roger S. Pressman in (Guo et al., 2025) explained that if an application has been completed, a series of trials must be carried out to see the weaknesses of the application to avoid errors and dire consequences in the future. Next, to get the accumulated test results from users of the software application being built, the alpha method is used. To obtain a classification of results, analysis techniques with a Likert scale are used. SDLC with the waterfall method, the stages are as shown in Figure 1 below :

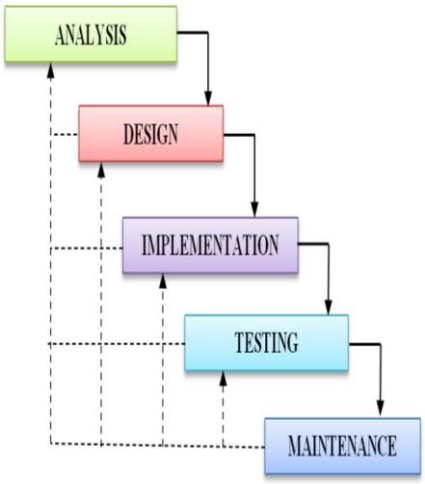

Figure 1. Waterfall Method SDLC Stages

The formula for obtaining the mean value is used:

$$\bar{x} = \frac{\sum x}{n} \quad (1)$$

With Information :
$\bar{x}$ = Average value
Σx = The value of the whole component
n = Number of components

Then for categorization using a Likert scale, as in table 1:

Table 1. Likert categorization

No.	%	Category
1	0-21	Very Not Strong
2	22-41	Not strong
3	42-61	Strong enough
4	62-81	Strong
5	82-100	Very Strong

Categorization will adjust to the actual conditions of the application being built. The form of adjustment referred to, is as in table 2:

Table 2. Condition adjustment

No.	%	Condition
1	0-21	Very Unworthy of All
2	22-41	Not feasible
3	42-61	Decent enough
4	62-81	Well worth it
5	82-100	Very Worth Once

RESULTS AND DISCUSSION

A. Application Specifications and Analogy

Design using UML. Actors as participants in research activities are guest, student and admin. Use cases have a composition of instructions or behaviour that is the activity of the actor. By the product description of actors and use cases and use case scenarios, the application use case designs that will be developed include in figure 2:

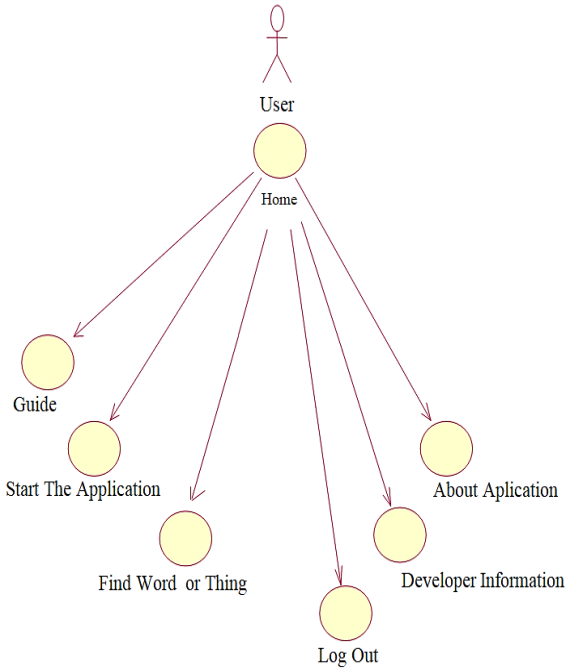

Figure 2. Use Case Design

The definition in Figure 2 can be described in table 3 below :

Table 3. The use case definition's overview

Use Case	Description
Attendant	How to use the program
Launch The Application	Commencement of the designed application
Locate a Word or Object	Conduct a word search or a search inside the application for the desired.
Developer Information	See the application figure display
About Application	Application menu that defines the parts that exist in the application being built
Logout	Button to exit the application
User	A user of the application being built
Home	The main display menu or the main menu of the application

B. Implementatiton

Implementation is built using an Integrated Development Environment (IDE). Java programming language based on Android Studio. In Android Studies, several classes are classified as part of the implementation step. The classes are: 1) MainActivity. To arrange elements that are on the main page of the application. Then set the activity_main.xml layout; 2) BManager. Being the controller of the application database, from initiating data to displaying specific instructions; 3) CariActivity. Serves to perform settings

related to word searches; 4) Activity results. To adjust the results that are the target of the search; 5) MateriActivity. Serves to make arrangements for the material to be displayed on the application; 6) Instructions for Activity. Serves to make arrangements for elements related to the instructions for using the application; 7) About Activity. Serves to make arrangements for elements that display information about researchers; 8) Delete Text. Serves to arrange elements in the material and results menu, as well as explore.

Next will be the appearance of the application as shown in Figure 3:

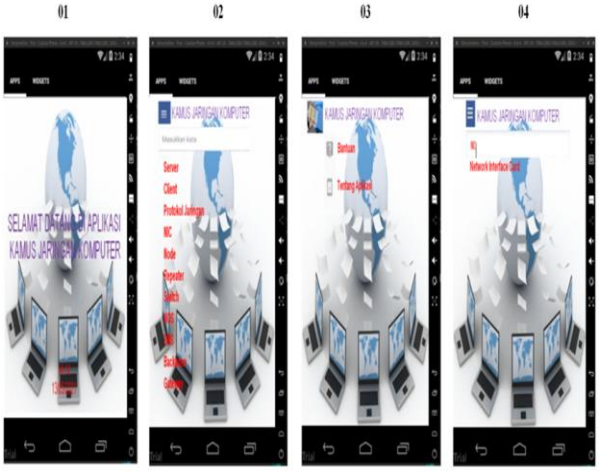

Figure 3. Implementation of Applications Built

As for the explanation of Figure 3, namely the implementation of the dictionary application built, for the initials, 01 is the initial display when the application is first to run; initial 02 is a display when pressing a button to enter the following menu. For the initials, 03 is a display if you need help and information about the dictionary application. The initials 04 display if the user wants to search for components related to computer network devices. By exploring the application display code shown, the user will be guided entirely about the computer network information he needs. So that students will be helped when students do not fully understand the explanation in the classroom when lectures are carried out.

Next will display the application with another menu, where the function is also the same as the application menu that has been displayed previously. This means that the menu displayed is intended to help students take computer network lectures, both in practice and theory. All displays in the application that are built will answer the needs of students. As for how it looks like in Figure 4:

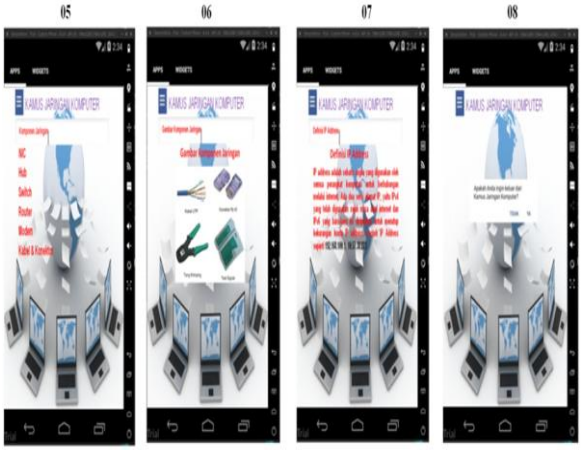

Figure 4. Continued Application Implementation Built

As for the explanation of Figure 4, namely the initials 05 is a display when searching for network components is carried out. When a keyword is typed, the application will automatically search according to the typed keyword. If found, what the user was looking for is displayed. For the initials, 06 is a search display by displaying images according to the typed

keywords. The initials 07 is a keyword whose view defines what is typed in the search column. Then for the initials, 08 is a display if you want to exit the dictionary application. Several more features are not shown in this paper, which has the same function: to help students understand the context of computer networks.

Component	Total Value	Maximum Value	%
Functionality of All Components	546	640	0,853 (85,3)
Efficiency Level	265	320	0,828 (82,8)
Benefit Level	1102	1280	0,860 (86,0)

C. Testing with Blackbox

Testing with a BlackBox context aims to see the appropriateness of the application based on its usability. Application components are tested sequentially, such as the steps that are carried out when designing an application. To test with a BlackBox pattern, Android Virtual Device (AVD) media were used. For the purpose of concluding the BlackBox test, see Table 4 :

Table 4. Blackbox Test Conclusion

Activity	Response	Conclusion
Run the Application	- Press button to run application - Connection to database	Suitable
Accessing Learning Componen	- Execute the file menu to display components	Suitable
Access the About Menu	- Execute menu to show About file	Suitable
Exit Menu	- Execute to exit the application	Suitable
Perform searches words, definitions, and images	- Execution of the menu to search Words, Definitions, and Images	Suitable

By the display described in table 4, all the menus in the application are suitable or by expectations and function properly.

D. Testing with Alpha

The testing process with the Alpha model is based on three elements according to the capacity and capabilities of the application being built, including the functionality of the entire menu, the level of efficiency, and the level of usability. This Alpha test was carried out on 32 students of the STMIK Methodist who took computer network lectures. The conclusions of the alpha test are shown in table 5:

Table 5. Alpha Test Conclusion

After obtaining the conclusions from the Alpha testing phase, an overall evaluation can be carried out to measure the extent to which the developed application meets the predetermined quality indicators based on the categories presented in Table 5, including aspects of functionality, usability, reliability, efficiency, and compatibility. The results of this evaluation reflect the level of conformity between system performance and the initial design specifications, while also identifying areas requiring minor

improvements. Based on the cumulative assessment in these categories, it can be concluded that the overall achievement level of the application quality is summarized in Table 6, which presents the percentage results and indicates that the application has achieved a satisfactory level of quality and is feasible for further implementation or testing stages.

Table 6. Application Conditions Compliance Level

By what is shown in table 6, a conclusion can be drawn if all the menus available in the application built have met the criteria to be categorized as Very Feasible. The conclusion of the assessment of the suitability of the application conditions can be shown as in Figure 5 below:

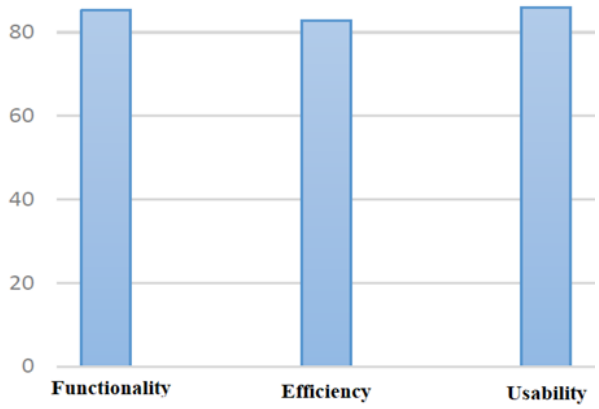

Figure 5. Conformity Assessment Conclusion Graph

E. Learning Outcomes

The learning outcomes of the experimental class demonstrated a more substantial improvement compared to the control class. This is evident from the difference between the average pretest and posttest scores, where the experimental class achieved an increase of 15.93, while the control class showed a smaller improvement of only 10.5. The larger score gain in the experimental group indicates that The Dictionary Application contributed positively to enhancing students' learning performance. This finding is further supported by the results of the statistical analysis. The independent samples t-test produced a t_calculated value of 5.140, which is higher than the t_table value of 3.003. Since t_calculated exceeds t_table, the decision is to reject H_0 and accept H_a. This confirms that there is a significant difference in learning outcomes between students in the experimental class and those in the control class.

Component	%	Condition-Match Level
Functionality of All Components	85,3	Very Worth Once
Efficiency Level	82,8	Very Worth Once
Benefit Level	86,0	Very Worth Once

Additional evidence comes from the analysis of learning improvement using the N-gain score. The experimental class obtained an average N-gain of 0.63, categorized as a medium level of improvement, while the control class recorded an average N-gain of only 0.28, which falls into the low improvement category. This difference clearly shows that students in the experimental class experienced a stronger enhancement in understanding than those in the control class. Overall, the N-gain results reinforce that the experimental class achieved a higher

degree of learning improvement compared to the control class. Therefore, it can be concluded that The Dictionary Application serves as a key factor influencing the increased learning outcomes observed in the experimental group.

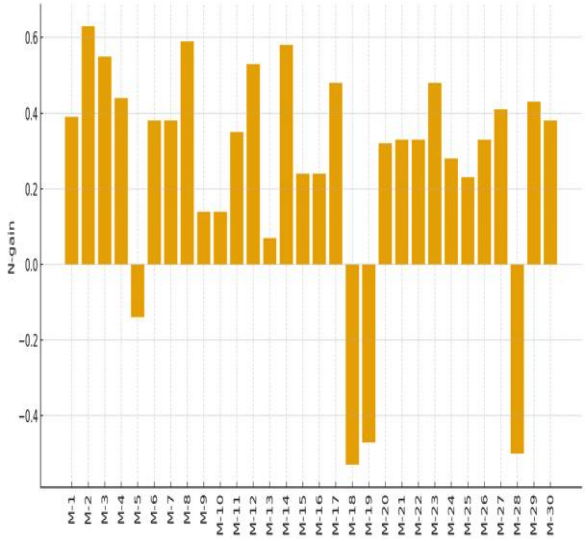

Figure 6. N-Gain Control Class

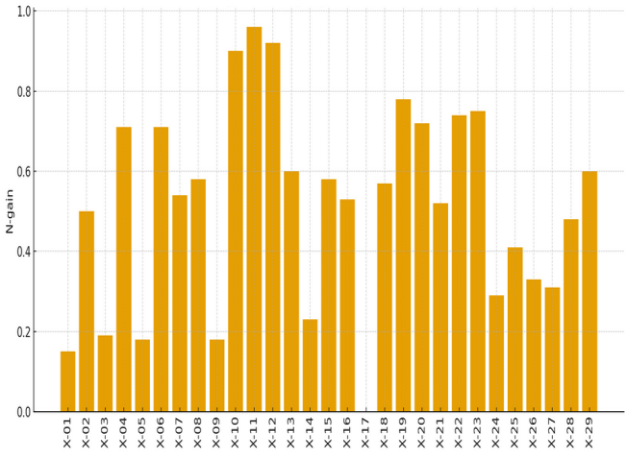

Figure 7. N-Gain Experiment Class

CONCLUSION

The dictionary application runs smoothly, produces precise outputs, and aligns well with user expectations, particularly regarding ease of use, clarity of menus, and intuitive interface navigation. With evaluation results of 85.3%, 82.8%, and 86.0%, all of which place the application in the Very Appropriate or Very Eligible category. These results confirm that the developed application meets high standards of reliability, usability, and suitability as a digital learning tool.

The learning outcomes indicates that experimental class experienced a noticeably higher improvement compared to control class. The average pretest–posttest gain for experimental group reached 15.93, exceeding the 10.5 point gain observed in control group. This substantial difference highlights the positive influence. Statistical testing reinforces this conclusion, where the independent samples t-test produced a t_calculated value of 5.140, greater than the t_table value of 3.003, resulting in the rejection of H_0 and acceptance of H_a. This confirms that the difference in learning outcomes between the two groups is statistically significant.

Further evidence arises from the N-gain analysis, the experimental class achieved an average N-gain of 0.63, categorized as medium improvement, while the control class obtained an average N-gain of 0.28, categorized as low improvement. These results indicate that students who utilized the dictionary application achieved stronger conceptual gains compared to those who followed traditional learning methods. Overall, the findings conclusively demonstrate that the dictionary application not only fulfills system quality criteria but also contributes significantly to improving student learning performance. The

developed smart network reference dictionary is effective, feasible, and valuable as a digital learning resource capable of enhancing learning outcomes in computer networking courses.

REFERENCES

Agha, R. A., Mathew, G., Rashid, R., Kerwan, A., Al-Jabir, A., Sohrabi, C., Franchi, T., Nicola, M., Agha, M., & Thoma, A. (2025). Revised Strengthening the reporting of cohort, cross-sectional and case-control studies in surgery (STROCSS) Guideline: An update for the age of Artificial Intelligence. *Premier Journal of Science*.

Alghazzawi, D. M., Hasan, S. H., Aldabbagh, G., Alhaddad, M., Malibari, A., Asghar, M. Z., & Aljuaid, H. (2021). Development of platform independent mobile learning tool in Saudi universities. *Sustainability*, *13*(10), 5691. https://doi.org/10.3390/su13105691

Alshuaybat, W. A. M. (2025). The Reality of Using Information and Communication Technology (Ict) and its Relationship to Academic Achievement and the Development of Creative Thinking Among Secondary School Student. *Journal of Lifestyle and SDGs Review*, *5*(2), e02652–e02652. https://doi.org/10.47172/2965-730X.SDGsReview.v5.n02.pe02652

Ambiyar, A., Verawardina, U., Lubis, A. L., Ramadhani, D., Wakhinuddin, W., & Asnur, L. (2021). Application of Adaptive Media and Enganging E-learning for Students in E-learning Courses. *JPI (Jurnal Pendidikan Indonesia)*, *10*(2). https://doi.org/10.23887/jpi-undiksha.v10i2.24376

Azeez, A. L., Akerele, O. E., Adeniyi, A., & Ibrahim, R. (2025). Media convergence on androids and journalistic practice: A study of the use of channels television mobile application among professionals in Lagos. *Sustainable Futures*, *10*, 100816. https://doi.org/10.1016/j.sftr.2025.100816

Bin-Hady, W. R. A., Al-Kadi, A., Hazaea, A., & Ali, J. K. M. (2025). Exploring the dimensions of ChatGPT in English language learning: A global perspective. *Library Hi Tech*, *43*(4–5), 1315–1328. https://doi.org/10.1108/LHT-05-2023-0200

Chasokela, D., & Mangena, N. (2025). The Future of Learning in the Digital Age. In *Insights into International Higher Education Leadership and the Skills Gap* (pp. 471–500). IGI Global.

Criollo-C, S., Guerrero-Arias, A., Guaña-Moya, J., Samala, A. D., & Luján-Mora, S. (2024). Towards sustainable education with the use of mobile augmented reality in early childhood and primary education: A systematic mapping. *Sustainability*, *16*(3), 1192. https://doi.org/10.3390/su16031192

de Sales, J. J. C., & Oliveira, S. R. B. (2025). Educational Games for Mobile Applications: A Systematic Literature Mapping. *Journal on Interactive Systems*, *16*(1), 544–588.

Dewi, T. A., Sumarti, S. S., Ellianawati, E., Subali, B., & Avrilianda, D. (2025). Literature review: the efficacy of mobile learning media in enhancing critical thinking skills among elementary school students. *Jurnal EDUCATIO: Jurnal Pendidikan Indonesia*, *11*(1), 135–143.

Elvira, G., Sergeeva, O. V, Zheltukhina, M., Sokolova, N. L., Zakharova, V., & Drobysheva, N. N. (2025). Mobile

Learning in Science Education to Improve Higher-Order Thinking Skills (HOTS) and Communication Skills: Scoping Review. *Frontiers in Communication*, *10*, 1624012. https://doi.org/10.3389/fcomm.2025.1624012

Giannakos, M., Azevedo, R., Brusilovsky, P., Cukurova, M., Dimitriadis, Y., Hernandez-Leo, D., Järvelä, S., Mavrikis, M., & Rienties, B. (2025). The promise and challenges of generative AI in education. *Behaviour & Information Technology*, *44*(11), 2518–2544. https://doi.org/10.1080/0144929X.2024.2394886

Guo, L., Pressman, G. S., Kieu, S. N., Marrus, S. B., Mathew, G., Prince, J., Lastowski, E., McDonough, R. V, Currie, C., & Tiwari, U. (2025). Automated detection of reduced ejection fraction using an ECG-enabled digital stethoscope: a large cohort validation. *JACC: Advances*, *4*(3), 101619. https://doi.org/10.1016/j.jacadv.2025.101619

Hadiarto, A., Firdaus, M., Harianto, H., & Novianti, T. (2025). Impact of mobile and smartphone usage levels and multivariate factors on household income in vegetable farming: evidence from Indonesia. *Information, Communication & Society*, 1–18. https://doi.org/10.1080/1369118X.2024.2443579

Haruna, M. J., George, G., Abba, A., & Abubakar, U. B. (2025). USING ANDROID PLATFORM FEATURES TO IMPROVE THE USE OF MOBILE DEVICES IN ASSISTED LEARNING FOR CHILDREN BELOW THE AGES OF TEN. *Zaria Journal of Educational Studies (ZAJES)*, *25*(2), 71–83.

IJOKO, G. A. (2025). Effects of Flipped-Classroom Strategy on Performance in English Language Concept among Secondary School Students. *Federal University Gusau Faculty of Education Journal*, *5*(4), 42–50. https://doi.org/10.64348/zije.202587

Jaradat, Z., AL-Hawamleh, A. M., & Altarawneh, M. (2025). Investigating the impact of technological orientation and innovation orientation on the sustainability and development the industrial sector. *Competitiveness Review: An International Business Journal*, *35*(2), 409–433. https://doi.org/10.1108/CR-11-2023-0303

Li, L. (2024). Reskilling and upskilling the future-ready workforce for industry 4.0 and beyond. *Information Systems Frontiers*, *26*(5), 1697–1712.

Lindner, K.-T., & Schwab, S. (2025). Differentiation and individualisation in inclusive education: a systematic review and narrative synthesis. *International Journal of Inclusive Education*, *29*(12), 2199–2219.

Mauri Medrano, M., Lafarga Ostariz, P., Del Barrio Aranda, L., & Soler Costa, R. (2023). Mobile learning and communication: educational change?; a systematic review. *Education+ Training*, *65*(2), 193–209.

Moroki, I. (2025). Design and Use of Android-Based Games to Improve Basic Math Skills and the Effect of Basic Math Skills and Learning Motivation on the Student's Learning Outcomes. *The 3rd International Conference on Christian and Inter-Religious Studies (ICC-IRS 2024)*, 612–631.

Nuryana, I. K. D., Indriyanti, A. D., & Rofa, M. (2024). Application of the Binary Search Method to the Arabic-Indonesian Translator Application. *5th*

Vocational Education International Conference (VEIC-5 2023), 10–18.

Pessot, E., Zangiacomi, A., & Sacco, M. (2025). Exploring SMEs innovation paths with augmented and virtual reality technologies. *European Journal of Innovation Management*, *28*(3), 1181–1201. https://doi.org/10.1007/s10796-022-10318-w

Purba, R. A., Sembiring, J., Sihombing, E. H., & Sondang, S. (2019). Edge image detection combines Laplace operation with convolution technique to produce drawing materials for children. *Journal of Physics: Conference Series*, *1402*(6). https://doi.org/10.1088/1742-6596/1402/6/066097

Purba, Ramen Antonov. (2021a). Application design to help predict market demand using the waterfall method. *Matrix: Jurnal Manajemen Teknologi Dan Informatika*, *11*(3), 140–149. https://doi.org/10.31940/matrix.v11i3.140-149

Purba, Ramen Antonov. (2021b). The Effectiveness Combination of Blended Learning and Flipped Classroom with Edmodo as a Digital Media Innovation for Learning From Home. *Journal of Education Technology*, *5*(3). https://doi.org/10.23887/jet.v5i3.36210

Purba, Ramen Antonov. (2022). Hybrid Models with Technology: Is it Effective for Learning in Abnormal Situations? *Journal of Education Research and Evaluation*, *6*(1). https://doi.org/10.23887/jere.v6i1.41546

Purba, Ramen Antonov, Munthe, R. G., & Ginting, K. (2022). Learning Model with LMS as an Innovation to Facilitate the Implementation of Learning from Home. *JPI (Jurnal Pendidikan Indonesia)*, *11*(2), 293–301. https://doi.org/10.23887/jpiundiksha.v11i2.38811

Purba, Ramen Antonov, & Sembiring, J. (2016). Selection of scholarship recipients by using Promethee method in Polytechnic Unggul LP3M Medan. *2016 International Seminar on Application for Technology of Information and Communication (ISemantic)*, 86–92. https://doi.org/10.1109/ISEMANTIC.2016.7873815

Purba, Ramen Antonov, Simarmata, J., Limbong, T., & Damanik, R. (2024). Mixed Learning Models and IoT Devices: Effectively Increasing Competence and Training Independent Learning Students in Unnormal Situations. *JOIV: International Journal on Informatics Visualization*, *8*(4), 2502–2510. https://dx.doi.org/10.62527/joiv.8.4.2553

Purba, Ramen Antonov, & Sondang, S. (2022). Design and Build Monitoring System for Pregnant Mothers and Newborns using the Waterfall Model. *INTENSIF: Jurnal Ilmiah Penelitian Dan Penerapan Teknologi Sistem Informasi*, *6*(1), 29–42. https://doi.org/10.29407/intensif.v6i1.16085

Rathod, H., & Agal, S. (2023). A study and overview on current trends and technology in mobile applications and its development. *International Conference on ICT for Sustainable Development*, 383–395.

Sakibayeva, B., & Sakibayev, S. (2025). Enhancing professional competence in physics and mathematics education through information technology. *Educational Research and Evaluation*, 1–13. https://doi.org/10.1080/13803611.2025.2502813

Sudarma, T. F., Fadilah, M., Tanjung, R., Surahman, D., & Ummi, S. (2025). Developing Android-Based Learning Media for Enhancing Critical Thinking Skills Through Problem-Based Learning. *2025 4th International Conference on Creative Communication and Innovative Technology (ICCIT)*, 1–7. https://doi.org/10.1109/ICCIT65724.2025.11167817

Tantawi, K., Fidan, I., Huseynov, O., Musa, Y., & Tantawy, A. (2025). Advances in industry 4.0: from intelligentization to the industrial metaverse. *International Journal on Interactive Design and Manufacturing (IJIDeM)*, *19*(3), 1461–1472.

Werner, S., & O'Dowd, R. (2025). "The Learning Process Is Mutual": Connecting Student Teachers and In-Service Teachers in Intercultural Virtual Exchange. *Social Sciences*, *14*(4), 242. https://doi.org/10.3390/socsci14040242

Widyanti, A., Pratama, G. B., Anindya, A. H., Sari, F. P., Sumali, A., Salma, S. A., Yamin, P. A. R., & Soetisna, H. R. (2020). Mobile phone use among Indonesian motorcyclists: prevalence and influencing factors. *Traffic Injury Prevention*, *21*(7), 459–463. https://doi.org/10.1080/15389588.2020.1789121

Wong, C. H. T., & Yunus, M. M. (2021). Board games in improving pupils' speaking skills: a systematic review. *Sustainability*, *13*(16), 8772. https://doi.org/10.3390/su13168772

Xun, J., Chong, W. K., & Dolega, L. (2025). Mobile Operating Systems' Impact on Customer Value: IOS vs. Android. *Journal of Computer Information Systems*, *65*(4), 401–414. https://doi.org/10.1080/08874417.2023.2292712

Yuan, R., Ab Jalil, H., & Omar, M. K. (2025). Adopting strategies of mobile technology for assisted learning performance in higher education in China. *Computers and Education Open*, *8*, 100263. https://doi.org/10.1016/j.caeo.2025.100263