

Firemanlogi: Innovative E-Learning to Improve Firefighter Cadet Learning Outcomes

Ayu Hoiru Nisa¹, Rezky Utama Putra², Yeti Komalasari^{3*}, Anton Abdullah⁴,
Muhammad Kahfi Almuktadir⁵

^{1,3,4}Politeknik Penerbangan Palembang

²UPBU Kelas III Mentawai

⁵UPBU Kelas III Letung Anambas

Corresponding Author: Yeti Komalasari, yeti.komalasari@poltekbangplg.ac.id

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ABSTRACT

This study aims to develop e-learning for a website-based firemanship course with interactive schedule, assessment, regulation, and Q&A features called firemanlogi to improve the learning outcomes of cadets. The Research and Development (R&D) method with the 4D model is used. The results of the study showed that at the define stage, the reasons why cadets had difficulty understanding learning materials in class were found, and the cadets agreed to develop e-learning as an interactive and flexible learning media. At the design stage, preparations were made for developing the firemanlogi website. Learning videos were made at the development stage, and media and material experts validated the video results. Moreover, at the dissemination stage, the results of the firemanlogi development were disseminated to lecturers and cadets. A limited trial implementation was carried out on PPKP 03A and B Study Program cadets, totaling 46 people. There was a significant increase in the learning outcomes of the cadets after being given education and training on the material through firemanlogi. The average pre-test result was 87.00 and increased by 91.86 after being given material intervention through the firemanlogi website. The indicator of success is seen in the increase in cadet learning outcomes in the material delivery intervention using Firemanlogi

INTRODUCTION

The 5.0 revolution fundamentally impacts the changing way of human thinking, living, and relationships with each other. This era greatly influences the world of education, where, with technological advances, education should be integrated into information technology to support the learning process (Assiddiqi et al., 2023; Cahyaningrum et al., 2023). Education is a lifelong need. Every human being needs education wherever he is and throughout his life. Several aspects influence a quality learning process. One of them is the use of innovative learning media (Affandi et al., 2020). The limited learning media available causes students to understand the material they are studying less. Website-based learning media can make learning more interesting and improve student understanding (Annisa, 2021). E-learning is currently being widely used during the pandemic, where we can use many applications or platforms for e-learning (Hernanda & Makhrus, 2022; Nur, 2021; Ota, 2021). E-learning is a learning media that uses the internet (Jannah, 2022; Ramdani et al., 2018; Sutama & Fajriani, 2022).

In today's digital era, digital-based learning is urgently needed to improve student competency. This is driven by rapid technological developments, changes in student learning patterns, and the increasingly complex demands of work and industry. Digital-based learning offers various advantages that cannot be obtained from conventional learning methods. First, digital-based learning provides access to broader, interactive, and up-to-date learning resources. Students can access various learning materials such as videos, simulations, and interactive modules anytime and anywhere to make the learning process more flexible and effective. Second, digital platforms allow for the personalization of learning according to individual needs. Technologies such as artificial intelligence (AI) can help identify students' weaknesses and strengths, and recommend appropriate materials or activities. This helps students learn at the pace and style that best suits them. Third, digital-based learning improves students' digital competence, which is an essential skill in the 21st century. In the process, students not only learn academic content, but also other skills such as digital literacy, technology-based problem solving, and collaboration in a virtual environment. One of the goals of implementing e-learning is to increase students' motivation, which will result in better learning achievement (Grariyanto & Prasetyawati, 2022).

Learning media that do not facilitate students to develop critical and creative thinking skills impact achieving learning objectives (Rahmat & Suparman, 2018). According (Ulayyah & Rosy, 2022) The use of e-Learning learning media can affect students' learning motivation. In line with previous research, e-learning can also improve students' learning outcomes (Nofrianda et al., 2023). Learning media is shifting from conventional learning media to e-learning media (Harmany, 2023). Teachers must have important skills in the modern age and digital era in using e-learning (Hasyim & Hayati, 2023). Website-based learning media or what is usually called e-learning can be used anytime, anywhere, so its use is more flexible (Panjaitan et al., 2022). The need for e-learning media in education is inevitable in today's digital era. E-learning offers

flexibility, accessibility, and effectiveness that not only facilitate the teaching and learning process but also improve the overall quality of education. Through technology integration, e-learning can bridge various geographical limitations, expand access to global educational resources, and enable the personalization of learning according to individual needs.

E-learning prepares students and educators to face the challenges of an increasingly technology-oriented world of work. By providing an interactive and adaptive platform, e-learning-based learning media improves academic competence and 21st-century skills such as digital literacy, virtual collaboration, and critical thinking skills. Currently, classroom learning in firemanship courses only uses teaching modules that tend to be less attractive to Gen Z. Education must of course adjust to existing trends where learning media is already based on digital technology that is more interactive with attractive visuals and flexible in its use so that learning can be more comfortable and not limited by time. The novelty in this study is the development of a website-based e-learning called *firemanlogi* which is equipped with scheduling, assessment, regulation and question and answer material features so that cadets can learn through interesting and contemporary media that can be accessed via desktop or smartphone mode.

THEORETICAL REVIEW

The development of industrial technology 4.0 has entered the world of education through e-learning-based learning media (Latapamei & Rosy, 2021). The learning process will run well if adequate teaching and learning resources, engaging media, and the right learning system are supported. Learning media today are diverse and developing according to technological developments (Padwa & Erdi, 2021). Learning media is a medium used to convey information and messages. Since the pandemic, technology-based learning media has been essential (Muzayanati et al., 2022). E-learning is a type of teaching and learning that allows the delivery of teaching materials to students using the internet or other computer network media. E-learning needs to be used to familiarize students with technology (Jahiri et al., 2023). The e-learning medium is a learning process in which the participants are separated from the teacher. There is also the use of electronic technology as a learning medium (Huda & Wulandari, 2022). The internet can be used to transfer knowledge from lecturers to students while learning that utilizes the internet is one of the e-learning Learning media (Yuliana, 2020). Various media can be used for online learning or e-learning tools, such as Zoom, Google Meet, web-based applications, and so on (Widianto, 2021).

Cadets in the Aviation Rescue and Firefighting study program, hereinafter referred to as PPKP, must be competent to provide services to support aviation safety operations (Komalasari et al., 2023). In providing these services, PPKP Study Program cadets are responsible for assisting in the event of aviation accidents (Abdullah et al., 2022, 2023; Yogik Hendra Saputra, 2022). The *firemanlogi* website with AI features is a learning media website for the aviation industry. This website is online-based and has several contents. One of its main features is artificial intelligence, available using desktop mode, and if you open

it via a cellphone, you must change the mode first. This website is straightforward to access using only the internet, accompanied by a link you can use to visit it. Unlike applications that must be downloaded first and adjusted to the device's specifications, anyone can access this website link. The features on this website include schedules, assessments, artificial intelligence, regulations, and documents related to firefighting. For the schedule feature, cadets can set training times, maintenance, and operating times. The second feature is the assessment, which includes personnel performance assessments, operational commanders, squad commanders, and others. In addition, it can also create quizzes or ability tests by personnel. The third feature is artificial intelligence, which is the main feature, namely artificial intelligence that is able to accommodate questions from personnel, cadets, and teachers, even the general public, but its scope is only related to PKP-PK which is contained in PR 30 of 2022. The fourth feature is the regulation which includes national and international regulations or regulations regarding PKP-PK procedures. Finally, there is a document feature covering fire fighting equipment material.

METHODOLOGY

This website was developed using the Research and Development (R&D) type by adapting the 4D development model, which includes definition, design, development, and distribution (Astutik et al., 2023; Salsabila et al., 2023; Silitonga et al., 2024). This research has reached the implementation stage of limited trials on PPKP study program cadets. The research location is at the Palembang Aviation Polytechnic. The Firemanologi was developed with coding systems such as PHP, CSS, HTML, MYSQL and JS. Website creation uses Visual Studio Code, a coding application, and publishing uses hosting. This website will continue to grow because its own features have an admin.

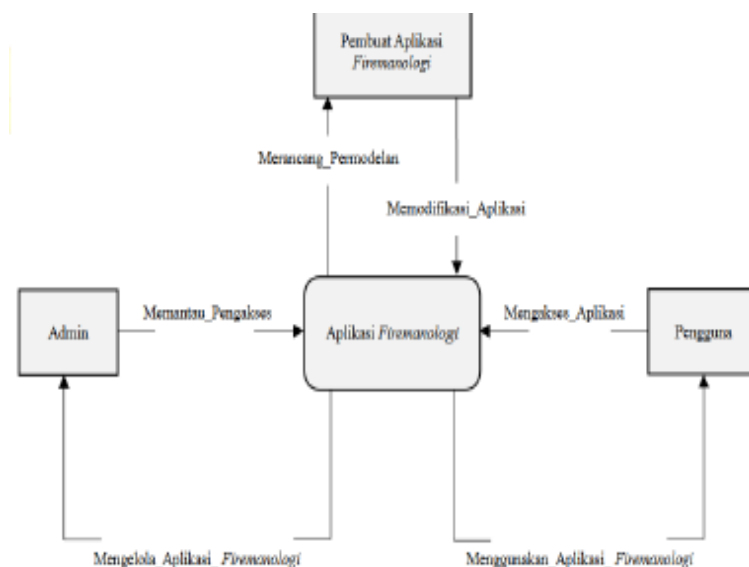


Figure.1 DFD Website Firemanologi

Data Flow Diagram (DFD) is a structure of several analysis tools and design activities arranged so that researchers can visually analyze and understand systems and subsystems as a series of interconnected data flow diagrams. Based on the DFD diagram, the ones related to this system consist of three follows: 1) the creator of the Firemanologi website modifies the website for website users, 2) the admin, and manages the Firemanologi website for users., 3) the user uses the firemanologi website and inputs personal data. The description of the research procedure can be seen as follows:

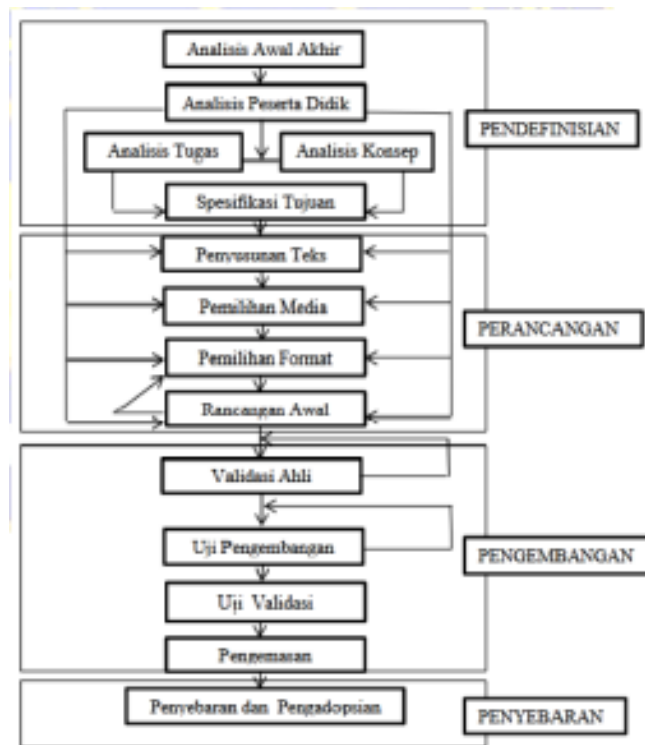


Figure 2. Research Procedure for the 4-D Learning Device Development Model

RESEARCH RESULTS

The development of the Firemanologi will continue to be developed to suit existing needs and trends. The resulting product design can be described as follows:

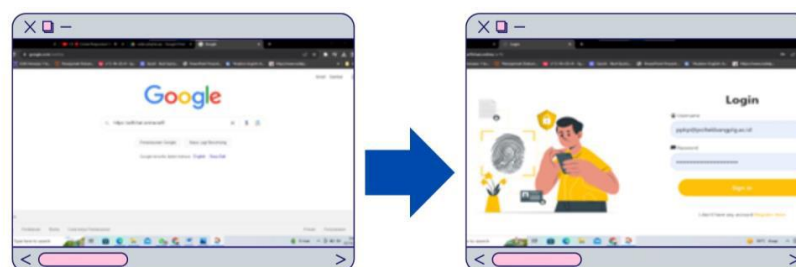


Figure 3. Firemanologi Login Page

Figure 3 shows a display of the Firemanologi website with AI features, namely the initial display that displays the page for logging in as a user.

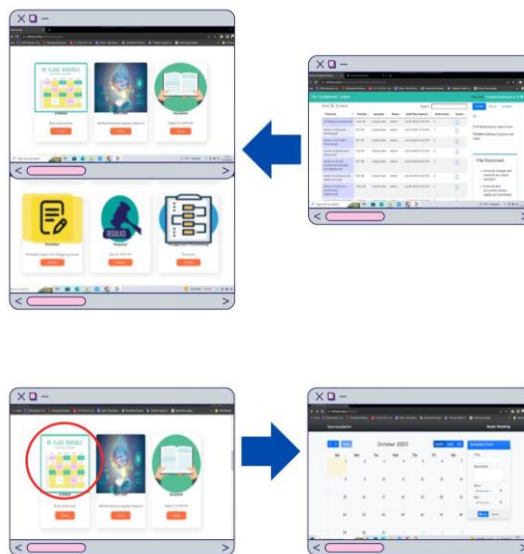


Figure 4. Firemanologi Student Class Features

Figure 4 shows a display of the class schedule or daily class schedule, in which you can organize and schedule class activities according to the user's wishes.

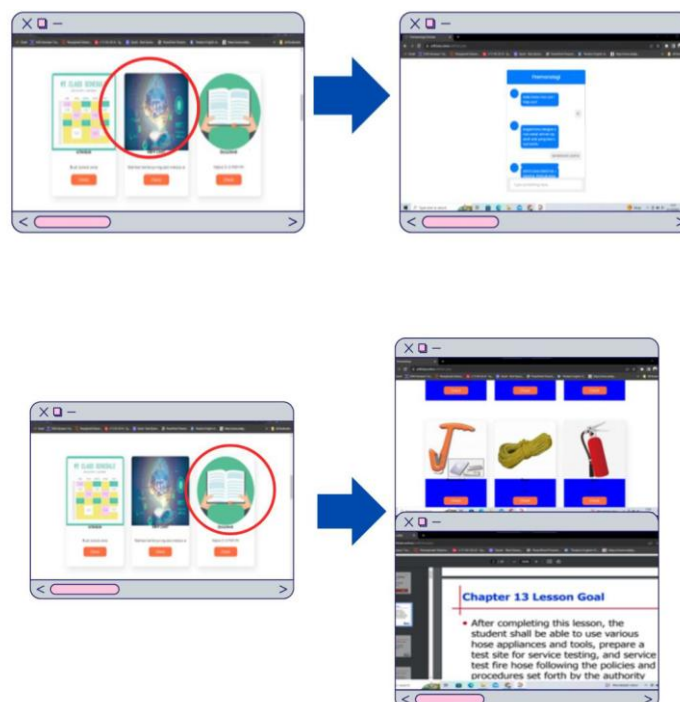




Figure 5. Learning and Work System

Users can utilize the website in the learning and work system, because as we know the website has many features, both from learning materials, assessments, artificial intelligence, time management, and regulations or other things that are combined in one website. The use of the general public can be applied by this website because it uses a hosting system. This can be an appropriate technology product from cadets and lecturers as an achievement in increasing the accreditation of the PPKP Poltekbang Palembang study program.

Limited implementation of the Firemanologi was carried out on cadets in firemanship learning in class and learning was carried out using the method in class and after treatment using the Firemanlogy website. Implementation was carried out in PPKP 03A and B classes with a total of 46 cadets in the firemanship course. The following are the results of data processing based on the results of the exams given to PPKP study program cadets distributed via Google Form to measure the learning outcomes of the firemanship course before and after receiving educational intervention on the material via the Firemanlogy website.

The first test is the univariate test, in the pre-test variable, the average value was 87.00, the median value was 88.00, the standard deviation was 4.37. While for the post-test variable, the average value was 91.86, the median value was 92.00, and the standard deviation value was 4.62. Furthermore, a normality test was carried out to ensure the data was normally distributed. The Shapiro-Wilk Test method was used because the data was less than 100 samples. The basis for decision-making is if the probability value of t-statistics > level of significance = 0.05, then the regression model meets the normality assumption. From the table above, it can be seen that the pre-test and post-test variables are normally distributed (sig > 0.05).

Table 1. Paired Sample T-Test

Variabel	Mean	SE	P-Value	Correlation	CI
Learning outcomes for the Firefighting Science course					
Pre-Test	87.00	0.645	0,000	0.525	-6.174 s/d -3.564
Post-Test	91.86	0.682			

A significance value of 0.000 was obtained, meaning a significant difference exists between the pre-test and post-test values. Furthermore, the Correlation value of 0.525 can be seen, which indicates the strength of the relationship between the two variables tested, namely pre-test and post-test.

This study was conducted to assess the learning outcomes of the firemanship course for PPKP study program cadets before and after treatment using the Firemanlogi website. The average pre-test result was 87.00. This result shows the basic average learning outcomes of the firemanship course, after the learning treatment using the Firemanlogi website, a re-assessment was carried out to obtain the average post-test results. The average post-test result changed to 91.86.

There was a significant increase in the basic knowledge possessed by the cadets after being given education and training on the material. Furthermore, the data was tested using a paired sample t-test analysis test with a cross-sectional research design to aim to see the difference in the average value of the pre-test and post-test which was previously tested for data normality to ensure that the data was normally distributed, namely with the same number of pre-test and post-test data. The success of the study can be seen from the significant increase in test results through the average pre-test results and the average post-test results indicating that educational and training interventions through the Firemanlogi website are considered more effective in increasing learning outcomes.

DISCUSSION

The findings of this study indicate that the implementation of the Firemanlogi features has a positive effect on the learning outcomes of cadets in the Firemanship course. The descriptive analysis showed an increase in the average score from 87.00 in the pre-test to 91.86 in the post-test, representing an improvement of 4.86 points. This increase indicates that learning through the Firemanology website can support the improvement of cadets' knowledge after receiving instructional intervention. Although the initial pre-test scores were already relatively high, the increase in post-test scores demonstrates that the digital learning intervention provided additional learning benefits.

The results of the paired sample t-test further confirm the difference between pre-test and post-test scores, with a p-value of 0.000 ($p < 0.05$). This finding indicates that there is a statistically significant difference in learning outcomes before and after the implementation of the Firemanlogi website. The correlation coefficient of 0.525 indicates a moderate positive relationship between the pre-test and post-test scores. These findings suggest that the use of the

Firemanology website can serve as a supporting learning medium for delivering Firemanship materials, particularly through the integration of learning materials, assessments, regulations, and AI-supported features within a single digital platform.

The effectiveness of the intervention can also be understood from the characteristics of the Firemanologi website, which integrates several learning resources into one platform. The availability of digital learning materials, assessments, aviation and fire safety regulations, and AI-based features provides cadets with greater flexibility to access learning resources beyond conventional classroom activities. This integrated approach is particularly relevant to vocational aviation education, where learning requires not only theoretical understanding but also continuous access to regulations, procedures, and technical knowledge that support professional competence.

However, the results should be interpreted within the context of the limited implementation of the developed system. The intervention involved 46 cadets from PPKP 03A and 03B in the Firemanship course and was conducted using a pre-test and post-test design without a control group. Therefore, the statistically significant increase cannot be attributed exclusively to the Firemanology website because other factors, such as classroom instruction, prior knowledge, lecturer guidance, and test familiarity, may also have contributed to the improvement. In addition, the current system remains primarily a web-based learning platform with relatively limited *e-learning* functionality. Features such as attendance management, comprehensive learner monitoring, learning activity tracking, and integrated evaluation have not yet been fully developed.

These limitations provide an important direction for further development. The Firemanologi platform can be expanded from a supplementary learning website into a comprehensive and integrated digital learning system for aviation personnel. Future development may include mobile application support, attendance management, learning progress monitoring, online assessment, competency tracking, learning analytics, certification, and more advanced AI-based learning assistance. Furthermore, the scope of users can be expanded beyond cadets and PKP-PK personnel to include other airport personnel according to their respective competency needs. Such development would strengthen the practical value of the platform and support continuous competency development and a stronger safety culture within the aviation environment.

Overall, the findings demonstrate that the Firemanologi has promising potential as a digital learning medium for improving learning outcomes in Firemanship education. The significant increase in post-test scores provides initial empirical evidence supporting its use as a complementary learning platform. Nevertheless, broader implementation with a larger and more diverse sample, a control or comparison group, and a more comprehensive evaluation of learning effectiveness is required to establish stronger evidence regarding the effectiveness and sustainability of the Firemanology platform.

CONCLUSIONS AND RECOMMENDATIONS

Based on the data from the evaluation and discussion, the conclusions that can be presented are:

1. Firemanlogi can be used as an alternative to more interactive and flexible firemanship learning, as seen from the improved learning outcomes.
2. Firemanlogi is a flexible website-based learning media with attractive features and can be used by cadets, PK personnel, lecturers.
3. The features presented should be diverse and have their respective benefits, and bugs and other problems should be avoided on online-based websites.

FURTHER STUDY

Future research could focus on developing and refining the system to expand its functional scope and user base. Previous iterations of the system were web-based and not available as applications downloadable from app stores, which limited accessibility and implementation. Furthermore, the features developed thus far centered on the learning needs of PKP-PK personnel—specifically the provision of regulations, learning modules, and operational materials. The existing learning features do not yet fully encompass comprehensive e-learning characteristics, such as attendance tracking, participant management, learning evaluation, activity monitoring, and the management of learning outcomes. Therefore, future research should aim to evolve the system into a more integrated digital learning platform that can be optimally utilized via both mobile devices and the web. Development could also expand the user base from PKP-PK personnel to personnel across all airport operations, offering materials and features tailored to the specific competency requirements of each functional area. Ultimately, such research is expected to yield a system that is comprehensive, adaptive, and highly accessible, thereby supporting competency development and a culture of safety for all airport personnel.

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