Evaluation Practicum Application Design on NOTAM for Reconceptualization Learning of Management Air Traffic Controller

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Abstract

The research aims to develop new learning media that can be used to support learning activities, especially in the Air Traffic Management Study Program at the Makassar Aviation Polytechnic. The research method used is Research & Development. The researcher collected data through literature studies, interviews, field observations, product trials, and FGDs. NOTAM learning media is made based on web programming by making flowcharts to structure the program. Furthermore, the application display design uses HTML, JavaScript, and CSS programs. Design implementation is done by backend programming. The last stage involves trials with prospective users, experts, and validators. The study results show that the application of learning media is appropriate for students and teachers to support the smooth learning of NOTAM in the Air Traffic Management Study Program. However, experts have input to add a list of practice scenarios and system assessments.

Keywords: *Learning Media, Web Programming, Air Traffic Management Learning, NOTAM*

INTRODUCTION

Changes in people's mindset about the importance of education have a positive influence on increasing people's interest in attending higher education. Data from the Ministry of Education and Culture shows an increasing trend of 4.5% in the gross enrollment rate of residents aged 19-23 who are pursuing higher education in Indonesia from 2016-2020. Several things need to be implemented to manage the high enthusiasm of the community. For example, evaluation of the applied curriculum must be carried out continuously. Curriculum evaluation has a very important role in gaining information about the achievement of the developed curriculum (Hadi et al., 2019). Curriculum evaluation needs to be carried out regarding developing regulations related to competence, technological developments, and competency requirements adapted to the needs of the Business World Industry (DUDI). Soft skills like good attitude and habit are included as a needs of the Business World Industry, besides that international experiences are preferred to be included in the curriculum (Fitriyanti Zulaikha et al., 2021). In response, the Air Traffic Management Study Program (MLLU Study Program) of the Makassar Aviation Polytechnic 2019 carried out a curriculum evaluation which resulted in additional competencies being taught to students to answer the developments and needs of DUDI, especially in the aviation industry.

Changes to the curriculum and syllabus in the MLLU Study Program have resulted in significant differences in competence and the courses contained therein. In these conditions, updating learning media is expected to support learning and lead to appropriate learning outcomes. Learning media is a learning resource that can assist lecturers in enriching students' insights. The need to optimize student interactions in universities for enhanced academic performance has been a subject of debate and discussion in different academic fora (Rudhumbu, 2022). Using learning media can foster students' interest in learning new things in learning material delivered by lecturers so that they can understand. The importance of teaching media to the achievement of student learning outcomes requires educators to be able to develop learning media that can

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not only be a knowledge transfer facility but also by technological and information developments in Industry fields (Dwijayani, 2019).

NOTAM is a text message in a set format in capital letters (Prokhorov, 2022). Furthermore, NOTAM is competency material that provides notifications delivered through telecommunications media containing information about the application, conditions, or changes of aeronautical facilities, services, procedures, or hazards given on time. This competency is one of the competencies that graduates of the MLLU Study Program must master as candidates for air traffic control personnel (Majid et al., 2022). However, the research results on the urgency of practicum applications in the MLLU Study Program, which the researcher implemented in 2021, show that the availability of NOTAM practicum learning media in the MLLU Study Program has a negative value. The research result shows that students expect a tool to support the NOTAM course's practical activities, which has yet to be available. Furthermore, the human factor plays an essential role in the success of the NOTAM system implemented in air traffic control (Hoeft et al., 2005). Therefore, it is crucial for students to thoroughly understand the NOTAM material while studying so that later they can effectively practice it when they enter the world of work. In addition, data processing results related to the success of practicum activities in the MLLU Study Program also show that the success rate of students in practicum activities supported by Package Books and Practice Questions has only reached 70%. In fact, according to (Dewi, I. P., Mursida, L., & Marta, 2017), the use of learning media will significantly help the effectiveness of the learning process and the delivery of messages or lesson content. Therefore, respondents consisting of students and educators in the Makassar Aviation Polytechnic MLLU Study Program agreed that the existence of learning media would increase the success of practicum activities and positively impact rising students' mastery of competencies, especially in NOTAM material.

Based on the facts above, the problem that is faced by lecturers and students in practical learning for the NOTAM course is the use of media limited to textbooks and practice questions. The two media are considered irrelevant in the learning process, considering the technological developments that continue to occur in the world of education today. Furthermore, learning that can be self-regulated by students, for example, through applications, has a positive effect on their interest and learning outcomes (Hatala, M., Nazeri, S., & Kia, 2023). Therefore, as facilitators in a teaching and learning process, educators need to find alternative solutions to problems. Educators must design particular media/missions for individual/group students to achieve the expected learning objectives (Tenório et al., 2022). Therefore, to overcome problems related to the limited learning media for the NOTAM course in the MLLU Study Program, one alternative solution that can be done is to develop learning media in the form of Design and Build Practicum Applications in the NOTAM Course in the MLLU Study Program. Interactive learning media, especially interactive multimedia, has the biggest influence on student learning outcomes (Sahronih, S., Purwanto, A., & Sumantri, 2019). The existence of this application is expected to become a new learning media in the world of education which can have a positive impact on increasing the competence of students and is helpful as a support for learning activities that can be carried out independently by students outside the classroom.

METHOD

This article uses research and development methods, where the implementation application uses the ADDIE Model, developed by Dick and Carry in 1996. According to Morrison, The ADDIE model is the framework used by instructional designers because it has flexible guidelines that help them build an effective support tool in five phases (Nadiyah & Faaizah, 2015). The researcher used the model because the research aims to develop a media that has never existed, so systematic steps are needed. Furthermore, the ADDIE model is structured and programmed with sequences of organized activities to solve learning problems related to learning resources that are under the needs and characteristics of students (Widyastuti & Susiana, 2019). In line with this, the ADDIE model is a model that is very suitable for use and applied in a curriculum that includes the development of knowledge, skills, or attitudes (Cheung, 2016). These two opinions prove that the ADDIE model is very suitable for use to meet the learning needs of students through the development of media adapted to the characteristics of these students. The ADDIE Model Research and Development Stages consist of Analyze,

Design, Develop, Implement, and Evaluation (Salas-Rueda et al., 2020). Referring to this model, the research design in this article is described as follows:
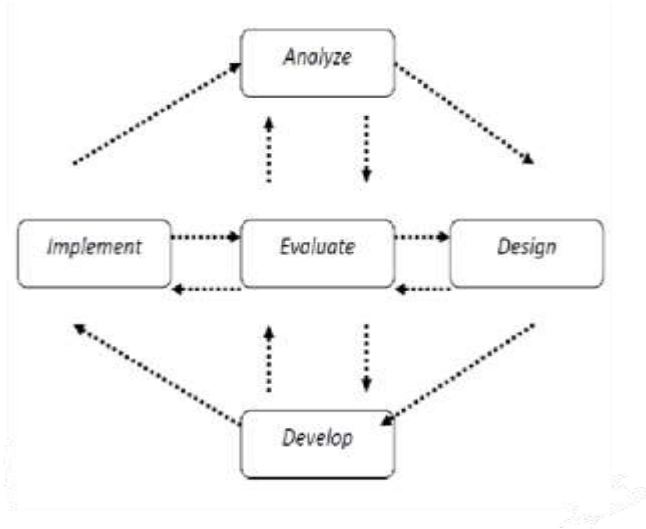

Figure 1. Research design

Phase Analyze

The analysis stage in development research related to the learning process aims to identify problems that occur to students during the learning process (Kurnia, T. D., Lati, C., Fauziah, H., & Trihanton, 2019). Therefore, this stage is used to collect data related to existing problems in the field, the owned needs, and potential solutions that may be available. The data collection techniques were questionnaires, interviews, observations, and documentation studies. At this early stage, the researcher attempted to identify the problems that occurred comprehensively from various points of view so that they could be used to determine the formulation of the problem-solving to be implemented. Furthermore, the potential problems found are arranged based on the priority and urgency of their resolution. The problem with the highest importance and urgency for completion is then used as the main subject in the initial design formulation.

Phase Design

At the Phase Design, the objectives to be achieved are described along with an outline of the application made as a step in solving the problem, which is the main objective of the research activity. The design stage starts with designing flowcharts and storyboards, preparing materials, preparing assessment instruments, and gathering supporting materials (Andi Rustandi & Rismayanti, 2021). The design stage produces an initial design flowchart to build a practical application for the NOTAM course. The existence of a design flowchart resulting from this stage is expected to be a reference in creating an initial model of learning media in the form of an application to solve problems that are a priority to be resolved immediately.

Phase Develop

At this stage, the learning media in the form of applications began to be prepared by the plans that had been made before. Even though it already has a flowchart that can be used as a guide in preparing the application, it is also accompanied by several minor revisions deemed necessary by the researcher. The statement aligns with Wicaksana's opinion, which states that when turning a concept into an initial product, evaluation, and revisions can be made to improve the initial product produced (Wicaksana, I. P. G. C. R., Agung, A. A. G., & Jampel, 2019). The initial model that has been formed is then validated using trials on prospective users and experts to assess the feasibility of the model that has been made. The results of these activities are then used as a guide in product revisions so that the resulting product can later be by the needs of prospective users. The revised product is then tested again to assess the suitability of the product to the needs of future users. Products that have successfully answered the needs of potential users will then be implemented directly to see their effectiveness in overcoming problems.

Phase Implement

This stage aims to implement the media developed within the scope of a real class where educators and students carry out the teaching and learning process (Puspasari, 2019)(Cahyadi, 2019). The result of this implementation is in the form of a learning strategy that includes the use of media that has been developed to bring the maximum possible benefits for both teachers and students.

Phase Evaluate

This stage is used to assess the quality of learning media implemented in the learning process. The evaluation stage is used to improve products based on the results of field trials so that the final product is obtained (Budiarta, I. W., Margi, I. K., & Sudarma, 2016). At this stage, the researcher also compiled evaluation criteria and the tools to be used in the evaluation process for the learning media that had been developed. Revision made according to the evaluation results or needs that cannot be met filled with developed learning media (Bintari Kartika, 2017). The results of this stage are in the form of an assessment score on the success of learning as well as recommendations for possible improvements that can be implemented to improve the learning media developed to achieve the goals formulated at the beginning.

RESULT AND DISCUSSION

Advances in the development of computer technology allowed address an increasingly broad class of tasks using software systems, among them the automatic processing of aeronautical information(Eshmuradov, D. E., Elmuradov, T. D., & Turaeva, 2021). NOTAM course but are also applicable in the world of work. Nowadays flight safety and efficiency are impossible without qualitative aeronautical information (AI), as it is necessary to take a large number of crucial factors into consideration. A Notice to Airmen (NOTAM) contains important flight route related information (Patel et al., 2023). Notice to Air Men (NOTAM) provides key aeronautical security information during flight operation. However, a large number of NOTAM texts lack systematic utilization and organization (Mi et al., 2022)(Åtland et al., 2022). Nevertheless, it is not always possible to analyze the whole AI package given the large amount of information and format of its disclosure (Prokhorov, 2022). The development of application-based learning media has a positive impact on increasing student knowledge (Murtiyasa, B., & Rahmawati, 2021). Where the focus of learning utilizes NOTAM which aims to use media which is limited to textbooks and practice questions in the learning process that considers aspects of technological development in the world of education (Umboro Wahyu Nur Wening et al., 2022). Research and development steps were carried out to achieve this goal based on the ADDIE Model developed by Dick and Carry in 1996. The ADDIE Model is one of the systematic learning design models chosen based on the consideration that this model is developed systematically and rests on the theoretical foundation of learning design. The research and development carried out are divided into five stages, namely, Analyze, Design, Develop, Implement, and Evaluation (Widyastuti & Susiana, 2019).

The first is the Analyze Phase. The Analyze phase may include specific research techniques such as need analysis, goal analysis, and task analysis (Muruganantham, 2015). The output of this phase often includes the instructional goals and a list of tasks to be instructed. These outputs will be the inputs for the Design phase. At this stage, the researcher tries to describe the existing problems to find the source of the problem and possible solutions that can be taken. The analysis is carried out to map user requirements, functional requirements, and application system requirements. Analysis of user needs aims to obtain information on user needs as the main focus of the practicum application design in the NOTAM course of the Air Traffic Management Study Program. A needs analysis carried out before learning media development can help students obtain learning that is on their character (Failasuf, C., Bahtiar, I. R., & Ilham, 2022) (Nasrulloh & Ismail, 2018). Therefore, the research also aims to determine what type of program students desire and need as end users. The steps taken to obtain this data started from a literature study of the results of previous research related to the study of the design and build of practicum applications in the NOTAM course in the Air Traffic Management Study Program.

Next is the analysis of functional requirements, which aims to make the media to be developed aligned and relevant to existing rules/guidelines. The results of research conclude that functional requirements are determined by first looking at the needs of prospective users and policymakers' expectations closely related to the application/product to be developed (Setiyani, L., Rostiani, Y., & Ratnasari, 2020) (Setiyani, L., & Tjandra, 2021). Therefore, at this stage, the analysis is carried out by carrying out a document study of the Minister of Transportation Regulations which discuss Civil Aviation Safety Regulation Part 175 concerning Aeronautical Information Services, the document of Standard Operational Procedures of the Aeronautical Information Center regarding procedures for drafting and submission of NOTAM and SNOWTAM requests; Documents of Standard Operational Procedures of the Aeronautical Information Center regarding Repair Procedures for NOTAM or SNOWTAM requests and Evaluation of NOTAM or SNOWTAM; as well as the Standard Operational Procedure document for the Aeronautical Information Center regarding Procedures for Submission of NOTAM, ASHTAM, and SNOWTAM Documents by the Regional PIA.

Finally, the analysis of the application system requirements where researchers try to map the components needed to develop learning media so that they can run optimally. The results of the study of the 3 (three) aspects above are as follows:

Table 1. *Analysis Results*

ASPECT	ANALYSIS RESULTS
User Requirements	Applications that are built must meet the criteria of "user friendly," where learning media must be easy to use, operate, and have an attractive appearance but still refer to the actual equipment in the field and fulfill the elements as learning media.
Functional Requirements	The menu provided in the application must refer to standards set nationally. Namely: the main page displays a list of menus, and the available icons can display information according to the selected menu. They can be used for learning media both guided and independently.
Application System Requirements	The application can be accessed via the student's PC that is connected to wifi. If using a local network, wifi is unnecessary, but a different PC must be provided that functions as a server. From the software side, the application is accessed through the PC browser of each student because the application is designed to run via internet protocol on the page that will be provided.

The next stage is the Design Stage. During this phase, the investigator outlines how to reach the instructional goals determined and expand the instructional foundation(Muruganantham, 2015). At this stage, the researcher planned by making a program flowchart and dividing the work. The designed application has five user levels, namely: Admin as the application system manager, Originator as the NOTAM issuance applicant, Drafter as the NOTAM issuance document maker, Quality Control as the NOTAM issuance evaluator, and Notam Office as the information center. There are many variations of users who will be involved in the application, so in this design stage, the researcher divides the work into three main tasks, namely:
Creating a database whose job is to compile database tables.

Creating a front task with making application display listings.

Creating a backend tasked with making listings so that the application can function properly and is connected to the database.

In the next stage, namely development, the design that has been made is then developed into an initial product model. Development starts on the front-end side, which utilizes HTML and Javascript programming. Furthermore, on the backend side, that focuses on developing features, namely where the appearance of the application that has been made can work as its function. At this stage, programming is made using the Visual Studio Code application to manage databases and execute the programming languages needed in completing this application. After the display and function can run properly, then arrangements regarding the delivery of NOTAM documents are made based on the results of a documentation study that has been carried out previously. NOTAM documents that will be submitted through the application must go through several stages.

The characteristics of NOTAM distribution services are that they are widespread in geographic and requires real-time transmission (Hu et al., 2014)(Volz, K. M., & Dorneich, 2020). Therefore, submission of the NOTAM document is carried out if several conditions are met. Namely, the NOTAM request submitted by the Regional PIA has been issued by the NOTAM Office, where the daily PIB in that period has been distributed, and there is a NOTAM request from the originator. Furthermore, the personnel makes a NOTAM document including information containing the following: NOTAM number, location, namely airport location indicator and airport name or location indicator FIR and FIR name; NOTAM topic, namely a description of the subject and condition of the NOTAM, summary, namely a brief description of the contents of the NOTAM with the Indonesian language that is easily understood by aviation or non-aviation people, as well as NOTAM news, namely NOTAM received from the NOTAM Office in the format of aviation news. The next stage is NOTAM documents will be equipped with NOTAM graphics so that the information conveyed becomes more informative. NOTAM graphics were created using NavEarth, Google Earth, Autocad, Adobe Illustrator, or Adobe Photoshop. After all the steps have been carried out, the last step is submitting the NOTAM document, which is done through the application that has been made. From the results of the initial trials that have been carried out, the display on the learning media shows that the application has succeeded in processing the NOTAM until it is issued according to existing procedures and has similarities to those used in the actual aviation industry. The final stage in the development stage is a limited trial of the product that has been prepared. The trials carried out at this stage are in the form of developmental testing is a product design trial activity on the actual target subject (Mulyatiningsih, 2016). During this trial, response data, reactions, or comments were sought from the target user of the model. The trial results are used to improve the product. After the product is repaired, it is then tested again until it obtains effective results.

After finishing making the initial product from the practicum application in the NOTAM course, which has been limitedly tested, the researcher proceeds with the first stage of the trial process or alpha testing. Alpha testing must be done to ensure the quality of the prototype before proceeding to the next stage (Oladimeji, 2014). Furthermore, Alpha testing is done by internal employees of the organization (Nadiyah & Faaizah, 2015). The results of this initial trial are as follows:

Table 2. *Alpha Test Results*

MENU	RESULT OF TRIALS	
	YES	**NO**
Admin Login	√	
Originator Login	√	
Drafter Login	√	
Quality Control Login	√	
Notam Office Login	√	
Dashboard Menu	√	
New NOTAM Issuance Application	√	
List of NOTAM Issuance by Drafter	√	
Submission of NOTAM Documents		√
Issuance of NOTAM		√

Revisions to the initial product were carried out, seeing that the trial results showed that two menus could not operate correctly. At this stage, the researcher made revisions as necessary, considering that only a few menus could not be appropriately managed. After the revision, the researcher conducted trials with a broader scope or Beta Testing. Beta testing focuses on the prototype quality and ensures the prototype is ready for real-time users(Jones, T. S., & Richey, 2000). Furthermore, beta testing needs to involve user and customer participation to determine whether the product being built can meet their needs (Larusdottir et al., 2010). Therefore, at this stage, apart from students and lecturers, researchers also involve relevant stakeholders. The test results are as follows:

Table 3. *Beta Test Result*

MENU	RESULTS OF TRIALS	
	YES	**NO**
Admin Login	√	
Originator Login	√	
Drafter Login	√	
Quality Control Login	√	
Notam Office Login	√	
Dashboard Menu	√	
New NOTAM Issuance Application	√	
List of NOTAM Issuance by Drafter	√	
Submission of NOTAM Documents	√	
Issuance of NOTAM	√	

After obtaining feedback from the results of previous product trials, slight product revisions were made for final refinement before the application was disseminated. The final product revision refers to the results of trials with the aim of improving the product to be produced (Anafi et al., 2021)(Rusmulyani, 2020). Products that have been refined are application models that have been able to answer user needs. However, the application is disseminated in a small scope to ensure accuracy and consistency (Anggraini et al., 2021). Through a questionnaire, students were asked to answer seven questions related to 3 aspects of the application being developed. The trial process for using the NOTAM Application was carried out on student respondents in the XIV Air Traffic Management Study Program, 24 people, 24 students from XV class, and four lecturers teaching NOTAM courses. The test was carried out 2 (two) times. The result is that students feel helped by the application. Questionnaire calculations state that the application uses correct, simple, and communicative Indonesian sentences that are easy to understand and do not cause two interpretations. Furthermore, from the educator's point of view, the results of the questionnaire calculation stated that educators feel facilitated with this application because they can carry out practicums with a flow and appearance tailored to the needs of the workplace. The results of the questionnaire on the development of learning media for the NOTAM course are as follows:

Table 4. Rating of Applications

No	Description	Rating Score				Suggestions/ Comments
		1	**2**	**3**	**4**	
A	**Guidance Aspect**					
	Instructions for student response questionnaire sheets are clearly stated			2	50	
	The assessment criteria are clearly stated			1	51	
B	**Coverage Aspect**					
	In accordance with the purpose of the student response instrument Statements according to indicators				52	
	Statements according to indicators			2	50	
	Statement boundaries are clearly defined			4	48	
C	**Language Aspect**					
	Use correct, simple, and communicative Indonesian				52	
	Use sentences that are easy to understand, and do not cause multiple interpretations			2	50	

Furthermore, validation of the learning media that has been developed is also carried out by involving experts. The experts consisted of the regulatory side represented by the Directorate of Aviation Navigation, the training institution side represented by the Center for Air Transportation Human Resources Development (PPSDM HUBUD), and from operators represented by the Aeronautical Information Center, AirNav Indonesia. The results of the validation of the experts that have been carried out state that the material for the study of the

Design and Build Application of the NOTAM Practicum Course in the Air Traffic Management Study Program is feasible for field trials with revisions taking into account the inputs from the experts, namely as follows:

Explanation of the topic and application development material to accommodate problem scenarios from the lecturer's side;

Instructor features need to be added;

It needs to be equipped with the NOTAM Selection Criteria database, location Indicator, abbreviation and code to facilitate the process of detecting errors from the lecturer's side;

Adjustment of Qualifier Lines format and logo used in practice;

It is necessary to provide template questions for educators to practice.

After obtaining a lot of input and suggestions from the trial phase that has been implemented, the next is the improvement and evaluation stage. The learning media in the form of this application is revised according to the input that has been obtained to be implemented in stages. Furthermore, during the implementation process, researchers also began to carry out monitoring and evaluation in order to assess the impact of using learning media that had been developed on increasing student competence.

CONCLUSION

Based on the results of the research and discussion regarding the design and construction of practicum applications in the NOTAM course, the air traffic management study program, the following conclusions can be drawn, the making of learning media applications for the NOTAM course uses a web programming basis that begins with an analysis of user needs and design by making program flowcharts so that the program is well structured—furthermore, creating a display design which is then followed by implementing the strategy by doing backend programming. After the entire programming series has been completed, it is continued with trials, and prospective users and experts/validators carry out practices to see the feasibility/validity of the application. The final step is maintenance and updating, which is carried out to improve the program from revisions or validator input at the previous stage. And the feasibility of using learning media for the NOTAM course by users and teaching staff practitioners stated that the material for research on the design and build of the practical application for the NOTAM course in the Air Traffic Management Study Program is suitable for field trials with revisions.

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