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Development of the Wind Direction Indicator Display as a Learning Media for Visual Landing Aid Systems

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Abstract: In this study, we designed a wind direction indicator display as a learning medium to help cadets understand how the equipment works. Wind direction indicators are used as a navigation tool for pilots to determine landing direction on airport runways. This study was conducted at the Palembang Aviation Polytechnic using mixed methods, namely research and development and quantitative. The object of the research is cadets of the airport engineering technology study program. Determining whether there are differences in the results or not, by using paired t test. The study results show that the cadets are very enthusiastic in learning and developing these tools, as well as increasing their knowledge and competence in the field of visual landing aids at airports. With this learning media, cadets can better understand how it works. By increasing the competency of cadets, it is hoped that it can support aviation safety in Indonesia.

Keywords: Airport, Display Wind Direction Indicator, Learning Media

A. Introduction

One of the courses in the applied bachelor airport engineering technology study program is visual landing aids. In this course, we learn how an airplane can fly from a runway to landing back on the destination runway at an airport using visual navigation tools (Fatonah et al., 2020). There are many visual landing navigation tools at airports, as instructions for pilots for landing and taking off from the runway (Kemenhub, 2019). Currently in the air traffic laboratory the controller has to see the wind direction visually with an analog device. With the results of this study, the air traffic controller in the laboratory tower can see the wind direction accurately without having to ask other parties (Herkenhoff et al., 2023).

Visual aircraft landing aids are very important at an airport, such as wind direction indicators which are one of the most important infra structure at airports which are used to show the wind direction on the airport runway as a reference for pilots to land their aircraft safely and securely. This tool is located on a control tower at an airport

so that it can be seen by air traffic controllers. With this tool, the control officer can inform the pilot from which direction the pilot will take off and landing (Suhanto et al., 2024).

Current wind direction indicators are generally placed near the runway in an immovable condition and have a power source from the main grid. Therefore, the author has the idea to conduct research regarding the development of a wind direction indicator display that is easy to move and has a stand-alone power source (Lestari & Hadiwinarto, 2022). As an educational institution, we develop it in the form of learning media for cadet practical teaching aids. Then we developed a wind direction indicator display in a form that is simpler and easier to read directly by control tower officers, as a learning medium at the Palembang Aviation Polytechnic (Zhang, et al., 2019).

One of the lessons learned in the airport engineering technology study program is aircraft landing navigation aids as a visual landing aid (Sari, 2023). This tool is used as a practice medium for cadets in learning how wind direction indicators work. The wind direction at the airport can be detected with a wind direction indicator. At the airport there is something that can be seen directly near the runway in the form of a cylindrical red and white or orange cloth. When exposed to wind, this cylindrical cloth will appear to flutter in the direction the wind moves. However, this tool is less accurate, because the direction and speed of the wind cannot be seen directly (Zhang, et al., 2019).

Based on the above, to implement an innovative learning system it is necessary to develop it by providing innovative learning media equipment in accordance with current and future technological developments (Rifai, et al., 2022). Then the researchers developed the idea of making a wind direction indicator display by displaying it on a screen, so that it can be seen and read directly by operators and air traffic controllers. If pilots need data on wind direction and speed at the airport, then air traffic controllers can see, read and convey it directly to the pilot (Yuniar et al., 2023).

In previous study, it was stated that learning media is very important for the teaching and learning process. Therefore, learning media is needed that is easy to use and easy for students to practice. So that students can more easily understand the subjects they are studying. Learning is carried out in accordance with the procedures and instructions in the practicum guide. Likewise, the practical equipment provided will greatly influence students' understanding abilities. For example, equipment at airports is used to support flight safety. As a student studying airport engineering, you must study the exact equipment found at airports. So, we have to provide the equipment as similar as possible to that at the airport (Danim, 2023).

To provide practical equipment similar to that at airports, we developed practical equipment for the visual landing aids course. One of the visual landing aids used is the wind direction indicator. Currently, wind direction indicators still use analog equipment which is less accurate (Soleh, Callista, & Maulana, 2024). With the development of digital-based wind direction indicator monitoring equipment, it is hoped that it can be more accurate in displaying the wind direction around the runway. This equipment uses modern microcontroller-based equipment. For monitoring and display, liquid emitting diodes are used, so that the display is easier to read by the air traffic controller (Paulina Maria Ekasari Wahyuningrum & Irene Hartutik, 2022).

With the development of this learning media, students can learn directly using equipment such as at airports. With the project-based learning method, all students can learn to create and develop a wind direction and wind speed monitoring tool from the start until it becomes a tool that can be used. Apart from that, students can also learn systematically from planning the design, validating the design, manufacturing the tool, carrying out trials, until the tool can be used to display wind direction and wind speed digitally. Thus, students can achieve the expected competency. The competency in question is being able to plan, maintain, carry out troubleshooting and be able to solve problems if damage occurs to the equipment. Likewise, students are expected to be able to plan curative and corrective maintenance. This learning process has never been carried out before (Erlina et al., 2022).

In the context of learning media, cadets as students who will later become engineers at airports can learn how to work and make these tools (Danim, 2023). With this media, cadets are expected to understand and understand and design this equipment (Hosnan, 2013). So that when cadets graduate and work at an airport, they will be able to create this device, if the airport where they work does not yet have this wind direction indicator display device. If the airport already has a wind direction indicator device, then after working at the airport the cadets can maintain and repair the device if damage occurs. Therefore, the learning media for display wind direction indicators is really needed by the airport engineering study program to create graduates who are competent in the airport field (Soleh, 2019). Currently in the air traffic control laboratory the control desk still uses an analog display to see wind direction and speed. With this study, the control desk in the laboratory will use digital numbers so they will be easier to read and more accurate (T. Oktavia et al., 2022).

B. Methods

In this study, the development of the wind direction indicator display was carried out using the research and development method in accordance with the stages set by Borg & Gall (Soleh, Tobari, & Kesumawati, 2019). The research location was carried out at the Palembang Aviation Polytechnic with a sample of one class in the airport engineering technology study program. To determine the effectiveness and

practicality of learning media, cadets were given a pretest before learning and a posttest after learning. From the results of the pretest and posttest value data, the t test was then carried out with a sample paired test (Candiasa, 2004). So that later it will be known the difference in understanding of cadets who use learning media and those who do not use the wind direction indicator display learning media.

Research and development research can be used to develop learning media with the aim of achieving teaching competency. This can be done by developing taxiway light learning media for student learning. Students are given practical instructions as well as tools and materials. The lecturer guides and guides the students to carry out the practicum according to the stages in the project-based learning practicum guidelines. As a result, students can complete taxiway light learning with a taxiway light output that can be lit and can be used according to standards. In carrying out practice, students use research and development methods (S. Oktavia et al., 2023).

The research method in its implementation can be carried out using more than one method. Several methods can be combined into one, for example qualitative methods can be combined with quantitative methods, research and development methods can be combined with quantitative methods. Combining several research methods is called mixed methods. This method can be carried out simultaneously or sequentially, depending on the situation and conditions in the field (Carruthers et al., 2014).

In this study, we used two methods, namely, first using the research and development method to develop a tool for monitoring wind direction and speed which was carried out by students guided by practicum lecturers. Next, the lecturers will assess, observe and observe the students in carrying out the practicum. When learning begins, a pretest is carried out to determine the students' level of knowledge. After the students completed the practicum using the research and development method and produced output in the form of a wind direction and speed monitoring tool, a post test was then carried out on the students who carried out the study (Chen et al., 2020).

C. Results and Discussion

Needs Analysis Stage: For the wind direction indicator display learning media, the author conducted preliminary research regarding whether or not this tool was needed to be made at the Palembang Aviation Polytechnic. The research was conducted on respondents consisting of cadets and lecturers at the Palembang Aviation Polytechnic. The questionnaire was created in the form of a Google document and given to cadets via their respective accounts. This filling is not coercive and is free to fill in according to each individual's conscience. From the results of the questionnaire distributed by the author to 70 respondents, all respondents had filled out a questionnaire consisting of lecturers and cadets at the Palembang Aviation Polytechnic with the question 'In your opinion, is a wind direction indicator display needed as a learning medium in the airport engineering technology study program?'

Figure 1. Results of Respondent's Answers to Preliminary Research

The results of the answers from respondents were 68 respondents answered yes and two respondents answered no. Researchers ask for suggestions and input for making a wind direction indicator display. Respondents generally supported developing the wind direction indicator display. Apart from that, there were also respondents who asked to be involved in developing wind direction indicator displays to provide experience and increase their knowledge in terms of airport development.

From the results of the questionnaire data, it shows that with the creation of this tool, both cadets and lecturers really support the development of this tool to increase cadets' understanding of how the tool works. If later the cadets graduate and are placed at an airport that does not yet have this equipment, it is hoped that the cadets will be able to immediately give this idea to their leaders. So that accurate data can be obtained easily if pilots need this information from air traffic controllers.

Wind direction indicator display development stage: We adapt the design of this wind direction indicator display device to the existing sensor equipment, targets that will be developed according to needs and functions. The wind direction indicator display tool that we developed is in the form of a wind direction indicator and a wind speed display. This tool is very compact so it can be used wherever needed. The design of this tool can be seen in the following image:

Figure 2. Wind Direction Indicator

Likewise, designs for poles and wind direction indicator displays and other supporting devices are also made. The wind direction indicator pole is made from galvanized iron or aluminum pipe with a diameter of 1 inch and a height of 60 centimeters. The pillars are supported by iron horses in the shape of a rectangular angle measuring 20x20 centimeters. To avoid rusting of the pole, the pole is painted black to match the direction and wind speed sensors.

Meanwhile, for the wind direction indicator display, we use a Liquid Crystal Display to display wind direction and speed. Liquid Crystal Displays use a size of 4x20 characters, where there is a length of 20 characters and four lines of characters. The wind direction indicator display image can be seen in Figure 3 below:

Figure 3. Display Wind Direction Indicator

On this display, the first line says 'POLTEKBANG PALEMBANG', this is to show the identity that this device was made by academics at the Palembang Aviation Polytechnic campus. Then in the second line is the text 'Data Arah Angin Saat Ini' to show information about the current wind direction around the airport. Then in the third line is 'Kecepatan' which shows the wind speed in the form of a number in front of it in kilometers per hour, written in the 'KpJ' display. On the last line is written 'Arah', in front of which there are three digits numbers indicating the wind direction in degrees, in the display it is written 'Der'. The units of degrees in direction can be converted according to the degrees of the cardinal direction.

Design Revision, After the validation process by experts, there are several things suggested by the validator to be revised in the tool design. So we revised the tool design according to the suggestions given by the validator. There were no significant results in the validation results, so no revisions were made to the design. The validator's suggestion is that if it is more attractive, the casing of the tool should be made more flexible and can be moved so that it makes it easier for lecturers to carry the tool both indoors and outdoors when explaining to cadets. This tool needs to be explained outdoors to get the direction and speed of the wind at that time.

Next is the testing stage, at this stage we test the wind direction indicator display equipment system that has been made, whether it works as planned. After testing, there were no significant things that were of concern. During the test, everything went normally, the cadets also paid close attention to the condition and operation of the equipment. When there is wind and you turn the direction sensor, the direction on the screen will change according to the wind direction. Meanwhile, in Speed, if the speed sensor rotates, you will see changes in wind speed in kilometers per hour. The faster the sensor spins, the bigger the number on the display will be.

Usage Trial: At this stage, it is tested directly according to the desired usage. Tests were carried out as a whole, namely the wind direction indicator display unit and the electrical system. The first test was carried out on top of the airport laboratory building at the Palembang aviation polytechnic. From the test results, the wind direction indicator works well, as can be seen from the wind direction indicator which rotates according to the wind direction. Likewise, the electrical system can work well, the power supply is normal and the screen can show the direction and speed of the wind according to current conditions.

Next, we moved the wind direction indicator display to the top of the airport laboratory building, with the aim of getting a wider space to get more wind. The location of the wind direction indicator display can be seen in the following image:

Figure 4. Test of the Wind Direction Indicator Display

The next stage is to test the cadets' theoretical understanding in class. When carrying out trials as a learning medium for cadets, a pretest and posttest were carried out. At the beginning before learning, the researcher conducted a pretest for the cadets to determine the extent of the cadets' knowledge regarding the wind direction indicator display. Next, learning was provided using learning media to the cadets. After

completing the learning to the cadets, a posttest was carried out on the cadets to measure the results of learning understanding using the wind direction indicator display learning media. From the results of theoretical learning in class, the researcher collected the pretest and posttest results as in table 1 as follows:

Table 1. Cadet Score

Cadets Number	Test Result		Cadets Number	Test Result	
	Pre	Post		Pre	Post
1	64	83	11	72	93
2	71	89	12	70	86
3	66	87	13	67	90
4	57	86	14	57	85
5	63	92	15	69	89
6	73	92	16	64	90
7	68	87	17	69	94
8	72	89	18	73	86
9	61	88	19	78	83
10	59	85	20	68	90
11	72	93	21	76	84
12	70	86	22	55	86

Next, from the values in table 1, a normality test was carried out using the IBM SPSS application. The results of the normality test can be seen in the following table:

Table 2. Normality Test Results

		Unstandardized Residual
N		22
Normal Parameters[ab]	Mean	0E-7
	Std. Deviation	18.173454 50
Most Extreme Differences	Absolute	.260
	Positive	.164
	Negative	.268
Kolmogorov-Smirnov Z		.821
Asymp Sig. (2-tailed)		.415

The results of the One Sample Kolmogorov-Smirnov normality test in table 1 above can be seen as the Asymp value. Sig (2-tailed) is 0.415 more than 0.05. Based on the results of the Kolmogorov-Smirnov test above, it can be stated that the data is normally distributed.

Next, a hypothesis test is carried out to determine whether there is a difference between before and after learning. To determine the differences before and after being given learning media, the hypothesis Ho = There is no average difference between the

learning outcomes of cadets before and after learning with the wind direction indicator display learning media, meaning that there is no influence on cadets if learning is carried out or there is no learning. with wind direction indicator display media. Ha = There is an average difference between learning outcomes before and after learning using the wind direction indicator display media, meaning that there is an influence on the cadets if learning is carried out using learning media or not using the wind direction indicator display learning media.

The next step is to determine whether there is a difference between before learning is carried out with learning media and after it is carried out with learning media based on the results of the paired sample test in the table produced by SPSS in table 3. Determining whether there are differences in the results or not will be presented in the next discussion section.

Table 3. T test with SPSS

		Paired Differences					t	df	Sig. (2-tailed)
		Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference				
					Lower	Upper			
Pair 1	Pretest Score - Posttest Score	-16.000	11.268	5.312	-25.235	-1.743	-2.432	8	.030

By looking at table 3, the significant value of Sig. (2-tailed) shows a figure of 0.030. Based on decision making in the paired t test, we look at the sig value. SPSS output (Santoso, 2014) so that it can be concluded as follows: If Sig. (2-tailed) < 0.05 then Ho is rejected and Ha is accepted. If Sig.(2-tailed) >0.05 then Ho is accepted and Ha is rejected.

The Sig.(2_tailed) value in table 3 is 0.030, meaning it is less than 0.05, so it is based on the first hypothesis, namely Ho is rejected and Ha is accepted. Furthermore, if Ha is accepted then there is an average difference between the learning outcomes before and after learning, meaning that there is an influence on students if learning or no learning is carried out using the wind direction indicator display as a learning medium. The influence and difference referred to is the increase in cadets' knowledge and skills after taking part in learning using wind direction indicator display media.

Evaluation Stage: After carrying out all the stages, the next step is to carry out the evaluation stage. This is to find out the obstacles faced when this product is implemented directly as a learning medium. From the test results, the product can function according to the purpose of using this tool, namely being able to indicate wind direction and wind speed. Cadets can also better understand how wind direction indicators work and all the equipment and supporting components.

In a study using mixed methods, namely research and development and quantitative methods, to differentiate between classes that use project base learning methods and those that use conventional learning methods. Data collection was carried out by evaluating students and conducting interviews with several samples. Data processing uses manova statistics, which first carries out preliminary tests such as normality tests and the next stages are in accordance with the procedure. The study was carried out by the Palembang Civil Aviation Polytechnic with a sample of third level students. The results of this study suggest that we can see a difference in creativity outcomes and the final results are beyond expectations. Students who use this learning system can understand both practically and theoretically the courses given (Soleh et al., 2023).

Another study states that using a wind direction indicator as a learning medium really helps students learn how equipment is assembled and programmed and this equipment works. The research method uses research and development. The study was conducted at the Palembang Aviation Polytechnic using a sample of third level students. As a result, the students were very enthusiastic in participating in the learning and they really wanted to know how the equipment worked and how the equipment was programmed to produce accurate wind direction and speed data with a digital display. By practicing using this method, students can understand how wind direction indicator equipment works. They understand how direction sensors and wind speed sensors work. Then from the sensor the interpretation will flow into digital data and finally it can appear on the display as a number in the form of degrees using three digits numbers. These three digits numbers correspond to the digits that are always used to indicate the direction of the starting point on an airport's runway (Soleh et al., 2023).

Another study on the importance of learning media is the study of learning media for aviation security students. In this study they created learning media using website media to theoretically present aviation security material using a website. Likewise, their practice is to display x-ray images as if they were using real x-rays on a website. Students will study the x-ray images on the website, whether the item contains dangerous goods or not. Websites can simulate themselves like x-ray equipment. The research was conducted at the Palembang Civil Aviation Polytechnic. The research sample was third year students of the airports management third grade. By using this tool students will learn more about various kinds of dangerous goods. In this way, students will have a lot of experience and learn a lot about what dangerous goods will look like on an x-ray. The students were very enthusiastic in using this learning media. Likewise, lecturers are happier and easier to provide learning both theoretically and practically. The results of the evaluation of students using aviation security learning media are very good. In general, they get study scores that exceed the passing limit (Yuniar et al., 2023).

Another study is learning media using websites. In this study they used website-based learning media to study fire extinguishing during accidents or fires at airports. This

research method uses research and development. The research was conducted at the Palembang Civil Aviation Polytechnic. The research sample was third year students of the aviation rescue and firefighting study program. To learn about extinguishing a fire, students will use computer media to simulate the steps in extinguishing a fire correctly according to procedures. Also, when extinguishing a fire, you must pay attention to personal safety and the safety of fire or accident victims. In carrying out this study the students were very enthusiastic about carrying out the learning. They are very curious and enthusiastic about doing practicum. The evaluation results for the students were also very good, exceeding the pass mark very significantly (Nugraha et al., 2023).

In another study, they used the blended learning method. The media used are Google Meet learning media and Pizzaku learning media. This learning media is based on websites and computer applications to provide new experiences to students. The research was carried out at Bujanggadung Elementary School, Grogol district, Banten Province. The sample for this research was thirty-two students consisting of seventeen male students and fifteen female students. The research sample was sixth grade students at Bujanggadung elementary school. Students are very enthusiastic in undergoing this learning. For them this is very fun and feels like playing, but they can easily understand the lessons given. This learning media is to help students learn mathematics, especially circle problem content. The study uses the blended learning method. Based on the results of the study, this learning media really helps students in speeding up their understanding of mathematics learning, especially those that contain circles (Yusmawati, 2022).

Another study was conducted at Palembang University using video conference media. This study aims to examine how video conferencing can be used to assess students' learning achievements. The sample from this research was accounting training students at the Palembang University accounting study program. The method used is descriptive analysis. In the first experiment the students were a little less active, because they lacked focus and did not listen carefully to the video conference. So that on the second question the results of the students' answers were less than optimal. But at the second meeting the students were more active during the learning process. Many students asked the lecturers about the material being taught and when they were given questions, students were able to answer them well. The results of the study show that learning media is successful in providing students with an understanding of the material. They are very enthusiastic and provide motivation for students to learn and understand the lesson (Lestari & Hadiwinarto, 2022).

Based on the results of the study presented, it can be stated that learning media is very important for the teaching and learning process on campus. Learning media can speed up students' understanding of a subject. Learning media also makes students more enthusiastic and provides additional motivation in the learning process. Meanwhile, the research methods used vary greatly. In general, many studies use mixed methods.

This is used to provide research results that are more accurate and in accordance with the rules of science(Soleh et al., 2022).

D. Conclusion

The development of this wind direction indicator display can be used and implemented as a medium for cadet practical learning and to indicate wind direction and speed at airports. With this learning media, cadets better understand how the tools work and the components that make them up. This wind direction indicator display can also be used to indicate wind direction at emergency airports caused by disaster conditions or other emergency airports because it is easy to move.

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