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Research Paper

Developing Application Main Condensate Water System as a Learning Media

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Abstract

An innovation of learning media through application is the answer to the learning challenges in the digitalization era as well as the impact of the COVID-19 pandemic. In this study, the main condensate water system is transformed into a learning media application for simulating the work process, distribution flow, and operation of the main condensate water system on board a ship. This study applied a research and development method using a five-stage research model known as "Mantap". The study was started by conducting an initial study and followed by model development through designing the basic concept of the application. Validation and effectiveness assessments were then conducted to determine whether the application was valid and applicable enough as learning media. The study revealed that the application visualized using Adobe Animate is valid as a learning media. It gained a validity score of 3.25 from the visual design expert and 3.5 from the curriculum experts. Besides, the application was assessed to be effective as a learning media by receiving a validity score of 3.69 from the Marine Engineering students.

Keywords *learning media, main condensate water system, Mantap research method*

INTRODUCTION

The essential purpose of learning was empowering students' potential into competence through a learning process that involved a direct interaction between student and lecturer through learning media. Besides, technological advance impacts the pattern of learning media that supports the students' study with different methods to gain effective learning (Sajidan, et al., 2020). However, the rough wave of the COVID-19 pandemic changed the ideal pattern of the learning process through "physical distancing" by limiting crowds' activities, including direct learning activities at school causing all learning processes must be accessed online (Astini, 2020).

To prepare students for a pandemic, schools and government should be able to supply alternative learning media, such as E-learning. (Mailizar, et al., 2020). On the other hand, the distance and connectivity limitations may affect the student's comprehension of the courses, particularly for students who need direct observation and practice in the laboratory, workshop, or simulator which could lead to depression and anxiety (Kalok, et al., 2020). In some cases, students' perception and interest in e-learning showed an average level, meaning it was not fully implemented (Hidayat, 2020). Providing adequate and well-planned learning media was the best solution for facing the challenge (Al-Juda, 2017).

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There has been research on the differences between learning with and without an application as a learning media. Evidence indicated that the use of applications improved students' learning outcomes. (Dyanti, et al., 2022). Interaction between learning media and new learning styles through interactive application was the most effective way to engage students and their multiple senses in their learning process (Laswadi, et al., 2022). On the other hand, the development of the application was chosen to provide students's comprehensive understanding of theoretical and practical matters of working systems, the cost was cheaper compared to developing the simulator (Sabrina, et al., 2018).

LITERATURE REVIEW

Learning Media

Learning media plays a substantial part in helping student's learning process (Akbar & Isnawati, 2015). The development of applications as learning media and learning approaches was a form of innovation as well as the answer to learning challenges in the digitalization era responding COVID-19 pandemic (Thaheem, et al., 2022).

Learning in the early 21st century required people with skills and competencies beyond information and communication technology (ICT) literacy, so students were specifically expected to have an innovative platform for transferring knowledge among others through their concepts and ideas (Cyntia Dewi & Rusanti, 2021). The importance of ICT literacy will prepare students to develop their academic application comprehension with innovation, information, technology, and life skills for upcoming work efficient and productive life (Khlaisang & Koraneekij, 2019). Teachers should comprehend themselves with ICT literacy, so teachers' learning media can be helpful for students' attractiveness and settlement (Hilman & Dewi, 2021). To afford it, teachers should meet ICT standard requirements: computing literacy, computer error troubleshooting, computer word processing, computer database management, and be qualified to make creative presentations with visual and communicative standard requirements (Wijayanti, 2011).

The learning media with computer-based learning provided students with greater flexibility and accessibility, then considered computer-based learning as an alternative way of learning (Saputrama et al., 2022). Research showed the use of E-modules for online learning, students could follow the learning process which was proven by evaluation results of more than average scores (Dewi, et al., 2022). An affordable, simple, unpaid, and compatible application was the ideal and suitable learning media that can be accessed by all students and teachers (Rezi & Mudinillah, 2022)

Experts and students evaluated application as learning media through research and development, giving satisfactory and effective results in increasing students' interest and conceptual understanding(Astuti & Nurcahyo, 2019). It also stated research on application-based learning media that an application effectively increased student's learning motivation (Kusuma, et al., 2022). So, learning media can create higher individual learning outcomes when using virtual reality media to learn and prepare effective learning materials (Haryana, et al., 2022).

Main Condensate Water System

The main condensate water system was chosen because of its critical rule on the process of a feedwater boiler's circulation and waste heat recovery on board an LNG/C ship that uses superheated steam for the main propulsion system. Every marine engineer working on this specific type of ship must be familiar with the system. However, the fact that most modern ships work with diesel oil has made students find it quite difficult to have a comprehensive understanding of the main condensate water system.

According to the SS. Tangguh Batur Machinery Manual (2008), main condensate water system provided an overview of the condensate water circulation from the main condenser to the main feed pump turbine through the deaerator providing condensate water from 32.5oC to 132.5oC. It balanced the water supply to the deaerator before entering the main boilers. Condensate water was generated when steam from the main turbine exhaust, turbine generator, and dump steam condensed in the main condenser under vacuum conditions (Poljak et al., 2022).

As stated in the instruction book from Entec Donghwa manufacturer (2008) Low-Pressure (LP) Feed Water Heater, the condensate pump pumped out the feedwater to the Fresh Water Generator's cooler as the first heat exchanger produces 42.5oC at the outlet temperature. Feedwater entered the gland condenser as a second heat exchanger with an air extraction gland exhaust fan. Condensate water entered- Pressure Feed Water Heater to receive heat resulting 80oC temperature, with heat coming from the steam air heater and the LP bleed turbine. Finally, the condensate water entered the deaerator to raise the temperature became 130oC. the NYK Handout (2020) mentioned that the deaerator reduced dissolved oxygen level to 0.02 cc/liter, increased the turbine plant's thermal efficiency, and provided a positive suction head to the main feed water turbine.

Based on the conditions mentioned earlier, this study aimed to design a learning media to bridge the difficulty of distance learning. Besides, the proposed application can be useful for increasing students' comprehension of the main condensate water system's working mechanism, moreover when most modern ships nowadays no longer use this system. It can be a useful self-study learning media as well to improve the student's competency on the topics.

METHODOLOGY

Research Method

This research applied a five-stage research model introduced by Sumarni(2019), this model known as "*Mantap*" composed of (1) Initial research and study, (2) Model and design development, (3) Model and design validation, (4) Effectiveness assessment, and (5) Dissemination. The initial research and study were conducted through 8 months of observation on board LNG/C SS. Tangguh Batur. The researcher interviewed the Chief Engineer and observed the system's working mechanism, including system malfunction. The researcher then designed the Main Condensate Water system's basic sketch and mechanism concept using Adobe Animate. The following step was model and design validation. The researcher used questionnaires with four-scale Likert to assess the model and design of the application from both curriculum and visual aspects. Three experts were chosen to give their assessment of whether the proposed application was valid to be used as a learning media or not.

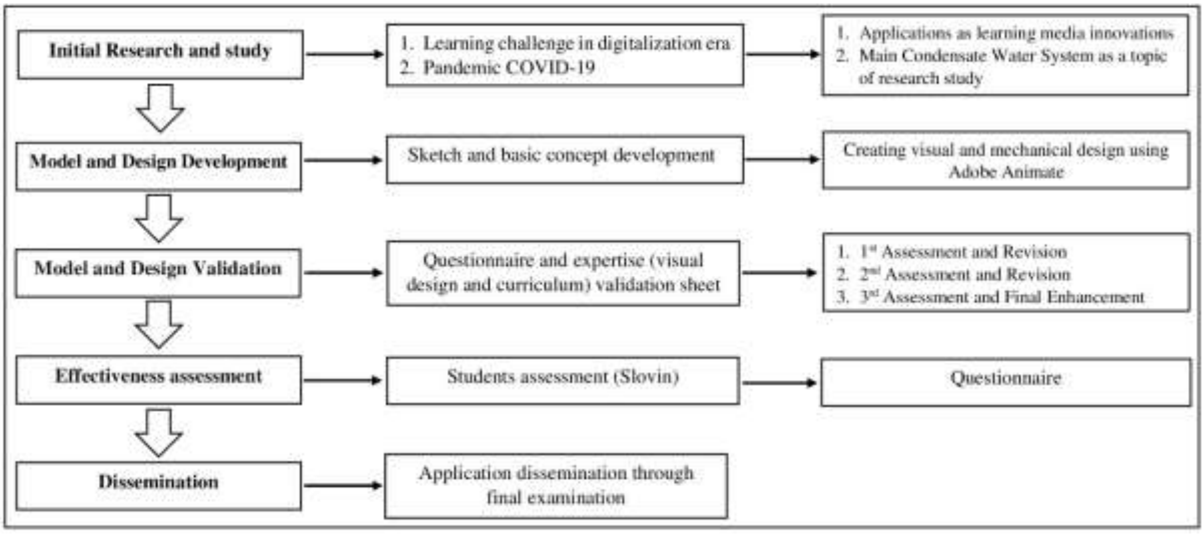

Figure 1. "*Mantap*" research method

Next, the effectiveness of the application was measured through group assessment. The researcher distributed a questionnaire to 80 Marine Engineering students of Politeknik Ilmu Pelayaran Semarang, consisting of different stages of study (2nd,4th,7th, and 8th semesters). This sampling number was calculated using the Slovin formula out of 404 Marine Engineering students' population. The students were chosen because they have studied the topic of both main condensate water systems and control systems since the 1st semester. Both expert's and students' feedback were then calculated to find out the validity score of the proposed application.

Table 1. Validation criteria

Validity Score	Validation Criteria	Remarks
$3.26 < \bar{x} < 4.00$	Valid	Perfect, Without revision
$2.51 < \bar{x} < 3.26$	Quite Valid	Good, Partial revision
$1.76 < \bar{x} < 2.51$	Less Valid	Deficient, Reassessments
$1.00 < \bar{x} < 1.76$	Invalid	Deficient, Overall revision

FINDINGS AND DISCUSSION

General Application Overview

The development of the world of digital technology is currently giving birth to a variety of e-commerce which then makes the number of couriers including food couriers increase. From the questionnaire distributed, there were 50 couriers with the following data:

The basic concept of the Main Condensate Water System as a learning media was designed as an innovation and alternative learning model, which explicitly discusses control systems and main condensate water systems. The design was made based on the main condensate water system's working mechanism, including the troubleshooting found during the researcher conducted the initial study on board ship SS. Tangguh Batur.

The application was designed into five sections, including a homepage and four main chapters, consisting of basic knowledge, piping diagrams, machinery operations, and quizzes. Users can access the application without specific steps in sequence, starting either from basic knowledge and ending with the piping diagram or vice versa. Shortly, the researcher summarized the flowchart of the basic concepts of the main condensate water system application as shown in Figure 2 as follows.

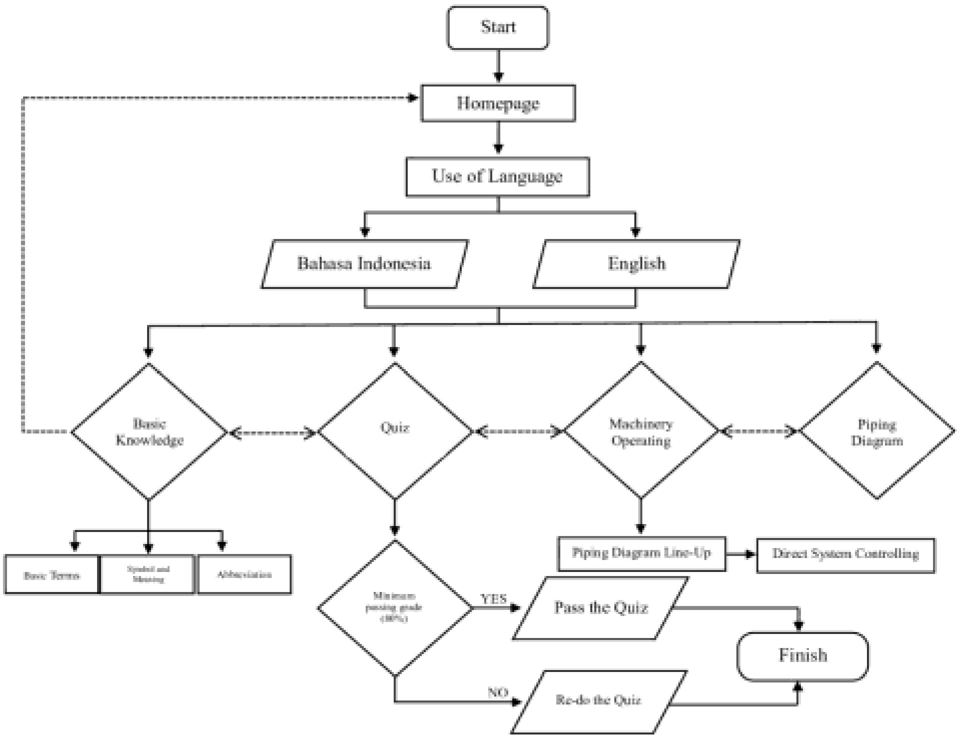

Figure 2. Flowchart of application of main condensate water system

a. The Application Sections

The Main Condensate Water system was a bilingual application. The first display was a homepage with an English audio description. Users must select the desired language, it can be either Bahasa Indonesia or English. Once the language is selected, users will see four main chapters: Basic Knowledge, Piping Diagram, Machinery Operating, and Quiz.

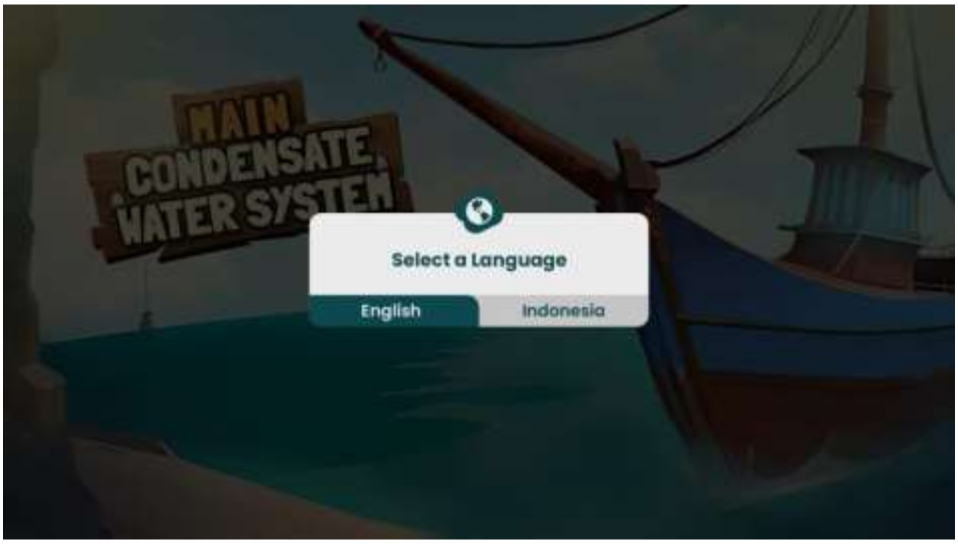

Figure 3. Homepage display and selection of language use

Basic knowledge was the first part of the application. It included several fundamental aspects of the control system and main condensate water system for initial familiarization and understanding of the system's fundamental aspects. It consists of Basic Terms, Abbreviations, and Symbols. The users can learn the fundamental terminology before learning the whole system. The second chapter of the application was a piping diagram. It explained the system's flow integrated with the respective system to give users a comprehensive understanding of the main condensate water system. The next chapter was the machinery operation. It was an essential chapter of the main condensate water system. It contained the main condensate water system's visualization and operating procedures as a complete integrated unit divided into two stages of operation: piping diagrams line-up and direct system controlling. The final part of the application was a quiz consisting of several questions for users to evaluate their understanding of the topics and gather users feedback.

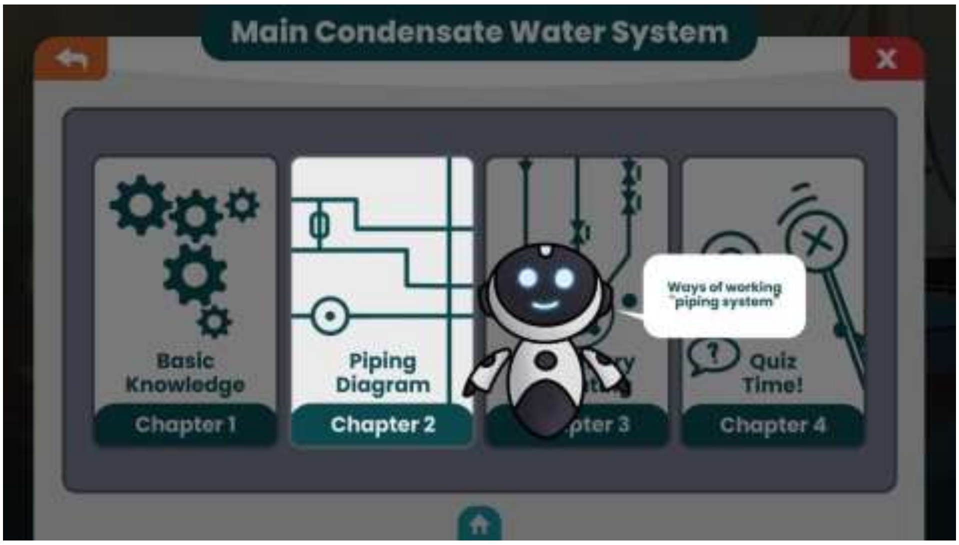

Figure 4. Display of the application's main chapters

b. The Application Operation

Piping Diagram Line-Up

The first section in Chapter III illustrated the procedure of systematic operation from an initially turned-off system to a live system. At this stage, the system was ready to be operated and proceed to the direct controlling mechanism. Users will see the piping diagram and boiler gauge board panel and controller, which were parts of the operation system. The users should follow the instructions through uninterrupted audio (voiceover) and visual (text display) information.

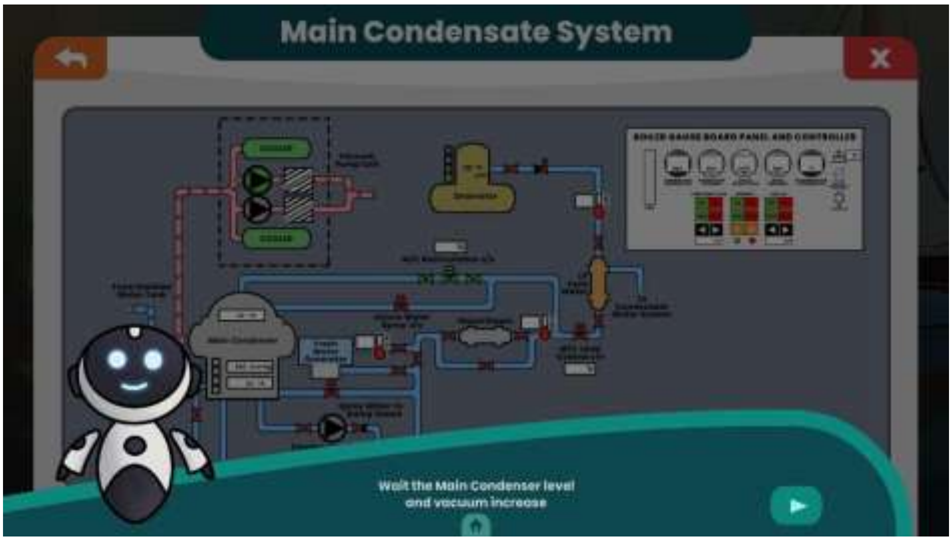

Figure 5. The display of the piping diagram line-up

Direct Controlling

The user will be granted access to direct controlling once they complete the piping diagram line-up with all the parameters on. Users can perform direct control via the boiler gauge-board panel. Users only control the force draft fan, burners, and fuel oil by increasing or decreasing the value of each parameter. To do direct controlling, Users must move the controller from AUTO (automatic) to MAN (manual) mode. Adjustments cannot be made if users perform direct controlling in AUTO mode, or access will be denied.

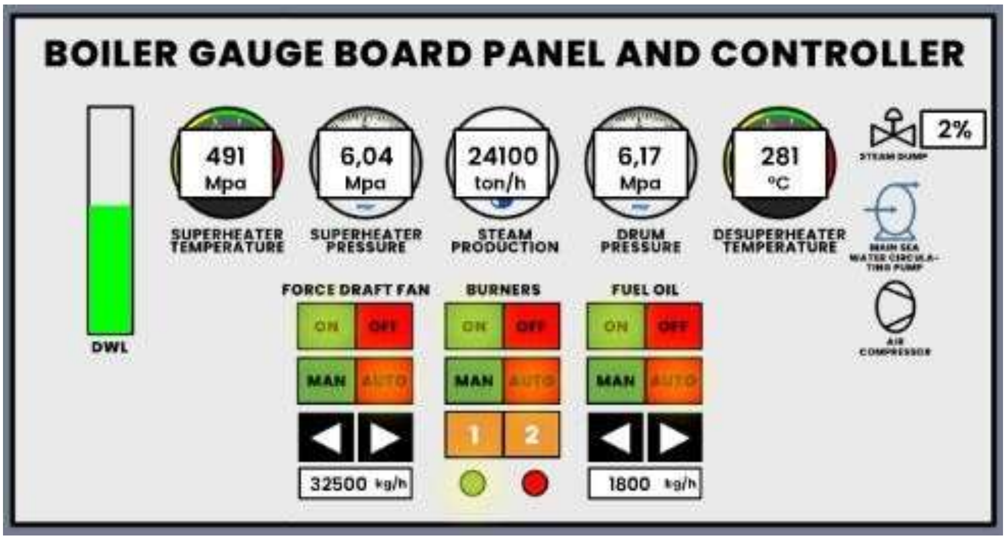

Figure 6. Display boiler gauge board panel and controller

- Main Condensate Water System

The desired controlling concept in this application was boiler load adjustment through a combination mechanism of burner, fuel oil, and force draft fan, which related to a proportional fire triangle ratio corresponding to the burner.

The system process designed by the researcher was the duration of condensate water circulation's cycle in a deaerator, with an initial design of 30-second intervals divided into two-cycle stages, each at 15-second intervals. When the boiler load is added via the "◄►" button on the boiler gauge board panel and controller, the circulation cycle time interval will be faster or shorter, reaching 20 to 10 seconds with each division of the cycle stage intervals running 10 seconds and 5 seconds.

- Condensate Water System

The condensate water system was integrated with the main condensate water system. So, in each boiler load adjustment process through a direct controlling mechanism with the "◄►" button on the boiler gauge board panel, it will directly affect the process mechanism that runs on the system.

The researcher designed a direct controlling mechanism for the condensate water system which impacts the time interval for each make-up and spill mechanism. With an initial time-interval design of 15 seconds, through direct controlling, the interval will be shorter to 10 and 5 seconds. Besides, the system was designed with split range control by automatically shutting both spill and make-up valves simultaneously to provide a surge under certain conditions to minimize the occurrence of system instability (oscillating) during level fluctuations in the deaerator.

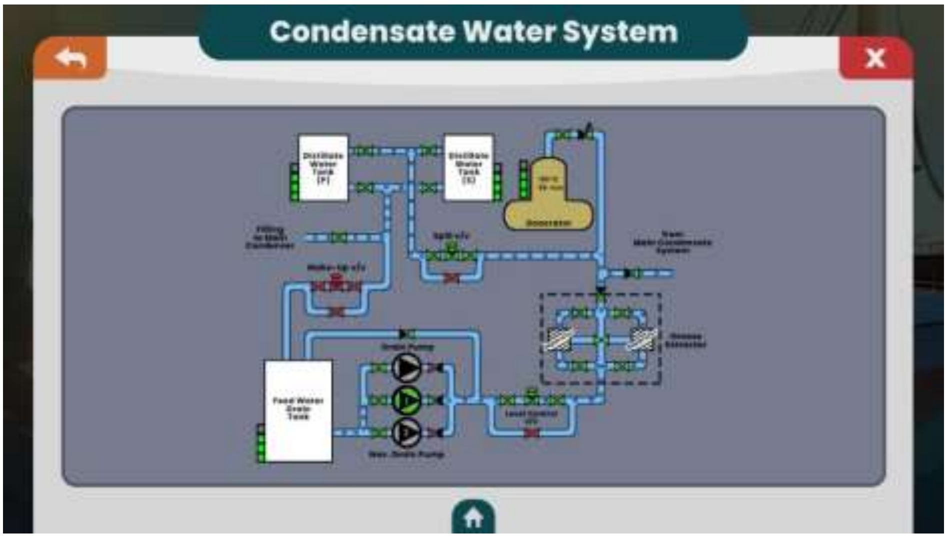

Figure 7. Condensate water system during spill mechanism

Model and Design Validation

The application validation involved two curriculum experts and one visual design expert. The experts were asked to give their honest reviews based on several aspects, covering the visual design and curriculum aspects. Some adjustments were made based on experts' feedback. A final validation assessment was conducted once the proposed application was done.

The first validation came from the visual design expert. The expert gave a score within the range of 2.5 to 4. Audio and layout design became the main concern. Meanwhile, the other aspects' scores were from 3 to 4. It was valid, and the remarks as perfect with no revision needed. With a 3.25 average validity score, it can be concluded that the design validation was good with some adjustments in audio quality.

Table 2: Design expert validation data

No	Validation Aspect	Validation Score	Validation Criteria	Remarks
Design				
1	Design Layout	2.5	Quite Valid	Good
2	Coloring	3	Quite Valid	Good
3	Design Illustration	4	Valid	Perfect
4	Attractiveness	4	Valid	Good
5	Audio quality	2.5	Quite Valid	Good
Programming				
6	Combability	4	Valid	Perfect
7	Easy to maintain	3.5	Valid	Perfect
8	Accessibility	3	Quite Valid	Good
9	Smooth operation	3	Quite Valid	Good
$\sum \bar{x}$		**3.25**	**Quite Valid**	**Good, Partial Revision**

The second validation involved two curriculum experts who taught control system courses. They gave feedback with scores ranging from 3 to 4 in all validation aspects. The aspect of topic clarity and knowledge enrichment even had perfect remarks from the experts. With an average validity score of 3.5, it can be concluded that the application was valid as a learning medium.

Effectiveness Measurement

To see whether the application was effective as a learning media in the main condensate water system course, an assessment involving 80 Marine Engineering students was conducted. A questionnaire with a four-scale Likert was distributed to measure the validity score of each aspect of the application. Table 4 below shows the validity score for the respective variable.

Table 4. Summary of validation aspect of effectiveness assessment

No	Variable	Validity Score	Remarks
1	Display	3.81	Perfect, without revision
2	Information clarity	3.75	Perfect, without revision
3	Image conformity	3.73	Perfect, without revision
4	Topic comprehension	3.80	Perfect, without revision
5	Language use	3.73	Perfect, without revision
6	Help learning process	3.78	Perfect, without revision
7	Motivate the study	3.34	Perfect, without revision
8	Ease of use	3.76	Perfect, without revision
9	Smooth operation	3.43	Perfect, without revision
$\sum \bar{x}$		**3.69**	**Perfect, without revision**

Table 4 describes that most students found that the application was valid with the variables mentioned above. With an average validity score of 3.69, it can be concluded that the application was effective as a learning medium.

CONCLUSION AND FURTHER RESEARCH

The Main Condensate Water System application as an alternative learning media was designed and developed through the "*Mantap*" research method (Five-Stage research Model) comprising five stages starting from problem identification leading to the innovation of a learning media application with main condensate water system as the main topic. Subsequently, the researcher developed a model by designing mechanism concepts using Adobe Animate. Validation testing involving two curriculum experts and one visual design expert using four-scale Likert questionnaires showed that the application was valid regarding curriculum and visual design aspects. Moreover, the group assessment involving 80 of 2nd,4th,7th, and 8th semesters Marine Engineering students indicated that the application was effective to be applied as a learning media of system control course, with a particular topic of the main condensate water system. The application was somehow still in a simple form. Further research and development of the application into a machinery operating simulator will be useful for the learning process of the control system course.

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