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Developing a Sustainable Technical Work with Environmental Augmented Reality on Innovative Modul Training

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Abstract

The present research aimed to reveal whether an augmented reality (AR) direction method would result in more rapid job accomplishment times, reduce mental workload, and have limited faults for simple duties in operational programming. This paper proposes a marker-based mobile AR application called SIPEMA-AR to improve the sustainable, innovative training module to provide interactive content in the form of work instructions for the water meter reading process in the context of a regional water company of workers' training. Previous research on technical work which directly compared AR directions to conventional direction methods (e.g., paper) appeared which AR directions can increase technical work. However, this needed to be more accurate for modest duties in an operational setting. Applicants fulfilled modest technical tasks on the SIPEMA-AR application utilizing AR and paper command methods. The research results indicate that AR instruction has a significant influence on the time needed to do the task could be categorized as fast and the mental of workload could be categorized as low. Using AR instructions before paper instructions provides training that sustainably builds on paper instructions. The SIPEMA-AR application can be used as a support for modest tasks that focus on operational work. The SIPEMA-AR application can avoid problems that occur in operational work. This is because the time, effort, and funds needed in operational work can be minimized and provide maximum results.

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INTRODUCTION

Augmented Reality (AR) is essential in instructional work because AR provides practical steps to achieve research goals. Instructional work focuses on work capable of creating a valuable paper medium by designing, installing, and publishing it to the public, Wahyuni at all (2023). The process of instructional work is very complicated such as explanations in the form of text, images, tables, figures, etc. Wahyuni at all (2023). That is why time is really needed in instructional work because operators have to learn all the elements needed in paper instructions. The result is that they can create valuable and practical works for life. This is supported by Wahyuni at all (2023), that the operators need about 45% of their working time to get much information to support their work.

Instructional work can be divided into two parts, namely physical instructional work and informational, instructional work Wahyuni at all (2023). Informational, instructional work focuses on information obtained by operators by searching, collecting, and summarizing. Physical instructional work focuses on checking that information to investigate the needs of the instructional work. Therefore, operators must have competence in obtaining information.

A distance or gap between the two parts is due to the separation from the part in the instructional work, but both are mutually continuous; this is called cognitive distance Wahyuni at all (2023).Based on the particular context, these two sections require resources in the form of attention and cognition by organizing, studying, revising, and linking the two sections so that they have a positive impact on the instructional work.

Operators have a responsibility in this instructional work that focuses on information and physics because they must be able to multitask in the work process. This relates to the increased skills in working memory, which can be assessed based on multitasking skills Research by Wahyuni at all (2023).shows that access to information can increase rapidly due to the ability to scan space by carefully moving the head. As a result, mobile learning applications can improve and develop with initiative and innovative concepts. The initiative focuses on problem-solving or independence skills by practising motion based on pre- designed guidelines Wahyuni at all (2023). It plays an essential role in gaining knowledge, experience, and information to improve capabilities in working remotely.

Augmented Reality (AR) can be used to minimize the costs required for cognitive distance. Operators can increase their skills to utilize physical space by implementing it in the environment. It can provide an authentic experience because a visual form can appear physically Wahyuni at all (2023). Operators must focus on one space, namely information or physical, to minimize work and time with maximum results Wahyuni at all (2023). The operators will use paper instructions for joining the information space, following the instructions, understanding each element in the physical space, and checking and changing the location from visual to physical form. It is called AR, where visual forms that can be images, text, and diagrams can become physical forms.

AR cues are helpful as a distraction for the operator to focus on information in its physical form. Operators can get information directly through visual indicators around the target so that the operators can understand the tasks in physical form. However, this can harm operators because they will not get their needs. The task display will accumulate and multiply if the physical size is large. AR cues can make them distract the operator's attention to stay focused on the task place. In addition, if the operators are not currently focused on the task, an arrow-size task object will be placed on the display where the operator is located. It helps switch back to the task without

visually scanning Wahyuni at all (2023).Several steps can be used to research the effect of AR instructions Wahyuni at all (2023).

This research aimed to compare the effect of AR and paper instructions supported by the quantitative results that became reports and evidence for these comparisons. In addition, this research aimed to provide information related to the Augmented Reality (AR) direction method that can minimize the processing time needed to complete the work to reduce the workload and avoid problems in functional programming. This research proposal is a marker-based mobile AR application or SIPEMA-AR, practical as a training innovation or a forum for interactive content in the form of work instructions on water meter readings that focus on training Regional Water Company workers.

Current technological developments have supported the learning and training process. Many media, information, and features on today's mobile devices have developed. Augmented Reality (AR) is a technological development that plays an essential role in learning and training. AR is useful as an interactive medium that focuses on merging virtual media that can be integrated into the real world. It can give users a more authentic and genuine experience Wahyuni at all (2023). This is supported by Wahyuni at all (2023), who that AR significantly influences its users in understanding objects that come from virtual forms that are more detailed than reality. Then it appears physically so that users can better understand the object. These objects can be videos, live broadcasts, and images. It is based on the needs of the learning and training process.

AR plays an essential role in education because, with AR, teachers can provide an interactive and innovative learning process. After all, students will be more motivated to learn. They will get more authentic and genuine experiences than just explanations from the teacher without any supporting media for the learning process Wahyuni at all (2023). AR can be developed with current technological developments, including a mobile device Wahyuni at all (2023). To run effectively and efficiently, the mobile device uses must-have features supporting the learning process, such as flexibility and social, personal, and learning contexts Wahyuni at all (2023).

AR positively impacts the learning and training process because, besides having authentic experiences, AR can also be used as a gamification medium to create an interactive, fun and meaningful classroom atmosphere for students participating in the learning process. Students will more easily understand learning material, improve their learning abilities, and gain new experiences. It also supports teachers in providing student assessments in following the learning process.

Research conducted by Wahyuni at all (2023).focused on comparing the time required to assemble a car door using AR assembly instructions, expert instructions, and tutorial paper instructions. Participants who participated in this research received the assembly task using this method randomly. The results of this research indicate that the fastest time to complete the assembly task is the instruction from the expert, then the AR instruction, and the last is the paper instruction. In addition, based on the assembly task results, AR can minimize the time needed to complete the task, especially in installing window controllers. It differs from using paper instructions which require more time than paper instructions to complete the assembly task. However, the simple and repetitive tasks are similar, especially attaching wire clips.

Another research by Wahyuni at all (2023).focused on the performance results obtained using AR instructions, mainly flipping switches, removing bolts, and connecting cables. This research was done by changing manual images and text into virtual displays as primary objects. This research indicates that the maximum performance results are by using AR instructions instead of manual instructions. This proves that participants who use AR instructions can speed up the process because they can get information regarding

the next task to maximize performance results. In addition, the time required to complete the task using the media is different; however, this research focused on simplifying the task by avoiding displaying information related to the task.

Subsequent research by Wahyuni at all (2023) examined motorized vehicles' combustion chambers using AR and traditional instructions. This research was carried out by displaying images on mobile phone screens as the basic concept of this research. This research indicates that AR instruction significantly affects time efficiency, minimizing errors and maximizing results. Participants in this research stated that the use of AR instruction could assist them in completing this complex task.

From the results of the studies that have been described, the main focus is the use of AR instructions which have an essential role in procedural work. AR instructions are believed to minimize task execution time and maximize performance results. There are various examples of assembling using AR instructions, especially making toy blocks that can be completed efficiently and quickly Wahyuni at all (2023).

WahAR instructions also can be used for motor vehicle combustion chamber assembly, which showed maximum results Wahyuni at all (2023).Finally, the use of AR instructions for more complex tasks, especially car door assembly Wahyuni at all (2023).Unfortunately, AR instructions are difficult to use in carrying out the simple task of assembling a car door, especially attaching wire clips Wahyuni at all (2023).AR instruction also needs maximum results against simple tasks, such as flipping switches Wahyuni at all (2023).However, AR instruction can provide a low mental workload. Even though it significantly influences procedural work, AR instruction can cause problems, especially problems in the size and weight of the devices used in the procedural work Wahyuni at all (2023).

METHODS

This research was followed by 36 staff of Regional Water Company at Buleleng Regency aged 22 to 52 years. The researchers give information about visual acuity, motor control standard, and experimental hypothesis. In addition, this research obtained informed consent from each participant. This research was carried out by designing a notional procedure to install and maintain this instrument. This research was carried out by giving assignments to all participants, namely, reading the water meter. All participants used AR instructions and paper instructions to input the water consumption volume into SIPEMA-AR.

Figure 1. SIPEMA-AR Application

Current Research

This research focused on using AR instructions integrated with the SIPEMA-AR application, which aimed to determine how fast the time needed to do the task was, whether the mental workload could be categorized as low, and the errors that occur in its implementation in procedural tasks. This research

was carried out by displaying AR instructions as an application. The application provided an understanding of work procedures in reading water meters and estimating the time needed to make it more efficient. This was due to the speed at which physical objects in information space were integrated into a natural environment. The research hypothesis was that the research participants could complete tasks quickly, reports from participants that the mental workload could be categorized as low, and errors that occur during work implementation could be minimized. This is because AR instructions are more effective and efficient than paper instructions.

Instruction Method

The primary paper instruction method used basic procedural instructions for SIPEMA-AR. Paper instructions can be used as a checklist for procedural tasks. It consists of the customer's name, water id number, water level number, and catchment area where the water meter is located. Traditional instructions are developed using technological developments, namely AR instructions. It aims to make it simpler and different, but the information contained in it remains the same. In the experimental process, this research was carried out by attaching a paper checklist to a clipboard. All participants could hold a clipboard and place it on a table nearby. For every task they completed, they must put a tick mark on each task on the paper checklist. If they had given a sign, they could continue the next task.

The AR instruction method makes it easy for participants to see a virtual checklist in the centre of the instrument and see these essential task areas. The AR instruction method also displays the customer's name, water id number, water level number, and the catchment area are displayed. In addition, the AR instructions also have three types of cues (Figure 1). The researchers started this research by showing a display of a virtual bounding box in the target water meter area as the primary source. After that, each participant was given the name of the target water meter as a virtual procedure. Finally, a small virtual symbol appeared on the screen to direct the participant's attention to the target water meter. It occurred when the target water meter was not visible to the participants or users. After receiving the approval order, the column was finished with a check mark. It means that participants had completed the task and were going to the next task.

Procedure

After the participants completed the tasks given in this research, they were required to fill out a questionnaire that contained their experiences participating in this research process which focused on AR and VR instructions. Researchers provided information to participants regarding the science instruments that were the experimental material and an overview of the assignment. In addition, participants also did one block of 15 tests based on the use of instructional methods. Previously, the participants had been given three opportunities to try or practice the trials. It is intended so that participants get used to it and understand each element in the trial. If they do not understand, the research can provide a deeper understanding. Participants were also given a long time to adapt to the trial until they were ready to work on each trial block. Therefore, participants must learn to read procedures, especially inputting meter data, to carry out tasks using the SIPEMA-AR application.

Each participant in this research attempted to do the task quickly, briefly, and accurately or without the slightest error. Before this research started, the researchers asked all participants to check SIPEMA- AR in detail, especially a stable system. The time to complete the task was recorded by each participant using a stopwatch. After they give the check to the box in the paper instruction, the trial could be stated done. AR instruction method required participants to capture image objects after completing the task. In addition, the estimated time to do the task was 90 minutes.

RESULTS AND DISCUSSION

Results

This research was carried out with the experimental running time (in seconds) subjected to 2 (type of task: reading the vertical water meter, capturing the vertical water meter) x 2 (experimental order: A, B) x 2 (instruction methods: AR, paper) x 2 (instruction methods: first AR, first paper) ANOVA (mixed analysis) and group influence. The research result showed the water meter reading experiment (M= 33.58, SD= 9.14). This means rapid than the standing water meter capture experiment (M= 54.22, SD= 11.72). This is supported by the influence of main task, $F(1, 21) = 191.23$, $p < 0.001$. The researchers asked all participants find the standing water meter without any help at all. The SIPEMA-AR application is a more modern development of paper instructions that have a function as a target water meter guide. Based on the experiences of all participants, they stated that they were able to complete tasks faster by using AR instructions (M = 36.24, SD = 11.45). While the use of paper instructions took more time to do the task (M = 51.14, SD = 17.38). This result is supported by the main effect result in the instruction method, $F (1, 21) = 32.67$, $p < 0.001$. These results would be tested further to get valid results.

The instruction method and the instruction method sequence are related to each other, $F (1, 21) = 22.45$, $p < .001$. Researchers tested these results using the ANOVA test to provide more in-depth results in the instruction method sequence. This research also showed that completing experiments using AR instructions can be categorized faster than paper instructions (Figure 2). This happened when the participants completed the task using the paper instructions before the AR instructions. The participants will complete tasks faster if they start using paper instructions and then use AR instructions. This has a significant influence on using AR instructions, especially on the estimation of the time needed to do the task. Yet, the use of AR instructions before paper instructions showed no significant difference in the time needed to complete the task using both instructions. Furthermore, the researchers checked for errors that occurred in using the two instructions by using a sample t-test. These results indicate that there is no difference that becomes significant influence, $t (21) = -2.134$, $p = .213$, $d = 0.24$. Errors still occurred in both instructions, namely AR instructions and paper instructions. Therefore, the researchers attributed this result and the tasks.

The results of this research indicate that the time required to experiment using AR instructions can be categorized as fast (32.12

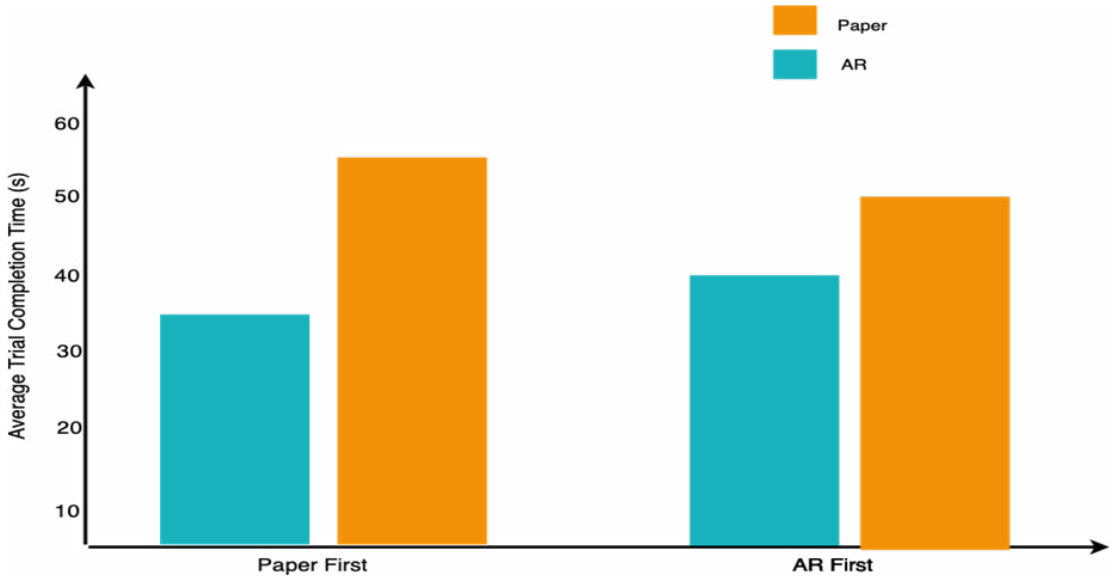

Figure 2. The Impact on Instruction Method for Average Experiment Accomplishment Time

seconds) compared to paper (39.68 seconds). There is a transfer of training in the process of using AR instructions, which can increase the number of subsequent procedures that focus on using paper instructions. In addition, participants in this research stated that the mental workload was low using AR instruction. However, these two methods did not have a significant difference in the errors made by the participants in this research.

Discussion

The research results are fascinating because the researchers carried out it simply by reading and capturing the water meter. The research novelty is the existence of hardware integration in the form of the development of AR instruction technology which significantly influences procedural work. This is believed to improve development, especially in virtual perception and user interaction. In addition, another difference between this research and previous research is the existence of the training. This research focused on participants with no experience using this research instrument, while [18] focused on participants with experience in their research. In addition, [18] focused on novice participants with different assembly tasks but still used AR instructions. Further research focusing on AR instruction needs to be carried out to support this research. So, there is other information related to AR that can improve procedural work for operators who perform ordinary or routine tasks.

Practical Implications

The practical implication of this research is procedural work in the operation of regional water companies using complex and validly tested instruments and documentation. Researchers need time to make instruments and documentation to succeed in this research. The researcher focuses on simplifying the paper instruction method into AR instruction, which is expected to affect procedural work significantly. In addition, researchers also hope that the performance results of more complex tasks can be further improved by using AR instructions.

Transferring of training using AR instructions can train new staff to understand water meters. The participants in this research used the sans procedures and instruments designed by the researcher for the first time. The results showed that although they had no experience using AR instructions, they experienced increased performance in the assembly task. Even though they only got a short time to learn the elements of AR instructions. It proves that AR instructions are easy to understand and significantly impact completing assignments on time. However, what needs to be emphasized is that if humans make an error in the procedure, problems will have a negative impact, such as loss of important information data, wasted time, and much money needed to overcome this problem[19]. Therefore, this procedure must be carried out correctly in order to have a positive impact.

CONCLUSION

Although the results of this research indicate that the use of AR instructions significantly influences procedural work, the research's limitations were the tools used in the research. Participants stated that they found using the features on the device challenging. They must be able to focus on virtual and physical objects. This makes them divert their eyes to two essential points for maximum work results. Researchers hope that with technological developments, there will be innovations, namely devices that can be lighter and display a wider field of view. In addition, optical display technology also needs improvement in its design so that the accommodation-vergence conflicts experienced by participants in the research can be minimized. All solutions have been made to minimize this

problem, but all of them take a long time to be used in the market. The asynchronous distance between AR displays and physical and virtual content will cause problems in convergence accommodation.

Researchers found that attention-directing cues in this research could minimize accommodation- vergence problems because the virtual bounding box is easy to reach seen. Furthermore, the transfer of training influences AR instructions to paper instructions, especially in virtual bounding boxes and visual scanning, which is avoided by displaying virtual checklists. This research does not focus on assessing every factor in AR instruction. Therefore, further research plays an essential role in continuing the assessment of other factors to provide a novelty from this research.

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