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AUGMENTED CLUTCH REALITY MOBILE: INNOVATIVE EDUCATIONAL MEDIA FOR MODERN ENGINEERING

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ABSTRACT

One of the interactive technologies that can be applied to improve the quality of education in the era of the 4.0 revolution is augmented reality (AR). The purpose of this study is to develop interactive media augmented clutch reality based on mobile (ACRMobi) in the powertrain course. In addition, it analyzes the responses of lecturers and students to the implementation of ACRmobi as a modern vocational education media in the 21st century. The 4D model is used as a media product development model while the instruments used are validation and response questionnaires to the media developed. It uses descriptive qualitative and quantitative analysis techniques to calculate the average score by looking at the criteria for the results. The findings obtained in the form of ACRmobi media that was developed are valid based on expert assessments and practical based on lecturer responses and student responses after being implemented at one of the vocational education institutions. Experts who act as validators report that ACRMobi is an interactive media that can be applied to vocational education. ACRMobi contains elements that can increase student motivation because it is technology-based. Integrated learning ACRMobi is more motivating and more flexible in its application.

Keywords: *Augmented Reality, Powertrain, 4D Model, ACRMobi, Quality Education*

1. INTRODUCTION

The technological advancements of the 21st century have significantly impacted various sectors, including vocational education [1, 2]. One of the technologies currently trending in educational institutions is Augmented Reality (AR), which has the potential to transform educational media [3–5]. AR is a technology that digitally integrates information with the real environment in real time, providing students with an interactive learning experience [6–9]. Unlike conventional learning methods, AR offers users a complete visualization of concepts, enhancing their understanding in unique ways [10, 11].

The use of AR in vocational education can significantly increase student engagement [12]. In learning, conventional students often only receive information passively. However, with AR technology, students can actively interact with the learning materials involved in this technology [13, 14]. AR technology allows for more flexible and personal learning [15]. Students can learn at their own pace and ability, able to repeat difficult-to-understand material based on a comprehensive 3D display to solve the problems that have been given [16–18].

In addition, students can visualize virtual experiments by imitating real-world conditions [19]. This makes learning activities more interesting and of course, can also develop students' practical skills. AR can display 3D models of engine components with the highest level of detail. For example, in the powertrain course, AR can display 3D models of powertrain components such as clutches, transmissions, propeller shafts,

differentials, and axles. This allows students to observe in more detail including parts that are difficult to reach on real objects. AR also allows visualization of component movements in real-time and interactively. Students can rotate, enlarge, or reduce the 3D model and can see the movement of components or the interaction of components with each other. Because the focus of AR technology is on cumulative units, students will be greatly assisted in understanding the working concept of transmission mechanization and be able to interact in the form of digital displays.

The clutch is part of the powertrain that explains the components that function to connect and disconnect power from the power source, namely the engine to the transmission in light vehicles [20]. This clutch unit is an important component for a vehicle to be able to run properly [21]. Students are expected to understand the clutch, how to disassemble and install it, understand the components, the measurement process and analysis of the damage that may occur in light vehicles, and understand how to handle it both theoretically and practically. With this visualization activity, students can manipulate and see the condition of each part of the clutch component and can interact dynamically. This provides a deeper experience of the clutch mechanism in the powertrain system course.

The powertrain is a component that involves principles that are often difficult for students to understand through conventional learning methods. Using conventional learning methods is often less able to provide the practical work experience needed to understand the clutch system in the powertrain. A need for an innovative approach to bridge the gap between knowledge and practical application of this system. The introduction of AR technology in project-based learning (PBL) is one alternative to answer this need by offering an interactive platform with activities in the form of real projects. Students can visualize and interact with the clutch unit model on the powertrain virtually. This not only improves their understanding of the learning material but students feel actively involved compared to using conventional methods [22–25].

According to the World Economic Forum (2023), practical skills in the 21st century are very important to pay attention to, there are at least 9 skills needed in the world of work [26]. These skills include analytical thinking, active learning, complex and creative problem-solving, adaptability, collaboration, communication, and decision-making skills. All these skills are at least able to face the challenges of life in the future. AR is one of the educational media that can help develop these skills with a platform for students to be able to apply the knowledge they gain in real situations. This research is a solution to developing these skills of concern.

The use of AR technology in education has attracted much attention from researchers and practitioners in the field of education. Several studies have shown that AR technology can increase student engagement in understanding broader concepts and also improve students' practical skills [27–29]. Although some evidence suggests that AR can improve the quality of learning in various disciplines, there is concern about the development and implementation of AR technology in powertrain courses which is still minimal. The absence of research that specifically examines the validation and implementation of AR technology on the topic of clutches in powertrain systems can leave a knowledge gap on how AR can be applied in this field.

The problems in this study center on the challenges faced by students in understanding the concept and working mechanism of the clutch through learning methods that are still based on text and static visualization. The lack of interactive learning media causes limitations in detailed visualization and understanding of the principles related to the working of components so students have difficulty in linking theory to practical activities.

Based on the problems that have been presented, the research questions raised are as follows: 1) to what extent is the level of validity and practicality of ACRMobi as an interactive media in facilitating students' understanding of the clutch system? 2) how do lecturers and students respond to ACRMobi after being implemented in class?

This study focuses on developing ACRMobi as an interactive media in powertrain learning on the topic of clutch units. This research process includes the process of designing, developing, and validating the product. After the implementation process in the field, the practicality of the ACRMobi media will be assessed based on responses from education experts and user responses. The scope of the material is limited to the clutch system which is part of the powertrain system in light vehicles. In addition, this study does not include an in-depth analysis of the impact of using ACRMobi on student learning outcomes because the main focus is on the validity and practical aspects of the media.

Another limitation is that the ACRMobi media can operate on certain specifications, such as the operating system used is based on Android and has the specifications needed so that the features can run optimally. Based on this, the purpose of this study is to develop ACRMobi. The ACRMobi that has been developed is then analyzed for the level of validity and practicality of the media based on the responses of lecturers and students when implemented at a vocational education institution.

For ACRMobi to be accessible to more students with different devices, the development of multi-platform applications (Android, iOS, and Web) needs to be considered. In addition, optimizing the application so that it can run on devices with lower specifications will increase accessibility for educational institutions that have limited technological facilities. Another solution that can be offered is to develop an advanced version of ACRMobi that includes other powertrain components such as transmission, differential, and propeller shaft. By expanding the scope of learning media to the entire powertrain system, students will gain a more holistic understanding, allowing them to learn the interactions and relationships between components.

2. METHODS

2.1 Research Design and Participants

This research, in addition to developing interactive media, also aims to reveal the validity and practicality of the media, namely augmented clutch reality mobile (ACRMobi) technology. It is called ACRMobi media because there is AR technology in presenting visual information in the real world. The clutch on ACRMobi is because the focus of this media development is on light vehicle clutch units. Mobile on ACRMobi because this media is designed for mobile-based cellular devices with the Android operating system so that users of the media can access it anytime and anywhere. Utilizing AR technology, ACRMobi allows users to see more detailed and interactive 3D visualizations of clutch unit components directly through mobile devices.

To achieve this goal, a qualitative descriptive and quantitative research design is used in the form of a survey method. The survey conducted was by collecting data on the validity of the ACRMobi that had been developed. Validity data collection activities were carried out when the product had been developed. The ADDIE model was used as the ACRMobi development model while the survey stage was in the third stage of the development model (**see Figure 1**). After the ACRMobi media was developed, to reveal the validity of the product using a validation assessment instrument on each of the recommended experts. After the revision process, ACRMobi was implemented to see the response from lecturers and students to the interactive media using a response questionnaire.

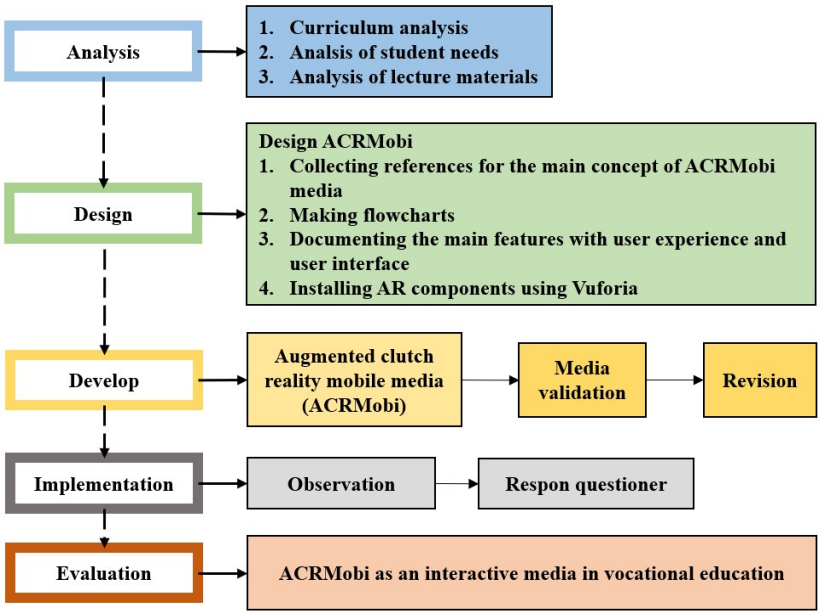


Figure 1: ACRMobi Media Development Flowchart

The feasibility of the ACRMobi product is assessed based on the validation aspects provided by experts in the fields of material, media, and pedagogy. 5 material validators come from lecturers who teach in the field of automotive engineering and language education lecturers. The media validators are 5 lecturers who are experts in the field of media and are graduates of informatics and animation engineering. Meanwhile, the pedagogical validators are 5 lecturers who are graduates of automotive engineering who teach in the field of education. The results of this survey will later provide quantitative validity of ACRMobi. Meanwhile, for filling out the response questionnaire after going through the implementation process, 5 automotive lecturers and 42 students filled out the response questionnaire to see the practicality of ACRMobi. This study has been reviewed by the Ethics Committee at the educational institution at Padang State University (UNP). Based on the results of the decision from the Ethics Committee, this study follows the ethical standards and the UNP Research Code of Ethics.

2.2 Data Collection and Analysis

This study uses a non-test instrument in the form of a questionnaire given to the validator after product development. After being implemented in the field, the response questionnaire was given to lecturers and students. The validation instruments were in the form of material validation, media validation questionnaires, and pedagogical validation questionnaires. a) The material validation questionnaire was used to see the completeness and clarity of the material presented by ACRMobi. This questionnaire contains aspects of curriculum suitability, completeness and suitability of the material, and the suitability of the grammar used (**see Table 1**). b) The media validation questionnaire was used to see if the quality of the media developed, namely ACRMobi can help the learning process. This questionnaire contains information about the appearance of ACRMobi, the animations developed, and the ease of using the media in the learning process (**see Table 2**). c) The pedagogical validation questionnaire was used to see the truth of the nature of the media developed in the learning process (**see Table 3**). The content aspects of this pedagogical questionnaire are in the form of components of the ACRMobi media and the usefulness of the media in the learning process.

Table 1: Variables and Indicators of ACRMobi Material Validation

Variable	Indicator	
Curriculum (C)	C.1	ACRMobi material is by the learning outcomes of graduates
	C.2	ACRMobi material is by learning objectives
Material Design (MD)	MD.1	ACRMobi material concept is correct
	MD.2	ACRMobi cases are by what is presented
	MD.3	ACRMobi material is by the learning outcomes of the coupling unit
	MD.4	ACRMobi material is clear and by the learning indicators of the coupling unit
	MD.5	ACRMobi material is complete and by the completeness of the learning outcomes of the coupling unit
	MD.6	The concept of material in ACRMobi is deep and the learning outcomes of the coupling unit
	MD.7	ACRMobi material presented is by competency achievement indicators
	MD.8	Images in ACRMobi can represent the topic presented
	MD.9	Easy-to-understand material
Grammar (G)	G.1	Language in ACRMobi material is by the specified language rules
	G.2	The language used in ACRMobi is simple and easy for students to understand

Table 2: Variables and Indicators of ACRMobi Media Validation

Variable	Indicator	
Display Design (DD)	DD.1	The design of the ACRMobi display is by the characteristics of the media that is designed interactively
	DD.2	The images on ACRMobi are visible
	DD.3	The videos on ACRMobi are easy to understand
	DD.4	The ACRMobi menu display makes it easy for users
	DD.5	The fonts on ACRMobi are clear and can be read by users
	DD.6	The buttons are consistent in terms of the colors and icons used
	DD.7	The colors used are consistent and not flashy
Animation Design (AD)	AD.1	The animations used are not excessive
	AD.2	The animations used are by the characteristics of the user
	AD.3	ACRMobi is interactive
Ease of Use (EoU)	EoU.1	ACRMobi is easy to use
	EoU.2	ACRMobi can be used on devices that use the Android operating system
	EoU.3	ACRMobi has navigation buttons
	EoU.4	ACRMobi is interactive and efficient

Table 3: Variables and Indicators of ACRMobi Pedagogical Validation

Variable	Indicator	
Media Content (MC)	MC.1	Instructions for using ACRMobi can be understood
	MC.2	Learning achievement indicators are by the level of student thinking
	MC.3	Components in ACRMobi support innovative learning
	MC.4	Components in ACRMobi support the achievement of problem-solving indicators
	MC.5	The material presented can help students solve problems
	MC.6	Images in ACRMobi can help students understand the lesson material
	MC.7	Videos in ACRMobi help students understand the material
Media (M)	M.1	ACRMobi can increase learning activity and motivation
	M.2	ACRMobi can be used for independent learning
	M.3	ACRMobi is by the level of student development

The next instrument after the implementation stage is a response questionnaire consisting of lecturer responses and student responses (**see Table 4** and **Table 5**). The response questionnaire contains the case method used, problem-solving indicators, and the display design of ACRMobi after being implemented.

Table 4: Variables and Indicators of ACRMobi Practicality based On Lecture Responses

Variable	Indicator	
Case Methode (CD)	CD.1	ACRMobi provides challenging cases
	CD.2	ACRMobi makes it easy for students to express cases
	CD.3	ACRMobi makes it easy for students to collaborate in solving cases
Troubleshooter Indicator (TI)	TI.1	ACRMobi can improve students' ability to understand problems
	TI.2	ACRMobi can improve students' understanding of analyzing problems
	TI.3	ACRMobi can improve problem-solving planning
	TI.4	ACRMobi can improve in compiling problem-solving solutions
	TI.5	ACRMobi can improve in evaluating problem solutions
Display Design (DD)	DD.1	ACRMobi's display design is attractive to students
	DD.2	The size of the writing on ACRMobi is readable
	DD.3	The use of color in the media is consistent
	DD.4	Animation on ACRMobi is not excessive

Table 5: Variables and Indicators of ACRMobi Practicality based On Student Responses

Variable	Indicator	
Case Methode (CD)	CD.1	ACRMobi provides challenging cases
	CD.2	ACRMobi makes it easy to express opinions
	CD.3	ACRMobi makes it easy to have group discussions to solve problems
Troubleshooter Indicator (TI)	TI.1	ACRMobi can improve the ability to understand problems
	TI.2	ACRMobi can improve the ability to analyze problems
	TI.3	ACRMobi can improve the ability to plan alternative problem-solving
	TI.4	ACRMobi can improve the ability to formulate solutions
	TI.5	ACRMobi can improve the ability to evaluate solutions
Display Design (DD)	DD.1	ACRMobi's display design is interesting to me
	DD.2	The size of the writing on ACRMobi can be read well
	DD.3	The colors used are consistent and not distracting
	DD.4	The animations used are not excessive

Validity and response instruments use a Likert scale with 5 alternative answers [30]. The analysis used is quantitative descriptive on validation data and qualitative descriptive to provide meaning and decision-making. The analysis technique used in the validity instrument is Aiken's V coefficient [31]. The results of the Aiken's V value obtained are interpreted in the minimum V criteria table which depends on the number of alternative answers and the number of raters (validators) used. The analysis technique used in the responses of lecturers and students is based on the percentage of questionnaire score assessments and interpreting data in the percentage criteria table.

3. RESULTS AND DISCUSSION

3.1 Results of The Define Stage

The define stage is the initial activity in developing ACRMobi media, this stage starts with curriculum analysis, analysis of student needs, and analysis of the teaching materials used. Based on initial observations, students have difficulty understanding powertrain concepts. Learning that focuses on physical demonstrations makes active student involvement less than optimal. Through ACRMobi, interactive visualization and simulation of powertrain components are possible, which helps students understand more deeply without the limitations of physical facilities.

The results of the analysis of student needs, as many as 47.5% of respondents agreed that they need the use of AR media, 35% of respondents said that AR is needed and 17.5% of respondents said it is quite needed in powertrain learning activities (**see Figure 2**). Although AR technology is no longer new, there are still many respondents who do not know about this technology. As many as 39% of respondents are not familiar with AR technology, although the rest know, that AR in the powertrain field has never seen it at all. Respondents who are aware of this AR information said that this technology can help them understand the concepts of powertrain lectures and they agree that AR can increase students' active participation in learning.

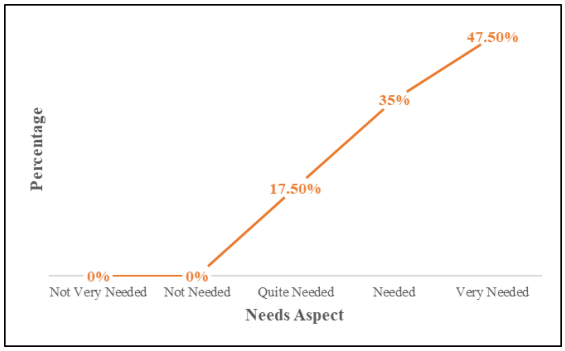


Figure 2: Student Perceptions Regarding Augmented Reality (AR) Technology

The results of the analysis of teaching materials, generally the materials used are in the form of textbooks, demonstration videos, and practical learning activity modules. So far, the media used by educators in teaching still use modules, powertrain media in physical form, and video references from several websites. Conventional teaching materials are not enough to answer the interactive learning needs of students. Teaching materials in the form of AR can enrich learning and offer flexible and interactive 3D simulations. Therefore, based on this, it is necessary to develop interactive learning media based virtual such as AR media so that there are group activities for students to be able to collaborate or be independent in the learning process.

3.2 Results at The Design Stage

The design stage includes designing ACRMobi by collecting main concept references so that there is a formulation of ideas and an understanding of how the existing references work. Vuforia was chosen as a platform for developing ACRMobi features because of its reliability in supporting image recognition, 3D object tracking, and integration with Unity. The next step is to design a flowchart that functions to plan ACRMobi to work. This diagram includes the steps that will be taken by users (educators and students) from the beginning to the end of the ACRMobi use process. The flow diagram regarding the sequence of stages that need to be carried out in using ACRMobi media can be seen in **Figure 3**.

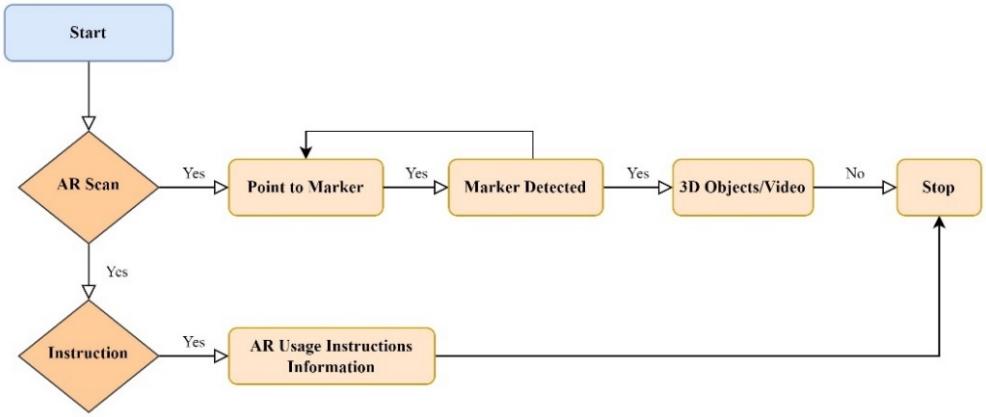


Figure 3: Flowchart of ACRMobi

To ensure that users can use ACRMobi easily, a user interface (UI) and user experience (UX) are designed to be user-friendly and interactive. The sequence of ACRMobi media usage by users can be seen in **Figure 4**. The figure shows how to use ACRMobi from both the student and educator sides. Of course, this will help students to maximize their knowledge of component displays that are clearer and can be accessed anywhere, if they use markers that have been set and adjusted to

the original image for the media scanning process. ACRMobi can display 3D objects on the clutch components as a whole and can show the function of each component that has been made into a 3D display. By referring to appropriate and relevant references, flowcharts, and interactive features, ACRMobi is designed to provide an in-depth and interactive learning experience in the powertrain course. This step ensures that the ACRMobi developed is following the curriculum needs and characteristics of students.

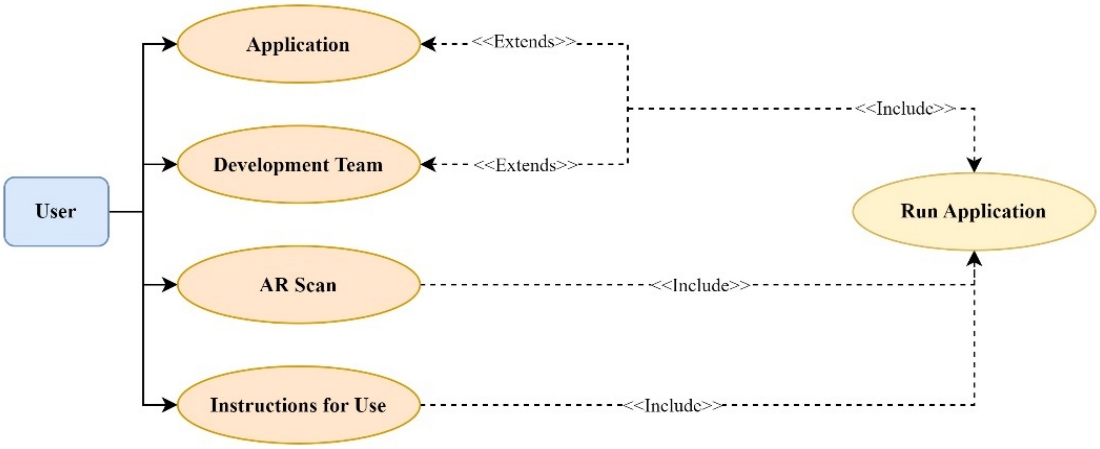


Figure 4: Use Diagram of ACRMobi Media

3.3 Results of The Develop Phase

The display of the results of the ACRMobi development can be seen in **Figure 5** and **Figure 6**. ACRMobi can display 3D digital images of the clutch components and the working mechanisms of the system. Through this visualization activity, it is hoped that students will be able to manipulate by seeing the condition of each component and be able to interact to create an interesting and in-depth learning experience regarding the clutch unit material in the powertrain course. The use of the Android platform is very helpful in processing digital visualization of the clutch unit mechanism so that it becomes more alive and easier to understand. This helps students to understand the learning material more quickly with the presence of real images that can be accessed in real time from existing components.

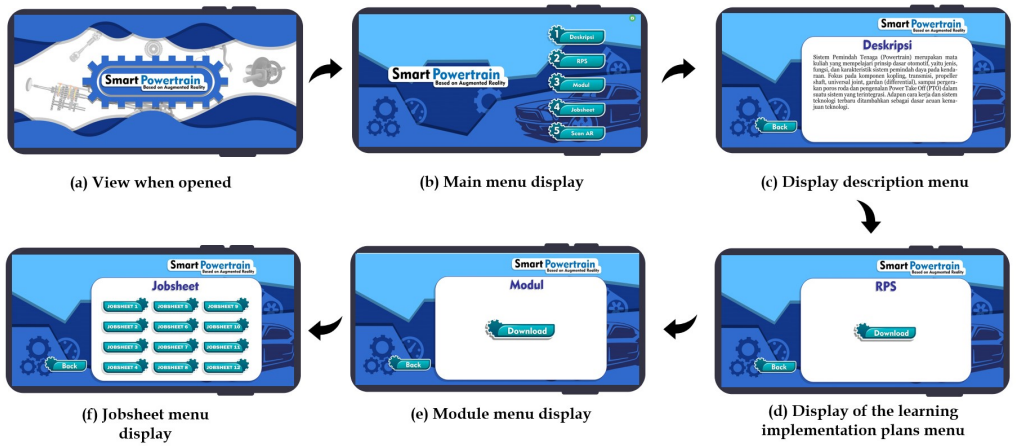
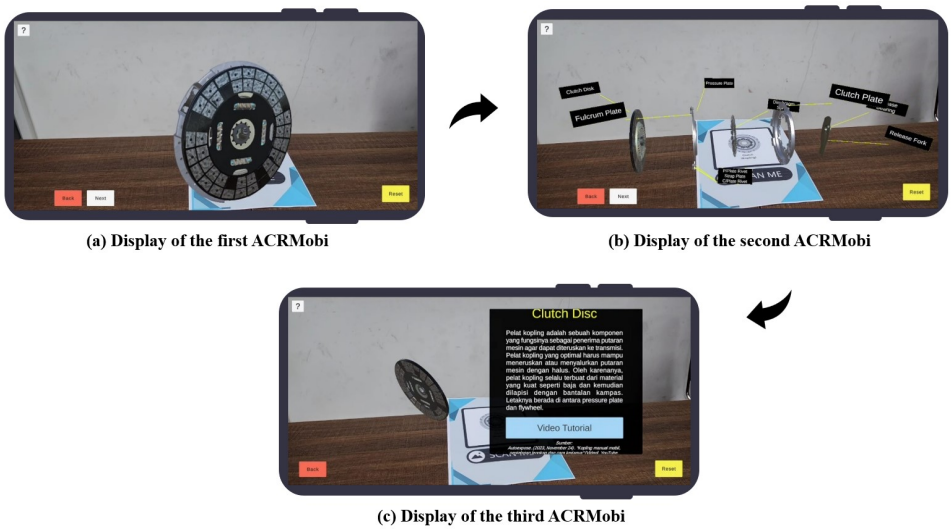


Figure 5: ACRMobi Mobile Application Media View

Figure 5 is a display of the ACRmobi mobile application media that can be opened using the Android system. Display (a) presents visual elements that represent the powertrain components in vehicles with the title "smart powertrain" which gives a professional and modern impression. After

passing the opening display, users will be taken to the main menu in section (b) which consists of various options such as descriptions, learning implementation plans (LIP), modules, and jobsheets. This menu functions as the main navigation for users to select the features they want to access in the ACRMobi application. The description menu display (c) contains a complete description of the powertrain as a whole and explains the background of the material to be studied. The LIP menu display section (d) provides access to LIPs that can be downloaded. This helps students understand the learning map for one semester. The module menu display (e) provides access to learning modules that contain structured material about the powertrain system and can be downloaded directly by users. Finally, the job sheet menu display (d) is used by users to access various available job sheets that are by the topics needed. This job sheet will help students follow instructions or practical assignments related to the powertrain system.



(a) Display of the first ACRMobi

(b) Display of the second ACRMobi

(c) Display of the third ACRMobi

Figure 6: ACRMobi Media Scan View

Figure 6 is a display of the scan results from ACRMobi on the prepared marker which provides 3 main scan displays that are made into 3D images. The first display (a) ACRMobi shows the clutch components in 3D. These components are displayed in detail to provide a more realistic visualization and can help students understand the shape and function of the clutch in the powertrain. The second display (b) shows a more in-depth visualization by showing several additional components in the clutch system. This display provides an interactive understanding for students to recognize important components in the clutch unit. The last is the third display (c) which provides additional information in the form of detailed explanatory text for each clutch component and there is an option for a video tutorial to add to and enrich the experience.

3.4 Validation Aspects from Experts

The average value of Aiken's V in the material aspect is 0.93. The Aiken's V value obtained is higher than the minimum level of validity requirements, meaning that the material aspect in ACRMobi is valid. This value obtained shows that the ACRMobi developed meets the criteria for significant material validity. These aspects include the relevance of content to learning objectives, the relevance of the material used, and ease of understanding for students. The assessment of the material aspects of each indicator can be seen in **Table 6**. The lowest average value of Aiken's V on the curriculum variable is 0.91, and the highest on the grammar variable with an average value of 0.98.

Table 6: Results of ACRMobi Material Validation

Variable	Indikator	Aiken's V Score	Average	Category
C	C.1	0.88	0.91	Valid
	C.2	0.94		Valid
MD	MD.1	0.00	0.92	Valid
	MD.2	0.90		Valid
	MD.3	0.00		Valid
	MD.4	0.90		Valid
	MD.5	0.85		Valid
	MD.6	0.85		Valid
	MD.7	0.95		Valid
	MD.8	0.95		Valid
	MD.9	0.95		Valid
G	G.1	1.00	0.98	Valid
	G.2	0.95		Valid

According to material experts, the ACRMobi that has been developed is by the competency achievement indicators and the topics displayed are by the learning objectives. The ACRMobi display already represents the material and is easy to understand and the language used in ACRMobi is simpler so that it is easy to understand. There are several corrections and revisions made so that ACRMobi gets a high validation value in the material aspect, such as adjusting the material that is relevant to the learning topic. The results of this revision will later go through communication and several discussions in joint improvements with the ACRMobi development team. This study is in line with the findings put forward by Hamzah et al (2021), emphasizing the importance of relevance and relevance of learning materials in the development of AR media [32]. This ACRMobi study shows that this media is not only relevant in terms of content but also valid for use. Research conducted by Zain et al (2022), states that material relevance is a key factor in developing AR media [33], but ACRMobi media can add elements of clarity and ease that are measured quantitatively.

Viewed from the media aspect, the average value of Aiken's V is 0.91. This media aspect includes the structure and organization of the material, the clarity of the instructions used, the visual design developed, and the interactivity of the ACRMobi media. The assessment of the media aspect for each indicator can be seen in **Table 7**. The average value for each variable in the material aspect has also passed the minimum validity limit. The lowest average value of Aiken's V is in the display design variable of 0.86 and the highest is in the animation design of 0.97. This shows that the ACRMobi media in a well-designed powertrain system has followed a clear structure and is easy to use by students. Good construction is very important to ensure that the ACRMobi developed is not only visually attractive but also easy to use and apply and easy to follow by users.

Table 7: Results of ACRMobi Media Validation

Variable	Indikator	Aiken's V Score	Average	Category
DD	DD.1	0.85	0.86	Valid
	DD.2	0.90		Valid
	DD.3	0.85		Valid
	DD.4	0.80		Valid
	DD.5	0.85		Valid
	DD.6	1.00		Valid
	DD.7	0.80		Valid
AD	AD.1	1.00	0.97	Valid
	AD.2	0.90		Valid
	AD.3	1.00		Valid
EoU	EoU.1	0.85	0.91	Valid
	EoU.2	0.90		Valid
	EoU.3	0.90		Valid
	EoU.4	1.00		Valid

According to media experts, the ACRMobi media that has been developed is by the characteristics of interactive learning. The images and use of colors are consistent and not too flashy. The use of animation is not excessive and by the characteristics of the user. The media developed is easy to use and can be used on various mobile devices that use the Android operating system. Although there were previous findings that it could not be operated on various brands of mobile devices, after continuous revision, this could be resolved properly. This study strengthens the findings of Prihandini & Siswati (2022) which emphasize the importance of visual design and interactivity in technology-based learning [34]. ACRMobi offers additional advantages in terms of easy use and clear material structure. Adenan et al (2022) and Yanto et al (2024) also emphasize the importance of interactive media to be implemented in learning [35, 36]. This study shows that ACRMobi is not only an interactive media, but the findings of this study are valid overall.

The average result of Aiken's V for the pedagogical aspect is 0.92. This pedagogical aspect includes technical accuracy, the suitability of the media developed based on engineering principles, and the ability of ACRMobi to simulate more complex and broad technical concepts. The assessment of the pedagogical aspect of each indicator can be seen in **Table 8**. The average value of Aiken's V on the media content variable is 0.90 while on the media variable, the average value is 0.91. The values obtained indicate that ACRMobi on the powertrain system is valid from a pedagogical aspect and pedagogical experts agree that ACRMobi can be used to teach concepts accurately and optimally in the field. The high average obtained shows that the ACRMobi media developed can provide a realistic and in-depth learning experience for students.

Table 8: Results of ACRMobi Pedagogy Validation

Variable	Indikator	Aiken's V Score	Average	Category
MC	MC.1	1.00	0.90	Valid
	MC.2	0.80		Valid
	MC.3	0.80		Valid
	MC.4	0.90		Valid
	MC.5	0.90		Valid
	MC.6	0.90		Valid
	MC.7	1.00		Valid
M	M.1	1.00	0.91	Valid

	M.2	1.00		Valid
	M.3	0.81		Valid

According to pedagogical experts, the ACRMobi media that has been developed has supported the achievement of indicators in problem-solving. The media displayed can help students to understand the subject matter well. The media used can increase learning motivation and can also be used in independent and collaborative learning. Although it has undergone several revisions, the problems have been resolved and received a good response from pedagogical experts. This is in line with the findings of Mihić & Zavrski (2017) who emphasized the importance of technical accuracy in vocational education learning media [37]. ACRMobi offers a deeper and more realistic experience.

Research conducted by O'Connor & Mahony (2023), states the importance of pedagogical components in making AR media to be applied to the world of education [38]. In its application, AR technology will help the learning process in the world of education [39, 40]. ACRMobi shows that these elements can be integrated with technology and can be applied in education. According to Ahmad & Junaini (2020) and Uriel et al (2020), learning by utilizing technology as a learning medium increases students' motivation to learn [41, 42]. Students feel more involved and feel the 3D image as if it were real so this becomes a fun motivation [43]. Al-Ansi et al (2023) added that using AR media can reduce the cognitive load for students so that they can think better in solving the problems that have been given [44]. The high validity value shows that the ACRMobi media can be relied on as a tool in the learning process and has great potential to be applied more widely in the field.

A summary of the results of the validity that have been given by experts to ACRMobi can be seen in **Table 9**. The table shows that ACRMobi has been validated and declared valid both in terms of media, material, and pedagogy with a total average of Aiken's V for each aspect being 0.91, 0.93, and 0.92. This shows that the ACRMobi media developed is suitable for use in the learning process because it meets the required validity criteria.

Table 9: ACRMobi Media Validation Summary

No.	Assessment Aspects	∑s	Score	Category
1	Media	252	0.91	Valid
2	Material	293	0.93	Valid
3	Pedagogy	173	0.92	Valid

3.5 Results of The Implementation Stage

ACRMobi interactive media has passed validation and revision and has been tested in one of the classes in vocational education. Conducting observations to see the responses of students and lecturers who teach using ACRMobi. Based on the results of the lecturer responses, most lecturers considered ACRMobi very practical in powertrain learning (**See Table 10**). DD is the aspect with the highest value with an average score of 95.00% with the criteria of very practical. This shows that the visual elements and user interface of ACRMobi have been well-designed based on implementation in the field.

Table 10: Results of Lecturer Responses Regarding ACRMobi

Variable	Indikator	Score (%)	Average (%)	Category
CD	CD.1	88	90.67	Very Practical
	CD.2	100		Very Practical
	CD.3	84		Practical
TI	TI.1	84	85.60	Practical
	TI.2	88		Very Practical
	TI.3	92		Very Practical
	TI.4	80		Practical
	T.5	84		Practical
DD	DD.1	96	95.00	Very Practical
	DD.2	92		Very Practical
	DD.3	100		Very Practical
	DD.4	92		Very Practical

This is in line with the findings of research on the development of AR-based media. Research conducted by Latif et al (2023), states that the integration of AR technology in learning can improve student understanding [45]. Zatapa et al (2024) highlighted the importance of student involvement in learning using AR media [46]. It was found that well-designed applications can provide interactive experiences that can increase engagement and motivation to learn. This opinion is in line with the objectives of ACRMobi development which is expected to provide a more realistic, interactive, and comprehensive learning experience.

Based on the results of responses from students regarding ACRMobi technology in learning, shows that the development of ACRMobi media can be well received by students (**see Table 11**). In addition, ACRMobi is considered very practical to be used in powertrain courses. The variables that get the highest and most prominent scores are also in the DD section plus the IT section whose scores are close to the same. The scores on the DD and TI

variables are sequentially on average 90.00% and 89.62% with very practical criteria.

Table 11: Results of Student Responses Regarding ACRMobi

Variable	Indikator	Score (%)	Average (%)	Category
CD	CD.1	84.76	86.83	Practical
	CD.2	85.24		Practical
	CD.3	90.48		Very Practical
TI	TI.1	90.95	89.62	Very Practical
	TI.2	89.52		Very Practical
	TI.3	88.57		Very Practical
	TI.4	90.95		Very Practical
	T.5	88.10		Very Practical
DD	DD.1	89.05	90.00	Very Practical
	DD.2	90.95		Very Practical
	DD.3	89.52		Very Practical
	DD.4	90.48		Very Practical

The results of the study regarding the responses given by students regarding the ACRMobi media are in line with previous studies that explored the use of AR technology in vocational education. Research conducted by Gill et al (2024) showed that the use of AR in learning can improve students' understanding and involvement in learning, especially in the problem-solving aspect [47]. According to Zhou et al (2024), it was stated that the display design of AR-based media contributes significantly to the experience gained by users [48]. ACRMobi was successfully designed well regarding a more intuitive and visually appealing interface.

Table 12: Comparison of Lecture and Student Response Results

Variable	Lecturer Score (%)	Category Lecturer	Student Score (%)	Student Category
CD	90.67	Very Practical	86.83	Practical
TI	85.60	Practical	89.62	Very Practical
DD	95.00	Very Practical	90.00	Very Practical

Based on **Table 12** regarding the comparison of response results between lecturers and students. The results of both responses show that the average DD display is very high with very practical criteria. This identifies that the visual design provided by ACRMobi has succeeded in providing an interactive and easy-to-understand learning experience both from the perspective of lecturers and students who use the media. Based on the CD variable, the assessment score given by the lecturer is higher than the student response score with an average difference of 90.67% of lecturers and 86.83 students. This shows that although this variable is practical, it is likely that students face challenges in its application and in this section, there is room to improve practicality as seen from the student's perspective. Based on the IT variable, the score results obtained are that the student's practicality value is higher than the practicality value given by the lecturer. This indicates that students feel helped by ACRMobi in solving technical problems.

High validity in all three aspects and high response results from lecturers and students indicate that ACRMobi on the powertrain is feasible and practical in the learning process. The use of ACRMobi can increase students' interactivity and understanding of the material being taught. On the other hand, with proven validity results, this media can be implemented in the vocational education curriculum such as a combination with innovative learning methods that provide a deeper learning experience for students. ACRMobi media is one of the solutions in the latest technology-based learning that can be used and implemented by teachers both offline and online. The AR media developed has characteristics that are by technological developments in the current era of revolution 4.0.

3.6 Results of The Evaluation Stage

The results of the ACRMobi trial were carried out on one of the vocational educations. The evaluation process was carried out by adding a column of criticism and suggestions for students and lecturers available on the previous observation sheet to write down improvements and provide solutions for the future. This is part of an effort to make improvements to several statements in indicators whose values are still low. It is hoped that a gradual evaluation will provide more reinforcement so that it can be used optimally.

4. CONCLUSION

This research produces a product in the form of interactive augmented clutch reality mobile (ACRMobi) media that is integrated into learning in the powertrain course. ARCMobi is designed to provide a richer learning experience using AR technology. Based on the findings that have been explained, this study has succeeded in showing that the designed ACRMobi media is feasible and practical to be used as a modern vocational education media in the 21st century, especially in powertrain learning. The main contribution of this study lies in the development of interactive

ACRMobi media with an assessment of validity and practicality in providing a more realistic and deeper learning experience. ACRMobi offers students the opportunity to practice practical skills in a virtual environment that also enriches their theoretical understanding. In addition, implementing ACRMobi is expected to prepare students to face future industry challenges, where mastery of technology and practical skills becomes more important. Thus, ACRMobi can be the basis for further research to improve the quality of vocational education.

5. LIMITATION

There are still limitations in the ACRMobi that has been developed, namely, it is only able to present the names of the main components with limited explanations. This clutch material is very complex and broad with a lot of knowledge sharing, while this media only displays one example of a clutch that is commonly used in light vehicles. More complex development is needed regarding the 3D components of the clutch to match the original conditions based on each brand of product that is widely circulated, both conventional clutches and in the form of torque converters.

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