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# Millealab-Assisted Virtual Reality for Driving Safety Education: Development, Validation, and Student Responses

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**ABSTRACT**

Driving safety education is essential for developing students' awareness and understanding of responsible road behavior. Virtual reality (VR) offers an immersive learning environment that may support the delivery of contextual and engaging safety education. This study aimed to develop and evaluate the feasibility and practicality of Millealab-assisted VR learning media for driving safety education among high school students. This research employed a research and development approach using the Sadiman development model, consisting of needs identification, objective formulation, material development, assessment design, media scripting, production, trials, revision, and finalization. Product feasibility was evaluated by material, design, and media experts. A practicality trial involving 25 Grade X students at MAN Palopo was conducted using a questionnaire. Quantitative data were analyzed descriptively using percentage scores and predefined feasibility and practicality criteria, while qualitative feedback from validators was used for product revision. Expert validation indicated that the developed VR media met the required feasibility criteria, with material, design, and media validation scores of 88%, 93%, and 97%, respectively. Student responses reached 85.4%, indicating that the media was practical and positively received. The findings demonstrate that Millealab-assisted VR provides a feasible and practical medium for delivering contextual driving safety education. Further studies should evaluate its effectiveness in improving students' driving safety knowledge and behavior using experimental designs.

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## 1. INTRODUCTION

Traffic defined as the flow of vehicles and pedestrians within designated spaces governed by legal regulations. Any movement within these spaces that deviates from established laws constitutes a violation. Traffic violations are actions performed by drivers or pedestrians that do not conform to the applicable legal standards and regulatory frameworks, potentially compromising safety and order within the traffic environment (Nurfauziah & Krisnani, 2021). Anny's research on traffic violations that often occur among students is due to a lack of legal awareness and compliance with traffic laws (Yuserlina, 2019).

Based on data from the Palopo Police's 2022 Operation Patuh, which was carried out in June, most of those caught were riders who did not wear helmets, were minors, and did not carry a driver's license, so the police also provided education to the riders who were caught because the fatal accident was caused by a head hit. Based on these problems, one alternative to foster legal awareness and student legal compliance is to insert knowledge about driving safety into learning.

Driving safety knowledge can be included in learning PPKn subjects, especially for junior high and high school students, so that students know the material on driving safety. Students need to understand the theory of driving safety to recognize traffic regulations, know driving equipment, understand what is required when driving, and, of course, drive according to standards to maintain their safety and that of other road users. Teachers can use technology to provide this teaching for students who are interested in learning driving safety material.

Technology development is growing; most activities are carried out by utilizing technology, including education. Learning is carried out using technology-related media. Teachers are given space to constantly innovate in the learning process so that students are interested in participating in learning. Learning innovations using technology include virtual reality (VR) technology.

Virtual reality is a learning design using a computer, where users seem to be directly involved in the actual situation. This aligns with the opinion of Yoyon Effendi et al. (Efendi et al., 2021)that virtual reality technology creates a 3D atmosphere that makes someone simulate natural objects. Virtual reality has been widely used in various fields, one of which is in education.

Virtual reality in education is a learning process that makes students feel as if they are directly involved in real situations, so learning is effective. In line with Christian P Fabris et al.'s research results, VR teaching improves learning efficiency. VR (Fabris et al., 2019) teaching starts from practical teaching and creates a panoramic teaching model that allows students to achieve an immersive learning experience. In line with the survey results on the millealab.com page, more than 93% of educators said that educational content based on virtual reality (VR) will help students enhance their learning experience.

Virtual Reality, in its use, requires VR glasses or a VR Box. These VR glasses are already widely sold, making it easier for people to have them. The use of these VR glasses helps us feel the reality of our situation. To develop this VR video, we need an application. Many applications can be used to create this VR video, including the Millealab application.

Researchers develop VR learning for driving safety for students through the Millealab application. Millealab is an application that can be downloaded directly to a computer/laptop to meet its specifications. The Millealab application is explicitly used for Android development on a computer (Zulherman et al., 2021). This application is equipped with complete features, is easy to use, and is available for free download, but the creator must pay to create a class account, the information of which can be viewed via the website millealab is https://www.millealab.com/id.

Millealab can help researchers develop educational videos in virtual reality efficiently because these educational videos can be accessed even without using VR glasses. If researchers develop educational videos that require users to use VR glasses, they must spend a lot of money to procure VR glasses so that all users have them. When VR glasses are few, the time required is even more, which impacts the product's effectiveness.

Researchers chose the Millealab application after considering its advantages and disadvantages. With its complete features and ease of use, this application can efficiently help researchers develop educational videos in virtual reality according to their needs. Millealab's role in this study is significant, as it assists in creating virtual reality educational videos on driving safety for students in Palopo City. This choice was made to produce data on the feasibility of the video and the responses from students.

## 2. METHODS

This research is development research with the selected development model, namely the Sadiman development model, which includes (1) identification of needs, (2) formulation of objectives, (3) formulation of material points, (4) formulation of success measurement tools, (5) writing media scripts, (6) production, (7) trials, (8) revisions, and (9) ready-to-use media. The Sadiman model was chosen because it is suitable for developing learning media.

Virtual reality educational videos on driving safety for students, assisted by Millealab, include the development of educational videos and product trials. For the trials conducted during the practicality test through field trials, the researcher used test subjects from class X MAN Palopo students, namely class XG, totaling 25 people, seven males and 18 females. This study only involved one school and one class, due to the limitations of VR tools.

The procedure for developing this educational video follows the existing Sadiman stages, namely:

a) Identification of needs: at this stage, students' needs are identified by looking at the results of observations, considering students' learning needs in civics subjects, and identifying interviews with related parties.
b) Formulation of objectives: at this stage, learning objectives are formulated by conducting a curriculum analysis on the PPKN subject.
c) Formulation of material points: at this stage, lesson materials are developed sequentially by consulting with teachers and the police regarding driving safety.
d) Formulation of success measurement tools, designing success measurement tools for virtual reality driving safety education videos assisted by Millealab using questionnaires to see the learning achievement of the developed products.
e) Writing a media script, script, or storyline is made as a guide in producing animated videos in the form of a storyboard.
f) Production: Educational videos produced with the assistance of Millealab are carried out by following the storyboard script that has been created.
g) Trial: a product trial is conducted through expert validation and student response processes at this stage. Material experts, media experts, and design experts are selected by lecturers/teachers/practitioners/police who are experts in their fields. For trials with high school students, see student responses to the products developed.
h) Revision: if, during the trial, there are suggestions to revise the educational video, then this stage will be passed.
i) Ready-to-use media: after a series of stages have been completed, a virtual reality driving safety education video-assisted by Millealab will be produced that is ready to use.

The data divided into two parts: quantitative data obtained in scores on the validation and trial questionnaires and qualitative data in direct responses from the validator on the validation and trial questionnaires.

The research instrument used questionnaire sheet to collect data, namely a questionnaire for experts/validators and subjects of practicality trials. The aim to collect data on the validity/feasibility and student responses to the products produced.

The data analysis technique used to manage data from expert review results and development trials in developing educational video products is descriptive statistical analysis. Namely, quantitative data is obtained from questionnaires in scores processed using formulas and categorized based on predetermined criteria. Then qualitative descriptive analysis, namely qualitative data obtained from questionnaires in the form of correction suggestions from validators and users, is used to revise educational video products to be better and meet valid criteria and good student responses.

Quantitative data obtained from the questionnaire in the form of scores processed using a formula

$$\boldsymbol{P = \frac{\sum x}{SMI} \times 100\%}$$

Information:
P= Percentage
$\sum \boldsymbol{x}$ = Total score
SMI = Ideal Maximum Score
Next, to calculate the total percentage of subjects, the formula used is:

$$\boldsymbol{P = \frac{F}{N}}$$

Information:
P = Percentage
F = Total percentage of subjects
N = Many Subjects
The categorization used in this study follows the conversion of achievement levels with a scale of 5 (Musa et al., 2021), namely:

**Table 1.** Achievement Level conversion on a scale of 5

| Level of Achievement | Qualification | Information |
|---|---|---|
| $90\% - 100\%$ | Very Good/Very Valid/Very Practical | There is no need to revise |
| $75\% - 89\%$ | Good/Valid/Practical | Revised as Necessary |
| $65\% - 74\%$ | Enough | Quite a Lot Revised |
| $55\% - 64\%$ | Not enough | Much Revised |
| $0\% - 54\%$ | Very less | Revised |

## 3. FINDINGS AND DISCUSSION

### *3.1 Analysis*

The second stage is the formulation of objectives; after identifying the importance of driving safety education and students are Generation Z, the formulation of learning objectives is carried out by analyzing the curriculum in the subject of civics, which is continued with the formulation of material points, this stage is the development of learning materials that are arranged sequentially with consultation with teachers and the police regarding driving safety. At this stage, we conducted a Focus Group Discussion (FGD) to gather information and align perceptions regarding the products made to overcome the problems. The material agreed to be included in this educational video is about driving safety, including driving preparation, vehicle equipment, understanding traffic, and driving dangers.



**Figure 2.** Formulation of Objectives and Materials

In the fourth stage, namely, the formulation of a success measurement tool, designing a success measurement tool for virtual reality driving safety education videos assisted by Millealab using a questionnaire sheet to see the learning achievement of the developed product. The questionnaire sheets created were validator questionnaires (material, design, and media experts) and trial questionnaires to get responses from students regarding the products made. The questionnaire created was adjusted to the researcher's needs to obtain appropriateness and reactions from students, according to the product developed by the researcher.



**Figure 3.** Formulation of Success Measurement Tools

The 5th stage is writing a media script; a script or storyline is made as a guide in producing animated videos as a storyboard. Next, the 6th stage is carried out, namely production, producing educational videos through the help of Millealab; activities are carried out by following the storyboard script that has been made. There are two scenes made; for scene 1, it takes time. ±3 menit, Scene 2 takes time. ±12 menit and a quiz ±10 menit.



Figure 4. Checking Educational Videos

The 7th stage is the trial; at this stage, the product trial is carried out through the expert validation process and student responses. Material experts, media experts, and design experts are selected by lecturers/teachers/practitioners/police who are experts in their fields. Expert data can be seen in the following table.

**Table 2.** Validator Names

| No. | Name | Work | Information |
|---|---|---|---|
| 1 | Aiptu Sahudi, S.H. | Member of the National Police of Palopo District | Subject Matter Expert |
| 2 | Fakhrul Islam, S.Pd. | MAN Palopo Teacher | Design Expert |
| 3 | Musril Hamzah, S.Pd. | MAN Palopo Teacher | Subject Matter Expert |
| 4 | Dianradika Prasti, S.Kom., M.Kom. | UNCP Lecturer | Learning Design and Media Expert |

### *3.2 Educational Video Feasibility Results Data*

At the product trial stage, a material expert test was conducted by two experts, the results of which can be seen in the following table.

**Table 3.** Material Expert Validation Results

| No | Statement | Validator 1 | Validator 2 |
|---|---|---|---|
| 1 | The accuracy of the content of the material with the competencies to be achieved | 4 | 4 |
| 2 | Clarity of driving safety material in the video | 4 | 5 |
| 3 | Clarity of terms used in the video | 4 | 5 |
| 4 | The completeness of the material in the video is in accordance with student needs | 4 | 5 |

| No | Statement | Validator 1 | Validator 2 |
|---|---|---|---|
| 5 | Presenting the material in videos makes it easier for teachers to teach driving safety material | 4 | 5 |
| 6 | The presentation of material in videos makes it easier for students to understand driving safety material | 4 | 5 |
| 7 | Accurate presentation of material can make students listen well | 4 | 5 |
| 8 | Conformity between learning objectives and material exposure | 4 | 4 |
| 9 | Correspondence between the image/illusion and the material | 4 | 5 |
| 10 | Accurate use of animation helps students understand the material | 4 | 5 |
| | Amount | 40 | 48 |

Based on the assessment results from the expert material validation test in Table 3, the following levels of validity of the learning video content were obtained.

$$P = \frac{40 + 48}{100} \times 100\% = 88\%$$

The assessment of material experts, with a result of 88%, is in the valid category, with the statement revised as necessary. The revisions made can be presented in the following table 4.

**Table 4.** Material Expert Revision

| No | Before Revision | After Revision |
|---|---|---|
| 1 |  Previously, only one educational video was displayed. |  After revision, there are 2 video options, scene 1 and scene 2. |
| 2 | In scene 1, there is a scene of a car accident and burning. | This scene is deleted; we add traffic signs; we present the video in scene 2 for the dangers of driving.  |

Comments and suggestions from validators:

a) The material contains education about driving safety.
b) Right on target according to the VR video theme.
c) The terms used are easy to understand.
d) Students' needs have been accommodated.
e) The language used is easy to understand.
f) Students can easily understand it because they are Generation Z.
g) The illustrator has represented.
h) It is suitable and can be used.

A trial was also conducted to see the feasibility of the educational video product design, so two experts tested the design feasibility of this product, the results of which can be seen in Table 5 below.

**Table 5.** Expert Design Validation Results

| No | Statement | Score | |
|---|---|---|---|
| | | **Expert 1** | **Expert 2** |
| 1 | *Cover* quality | 5 | 4 |
| 2 | The attractiveness of the *cover design* | 4 | 5 |
| 3 | Standard language/words used | 4 | 5 |
| 4 | Completeness of information conveyed with language/sentences | 5 | 4 |
| 5 | Ease of students' understanding of the language used | 5 | 5 |
| 6 | Suitability of design layout, image settings, transitions, and animations on media display | 5 | 5 |
| 7 | The suitability of the accompanying music and narration in the video display | 5 | 4 |
| 8 | Appropriate font selection and text color | 5 | 4 |
| 9 | Conformity of colors, text, and images on video display | 5 | 5 |
| | **Amount** | **43** | **41** |

Based on the assessment results of the design expert validation test in Table 5, the following levels of validity of the educational video design were obtained.

$$P = \frac{43 + 41}{90} \times 100\% = 93\%$$

The design expert's assessment, with a result of 93%, is in the very valid category with the statement that there is no need for revision. Comments and suggestions from the validator are:

a) The cover is contemporary.
b) The image display can be seen 360°.
c) It would be better if designed according to the target user.
d) The language used is relatively standard.
e) The information provided is complete.
f) The language used is appropriate to the target user.
g) The font type and colors used are comfortable to look at/use.
h) It is exciting because the attractive animation colors harmonize with the current content.
i) Overall, this VR educational video is worthy of use and implementation.

The trial was also conducted to see the feasibility of the educational video product learning media, so that the feasibility of this product was tested by 1 expert/specialist, the results of which can be seen in the following table.

**Table 6.** Media Expert Validation Results

| No | Statement | Score |
|---|---|---|
| 1 | The accuracy of the illustrations used in *the cover* | 5 |
| 2 | Suitability between the material and media used | 4 |
| 3 | The quality of the image used | 5 |
| 4 | Image size accuracy | 5 |
| 5 | Accuracy of image placement | 5 |
| 6 | Text quality | 5 |
| 7 | Sound quality | 5 |
| | **Amount** | **34** |

Based on the assessment results of the media expert validation test in table 6, the following levels of validity of the learning video media were obtained.

$$P = \frac{34}{35} \times 100\% = 97\%$$

Media expert assessment with a result of 97% is in the very valid category with the statement that it does not need to be revised. Comments and suggestions from the validator are:

a) The illustration images are in accordance with the title and material contained in the VR application.
b) It would be better if interactions in the VR world were made as similar as possible to the real world.
c) The image used is good, it doesn't look broken.
d) The image size is correct.
e) The image placement is correct, so it is easily visible to VR users.
f) The type of font / text used is easy to read.
g) The sound in the VR application is clear and easy to understand.
h) Overall, this VR-based learning media is worthy of implementation.

So, the validity test of the educational video product developed, obtained:

$$\text{Percentage} = \frac{88\% + 93\% + 97\%}{3} = 93\%$$

The percentage obtained 93%was in the "very valid" category, so this educational video is suitable for use in PPKn subjects at the SMA/MA equivalent level.

Meanwhile, for the trial on high school students at MAN Palopo, class XG students were selected to see the students' response to the product being developed.

### *3.3 Student Response Result Data*

The response data from 25 students were obtained from the practicality test of the learning video product, which was carried out on Wednesday, October 18, 2023 in class XG MAN Palopo. Student responses were obtained from a questionnaire that had been compiled based on the following aspects.

1. Learning aspects, including interactivity, developing learning motivation, expected functions to support learning, involving several senses, and ease of understanding.
2. Media aspects, including efficient use of media in terms of time, effectiveness as a learning medium, and ease of operation.
3. Design aspects, including the VR media display is quite detailed, the color composition of the VR media display is attractive, the balance of the size of the VR media display presented, easy for users to understand, as well as neat, orderly, and not mixed with unnecessary materials.

Based on these 3 aspects, the level of practicality of educational videos or student responses is obtained as follows.

$$P = \frac{1110}{1300} \times 100\% = 85{,}4\%$$

The results of student responses can be concluded that the total score of student responses 85,4%is in the category of "Good/Practical". Thus, in the practicality trial of educational video products, it is practical to use.



**Figure 5.** Product Trial

After the trial, the next stage is the revision, as presented in Table 4. The revision is a suggestion from the material expert. To make the educational video effective, the video on the homepage is prepared/divided into 2 scenes, making it easier for users to access the video according to their needs. The last stage is ready-to-use media, after a series of stages are passed, a virtual reality driving safety education video, assisted by millealab is produced that is ready to use which can be accessed at the following link:

Class Link: https://millealab.page.link/1dKEUkGEiXLprHMs8
Class Code: XYh4Pg

The class link on the millealab application has an expiration date according to the payment period of the researcher's account, so that the results of our research can always be accessed, we upload it on the researcher's YouTube. Users who want to watch the video can watch it via the link https://www.youtube.com/watch?v=sEZ2uKipuKI

The steps to use this product are:

1) Install the Millealab application on the Android cellphone Play Store .
2) Join the class, using the class code XYh4Pg
3) There are 3 mode options that can be accessed:
   a) VR mode, allows users to access content in an interactive and realistic way , it will be more comfortable if users use VR Box. Here's what it looks like if we use VR mode.

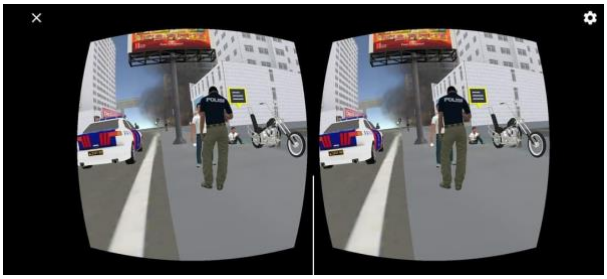


**Figure 6.** VR Mode

b) Mode Play in 360 °, allows users to access content in a 360 viewpoint °. Here's how it looks if we use 360 ° mode.



**Figure 7.** Play in mode 360°

c) Non-Gyro Mode, allows users to access content using the swipe button without requiring a gyroscope on your smartphone. Here's what it looks like if we use Non-Gyro Mode.c)



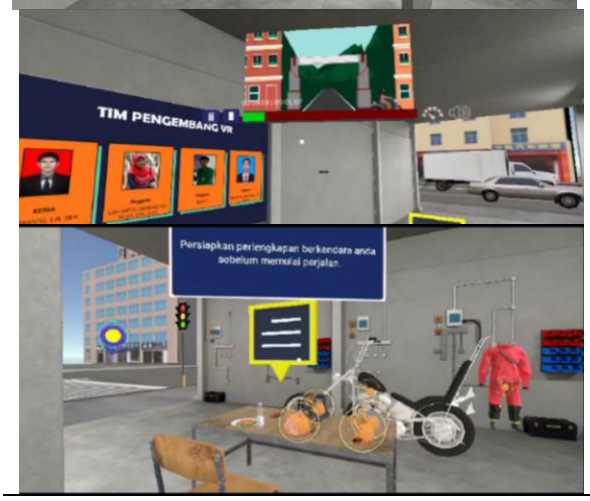

**Figure 8.** Non-Gyro Mode

4) If the mode option has been selected, then please wait for the loading process to 100%. Internet connection affects the speed of loading progress .
5) Please follow the instructions in VR.

The following is the content of the virtual reality driving safety education video assisted by Millealab:

**Table 7.** VR Educational Video Display

| No | Scene | Images & Captions |
|---|---|---|
| 1 | Introduction |   The initial display after joining the Millealab class, as shown in the image on the side. The class expiration date is visible. There is a class link sharing icon. There is a choice of scenes that we want to play. Please choose scene 1 or scene 2, but we recommend choosing scene 1 first, because scene 2 is a continuation of scene 1. In scene 1 there is also access or an icon that we can click to continue to scene 2. |

| No | Scene | Images & Captions |
|---|---|---|
| 2 | Scene 1 |  Scene 1 looks like the image on the side. There are 3 mode options that we can choose, according to our needs. If you have VR glasses or VR Box please choose play in VR mode. In scene 1, we will watch a video that the researcher took from YouTube, via the link https://www.youtube.com/watch?app=desktop&v=ndp7VDVlNcI, namely a video about motorcycle safety that lasts 1 minute 7 seconds. |
| | |  The initial display when we enter scene 1, there is a cover, video, instructions, and an introduction to driving equipment. |
| | |  An introduction to the equipment that needs to be prepared before driving.. |
| | |  The call to action display is accompanied by sound. |

| No | Scene | Images & Captions |
|---|---|---|
| | |  Shows the problems faced if you violate traffic rules. |
| | |   In the video there is also information about traffic signs that we often encounter on the road. |
| | |  View to continue to scene 2. |
| 2 | Scene 2. |  Scene 2 view if continuing from scene 1. |

| No | Scene | Images & Captions |
|---|---|---|
| | |  The image on the side is the view of scene 2 if we start from the initial view of scene 1, we are asked to choose the mode we need. |
| | |   In scene 2, there are pictures and 2 videos that we can watch about driving safety. The first video in scene 2 is about 10 safe motorcycle driving tips that you should know which the researcher took from youtube and can be accessed at the link https://www.youtube.com/watch?v=-NzYALWK0jw with a duration of 2 minutes 42 seconds, while the second video is about the dangers of driving which the researcher took via the youtube link https://www.youtube.com/watch?v=d5bfPybRVtQ with a duration of 7 minutes 35 seconds. |

| No | Scene | Images & Captions |
|---|---|---|

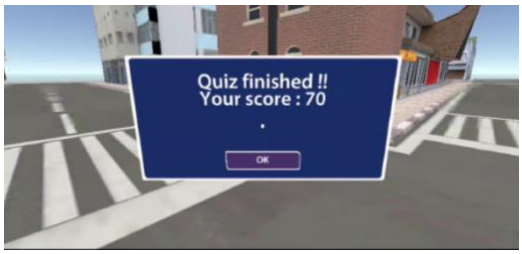



At the end of scene 2 there is a quiz, 10 numbers that users can work on to practice their knowledge after playing this educational video.



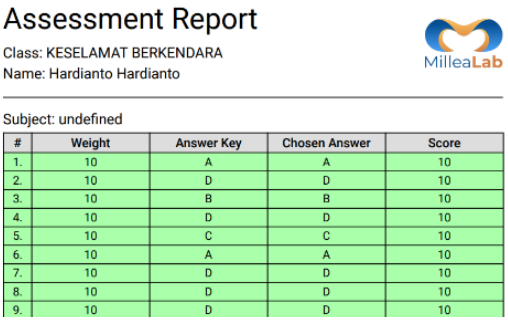

After working on the 10 questions, it will look like the following image. There are options to finish and review the answers.

After completing the quiz and clicking finish, the value/score obtained will appear (scale 100).




We can also see the answer review, green marks for correct answers, and red marks for incorrect answers.

Every user who joins the class and fills out the quiz, the quiz results can be accessed at the link https://millea-lab-assessment-report.firebaseapp.com/# , the link can be accessed by entering the email that has the class account and the results can be seen as in the image below.



Assessment Report

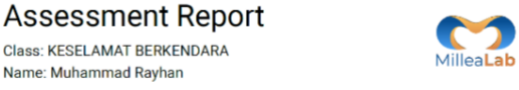
Class: KESELAMAT BERKENDARA
Name: Hardianto Hardianto

MilleaLab

Subject: undefined

| # | Weight | Answer Key | Chosen Answer | Score |
|---|---|---|---|---|
| 1. | 10 | A | A | 10 |
| 2. | 10 | D | D | 10 |
| 3. | 10 | B | B | 10 |
| 4. | 10 | D | D | 10 |
| 5. | 10 | C | C | 10 |
| 6. | 10 | A | A | 10 |
| 7. | 10 | D | D | 10 |
| 8. | 10 | D | D | 10 |
| 9. | 10 | D | D | 10 |

This image shows the results of users who answered correctly all 10 questions in the quiz.

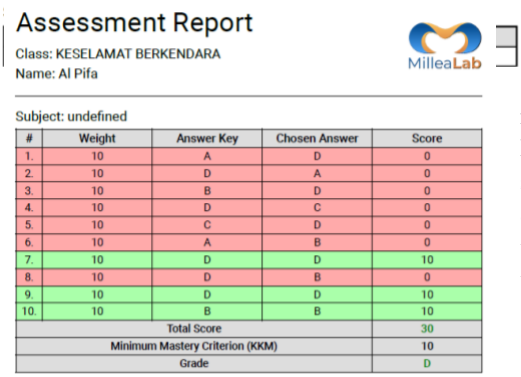


Assessment Report

Class: KESELAMAT BERKENDARA
Name: Muhammad Rayhan

MilleaLab

This image shows the results of users who joined the quiz but did not complete the quiz.



Assessment Report

Class: KESELAMAT BERKENDARA
Name: Al Pifa

MilleaLab

Subject: undefined

| # | Weight | Answer Key | Chosen Answer | Score |
|---|---|---|---|---|
| 1. | 10 | A | D | 0 |
| 2. | 10 | D | A | 0 |
| 3. | 10 | B | D | 0 |
| 4. | 10 | D | C | 0 |
| 5. | 10 | C | D | 0 |
| 6. | 10 | A | B | 0 |
| 7. | 10 | D | D | 10 |
| 8. | 10 | D | B | 0 |
| 9. | 10 | D | D | 10 |
| 10. | 10 | B | B | 10 |
| Total Score | | | | 30 |
| Minimum Mastery Criterion (KKM) | | | | 10 |
| Grade | | | | D |

This image shows the students' results during the trial, green for correct answers, and red for incorrect answers.

In this assessment report, it clearly shows the wrong answers, correct answers, total score obtained, and the grade obtained according to the score.

Based on Table 7, a description of the contents of the virtual reality educational video on driving safety assisted by Millealab for students in the city of Palopo is obtained. The video consists of 2 scenes which contain information about motorcycle driving safety. The video depicts a highway situation complete with traffic signs, vehicles, road users, and the police. In the video there are also 3 videos, as a source of information for students so that students better understand driving safety. This video was obtained by researchers through YouTube; the three videos are motorcycle driving safety, 10 safe motorcycle driving tips, and driving hazard animations. The educational video that was developed also contains a quiz to test students' understanding of driving safety.

***Discussion***

The findings demonstrate that the Millealab-assisted virtual reality (VR) learning media developed for driving safety education achieved satisfactory feasibility and practicality. Expert validation showed scores of 88% for material, 93% for design, and 97% for media, indicating that the product met the predetermined criteria for classroom use. In addition, the student response score of 85.4% placed the product in the good/practical category. These results suggest that the developed media is appropriate in terms of content, visual and instructional design, technical presentation, and usability. Nevertheless, these findings should be interpreted as evidence of product feasibility and practicality rather than effectiveness in improving students' driving safety knowledge or behavior.

The high material validation score indicates that the content was considered relevant to the intended learning objectives and students' needs. The media incorporates information on driving preparation, safety equipment, traffic signs, safe riding practices, and potential driving hazards. Presenting these topics through a simulated environment may provide students with a more contextual representation of situations that are difficult to reproduce safely in conventional classrooms. This finding is consistent with Fabris et al. (2019), who reported that VR can support immersive learning experiences by allowing learners to interact with or observe simulated environments. In the context of driving safety education, such visualization is particularly relevant because students can encounter representations of road conditions and safety practices without being exposed to actual traffic risks.

The design and media validation results further indicate that the developed product has appropriate visual, linguistic, audio, and navigational characteristics. The VR environment combines 360-degree visualization, animation, narration, videos, traffic-related objects, and interactive features. These characteristics are consistent with previous educational VR development research. Hartono and Mujahidin (2021), for example, emphasized the importance of accessibility, visual composition, color, and clarity of information when designing VR-based learning videos. Similarly, Zulherman et al. (2021) demonstrated that Millealab can be used to develop Android-based VR learning media that provides students with an interactive learning experience. The present findings extend this application to driving safety education, illustrating the potential of Millealab for presenting contextual safety-related content.

Student responses also provide evidence of the product's practicality. The 85.4% response score indicates that students generally perceived the media positively in terms of learning, media, and design aspects. One possible explanation is that three-dimensional and immersive presentations provide a learning experience that differs from conventional text- or lecture-based instruction. Hariyanto et al. (2022) similarly suggested that three-dimensional animation can make educational information more engaging and easier for young learners to understand. In addition, Shofiah et al. (2023) highlighted the usefulness of educational media in supporting traffic-awareness activities. In the present study, the integration of visual road environments, safety information, and quizzes provides multiple opportunities for students to engage with driving safety content.

An important feature of the developed media is its accessibility through different modes. Students can access the content using VR mode with a VR Box, 360-degree mode, or non-gyroscope mode on compatible smartphones. This flexibility is educationally important because access to dedicated VR equipment may be limited in schools. The availability of alternative modes may therefore reduce technological barriers while maintaining access to the core educational content. This

characteristic is particularly relevant to the study context, where limited VR equipment restricted the field trial to one class of 25 students. Accordingly, the positive student responses should not yet be generalized to broader student populations.

Overall, this study contributes to educational technology research by demonstrating the feasibility and practicality of integrating Millealab-assisted VR with driving safety education. However, the current evidence does not establish that the media improves students' knowledge, awareness, or safe-driving behavior. The study assessed expert validation and student responses rather than learning gains. Future research should therefore involve larger samples from multiple schools and employ pretest–posttest or controlled experimental designs to examine learning outcomes. Measures of driving safety knowledge, retention, engagement, and behavioral intention would provide stronger evidence regarding the educational effectiveness of the developed VR media.

## 4. CONCLUSION

This study developed and evaluated Millealab-assisted virtual reality (VR) learning media for driving safety education using the Sadiman development model. The findings showed that the developed media met the established feasibility criteria, with validation scores of 88% for material, 93% for design, and 97% for media, while student responses reached 85.4%, indicating good practicality. These findings suggest that the developed VR media is feasible and practical for supporting the delivery of contextual and engaging driving safety education to high school students. However, the study was limited to 25 students from a single class and one school, and its evaluation focused primarily on expert validation and student responses rather than changes in students' driving safety knowledge, attitudes, or behavior. Therefore, the findings should not be interpreted as evidence of the media's effectiveness in improving learning outcomes. Future research should involve larger and more diverse samples from multiple schools and employ pretest–posttest, quasi-experimental, or experimental designs to evaluate the effectiveness of the VR media. Further studies may also examine knowledge retention, student engagement, behavioral intentions, and actual safety awareness to provide more comprehensive evidence regarding the educational value of Millealab-assisted VR for driving safety education.

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