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Development of an AR-Based Learning Media Prototype for Basic Medical Equipment Education Using Assemblr EDU

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Abstract. The rapid advancement of information technology has encouraged the integration of interactive digital media into educational practices, particularly to overcome limitations associated with conventional learning resources. This study aims to develop and evaluate an Augmented Reality (AR)–based learning media prototype for basic medical equipment education using the Assemblr EDU platform. The study addresses challenges such as limited access to physical medical devices, high procurement costs, and safety risks during practical learning by offering an alternative visual and interactive learning solution.This research employed a Research and Development (R&D) approach using a modified Borg and Gall model, consisting of five stages: preliminary study, learning media planning, AR media prototype development, functional testing and evaluation, and prototype refinement. The AR learning media was developed by integrating 3D medical equipment models—including thermometers, stethoscopes, sphygmomanometers, medical masks, and symbolic syringes—along with textual explanations and interactive features. Media feasibility was evaluated through content validation and black box functional testing, focusing on instructional quality, content accuracy, visual appearance, navigation, interaction, and programming functionality. The evaluation results indicate that the developed AR learning media achieved a mean feasibility score of 4.37 for content and instructional aspects and 4.02 for visual and programming aspects, both categorized as Highly Feasible. These findings demonstrate that the media functions effectively and meets the essential criteria for educational use. The AR media supports independent learning, enhances conceptual understanding, and increases user engagement through immersive and interactive visualization. The novelty of this study lies in the development of an accessible AR-based learning media prototype using a low-code platform specifically designed for basic medical equipment education. The results contribute to the application of AR technology in educational media development and provide a foundation for future studies focusing on learning effectiveness, user experience, and broader implementation.

Keywords: Augmented Reality, Learning Media, Medical Equipment Education, Assemblr EDU, Educational Technology
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INTRODUCTION

Advancements in information technology have had a significant impact on the field of education, particularly in the development of innovative and interactive learning media. Learning media are no longer limited to textbooks and whiteboards, but have evolved into digital media capable of providing more contextual and visual learning experiences. Arsyad states that learning media function as intermediaries in delivering instructional messages so that learning objectives can be achieved effectively and efficiently through the utilization of various multimedia elements such as text, images, audio, and animation [1].

One of the technologies that is currently developing and has great potential in the field of education is Augmented Reality (AR). AR technology enables the integration of two-dimensional or three-dimensional virtual objects into real-world environments in real time, allowing learners to view and interact directly with learning objects in a more concrete manner [2], [14], [18]. The use of AR in learning is considered capable of enhancing conceptual understanding, learning interest, and active learner engagement, as instructional materials are presented in a visual and interactive form [3], [15], [16].

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In basic medical equipment education, understanding the form, function, and proper use of medical devices is a crucial aspect, particularly for learners in the health sciences as well as the general public. However, limitations in practical facilities, the cost of procuring equipment, and the risks associated with direct use of medical devices often present challenges in the learning process. AR-based learning media can serve as an alternative solution by presenting medical equipment representations in the form of 3D objects that can be observed from multiple perspectives without the need to use physical devices directly [4].

Assemblr EDU is one of the Augmented Reality–based learning media development platforms that is relatively easy to use and does not require advanced programming skills. This platform enables developers or educators to create AR learning media by utilizing 3D objects, text, audio, and simple interactions that can be accessed via Android and iOS devices. Several studies indicate that the use of Assemblr EDU in learning can enhance learning motivation and improve material comprehension due to its more engaging and interactive content presentation [5], [7], [18].

Based on the foregoing discussion, it is necessary to develop a prototype of an Augmented Reality–based learning media using Assemblr EDU that focuses on basic medical equipment education. This prototype is expected to serve as an alternative innovative learning medium that supports the learning process through visual, interactive, and easily accessible features, while also providing a tangible contribution to the application of educational technology.

METHODS

The study employed a Research and Development (R&D) approach aimed at developing and evaluating the feasibility of an Augmented Reality (AR)–based learning media prototype for basic medical equipment education. The development process adopted a modified Borg and Gall model, which consisted of five main stages [6], [13], as illustrated in Figure 1.

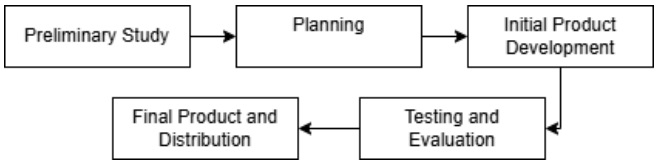

Figure 1. Stages of the modified Borg and Gall research and development model

1. Preliminary Study
   At this stage, a needs analysis and literature review were conducted to obtain information related to basic medical equipment educational content and relevant Augmented Reality (AR)–based learning media. The needs analysis was carried out through a review of literature and online resources to identify appropriate materials, media formats, and interactive features aligned with the educational objectives. Meanwhile, curriculum analysis was performed by examining official documents, such as subject syllabi or basic health education guidelines, to ensure that the developed content corresponds to the applicable basic competencies, achievement indicators, and learning objectives [7].

2. Learning Media Planning
   The activities carried out at this stage included:
   a. Determining development objectives
      The researcher formulated the objectives of developing the Augmented Reality–based learning media, namely to facilitate public understanding of basic medical equipment through interactive and visual approaches, while providing an engaging and easily accessible educational experience.
   b. Selecting instructional content
      The instructional materials incorporated into the learning media focused on basic medical equipment education, such as thermometers, stethoscopes, medical masks, and symbolic syringes. The content was selected based on its relevance to public educational needs and the availability of suitable 3D objects within the Assemblr EDU platform.

c. Development of evaluation instruments
The instruments used to assess media quality included content validation and media functionality evaluation. Content validation involved reviewing the accuracy of the instructional material and the appropriateness of information related to basic medical equipment based on credible literature sources. Functional validation was conducted through black box functional testing, which evaluated aspects such as visual appearance, interaction, navigation, and the rendering of 3D objects within the AR media [5].

3. Development of the AR Media Prototype Using the Assemblr EDU Platform
At this stage, an initial design was developed, encompassing the instructional framework, concept mapping, and media interface, particularly for basic medical equipment education such as thermometers, stethoscopes, sphygmomanometers, medical masks, and symbolic syringes. Subsequently, the AR media prototype was created using the Assemblr EDU platform by integrating 3D objects, textual information, audio elements, and simple interactions to support an interactive learning experience.

Media validation was conducted through a literature review to assess the alignment of the instructional content with credible references, as well as through functional testing (black box testing) to evaluate visual appearance, navigation, user interaction, and the rendering of 3D objects within the AR media [5].

4. Media Functional Testing (Black Box Testing) and Evaluation
This stage aimed to determine the feasibility of the developed AR learning media prototype. The evaluation was conducted through functional testing using the black box testing method.
The media evaluation process consisted of the following steps:
a. Individual testing (internal simulation)
The developer conducted independent testing by running the AR media on mobile devices to identify potential technical issues, display errors, and interaction difficulties that users might encounter when accessing the media.
b. Interactive feature testing
Each media feature, including 3D objects, navigation elements, interactive buttons, and medical equipment information displays, was systematically tested. The functional testing results were recorded to ensure that the media operated according to the design and that all features functioned properly.
c. Media evaluation
Based on the functional testing results, notes regarding visual appearance, navigation, interaction, and 3D object rendering were used as considerations for media improvement and refinement.
d. Final revision
After completing all functional tests and implementing the necessary improvements, the AR learning media prototype was revised and refined before proceeding to the documentation and dissemination stage. This process ensured that the media was ready to be used as an interactive and effective educational tool [5].

5. Prototype Refinement and Final Product Documentation
At this stage, the AR learning media prototype for basic medical equipment education was refined based on the results of the functional testing (black box testing). Improvements were made to aspects of visual design, navigation, user interaction, and 3D object rendering to ensure that the media functioned as intended and could be accessed optimally.

The final product is an Augmented Reality–based learning media developed on the Assemblr EDU platform, containing educational materials on basic medical equipment such as thermometers, stethoscopes, sphygmomanometers, medical masks, and symbolic syringes. The media was fully documented, including user guidelines, concept maps of the instructional content, and interactive interfaces, and can be accessed via a QR code to facilitate user access using Android or iOS devices. The product documentation was also prepared as a reference for relevant stakeholders, including educators and the general public interested in using this AR media as an educational tool [5].

The following are the media feasibility qualifications used to determine the feasibility criteria of the AR-based learning media prototype for basic medical equipment education, as shown in Table 1. The table outlines the range of mean scores ($\overline{X}$) and their corresponding categories for evaluating the feasibility of the media.

Table 1 Media Feasibility Categories

Range	Category
$\overline{X} > 4{,}01$	Highly Feasible
$3{,}34 < \overline{X} \leq 4{,}01$	Feasible
$2{,}66 < \overline{X} \leq 3{,}34$	Fair
$1{,}99 < \overline{X} \leq 2{,}66$	Less Feasible
$\overline{X} \leq 1{,}99$	Not Feasible

The mean score was calculated using Equation (1).

$$\overline{X} = \frac{\Sigma X}{N} \qquad (1)$$

where $\bar{X}$ represents the mean score, $\sum X$ is the total score obtained from the assessment indicators, and N is the number of indicators.
A learning medium is considered feasible if it meets at least the minimum criteria within the Feasible (F) category based on the evaluation results. According to Arsyad [1], the feasibility of learning media must be demonstrated through expert validation and trial testing, while Sadiman et al. [8] emphasize that effective learning media should meet requirements in terms of content quality, instructional presentation, visual appearance, as well as usability and interactivity.

In this study, these four aspects were adapted into the components of content, instructional, visual, and programming, which were evaluated through functional testing (black box testing) and literature-based validation. Therefore, media feasibility was determined based on internal assessment results of the prototype, and the media was categorized as highly feasible when all aspects met at least the minimum standard of the Feasible category [5], [8] [17].

RESULT AND DISCUSSION

This study resulted in an Augmented Reality (AR)–based learning media developed using the Assemblr EDU platform, designed to support education on basic medical equipment. The media can be accessed via Android and iOS devices and features an interactive interface, visually appealing design, intuitive navigation, and interactive functionalities such as 3D object zooming and informational explanations. Several interface displays of the developed AR learning media are illustrated in Figures 2–4.

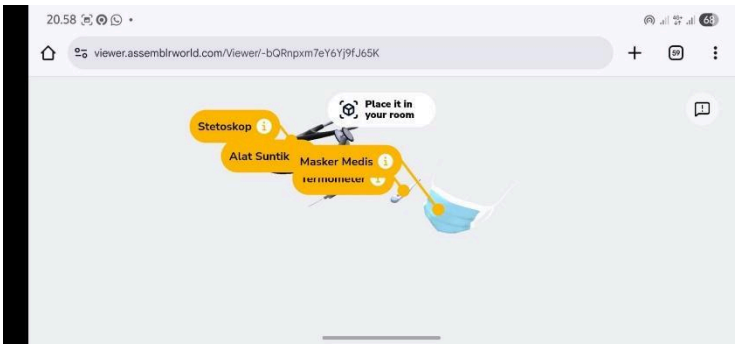

Figure 2 Initial Interface of AR Media in the Assemblr Viewer

Figure 2 presents the initial interface of the AR media displayed in the Assemblr Viewer. On this interface, users can observe several basic medical device objects, including a stethoscope, syringe, thermometer, and medical mask. Each object is accompanied by an information icon that provides a brief

explanation of the function and use of the respective medical device, enabling users to easily access essential information.

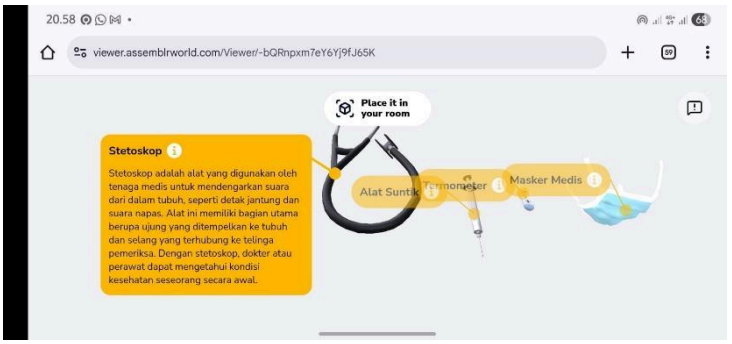

Figure 3 Interactive Labels on 3D Objects

The interactive labeling feature of the AR media is shown in Figure 3. As illustrated in this figure, users can interact with the information icons attached to each 3D object to display educational descriptions. This feature facilitates independent learning and supports users' understanding of the characteristics and functions of basic medical equipment.

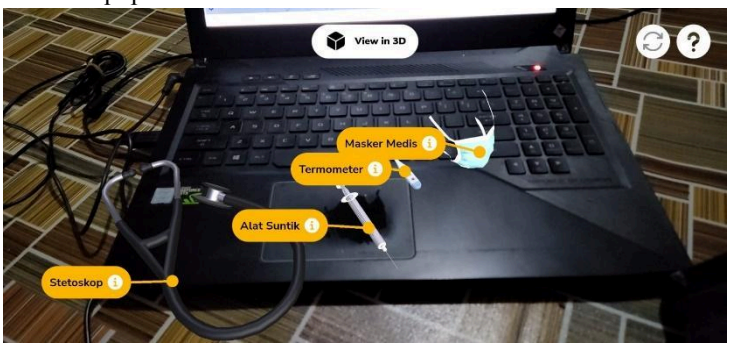

Figure 4 AR Display in Real-World Environment

Furthermore, the application of AR technology in a real-world environment is demonstrated in Figure 4. In this display, 3D medical device objects can be positioned within the surrounding environment using the device's camera. This AR-based visualization allows users to simulate the observation and use of medical devices in authentic contexts, thereby increasing user engagement and enhancing conceptual understanding.

The results of media content validation, which include instructional and content aspects, are presented in Table 2. As shown in this table, the instructional aspect achieved a mean score of 4.61, while the content aspect obtained a mean score of 4.12. Both aspects fall into the highly feasible category, indicating that the AR-based learning media meets the required instructional and content quality standards.

Table 2. Media Content Validation Results (Literature Review & Black Box Testing)

Assesment Aspect	Number of Indikator	Evaluation Score 1	Evaluation Score 2	Mean	Category
Intructional	9	44	39	4,61	Highly Feasible
Content	8	34	32	4,12	Highly Feasible
Mean				4,37	Highly Feasible

Table 3. Media Validation Results (Black Box Functional Testing)

Assesment Aspect	Number of Indikator	Evaluation Score 1	Evaluation Score 2	Mean	Category
Display	11	48	52	4,54	Highly Feasible
Programming	12	38	46	3,50	Highly Feasible
Mean				4,02	Highly Feasible

Furthermore, the results of media validation based on functional testing using the black box testing method are summarized in Table 3. The display aspect obtained a mean score of 4.54, and the programming aspect achieved a mean score of 3.50, with both aspects categorized as highly feasible. These results indicate that the media functions properly and is visually well designed, ensuring a smooth and reliable user experience.

Table 4 Media Feasibility Result

Stage	Category
Media Content Validation Results	Highly Feasible
Media Validation Results	Highly Feasible
Media Functional Testing (Black Box Testing)	Highly Feasible

According to Ramadhani and Afriani, learning media can be considered feasible when it fulfills instructional, content, visual, and programming criteria, supported by expert validation and learner trials achieving at least a good feasibility category [12]. This framework was adopted in evaluating the feasibility of the developed AR-based learning media.

An overall summary of the media feasibility evaluation is provided in Table 4, which consolidates the results of media content validation, media validation, and functional testing. As shown in the table, all evaluation stages resulted in the highly feasible category, confirming that the developed AR-based learning media is suitable for implementation in educational settings.

Based on the results presented in Tables 2–4, the developed media is considered highly feasible for use, as it has fulfilled all feasibility criteria, including content quality, instructional design, visual appearance, and programming performance [1], [5], [8]. The media integrates textual explanations and interactive 3D objects that support learners' understanding of basic medical equipment while enabling independent learning without the need for physical devices. In addition, the interactive and responsive design of the media enhances user engagement and supports self-directed learning through simulation-based interactions with the 3D objects [9], [10], [11], [15], [19].

CONCLUSION

This study successfully developed an Augmented Reality (AR)–based learning media prototype for basic medical equipment education using the Assemblr EDU platform. The development process followed a modified Borg and Gall Research and Development (R&D) model, encompassing needs analysis, media planning, prototype development, functional testing, refinement, and final documentation. The resulting media integrates 3D objects, textual explanations, and interactive features that allow users to visualize and explore basic medical equipment in a contextual and engaging manner. Based on the results of content validation and functional testing using the black box method, the developed AR learning media achieved a Highly Feasible category across all evaluated aspects, including instructional quality, content accuracy, visual appearance, and programming functionality. These findings indicate that the media operates effectively according to its design and meets the essential criteria for use as an educational tool. The AR-based learning media provides an alternative solution to limitations commonly encountered in

basic medical equipment education, such as restricted access to physical devices, high procurement costs, and safety risks during practice. By enabling learners to interact with virtual 3D representations in real-world environments, the media supports independent learning, enhances conceptual understanding, and increases learner engagement. In conclusion, the developed AR learning media using Assemblr EDU is highly feasible and suitable for use as an innovative educational medium for basic medical equipment education. Future research is recommended to conduct broader user trials involving students or the general public to measure learning effectiveness, user satisfaction, and long-term learning outcomes, as well as to expand the range of medical equipment and interactive features within the media.

The findings of this study support previous research indicating that AR-based learning media can serve as an effective alternative for overcoming limitations of conventional learning resources and facilitating independent learning through immersive visualization [12], [16], [18], [20].

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