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RESEARCH ARTICLE

Design of Augmented Reality-Based Learning Media Integrating Islamic Values for Teaching Atomic Structure

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Abstract

This research examines the creation of augmented reality-based educational media for physics that incorporates Islamic principles, primarily aimed at teaching atomic structure. The study sought to ascertain the appropriateness of augmented reality (AR) media in improving students' comprehension of atomic structure while simultaneously imparting Islamic precepts. This study utilizes the Research and Development (R&D) methodology, consistent with the ADDIE paradigm (analysis, design, development, implementation, and evaluation). Data was acquired by administering a questionnaire to specialists in media, materials, and Islamic religion to assess the viability of the learning medium. The questionnaire addressed three primary aspects: media design, content relevance, and the incorporation of Islamic principles. This research employs descriptive quantitative and qualitative analysis approaches. The study concentrated on evaluating the development of AR media, its practicality, and the congruence of the content with Islamic beliefs. The findings of this study demonstrate that the AR-based learning medium is exceptionally appropriate for physics instruction. The media validation achieved a score of 86%, the material validation received 88%, and the integration of Islamic principles attained 85%, indicating the medium's efficacy and suitability. This augmented reality educational medium facilitates the cognitive and ethical maturation of students, underscoring its advantages for attaining both scholarly superiority and moral advancement.

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INTRODUCTION

The accelerated progress of technology has significantly increased the relevance of Android-based mobile devices in education. Mujiono and Sarah (2021) assert that Android smartphones significantly augment student engagement by cultivating an immersive and interactive educational atmosphere. In alignment with this perspective, Hasanah and Sudira (2021) emphasize that interactive educational tools, distinguished by their vibrant visuals and kinetic elements, facilitate enhanced concentration and emotional equilibrium, which subsequently bolsters memory retention (Wen, 2021).

However, despite the clear benefits associated with interactive media, a notable deficiency persists in the integration of Islamic values within modern educational resources, particularly those that utilize augmented reality (AR). Although augmented reality has proven its efficacy in elucidating complex concepts, the investigation of its capacity to address abstract physics topics such as atomic structure—while embedding Islamic tenets—remains inadequately explored. The insufficiency of augmented reality (AR) educational tools specifically designed for Islamic education leads to the loss of opportunities to integrate advanced technology with the objectives of Islamic higher education institutions. As stated by Nasikhin et al. (2023), AR holds the promise of improving Islamic learning experiences by translating abstract concepts into more understandable and captivating forms. In a parallel context, Nurbaiti and Suyanto (2022) assert that the adoption of innovative technologies such as AR in Islamic education can transform educational practices while safeguarding fundamental values like *ilm* (knowledge acquisition) and *akhlak* (moral development), consequently fostering a comprehensive educational structure.

The topic of atomic structure, a pivotal aspect within the physics curriculum, presents one of these formidable challenges. The abstract nature of this subject necessitates that students visualize subatomic particles—protons, neutrons, and electrons—in a three-dimensional framework. This often culminates in misconceptions and inaccuracies, obstructing learners' ability to fully grasp the underlying concepts. Research by Putra et al. (2023) reveals that these barriers greatly impede students' success in physics. The existing instructional resources fail to adequately address these challenges, underscoring the imperative for innovative solutions (Capuno et al., 2019; Kırkıc et al., 2023).

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The Physics Education program at UIN Raden Intan Lampung is dedicated to the development of educators who possess not only scientific acumen but also pedagogical expertise, all while adhering to Islamic principles. The integration of Islamic values into augmented reality-based educational media for atomic structure represents a critical strategy in addressing these challenges as part of this overarching mission. This initiative aligns with the university's vision and contributes to the broader goal of nurturing ethically responsible and proficient educators.

This research endeavors to bridge these gaps by developing Android-based augmented reality instructional media that facilitates students' visualization of atomic structures and processes in real-time. This approach offers an interactive and captivating educational experience, designed to enhance students' understanding of complex physics concepts while promoting Islamic ethical values. The synthesis of AR technology with Islamic principles engenders a harmonious relationship between contemporary educational methodologies and ethical frameworks, thereby providing a valuable and impactful learning experience. This investigation seeks to elevate the standard of physics education at UIN Raden Intan Lampung through the implementation of instructional media that fosters both comprehension and moral development. The aim is to equip future educators with mastery in their respective fields while simultaneously instilling Islamic values within their teaching methodologies. Therefore, research question being addressed in this study are as follows.

1. How can augmented reality (AR)-based physics learning materials that cover abstract ideas like atomic structure be created using the ADDIE model?
2. How has the quality and viability of AR-based learning materials been validated by subject matter experts, media experts, and religious scholars?

METHOD

ADDIE (Analysis, Design, Development, Implementation, and Evaluation) is the methodology utilized in the R&D research and the selected model (Setiawan & Panuntun, 2021). The ADDIE development technique is based on a systematic and complex process design (Sabrina et al., 2022). The systematic application of the ADDIE model is expected to facilitate the design and development of contemporary, effective, and efficient learning products for the digital era (Suprapto et al., 2020). The outcomes of the research and development process include research and development techniques (Nandyansah et al., 2020). Research and development procedures encompass steps such as problem identification, data collection, data analysis, design, testing, and product evaluation (Yamtinah et al., 2023). Through this technique, scientists utilize their expertise to develop products that meet consumers' needs and expectations (Fombona-Pascual et al., 2022)

Population and Sample

This investigation was undertaken during the first and third semesters of the 2024-2025 academic calendar. The inquiry engaged physics students from UIN Raden Intan Lampung, who contributed to the implementation and usability evaluation of the

augmented reality-based educational media. In alignment with the research and development (R&D) methodology, the emphasis of this investigation was on the creation and validation of the educational product as opposed to traditional population sampling.

The validation procedure encompassed three primary groups of experts to guarantee the quality and viability of the developed media:
1. Material Experts: Entrusted with the task of appraising the accuracy and relevance of the physics content embedded within the AR media.
2. Media Experts: Tasked with evaluating the design, interactivity, and technical functionality of the augmented reality platform.
3. Islamic Experts: Assessed the incorporation of Islamic principles to ensure congruence with ethical and religious standards.

Physics students served as users during the implementation phase, supplying critical feedback on the practicality and efficacy of the AR-based instructional tool. This iterative feedback proved vital in refining the media to better align with educational aims and user requirements.

Data Analysis

Preliminary Stage

After the analysis results are obtained then the next product specification will be produce. The specifications are as follows (Ismail et al., 2021).
a. The product to be developed is a learning medium for atomic structure.
b. Educational media delivered through Augmented Reality.
c. This media employs Augmented Reality technology and is made for smartphones using the Android platform.

Following its completion, a thorough examination of the product specifications was conducted to specify the requisite software and hardware for the educational media designed for augmented reality. The software prerequisites encompass Unity version 2018.2.0f2 (64 bits), Vuforia-Unity version 6.2.6, Blender version 2.76b, and Canva. Concerning hardware, the baseline specifications necessitate a laptop equipped with a minimum of 4GB of RAM, a Core i3 processor, and a screen resolution that is subject to modification as needed. Furthermore, the product stipulates the possession of an Android smartphone that meets the minimum Android version requirements and possesses an adjustable screen resolution to facilitate the developed application.
Introductory research, literature reviews from various papers and books, and content analyses of physical materials indicate the advancement of augmented reality applications. This diagram illustrates the planning process for product development.

The use case delineates the functionalities included within the application system. The subsequent table presents the definition of use.

Table 1. features or components of the AR

No	Use Case	Definition
1.	Learning	Users can access the primary educational resources pertaining to educational resources pertaining to atomic structure. Multimedia and textual materials are probably included
2.	Learning Tools	Tools that facilitate learning, such as interactive or augmented reality-based resources, can be advantageous to students.
3.	Practice Maps	This feature includes practice problems or scenarios that relate to certain aspects of atomic structure.
4.	Atomic Map	Students can augment their comprehension of atomic structures through the utilization of an interactive map.
5.	Concept Map	A graphic depiction of fundamental atomic principles and their interconnections is presented.
6.	Practice Questions	It offers pupils practice questions to evaluate their understanding of atomic structure topics.
7.	AR Camera	The tool integrates augmented reality capabilities, allowing students to observe atomic models via their device's camera.
8.	Accator Profile	Probably includes details regarding the developers, educators, or the framework supporting the educational product.
9.	Discussion Profile	TTThis feature enables students to participate in conversations regarding atomic structure topics, possibly via a forum or chat format.
10.	Learning Guide	Provides guidance on navigating the educational resources and tools available on the site.

Augmented reality is generally made with market cards (paper), the development carried out in this study is that we make an augmented reality application using of real objects (Sumardani et al., 2023) . User interfaces resulting from this development phase are as follows.

Research data is gathered by expert validation sheets, educator assessment sheets, and student answer sheets, with data processed via a Likert scale. The formula for determining a qualifying presentation of each element is as follows:

$$P = \frac{\Sigma x}{SM1} \times 100\%$$

P = Presentation
Σx = Total score
SM1 = Ideal maximum score
The subsequent formula computes the presentation of the subjects:

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

F = Total number of subjects
N = Many subjects
P = Presentation number

Enhance the response by include five product alternatives that correspond with the inquiry's subject matter. Modifications in the evaluation outcomes of media experts,

material experts, religion experts, educators, and student responders from letters to numerical scores as per the stipulations of the subsequent table:

Table 2 . Likert Scale For Instruments

Literacy	Definition
SB (Very Good)	5
B (Good)	4
C (Enough)	3
K (Less)	2
SK (Very Less)	1

We employ angle validators to assess the quality of the produced material. The final number was derived by averaging the elements related to height, which entails dividing the feasibility value of each feature by several inquiries. The subsequent table demonstrates the transformation of the score into this rating statement:

Table 3. Criterion Interpretation Scale

Literacy	Definition
$0\% < x \leq 20\%$	Very Not Worth It
$40\% < x \leq 40\%$	Not Worth It
$40\% < x \leq 60\%$	Decent Enough
$60\% < x \leq 80\%$	Worthy
$80\% < x \leq 100\%$	Very Worth It

The scale table for interpreting the criteria enables the research to evaluate the effectiveness or inadequacy of comic learning media grounded in Islamic constructivism, utilizing Augmented Reality learning media that incorporates Islamic values related to atomic structure. The media is deemed valuable when it is presented comprehensively across all parameters.

RESULT AND DISCUSSION

This research analyzes the development of Augmented Reality (AR)-enhanced educational materials that incorporate Islamic principles, especially troubling Atomic Structure within the History of Physics curriculum in the Physics Education Department at UIN Raden Intan Lampung. The employed development model is ADDIE, comprising five principal stages: Analysis, Design, Development, Implementation, and Evaluation. This method is employed to guarantee that the generated educational material is effective and satisfies the requirements of the pupils.

At the Analysis section, the researcher does a needs assessment by gathering data via interviews and administering questionnaires to students. The investigation indicates that numerous students struggle to comprehend the information on Atomic Structure, which is frequently perceived as abstract and tedious. Furthermore, the existing learning tools, including modules, PowerPoint presentations, and guidebooks, are deemed inadequate for effectively visualizing abstract concepts within the Atomic Structure curriculum. Informed by these findings, the researchers developed AR-based educational media during the Design stage that not only articulates content descriptions but also visualizes

the concept of Atomic Structure through an Islamic lens to augment students' comprehension and engagement in learning. This media is tailored to align with the attributes of students at UIN Raden Intan Lampung.

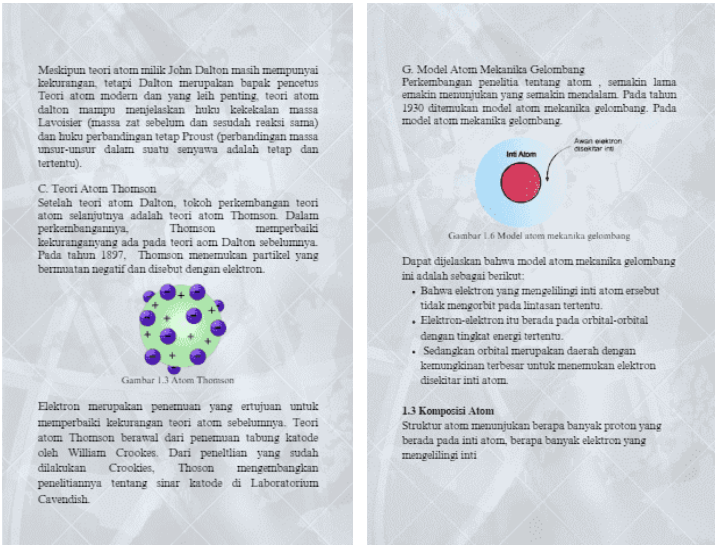
During the Development stage, this Augmented Reality-based educational media was created by aligning with the requirements and attributes of the Atomic Structure content, thereafter applied to students. Following the implementation phase, an evaluation was performed to assess the effectiveness and validity of the created learning medium.

The findings of this study demonstrate that the proposed AR-based learning media can improve students' comprehension of Atomic Structure concepts. Preliminary investigations and needs analysis revealed that:

a) Augmented reality-based educational resources are essential due to the challenges many students face in comprehending Atomic Structure concepts.
b) Atomic structure is an abstract concept that necessitates illustration beyond simple written explanation to facilitate comprehension.
c) Students advocate for the creation of AR-based educational resources to enhance their comprehension of Atomic Structure concepts.

Consequently, the implementation of Augmented Reality-based media for Atomic Structure content is anticipated to address students' challenges in comprehending abstract concepts and to improve their participation in the educational process. (Ibáñez & Delgado-Kloos, 2018)assert that the implementation of Augmented Reality (AR) in education significantly improves student engagement and comprehension, particularly in abstract disciplines such as science, technology, engineering, and mathematics (STEM).

Figure 2 illustrates the design of the "Atom Structure Augmented Reality" module for Augmented Reality-based Physics education.



Meskipun teori atom milik John Dalton masih mempunyai kekurangan, tetapi Dalton merupakan bapak pencetus Teori atom modern dan yang lebih penting, teori atom dalton mampu menjelaskan huku kekekalan massa Lavoisier (massa zat sebelum dan sesudah reaksi sama) dan huku perbandingan tetap Proust (perbandingan massa unsur-unsur dalam suatu senyawa adalah tetap dan tertentu).

C. Teori Atom Thomson

Setelah teori atom Dalton, tokoh perkembangan teori atom selanjutnya adalah teori atom Thomson. Dalam perkembangannya, Thomson memperbaiki kekurangannya ada pada teori atom Dalton sebelumnya. Pada tahun 1897, Thomson menemukan partikel yang bermuatan negatif dan disebut dengan elektron.

Gambar 1.3 Atom Thomson

Elektron merupakan penemuan yang ertujuan untuk memperbaiki kekurangan teori atom sebelumnya. Teori atom Thomson berawal dari penemuan tabung katode oleh William Crookes. Dari penelitian yang sudah dilakukan Crookies, Thoson mengembangkan penelitiannya tentang sinar katode di Laboratorium Cavendish.

G. Model Atom Mekanika Gelombang

Perkembangan penelitia tentang atom , semakin lama emakin menunjukan yang semakin mendalam. Pada tahun 1930 ditemukan model atom mekanika gelombang. Pada model atom mekanika gelombang.

Inti Atom

Awan elektron disekitar inti

Gambar 1.6 Model atom mekanika gelombang

Dapat dijelaskan bahwa model atom mekanika gelombang ini adalah sebagai berikut:

- Bahwa elektron yang mengelilingi inti atom ersebut tidak mengorbit pada lintasan tertentu.
- Elektron-elektron itu berada pada orbital-orbital dengan tingkat energi tertentu.
- Sedangkan orbital merupakan daerah dengan kemungkinan terbesar untuk menemukan elektron disekitar inti atom.

1.3 Komposisi Atom

Struktur atom menunjukan berapa banyak proton yang berada pada inti atom, berapa banyak elektron yang mengelilingi inti

Figure 1**.** Atomic structure learning module

The design of the 3D Object Creation for Augmented Reality-Based Physics Learning Media about Atomic Structure is illustrated in Figure 3.

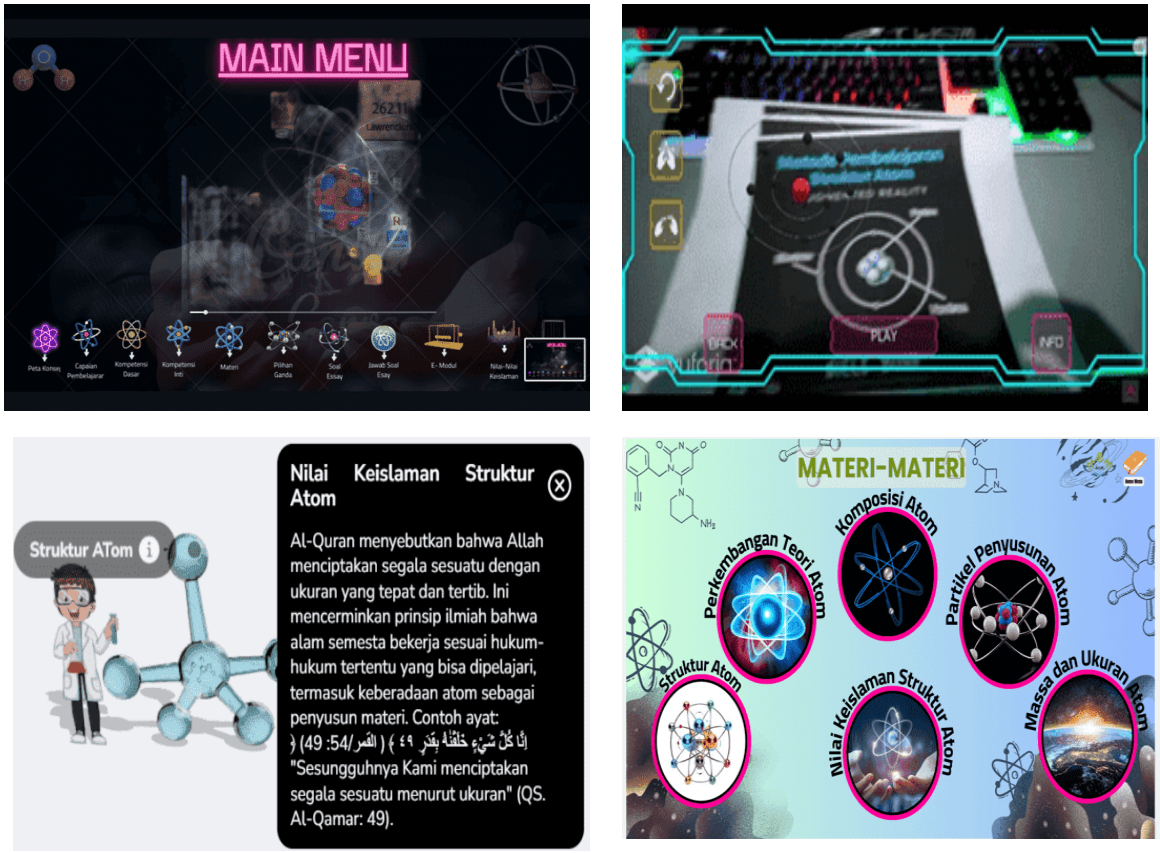


Figure 2. Display of Augmented Reality learning media based on islamic values on atomic structure.

The Augmented Reality (AR) product depicted in this image is an interactive educational tool aimed at assisting students in comprehending the concept of Atomic Structure within the History of Physics curriculum at UIN Raden Intan Lampung. This program includes a QR Code functionality that enables users to effortlessly access AR material by scanning. In the application's primary menu, users can select from many themes, including atomic composition, atomic constituent particles, and other atomic theories. This tool offers interactive visualization via a 3D representation of Atomic Structure when users scan a book or physical module, facilitating comprehension of abstract concepts.

This AR product not only facilitates scientific visualization but also incorporates Islamic principles, exemplified by interpretations of the natural order from an Islamic viewpoint, connected to atomic theory and Quranic passages. This feature enables students to learn physics while also understanding the relationship between science and faith. Core subjects include Atomic Structure, atomic constituent particles, and physical equilibrium are delivered using interactive and visual methods, facilitating enhanced comprehension and engagement for students in the learning process. This AR tool promotes academic comprehension and facilitates the incorporation of spiritual concepts into science teaching.

Table 4**.** Results of augmented reality media validation

Aspect	Presentation	Category
Aplication Use	85%	Very Interesting
Aplicability Display Vesibility	85%	Very Interseting
Use of Reference Media	88%	Very Interesting
Average	86%	Very Interesting

This table 4 illustrates the assessment outcomes of several facets of utilizing Augmented Reality (AR)-based educational applications, achieving an overall average score of 86% in the Highly Engaging category. The dimensions of Application Use and Reference Media both attained a score of 85%, signifying that the AR application is deemed engaging and successful in facilitating students' comprehension of the topic, while the references incorporated in the application enhance the learning experience. The Applicability Display Visibility earned a score of 88%, signifying that the AR visual display is exceptionally clear and effective in communicating abstract concepts. The results demonstrate that students highly value the AR application for its effectiveness in boosting their engagement and comprehension of the learning material.

Table 5**.** Results of augmented reality religion validation

Aspect	Presentation	Category
Tahwid	83%	Very interesting
Amanah	87%	Very interesting
Ihsan	85%	Very interesting
Tafakkur Islamic	84%	Very interesting
Values	86%	Very interesting
Khalifah	82%	Very interesting

Al-Mizan	88%	Very interesting
Average	85%	Very interesting

The Table 5 presented encapsulate the findings of the validation of Islamic principles incorporated into the educational materials, assessing each component including Tawhid, Amanah, Ihsan, Tafakkur, Adab, Khalifah, and Al-Mizan. The highest-rated element is Al-Mizan, achieving a score of 88% and classified as "Very Interesting," closely followed by Amanah at 87%. Additional factors, including Adab and Ihsan, attained elevated values of 86% and 85%, respectively. The overall average across all elements is 85%, signifying that the incorporation of these Islamic values is regarded as highly effective and engaging in the learning process. The graph distinctly depicts the percentage change of each value, with Al-Mizan and Amanah identified as the most esteemed in the learning materials. The application of Islamic values in education aligns with (Kamińska et al., 2023)research, which indicates that Augmented Reality (AR) and the incorporation of ethical values can improve student engagement and comprehension of the material through an interactive and significant methodology.

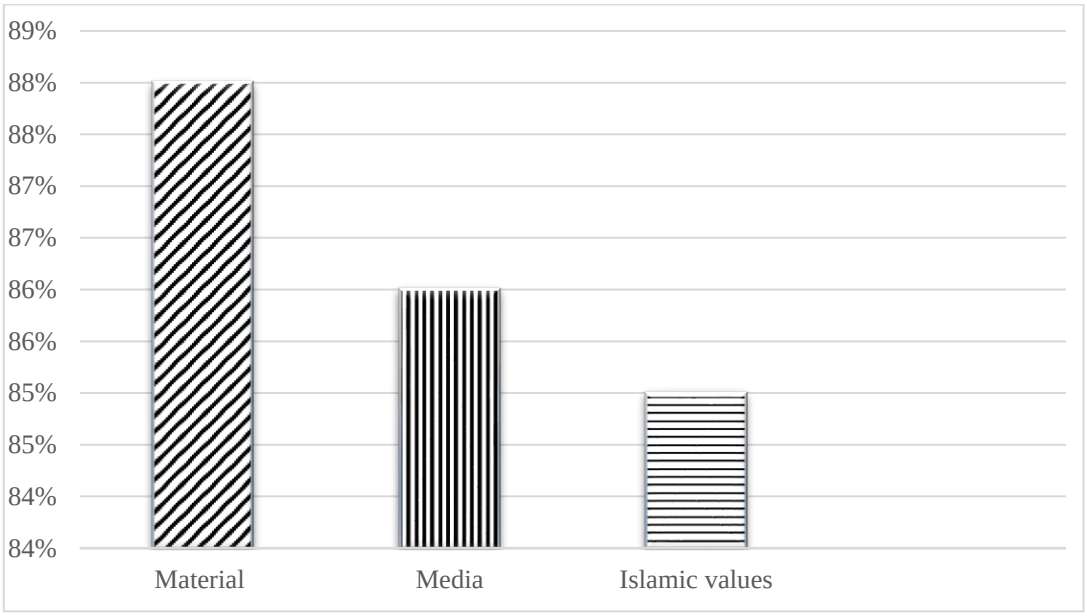


Figure 3. Evaluation of material, media, and Islamic values in AR-based learning media

The figure 3 above present the evaluation findings of Augmented Reality (AR)-based learning media utilized in the Atomic Structure content, assessed across three dimensions: Material, Media, and Islamic Values. The material part of the presentation received an 88% rating, classified as "Very Interesting," signifying that the content delivered through this AR media is exceptionally pertinent and effective for educational purposes. The Media component attained 86%, categorizing it as "Very Interesting," indicating that the overall quality of the AR media is seen as commendable. The Islamic Values component received a rating of 85%, marginally lower although still classified within the "Very

Interesting" category, signifying a favorable perception of the incorporation of Islamic values in education.

The average percentage of these three dimensions is 86.3%, signifying that this AR-based learning medium is highly viable and captivating in its application to the Atomic Structure content. This corresponds with research indicating that augmented reality might increase students' learning experiences through interactivity and visualization, hence improving their comprehension of intricate subjects like scientific principles in physics (Alzahrani, 2020).

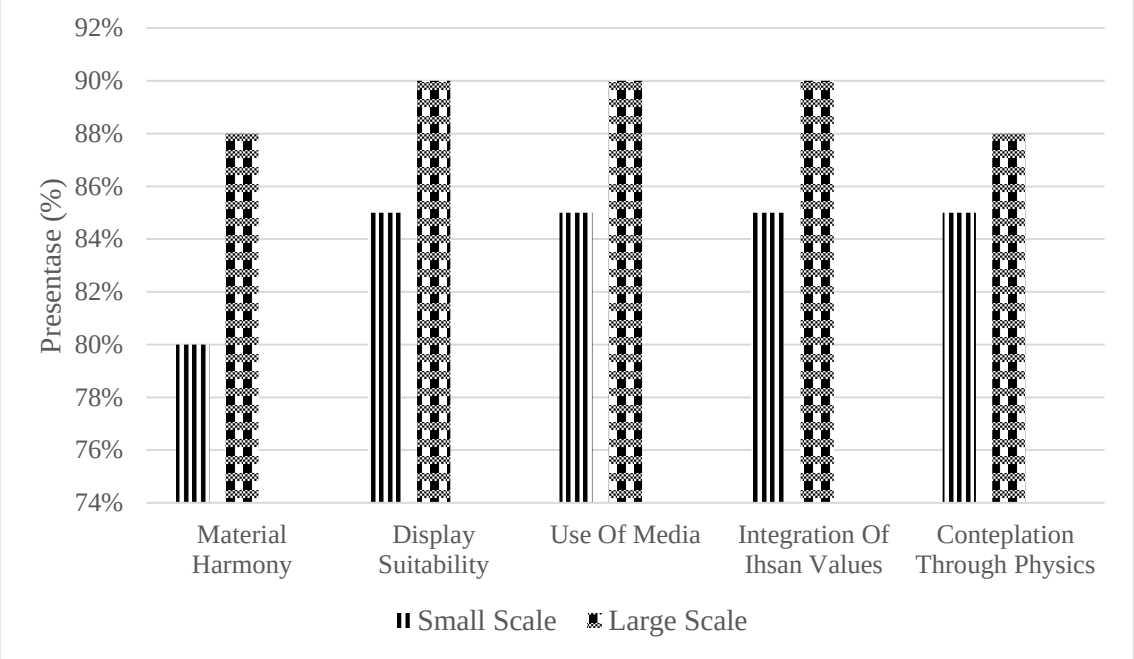


Figure 4. Illustrates a comparison between small-scale and large-scale experiments.

Figure 4 illustrates a substantial increase in each indicator following the execution of large-scale trials in comparison to small-scale trials. The small-scale test achieved a score of 77% on the conceptual material alignment indicator, whereas the large-scale test improved to 90%. This suggests that the curriculum aligns better with the learners' expectations when implemented with a bigger cohort. The Written Media Suitability Indicator rose from 80% in small-scale tests to 88.7% in large-scale tests, demonstrating that written media is more successful when evaluated on a wider scale. The Augmented Reality Display Suitability index increased from 77.6% on a small scale to 87.7% on a big size, indicating enhanced acceptance of augmented reality technology in larger applications.

The indicator of module compatibility with media rose from 79.2% on a small scale to 88% on a large scale. This suggests that the integration of modules with media is more efficacious when utilized within a comprehensive learning framework. The metric for learning media utilization rose from 78% on a small scale to 88% on a large scale, indicating that learning media operates more effectively on a larger scale. Research published in the Journal of instructional Technology & Society indicates that instructional

technology, including augmented reality, might improve student engagement and learning efficacy, particularly in extensive applications (Pikon et al., 2018).

While the results are articulated in a thorough manner, the discussion segment appears to lack adequate connections to overarching educational theories and antecedent empirical research. To enhance this section, it is imperative that the findings are framed within established educational paradigms and substantiated by pertinent scholarly literature. For example, the discerned enhancement in student engagement and comprehension can be correlated with Collaborative Active Learning (CAL), which accentuates the significance of group-based learning through intentional discourse and reflection to attain collective understanding (Ortega & Jambaya, 2022).

Likewise, the Engagement Theory posits that technology-mediated pedagogical approaches, such as augmented reality (AR), have the potential to augment student engagement and educational outcomes by fostering collaborative and substantive learning experiences (Kearsley & Shneiderman, 1998). Moreover, contemporary research indicates that the utilization of AR and virtual reality (VR) technologies considerably bolsters student engagement and learning outcomes, particularly when such technologies are deployed at an expansive scale (Huri et al., 2024). Incorporating these theoretical frameworks and previous investigations will yield a more robust basis for interpreting the findings and positioning them within the expansive educational landscape.

CONCLUSION

The ADDIE model has been employed to effectively develop augmented reality (AR)-based physics learning media for students and lecturers. The validation results indicate that the learning media is of superior quality, with material experts rating it at 88%, media experts at 86%, and religious experts at 85%, categorizing it as "Very Feasible." Augmented reality technology facilitates a more comprehensive understanding of the abstract concept of atomic structure for both students and lecturers through an interactive and engaging approach. The incorporation of Islamic beliefs introduces an ethical dimension, enhancing both the intellectual and moral facets of the educational experience. In addition to the use of this AR-based media, it is recommended to strengthen its interactive characteristics and broaden its application to additional areas in physics. Examining its application in a wider array of educational contexts, involving diverse student and instructor demographics, may yield more profound insights into its efficacy. Furthermore, undertaking longitudinal research would elucidate the media's enduring influence on academic achievement and the incorporation of Islamic values in education. Offering extensive training for educators to proficiently utilize AR technology in their instruction could enhance its educational efficacy.

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