Journal of Advanced Research in Applied Sciences and Engineering Technology

Journal homepage:
https://semarakilmu.com.my/journals/index.php/applied_sciences_eng_tech/index
ISSN: 2462-1943

Android-Based Augmented Reality Technology in the Application of Social Studies Textbooks in Schools

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ARTICLE INFO

Article history:
Received 12 December 2023
Received in revised form 12 March 2024
Accepted 3 June 2024
Available online 5 July 2024

Keywords:
android, textbook, augmented reality, social studies, secondary school.

ABSTRACT

This research aims to design and develop a Social Studies textbook using Android-based Augmented Reality (AR) Technology for the secondary school level. The research method uses a qualitative and quantitative approach with Design-Based Research. Data collection techniques use observation, documentation, and questionnaires. Qualitative data analysis uses data collection, data reduction, data presentation, and conclusions, and quantitative data analysis uses correlation regression. Research subjects are students, lecturers, and experts. The experimental results showed that implementation of social studies textbooks using Android-based AR technology is easy to visualize via cell phone. Based on expert validation, Social Studies textbooks are quite effective in Android-based AR technology. Research discussions provide evidence that the use of books is quite effective in fostering critical and creative thinking and building students' 21st-century skills. Research implications make it easier for students to visualize abstract material to become more concrete.

1. Introduction

Advances in technology and information in the Industrial Revolution 4.0 era have enabled transformation in the field of education [1, 2]. This fact is an opportunity that can be exploited by education experts who continue to move dynamically, especially to create media, methods, and educational materials that are increasingly interactive and comprehensive. Learning is supported by technology and digitalization to innovative learning and involves real-world problem [3]. Several studies reviewed recent studies conducted by adapting the use of technology and digitalization during learning, this has an impact on creating an interactive learning environment and changing passive learners into active learners who are fully involved [4].

Technology plays a role in the learning process curriculum planning and thinking in three ways, namely: (i) the use of new technology becomes a social goal of the curriculum, (ii) technology

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https://doi.org/10.37934/araset.48.1.2950

provides resources for curriculum development because it can enable teachers to find and collect teaching materials and guide students in learning, and (iii) technology can provide tools for assessing various areas of practice, such as simulation, namely making models or visualization tools in the field of science and tools for analysing texts in literature [5, 6]. Technology is effective, especially when facing the pandemic situation [7]. Covid-19 has changed the way of teaching and learning processes [8, 9]. The teaching materials or textbooks needed when studying at home during the Covid 19 pandemic situation are textbooks that are displayed via the internet network and can be accessed online. One of the tools in the teaching and learning processes using technology is Augmented Reality (AR). Many reports regarding AR have been published [10-12]. AR is an emerging new technology with the potential to be applied in education by providing an efficient way to represent models that need visualization to give users a sense of the real world when interacting with virtual and physical objects. Research on AR has been well-documented (see Figure 1).

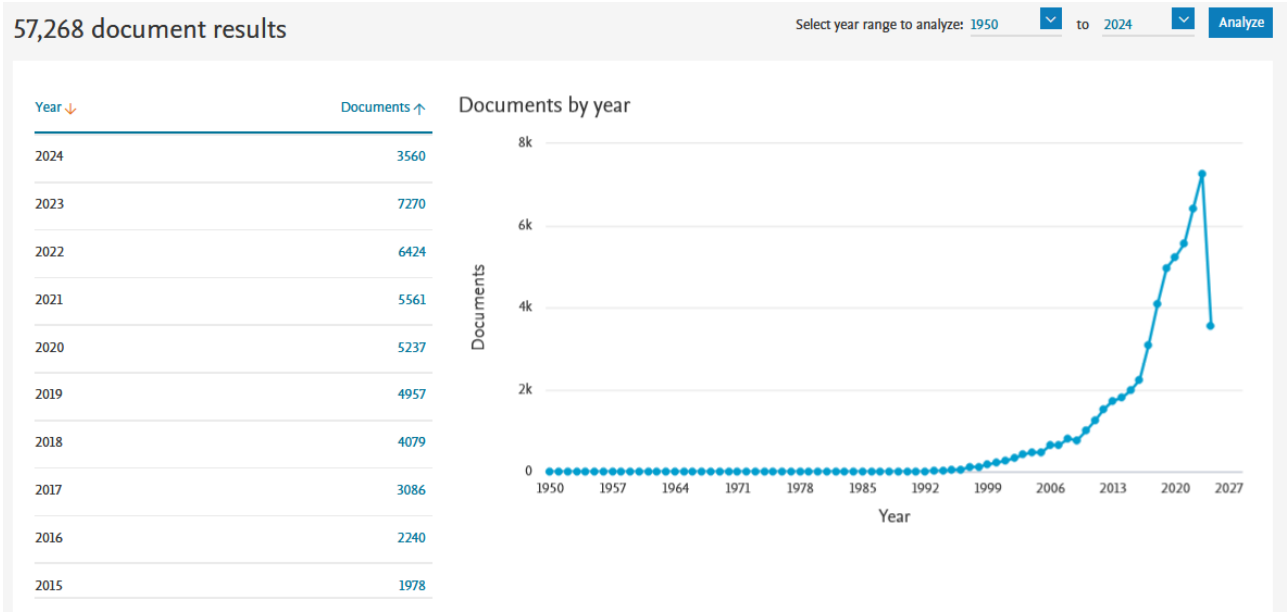

Fig. 1. Bibliometric analysis for obtaining research trend, taken from the Scopus database on June 2024, using the keyword "Augmented Reality"

Figure 1 shows the improvement of publication numbers in the research on AR based on the Scopus database taken in June 2024, showing the importance of this study for further uses and applications. Detailed information on how to get this data is explained elsewhere [13]. Bibliometric analysis is one of the effective methods for understanding current issues and research trends. Examples of the use of bibliometrics to understand research trends are presented in Table 1.

Table 1
Previous studies on bibliometric analysis

No	Title	Author	Ref.
1	Introducing ASEAN Journal for Science and Engineering in Materials: Bibliometric Analysis	Nandiyanto, A. B. D., Al Husaeni, D. F., & Al Husaeni, D. N.	[14]
2	Involving Particle Technology in Computational Fluid Dynamics Research: A Bibliometric Analysis	Nandiyanto, A. B. D., Ragadhita, R., & Aziz, M.	[15]
3	Particulate Matter Emission from Combustion and Non-Combustion Automotive Engine Process: Review and Computational Bibliometric Analysis on Its Source, Sizes, and Health and Lung Impact	Nandiyanto, A. B. D., Ragadhita, R., Setiyo, M., Al Obaidi, A. S. M., & Hidayat, A.	[16]

Table 1 (continue)
Previous studies on bibliomentric analysis

No	Title	Author	Ref.
4	Social Impact and Internationalization of "Indonesian Journal of Science and Technology" the Best Journal in Indonesia: A Bibliometric Analysis	Nandiyanto, A. B. D., Al Husaeni, D. F., & Al Husaeni, D. N.	[17]
5	Introducing ASEAN Journal of Science and Engineering: A Bibliometric Analysis Study	Nandiyanto, A. B. D., Al Husaeni, D. N., & Al Husaeni, D. F.	[18]
6	Concept of Computational Fluid Dynamics Design and Analysis Tool for Food Industry: A Bibliometric	Muktiarni, M., Rahayu, N. I., Nurhayati, A., Bachari, A. D., & Ismail, A.	[19]
7	Concept of Computational Fluid Dynamics and Its Application in Sport Science: Bibliometric Analysis of Modelling Thermal Comfort in Sport Hall	Rachmat, B., Agust, K., Rahayu, N. I., & Muktiarni, M.	[20]
8	Bibliometric Computational Mapping Analysis of Trend Metaverse in Education using vosviewer	Muktiarni, M., Rahayu, N. I., Ismail, A., & Wardani, A. K.	[21]
9	Phytochemical Profile and Biological Activities of Ethylacetate Extract of Peanut (Arachis hypogaea L.) Stems: In-Vitro and In-Silico Studies with Bibliometric Analysis	Sahidin, I., Nohong, N., Manggau, M.A., Arfan, A., Wahyuni, W., Meylani, I., Malaka, M.H., Rahmatika, N.S., Yodha, A.W., Masrik, N.U.E. and Kamaluddin, A.	[22]
10	Information and communication technology (ict) intervention targeting physical activity and diet behaviors in people with disabilities: vosviewer mapping analysis	Rahayu, N. I., Bachari, A. D., Muktiarni, M., & Maryanti, R.	[23]
11	Computational bibliometric analysis of English research in science education for students with special needs using vosviewer	Sukyadi, D. I. D. I., Maryanti, R., Rahayu, N. I., & Muktiarni, M.	[24]
12	Orange and strawberry skins for eco-enzyme: experiment and bibliometric analysis	Muktiarni, M., Rahayu, N., & Maryanti, R.	[25]
13	Counseling guidance in science education: definition, literature review, and bibliometric analysis	Solehuddin, M., Muktiarni, M., Rahayu, N.I. and Maryanti, R.	[26]
14	A bibliometric analysis of management bioenergy research using vosviewer application	Soegoto, H., Soegoto, E.S., Luckyardi, S., and Rafdhi, A.A.	[27]
15	Oil palm empty fruit bunch waste pretreatment with benzotriazolium-based ionic liquids for cellulose conversion to glucose: Experiments with computational bibliometric analysis.	Mudzakir, A., Rizky, K.M., Munawaroh, H.S.H., and Puspitasari, D.	[28]
16	Research mapping in the use of technology for fake news detection: Bibliometric analysis from 2011 to 2021.	Gunawan, B., Ratmono, B.M., Abdullah, A.G., Sadida, N., and Kaprisma, H.	[29]
17	Management information systems: bibliometric analysis and its effect on decision making.	Santoso, B., Hikmawan, T., and Imaniyati, N.	[30]
18	Sustainable Production-inventory model with multi-material, quality degradation, and probabilistic demand: From bibliometric analysis to a robust model.	Utama, D.M., Santoso, I., Hendrawan, Y., and Dania, W.A.P.	[31]
19	Biomass-based supercapacitors electrodes for electrical energy storage systems activated using chemical activation method: A literature review and bibliometric analysis.	Hamidah, I., Ramdhani, R., Wiyono, A., Mulyanti, B., Pawinanto, E.E., Hasanah, L., Diantoro, M., Yuliarto, B., Yunas, J., and Rusydi, A.	[32]
20	Antiangiogenesis activity of Indonesian local black garlic (Allium Sativum 'Solo): Experiments and bibliometric analysis.	Arianingrum, R., Aznam, N., Atun, S., Senam, S., Irwan, A.R., Juhara, N.Q., Anisa, N.F., and Devani, L.K.	[33]
21	Characteristics of tamarind seed biochar at different pyrolysis temperatures as waste management strategy: experiments and bibliometric analysis.	Rahmat, A., Sutiharni, S., Elfina, Y., Yusnaini, Y., Latuponu, H., Minah, F.N., Sulistyowati, Y., and Mutolib, A.	[34]
22	The compleat lextutor application tool for academic and technological lexical learning: Review and bibliometric approach.	Abduh, A., Mulyanah, A., Darmawati, B., Zabadi, F., Sidik, U., Handoko, W., Jayadi, K., and Rosmaladewi, R.	[35]

Table 1 (continue)
Previous studies on bibliomentric analysis

No	Title	Author	Ref.
23	How eyes and brain see color: Definition of color, literature review with bibliometric analysis, and inquiry learning strategy for teaching color changes to student with mild intelligence barriers.	Juhanaini, J., Bela, M.R.W.A.T., and Rizqita, A.J.	[36]
24	Bibliometric analysis of nano metal-organic frameworks synthesis research in medical science using vosviewer.	Shidiq, A.P.A.	[37]
25	Use of blockchain technology for the exchange and secure transmission of medical images in the cloud: Systematic review with bibliometric analysis.	Lizama, M.G., Huesa, J., and Claudio, B.M	[38]

Here, this research aims to design and build a social studies textbook with Android-based AR technology. Social studies are one of the difficult subjects, making them be researched, especially facing the way how to memorize [39, 40]. Thus, this study can facilitate students in interesting and interactive social studies. Novelties of this study were (i) we used in Social Studies textbooks which is still rarely done by other researchers. Thus, it becomes an innovation to develop interactive digital books, (ii) we translated social studies subject concepts that are easily understood by students from abstracts in a more concrete direction, and (iii) we used features that are easier for students and teachers to use. Technological developments in learning have shifted the delivery of material resources from printed teaching materials to digital teaching materials.

We recommend a textbook form supported by AR technology. Insight into Social Studies material in real time using marker less techniques and virtual buttons as well as video/audio output appears on the smartphone screen in the form of an augmented scene. Based on the background of this problem, in general, the problem that is researched is how to develop Social Studies textbooks using Android-based AR Technology for the Social Studies level.

2. Literature Review

2.1 Android-based Augmented Reality (AR) technology

AR technology is a technology that combines two-dimensional and three-dimensional virtual objects into a real environment which then projects these digital (virtual) objects in real-time conditions [41, 42]. AR displays to view the real world augmented with computer-generated information (3D virtual objects, digital text or photos, video, audio, etc.). The main characteristics of AR [43] can be summarized as follows: (i) combining the real and virtual worlds, in a real environment (blended learning); (ii) Real-time interactive (real-time interactive); (iii) 3D environment; and (iv) can be applied to all senses, including touch, hearing, etc. Currently, the most popular are AR displays on mobile devices, tablets, or other portable devices. AR with the help of Android certainly is more interesting because Android itself is an operating system for mobile devices that includes middleware and a few applications [44, 45]. The main goal of creating this operating system is to make it easier for people to access the internet and create applications with minimal limitations [43]. Thus, developer creativity can develop more [46, 47]. A simple Android-based AR system is presented in detail in Figure 2.

Based on Figure 2, the AR system works, namely the camera from the smartphone, detects a marker object or markers that have been provided, and then with the camera, it recognizes and marks the marker pattern and compares it with the existing database. If the database is appropriate, the information on the marker be displayed as a three-dimensional object or animation to what was created previously. This AR method has the advantage of being interactive because it uses markers

to display certain three-dimensional objects directed at the camera [48, 49]. These three-dimensional objects display an attractive interface that is close to the real thing. Meanwhile, how to use Android-based AR in Social Studies textbooks is presented in detail in Figure 3.

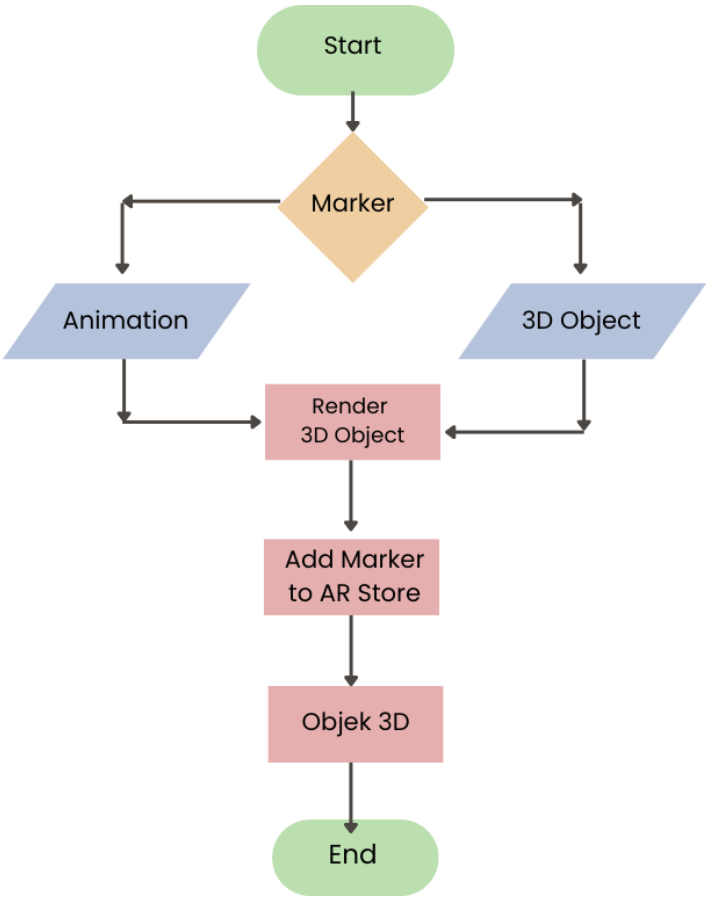

Fig. 2. How Augmented Reality Works

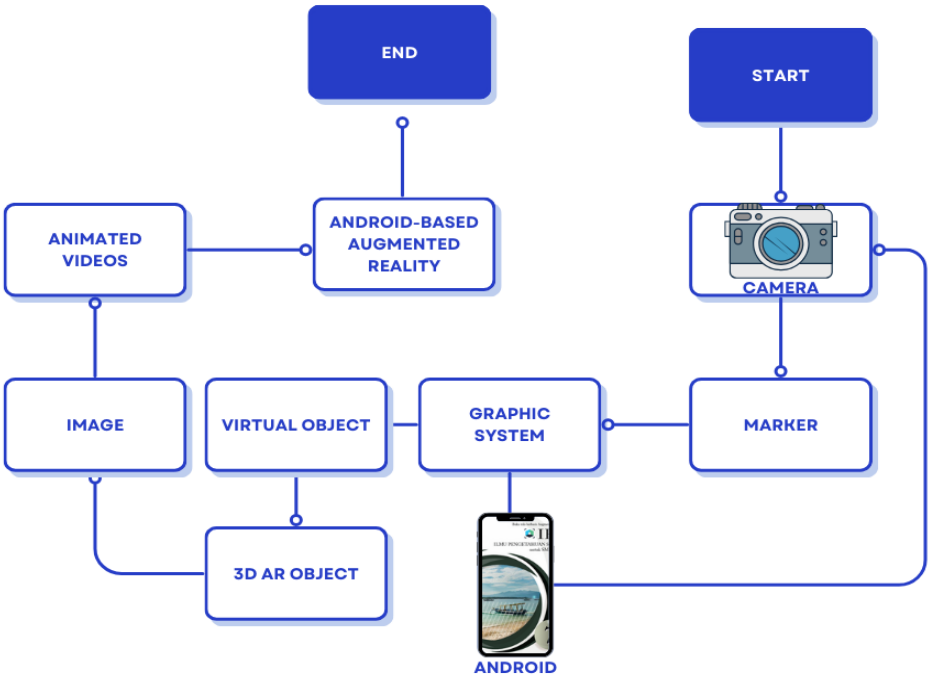

Fig. 3. Use of Augmented Reality in the Application of Social Studies learning books

2.2 Android-based Augmented Reality (AR) Technology in the Application of Social Studies Textbooks

In the context of Social Studies AR offers several advantages compared to conventional learning because Social Studies is a combination of social sciences, namely geography, economics, history, and sociology. Of course, Social Studies is a science that studies the phenomena of social phenomena and social problems as a learning process. Social Studies at various levels of elementary education to tertiary education does not emphasize the theoretical aspects of science but rather emphasizes the practical aspects of studying, examining, and studying social phenomena and problems. considering the weight and ability level of students at each different level [50, 51]. AR technology allows students to simulate creative and critical thinking and even interactions in learning become more visual [52] the use of AR in learning is divided into (i) AR classrooms by displaying AR animated content in classroom learning which can attract students' attention, and motivate students to learn, and 3D visuals provide broader topics; (ii) Explaining difficult concepts using AR technology turns them into 3D models making it easier to understand abstract and difficult content; (iii) Interactive, by incorporating AR into learning, teachers can involve students with real 3D dimensional models; (iv) Interesting findings and can use AR access via cell phone which is easy for students to use. The application of AR in social studies learning is presented in Figure 4.

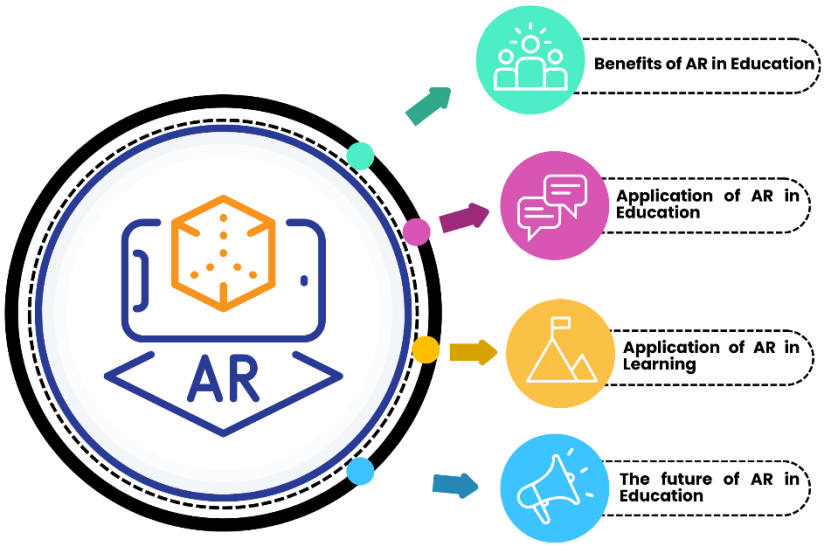

Fig. 4. Application of Augmented Reality in Social Studies Learning

Figure 4 explains the learning process, material is the most important element. This is because learning itself is a process of transferring knowledge from teachers to students. Learning material is usually summarized in a book which is commonly known as a textbook Many educational experts pay interest in and attention to textbooks [53]. Textbooks are textbooks in a particular field of study, which are standard books prepared by experts in that field for instructional purposes and objectives, equipped with facilities and easy to understand by users, in schools and universities to support a learning program. In this context it can be said that the term textbook can be considered as the equivalent of the term textbook from English which can be translated as textbook or textbook [54]. Based on this understanding, textbooks are books designed for use in the classroom, carefully compiled and prepared by experts in that field, and equipped with appropriate and harmonious learning tools.

Android-based AR technology in the application of the Social Studies textbook can certainly help students easily visualize a lot of material with social science concepts [55, 56]. One of them is material on interactions between spaces with sub-materials on understanding space and interactions between spaces, the geographical location and extent of Indonesia, the potential of natural resources and maritime affairs of Indonesia, the dynamics of the Indonesian population, the natural conditions of Indonesia, and changes that occur because of interactions between room [57, 58]. The following data is presented in Table 2 android-based AR technology in the application of social studies textbooks.

Table 2
Examples of Android-based AR technology in the application of Social Studies textbooks

Application of Android-based Social Studies Textbooks	Explanation
	The inter-room interaction sub-material explains examples of comparisons between traditional and modern market trading. Through Android-based AR visualization, students gain an interactive and interesting learning experience in real-time conditions.
	The spatial interaction sub-material explains examples of population movement from village to city. Through Android-based AR technology, students can easily analyze the causes of population movement without having to carry out mobility.

Table 2 (continue)

Application of Android-based Social Studies Textbooks	Explanation
	The inter-space interaction sub-material explains examples of Indonesia's geographic and astronomical location in a concrete way that can be understood by students through Android-based AR technology and students can even simulate coordinate projection calculations.
	The inter-space interaction sub-material explains examples of Indonesia's natural and maritime resource potential. Thus, Android-based AR technology can explore Indonesia's richness with its diversity of natural resources.
	Examples of climate change in Indonesia which are caused by human activities are presented. Thus, through Android-based AR technology students are helped to analyze the causes of these problems.

2.3 *Previous Research Android-based AR Technology in Textbook Application*

Android-based AR technology has been used in various applications to increase interaction in learning, one of which is interesting is that the application of textbooks can provide a more interactive learning experience, the research results are shown in Table 3.

Table 3
Results of Previous Research

Researcher	Research result	Ref
Design and development of a mobile augmented reality-based learning environment for teaching the lives of scientist	AR has proven effective in increasing student participation and helping students understand abstract concepts in learning.	[59]
Smart Maps Indonesia Based on Augmented Reality as Digital Learning Resources of **Social studies**	AR is quite effective in fostering students' attitudes, critical thinking and creativity.	[60]
Effects of Augmented Reality Applications on Academic Success and Course Attitudes in **Social Studies** Manuscript.	AR provides benefits for the world of education to place augmented reality technology in other courses, not just social studies and students like augmented reality applications.	[61]

3. Methodology

This research was conducted using the Design Based Research (DBR) approach. Borg and Gall's research and development design was adapted to obtain procedures to research needs. In this research, DBR was used to produce social studies textbook products with Android-based AR technology for secondary schools' level. This research has development steps consisting of three steps, namely pre-production, production and post-production steps. Thus, they can be described in Figure 5.

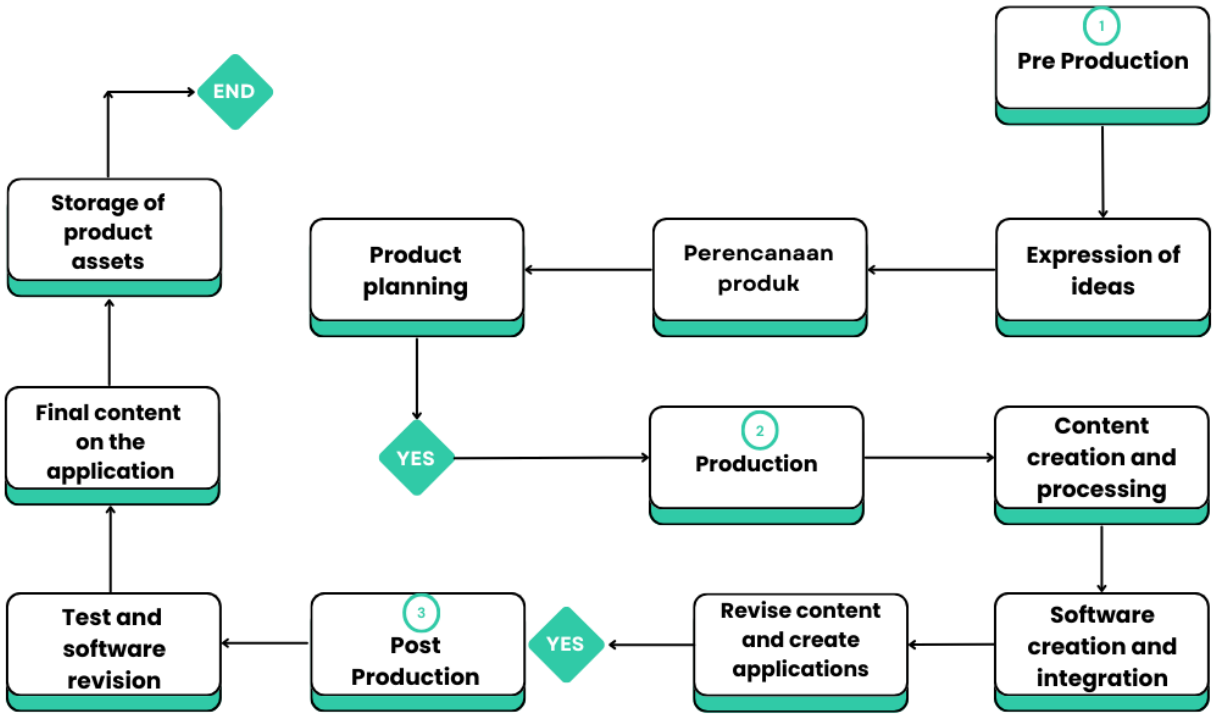

Fig. 5. Design Based Research (DBR) steps

This research was conducted using the Design Based Research (DBR) approach. Borg and Gall's research and development design was adapted to obtain procedures to research needs. In this research, DBR was used to produce social studies textbook products with Android-based AR technology for secondary schools' level. This research has development steps consisting of three steps, namely pre-production, production and post-production steps. Thus, they can be described in Figure 6.

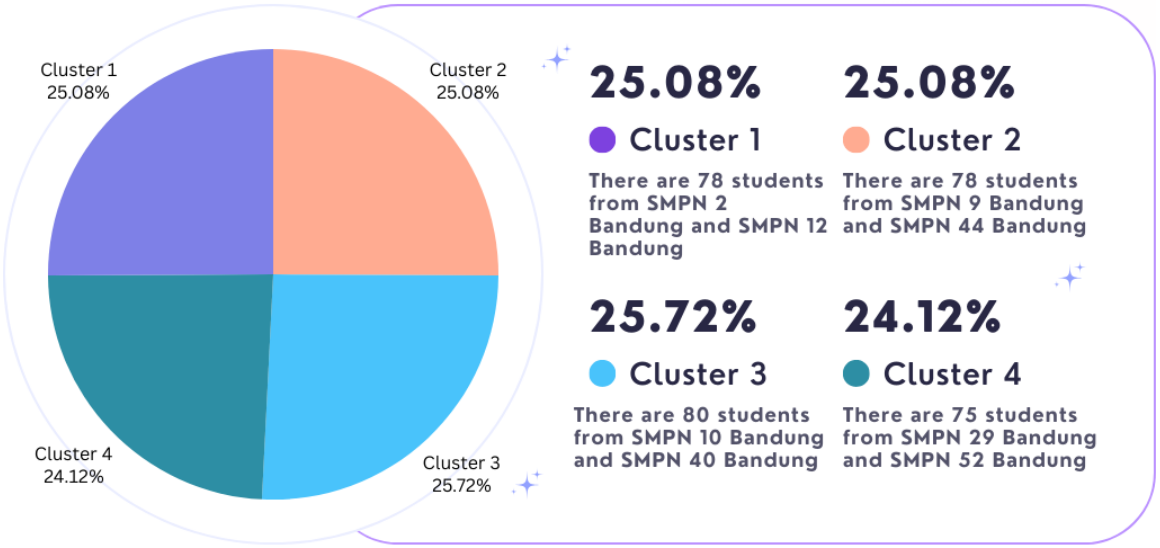

Fig. 6. Distribution of locations and research samples

Data collection techniques use questionnaire data distributed for product trials, field notes (Field Notes), documentation studies and Focus Group Discussions (FGD). The following is a presentation of the steps for qualitative data analysis in Figure 7.

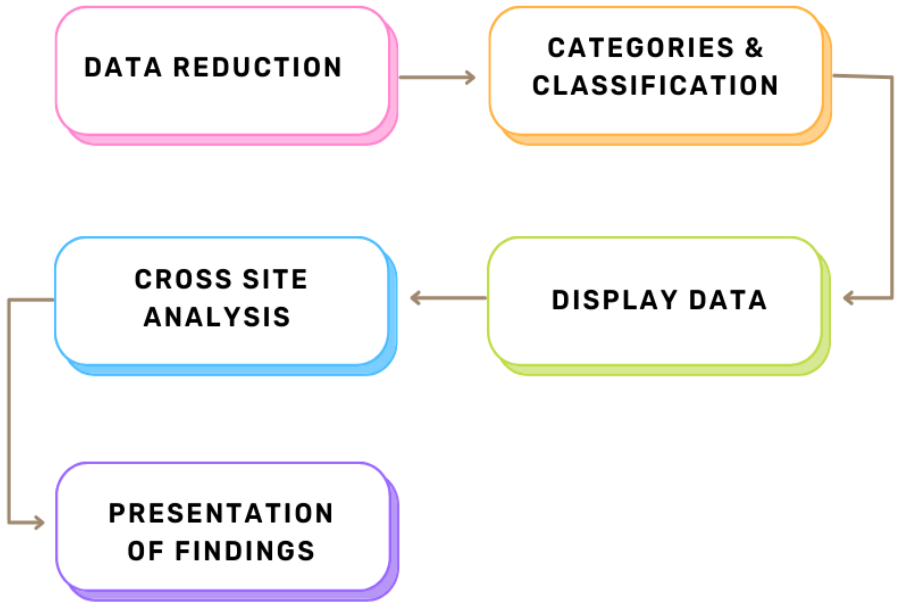

Fig. 7. Steps in Qualitative Data Analysis

Figure 7 explains the qualitative data analysis carried out through the following steps: (i) carrying out data reduction by summarizing the field report, noting the main things that are relevant to the research focus; (ii) arrange them systematically based on certain categories and classifications; (iii) create data displays in the form of tables or images. Thus, the relationship between one data and another is clear and complete (not separated); (iv) conducting cross-site analysis by comparing and analysing data in depth; and (v) presenting findings and drawing conclusions in the form of general trends and implications for their application, and recommendations for development. Quantitative analysis was carried out for trial data through questionnaires, using gain test analysis.

4. Results

4.1 Conceptual Model of Augmented Reality-based social studies Education Textbooks in Schools

The AR-based social studies education textbook model uses three-dimensional (3D) learning technology by displaying objects and concepts in different ways and angles to help students better understand social studies subjects. The form of developing this AR-based textbook consists of 3 stages, namely the pre-production stage, production stage, and post-production stage.

Pre-Production, there are 2 pre-production parts consisting of Idea Generating Process, and Planning. The ideas or thoughts of the authors of AR-based digital textbooks are based on the ease of the online learning process to provide information and insight into social studies material in AR-based social studies textbooks. The social studies material content is adapted to the 2013 curriculum and uses a variety of visual materials plus audio-visual animated movements. The AR-based social studies Education Textbook model design is adjusted based on curriculum analysis and analysis of textbook needs in schools [62]. The application of AR technology integration in textbooks pays attention to fact material, data material, principal material, and value material. The preparation of this textbook is shown in Figure 8. It contains the book's identity, book contents, and book cover, as well as the AR video and audio link features presented in Figure 8. Figure 8 shows that the social studies textbook has been designed using Android-based AR technology with interactive animated movements for students.

Fig. 8. Preparation of the social studies textbook on Android-based AR technology

Figure 8 shows that the social studies textbook has been designed using Android-based AR technology with interactive animated movements for students. The planning for making a work is based on a few systematic paths and considerations that make it possible to make work easier. In this stage, the author formulates several workmanship systematics consisting of planning time, work planning, and asset requirements. Work planning is the stage for creating a clear work workflow that includes stages in content work [63]. In creating this work, of course, there is a complex process with multiple software that integrates each other, the following is a visualization in Figure 9.

Fig. 9. Vuforia Developer setup

Production, there are several steps in this stage: (i) Content Creation, (ii) Processing Content, and (iii) Software creation. The author created graphic designs for several image features in the textbook using the Adobe Illustrator application. The image design uses appropriate colours using the CGF font as the main font in creating this work. Then the author designs the buttons used based on the target platform to be used. The designed button is based on the shape of the native Android button. In this native button design, we use shape tools and pen tools in Adobe Illustrator as the most dominant tools in designing. The buttons created are the main menu button, close application, silent mode, settings, take photos, share photos, instructions about application, next button, back, VR mode, AR mode, mix reality mode, flashlight, swap camera, zoom in and zoom out [64, 65]. The author created a background design for the panel layer requirements. This background asset was designed using pen tools in an organic triangular shape. Next, colour several parts of the plane using a graded grey colour and several parts using only lines. To meet the needs of information media, the author took book assets from several references. The data asset is in the form of an e-book with a PDF file type. Thus, the author uses the plugin feature in Illustrator, namely importing all to jpg. Thus, he can export all files in the form of a single image. At this stage, the author creates the content needed for animation by processing static content that has been created in Adobe Illustrator and moving the static content to the Adobe After Effect (AE) application. This content is needed for logo splash screens and panoramic image editing. Model creation uses the Cinema 4D Studio R19 application as an integrated application for creating three-dimensional objects. The next asset requirement is a character model for each province in Indonesia using the Blender application [66].

The content that has been created is compressed and converted into a file type that is compatible with the Unity application and the Android platform. Graphic file types are exported in the form of jpg and png files, 3D model shapes are converted into fixed file types, and videos are adapted to the Android platform code. Content that has been compressed with a choice of file types that are compatible with the Unity application is collected in one project asset. In one project asset, there are content assets and plugin assets sourced from software developers including Vuforia, Google Cardboard, Android Plugin Lite, Easy movie texture, Simple Player, and standard assets. The programming language used is Mono Develop which is supplied by Unity application and is the basic programming language for designing activations. Mono Develop continues to work on integrating content in the Unity application to customize the activation process and check the console if errors occur in the programming language. The stages in software creation consist of several menus designed for integrated and systematic access. The process consists of creating a splash screen menu, main menu, Virtual Reality menu, and gallery menu [67].

Splash Screen Menu, there are several steps in this stage: (i) Splash Screen Logo, (ii) main menu, (iii) Menu Interface, (iv) Integration of Augmented Reality Modules, (v) Revision of Content and Software, (vi) Content and Software Integration, (vii) Revision of Content and Software, (viii) Building Applications. The logo is displayed when the application is first run with a duration of 11 seconds in the form of video content. The steps are to create a new scene in Unity and then add a canvas, panel, and image, for the process code in Figure 10.

```
using UnityEngine;
using System.Collections;

public class splash : MonoBehaviour {

   void Start() {
      StartCoroutine(Example());
   }

   IEnumerator Example() {
      yield return new WaitForSeconds(4);
      Application.LoadLevel ("jurusan");
   }
}
```

Fig. 10. Process code for opening the logo scene

Figure 10 the main menu in this application appears after the splash screen menu is executed. The application menu contains an interface display consisting of several main buttons for the reaction action process and using the camera for tracking AR objects. An instruction window is displayed when entering the main menu which contains data on how to use AR. The use of user interface buttons is divided into main menu buttons and AR menu buttons, the user interface buttons are presented in Figure 11.

```
public void GoTomenuvr(){
    Application.LoadLevel("menuar");
}
public void GoToGaleri(){
    Application.LoadLevel("main_menu");
}
```

Fig. 11. User code for user interface button

This subchapter explains the technical aspects of AR programming which is integrated into the system. AR module programming is based on marker detection captured by the Android camera. The marker detection function is the beginning of the camera process for reading the Vuforia QR to display the target image, as shown in Figure 12. Figure 12 AR programming techniques in textbooks are integrated into the system. The programming of the AR module is based on the detection of markers captured by the Android camera. The marker detection function is the initial process of the camera to read the Vuforia QR to display the target image. The target image is a storage location for AR objects. Thus, they can be displayed by computerized Android on the second layer of the system. The next stage of content and software integration includes a preview image process to check the integration of all content and software. This process is to avoid application errors. The following is a target image that has been integrated between content and software. The visualization is shown in Figure 12. Apart from checking function activation, this integration stage aims to facilitate access. Marker Design. The marker design that was created in Adobe Illustrator was created to carry out the marker registration process in Vuforia. There are seven markers made with different image patterns to display different AR objects in one AR integration.

Fig. 12. Augmented Reality Markers in social studies Textbooks

To create markers, the author used the Vuforia developer as one of the major developers who concentrated on the AR field. To get a marker or QR code, first register on the site https://developer.vuforia.com/. After logging in, go to the developer menu and create an AR camera license by including the license name. The results of the AR camera license are in the form of a code entered in the app license key column in the Unity application. Before making the marker, the author designs the image first using the one that was created previously in the initial production subchapter. The step to create a marker or QR code is to select the target next to the license creation by including the same name of the license that has been created [69]. Once successful, upload the marker image that has been created with a resolution of 640. This resolution depends on the marker being created. The author made a small marker (the size of a card). Thus, it uses a small resolution. The next step is

to download the marker. The results of the download become a Unity package file that can be imported into the Unity application. The target image is a storage location for AR objects. Thus, they can be displayed by the Android computer's second layer of the system. From the game preview in the image, AR is running actively, marked by the activation of the webcam camera, followed by testing markers that can display AR objects [70]. After deactivating the game preview, check the Unity console, the console can display problems that arise if an error occurs, one of which is an error in parsing the script, figure 13.

Fig. 13. Android-based Augmented Reality Target in the Social Studies Textbook

The content and software integration stage includes a game preview process to check the overall integration of content and software. This process is to avoid application errors. Apart from checking function activation, this integration stage aims to facilitate access. Revisions to content and software include adjusting the scale of the Android screen which must be able to follow the screen logic of the Android platform to avoid stretching the screen too badly and above all, it is easy to access, and information is easily absorbed, as shown in Figure 14.

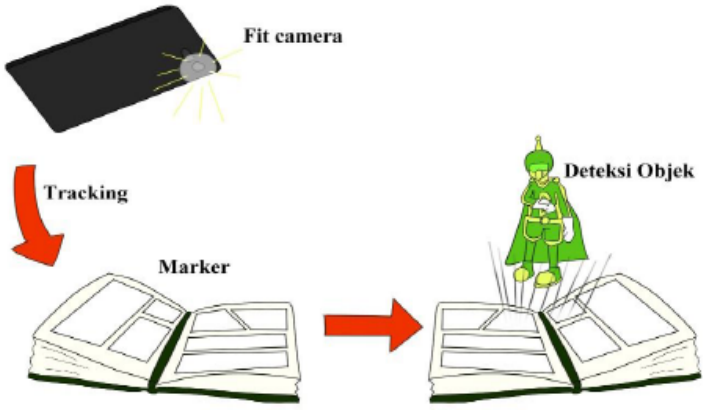

Fig. 14. Android-based AR tracking camera in the social studies Textbook

Figure 14 shows information after revision, the application was developed again as a finalization of the established functionality, completeness of the main implementation, and integration of all modules into one unit. Before developing an application, first select the Android platform and

integrate it. Next, select player settings to manage data from the application. In this process, of course failures often occur. Thus, the entire integration must be up to date both in terms of Android, Java, and the Unity application itself to combine the Android manifests needed for application access to the cellphone.

Building Applications, application development determines the functionality of the application being created, the completeness of the main implementation, and the integration of all modules into one complete unit [71]. Before developing the application, first, choose the Android platform and integrate it. Next, select player settings to manage data from the application. In this process, of course, failures often occur. Thus. the overall integration must be up to date, both in terms of Android, SDK tools, Java, and the Unity application itself to merge the Android manifest needed to access the application on the user's cellophane.

Post-production, there are several steps in this stage: (i) Testing Process. The testing process is to identify deficiencies in either software or content. In this process, several gadgets were tried to standardize the use of operating systems on cell phones. The content layout is checked in each scene to obtain good screen ratio aspects; (ii) Revision of Content and Software. Content and software revisions are carried out again after a thorough testing process. This revision is an overall revision and is the final revision for all content and software; (iii) Build an application. Building the final application is divided into several developments consisting of the minimum operating system to the latest operating system consisting of Os Kitkat to the latest OS; (iv) Storing Production Assets. The entire assets of Unity are made into a Unity package. Thus, they are stored properly for further development. Thus, they can be used effectively.

4.2 Expert Validation Results on the Draft Augmented Reality-based Social Sciences Education Book for Higher Education

The draft AR-based social studies Education book that has been created has been validated by experts. Based on validation results from 5 experts (curriculum experts, social studies education experts, language experts, IT and graphics experts). The results of expert validation obtained a picture as presented in Table 4.

Table 4 validation shows that most of the curriculum components, depth, readability, graphics and security of the Android-based social studies Augmented Reality Education book are considered quite good. In terms of curriculum target aspects that need to be improved are materials that are adjusted to targets per semester and per meeting. In terms of the suitability of book content and curriculum, what needs to be improved is material based on a scientific and project approach. The scope and sequence aspects that need to be improved are the depth, breadth and up-to-dateless of the material. The aspects of readability that need to be improved are the use of interactive language, sentence structure, and the relevance of material to illustrations [72]. The graphic aspects that need to be improved are the content design and colour combination. In the security aspect, the cultural values that need to be improved are materials based on current culture and religion, see table 4.

Table 4
Expert Validation Results of Android-based AR Technology in the Application of Social Studies Textbooks

No	Components to be assessed	Rated aspect	Validation Results (N=5)			
			Very good (%)	Good (%)	Enough (%)	not enough (%)
A.	Curriculum Targets	The material is in accordance with the 2013 curriculum targets seen from the material aspect of each semester in the Learning Implementation Plan (RPP)	**70**	**32.5**	**12.5**	**0**
B.	Conformity of book content with the curriculum	The suitability of the book with an integrative scientific approach which contains a project based on relevant brainstorming	**75**	**13**	**12**	**0**
C.	Scope and Sequence of book contents	The breadth of the content of each chapter is based on concepts, facts, data, theories and postulates in accordance with the curriculum content with up-to-date and fresh data	**56**	**30**	**14**	**0**
D.	Presentation of Material	The material is adapted to the learning objectives and is presented in an interesting way so that it is easy to understand and increases student activity	**60**	**22.5**	**15.9**	**1.6**
E.	Readability aspect	The material uses illustrations, symbols and sentence structures that are in accordance with good and correct Indonesian language rules	**48.3**	**25**	**20**	**6.7**
F.	Graphic Aspects	Use of an attractive cover design format with a clear color combination and easy-to-read content design	**55**	**25**	**15**	**5**
G.	Technological Aspects	Efficiency and effectiveness of media in textbooks to make it easier for users	**63.75**	**21.25**	**15**	**0**
		Total	**62.12**	**21.11**	**14.9**	**1.87**

5. Discussion

AR has the main characteristics of augmented reality [37, 40] which can be summarized as follows: (i) combining the real and virtual worlds, in a real environment (blended learning); (ii) Real time interactive (real time interactive); (iii) 3D environment; (iv) can be applied to all senses, including touch, hearing, etc. Currently, the most popular is the augmented reality display of mobile devices, tablets or other portable devices). To realize interactivity in learning, several development stages are needed in making Augmented Reality-based social studies textbooks.

In general, digital textbooks provide information that represents learning physically and visually. Nevertheless, the model developed here represents the collection of cultural and scientific knowledge in a system and supports audio-visual learning. In addition, this type of learning resource can be beneficial for students because it can foster learning, develop critical thinking, hone students' abilities to connect various concepts and bridge the gap between students' theoretical and practical knowledge [29]. Research has shown the importance of roles and interactions between students in physical digital learning environments because such environments offer a way to represent ideas. This research also shows how children creatively find and use their alternative digital resources. This creativity is equivalent to the way students use the modes presented by digital learning resources. Compared to text and images in a book, a computer screen can present information in a variety of modes, such as animation and sound effects [47].

Students' ability to understand information and knowledge digitally fosters new abilities such as digital literacy. Digital literacy skills encourage students to master content while producing,

synthesizing, and evaluating information from various subjects and sources with an understanding and appreciation of diverse cultures, practicing creativity, communication and collaboration skills, digital literacy, and responsibility. Digital literacy is defined as the ability to understand and use information in various forms from a very wide range of sources accessed via computer devices. Recent studies have adapted the use of digital learning resources, which has had an impact in creating interactive learning environments and turning passive learners into fully engaged active learners. Furthermore, learning that involves digitalization has the potential to increase students' insight as a form of literacy. This line of inquiry is worthy of attention in our efforts to increase students' literacy in navigating their social worlds using digital media. All these characteristics must be integrated into social studies learning to increase students' digital literacy.

The development of digital competence at the individual level depends on the level of digital use and the ability to transform individuals into digital literacy. The levels involved are: (i) digital competence, which covers a wide range of topics from general skills to more critical and analytical approaches digital use, where users utilize relevant digital competencies and elements specific to a profession, domain or context, and (ii) digital transformation, enabling innovation and creativity, and stimulating significant change at the individual or organizational level in the context professional. However, this last level of transformation is not a stage for someone to become digitally literate because a person's level of digital literacy depends on the appropriate level of digital use.

6. Conclusion

The application of the social studies textbook using Android-based AR technology in schools, especially at the secondary school level, through the pre-production, production and post-production stages is in accordance with the development steps. The curriculum that applies to Android-based AR technology in the preparation of the social studies textbook consists of four material chapters in which there are several sub-chapters of material relevant to science such as interaction between space, the geographical and astronomical location of Indonesia, the potential of natural and maritime resources and climate change. tropical. Expert validation of Social Studies book on Android-based Augmented Reality technology shows that most of the curriculum components, depth, readability, graphics and security of books applying social studies textbooks on Android-based Augmented Reality technology are considered quite good. Pre-production, production and post-production steps that are easy to visualize on your phone. Research arguments show that the use of books is very effective in encouraging critical and creative thinking and building students' 21st century skills. The implications of this research make it easier for students to visualize abstract content more concretely.

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