



The Development of An Effective Electronic Book for Learning Augmented Reality Technology in Thailand University

Parinya Bannaphesat^{1*} Kulpanya Bunnaphesat²

¹ Faculty of Education, Suan Sunandha Rajabhat University, Thailand

² Faculty of Pharmaceutical Sciences, Naresuan University, Phitsanulok, Thailand

Research Article

Corresponding E-mail*

parinya.bu@ssru.ac.th*

kulpanyab68@nu.ac.th

Article Info

Received 15 Aug 2025

Revised 31 Oct 2025

Accepted 4 Nov 2025

Keywords

Augmented reality (AR),
Electronic books (E-books),
Educational technology,
Learning achievement

Abstract Augmented reality technology will enhance the learning process with bright three-dimensional images and game elements, activate interaction and participation, and develop spatial thinking.

Thanks to augmented reality, students have endless opportunities to learn new things. It is worth noting that the use of electronic textbooks is becoming more popular; however, these are merely digitized copies of traditional paper textbooks, while systems and technologies like augmented reality have been widely used for a long time and continue to gain popularity each year. The development of this project aims to: 1. Develop an effective electronic book for learning augmented reality technology at Thailand University. 2.

Compare student achievement before and after using electronic books that incorporate augmented reality, and 3. Assess students' satisfaction with these augmented reality learning books. The sample was random and consisted of 40 Grade 7 students from one classroom at Horwang School. The instruments used in this research: 1) The electronic book for learning with augmented reality technology 2) the evaluation form 3) the student satisfaction form 4) achievement pre-post learning test.

The results indicated that the augmented reality e-book demonstrated good media quality. The research results show that 1. the quality of the development of an effective electronic book for learning augmented reality technology at a Thailand University is at the 82.50/80.10 criteria, and 2. the achievement score of student learning is higher than pre-test scores at the 0.05 level. 3. The students' satisfaction with the development was at good levels.

Introduction

Augmented reality in smartphones and tablets has a bigger role in daily life, in education, communication, and entertainment. In particular, applying smartphones and tablets to education using learning applications developed by technologies such as games, computer-assisted instruction, website learning, online learning, and electronic books.

Both e-books and augmented reality play a significant role in education. Smartphones and tablets are gaining attention for enhancing the effectiveness of classroom instruction management, empowering students' learning, and improving education in the country. The (National Institute of Educational Testing Service, 2017) Ordinary National Educational Test (O-NET) is the knowledge and thinking ability of Grade 9 and 12 students testing that every student must be tested by the National Institute of Educational Testing Service (Public Organization). The Minister of Education's policy requires the Office of Basic Education Commission (OBEC) to obtain the results of the Ordinary National Educational Test to incorporate them into basic education. Completion, and the Basic Education Committee approved the policy, so the O-NET is more important to study. Horwang School under the Department of Education managed learning from grades 7 to 12. From the survey data points of the National Educational Test of Grade 9 in Secondary Educational Service Area Office 4, which tie in with the academic, it was found that it had scores at 13th out of 42 schools with learning standards that accelerate to develop learning in social studies, religion, and culture. The geography score was 5.1 (understanding the nature of the physical world and the relationship of the things that affect each other in nature, using maps and geographic tools to search, analyze, summarize, and use effectively geospatial information), which is in the textbook content of geography subject 1, grade 7, 1st unit, chapter 2, the geographic tools. And from inquiries about the teaching and learning of the subject, social studies, religion, and culture of the teachers found the content of geography. An interview with a teacher revealed that the content related to geographic tools in the subjects of social studies, religion, and culture is difficult for students to remember and understand. Moreover, instructional media has few, out-of-date, and uninteresting things for students' attention. The origin and significance of the aforementioned issues have been identified. The organizers have prepared a concept to develop the electronic book for learning with augmented reality technology entitled "Geographic Tools for Grade 7 Students" to motivate them to learn and also cultivate a positive attitude toward learning the social study, religion, and culture subjects. In the development of electronic books for learning with augmented reality technology, the organizers created electronic books (eBooks) together with augmented reality in a three-

dimensional image model to solve the problem of learning for Grade 7 students in order to be used for making more attractive activities in the classroom. This will benefit teachers, and it will also allow students to learn independently.

The education system should always be up-to-date with modern levels of technology, intelligence, software, and other achievements. Therefore, the use of information and communication technologies in the educational process should not lag behind. After all, a student's result depends mostly on the adequate meeting of the need for knowledge, the quality of measures to deepen this knowledge, and on how informative and captivating the process of acquiring knowledge is. One of the latest achievements in the field of information technology is augmented reality, which aims to supplement our reality with virtual objects. This technology is widely used in computer games, architecture, marketing, and the military. We have reviewed, studied, and analyzed research and development in the field of augmented reality, such as "A Survey of Augmented Reality," "Semapedia," "ARtag," "Layar," and "Arget," wherein, in one way or another, a video stream is further digitally processed and overlaid with computer graphics. Visibility. (Aderogba & Isele, 2025) A typical example is 3D modeling. The three-dimensional approach is highly useful. The future specialist can assess all the details of a machine, understand its structure, and realize various improvements and changes via AR/MR headsets. Visualization. This technique is often used in teaching children. Visualization of the educational material with the help of augmented reality improves the process of memorization and assimilation. Interest. Reading black and white pages of a textbook is not a very exciting process for a child. You can show the content of these pages in another format—MR provides an opportunity to explain difficult moments in a way that is easy even for primary school children.

Objective

1. The development of the electronic book for learning augmented reality technology at Thailand University
2. To compare student achievement before and after learning of the use of electronic books for learning with augmented reality.
3. To investigate and study the students' satisfaction with the books for learning with augmented reality technology.

Methodology

System Development Approach to Learning Augmented Reality Technology

There are several methods of using augmented reality technology to support the educational process, methods of using the QR code system in the applied activity of an educational institution, methods of using augmented reality and virtual media objects, and methods of use in CAD. Let us give some examples:

1. Use QR codes with links to multimedia sources and resources that help solve particular problems. After printing out the codes, they can be pasted directly into the manuals or notebooks of students.

2. With project management you can create collections of links, news items, comments, etc. QR codes can be published on pages of sites to support the project posters.

3. When used in the library, QR codes can be placed on information stands with information such as video or multimedia comment (in the form of links) to the announcement or other material.

4. Placing the code in the University library's literature search catalog: the code is automatically displayed to summarize key information, table of contents, author, and location on the shelf.

5. Adding codes to the automated learning environment information system. These codes contain an indication of the URL page of a particular training course, a link to the schedule of classes, and the availability of classrooms.

6. Visual demonstration of complex processes.

To start the training, the user must be located in front of the device being studied. On a tablet computer (augmented reality glasses or virtual reality helmet), you must run the appropriate application and then point the camera of the mobile device to the labels located on the device (Lee, Choi, & Park, 2009). The tracking system recognizes the specified part (or specialized label on this part) and runs the appropriate educational program. The interactive educational program demonstrates directly on the device the order of actions, accompanied by visual and voice prompts, which must be carried out to perform a particular technological operation. The training is individual and takes place through the demonstration on the screen of the user's mobile device of additional information layers, including 3D models, tips, animation, text, and graphic elements, positioned on the coordinates of the structural elements of the studied device. Combining the coordinates of virtual and real objects is achieved through augmented reality technology, which allows you to track their changes in space by recognizing real objects in the video stream coming from the camera of a mobile

device. Training step by step. Each stage is accompanied by a corresponding demonstration showing through 3D models and additional visual elements the necessary information. Steps that demonstrate the sequence of certain actions are accompanied by voice prompts. Managing demonstrations of using voice commands and an additional input device and positioning (touch panels, controllers, and hardware positioning). Functional feature - Familiarity of the user with the basic elements of the device under study - Visual training of the user of a certain technological procedure with reference to the coordinates of the elements of the device or device - Visual training of the user of a certain technological procedure without reference to the coordinates of the elements of the device (or device) on its 3D model (for students who are at a distance) Voice control—voice guidance and tips

In the design and development of learning, there are numerous techniques and system tools from which the developers can choose. In this experimental research, system analysis is carried out using the context and data flow diagrams of the system development life cycle (SDLC) technique. With the rapid advancement in the information and communication technologies, e-learning, or distant learning, has become a reality, as the learning can take place 24/7/7 (i.e., 24 hours, 7 days a week, and on the world's seven continents). Learning augmented reality technology or distant learning can take the form of synchronous and asynchronous learning. The depiction of the context diagram of the experimental Learning Augmented Reality Technology system. As the name implies, synchronous learning requires the “simultaneous” presence of the instructor and learners either in the same place (offline) or in different locations via Internet-based applications, e.g., voice over Internet protocol (VOIP), text messaging, shared whiteboard, multi-user domain (MUD, in which people interact with people or objects primarily within a specified domain), or MOO (MUD, object-oriented, in which a text-based online virtual reality system to which multiple users are connected at the same time). In asynchronous learning, the learning takes place after the event (i.e., post-instruction) via the Internet, thus offering tremendous flexibility with regard to the time and pace of the study. In addition, asynchronous learning enables those who are neither instructors nor learners but have an interest in the topic or subject to access the database. Due to the ex-post nature of this mode of learning, the applicable IT applications and platforms include webpages, web forums, web boards, and e-mails. In this experimental research, the creation of the online

The Fundamentals of Information Technology course follows the eight steps below:
(Dick, Carey, & Carey, 2015)

Step 1: Define the course objectives.

Step 2: Determine learners' knowledge and skills related to information technology.

Step 3: Design the course, including:

3.1 Content

3.2 Content priority

3.3 Lengths of time required for individual chapters and the entire course

3.4 Instructional method

3.5 Instructional tools and media

3.6 Evaluation method

Step 4: Identify AR-learning activities.

Step 5: Establish an AR-learning ecosystem.

Step 6: Outline an orientation session for the learners.

Step 7: Implement the Learning Augmented Reality Technology initiative in accordance with the plan.

Step 8: Conduct an evaluation.

Currently, technology is used to enhance learning and teaching by enabling students to access educational resources anytime and anywhere through a restructured teaching and learning system that divides instruction into synchronous and asynchronous formats. E-learning has many similar terms, such as "distance learning," "computer-based training," "online learning," and many other words. Here, we would like to use the definition of e-learning as "a form of learning that relies on computer networks to transmit or support or interact" (computers may not be needed soon). Such a network can be the Internet or LAN (intra-school or university connection) or even WAN (a more broadly connected connection, such as in an organization or company). (Lee, Choi, & Park, 2009), Learning can be individual, computer-based, or in a group. This online learning has two special characteristics. Synchronous model It is teaching and learning with an appointment. Both a physical location and personal appointment are necessary to facilitate teaching and learning. There is a schedule, or teaching schedule, which is an instant interaction model. Examples of this include studying in a classroom setting. Chat, writing messages on web boards, teleconferences, videoconferences, MOOs or MUDs, and virtual conversations with many speakers. Information technology assists in presenting lesson content. Assistive tools such as slide systems PowerPoint The image simulation system, the teaching aids system, and simulation scenarios are all utilized to facilitate student learning and foster enthusiasm for active teaching and learning, while also significantly reducing learning time.

For example, the learning and teaching style includes recording lesson items, teaching records, measurement, follow-up, and helping to transmit information and record all teaching activities, such as when there is remote teaching. The video concept can also record all the teachings and put them on the video server for later viewing. Asynchronous Model Asynchronous System Nowadays, teaching and learning are popular through the web, with lessons and tools that help with teaching and learning on the web.

Electronic Book

"Electronic book" refers to books or electronic documents that the reader can read on the Internet or other portable electronic devices. Electronic books and electronic documents include content that is converted into a format designed to provide a consistent reading experience similar to that of traditional books in everyday life. But further, they are quick and easy to find, and readers can read along without waiting for the other to return to the library. Paitoon Srifa (Srifa, 2007) the implications of electronic books are similar to those of general books. But the noticeable difference is the process, pattern, and reading method. The electronic book structure consists of

1. The "front cover" is the book's first part, showing the title and author.
2. Introduction refers to the notice of the author to create a better understanding about information and the story of each book.
3. Contents refer to an indication of the subject of what is contained in the book and the relation of each page within the book.
4. Page Contents refer to the main point of each page that appears within the book that contains
 - 4.1 Page Number
 - 4.2 Texts
 - 4.3 Graphics
 - 4.4 Sound
 - 4.5 Video Clips, Flash
 - 4.6 Links
5. Reference refers to the data source to reference that could be textbooks or a website.
6. The index refers to specific keywords or other terms within the book that follow a designated character for easy searching. And also specify page numbers and links.
- 7) Back cover means the back part of the cover of the book.

Results

Augmented Reality: AR refers to the combination between the virtual world and the real world through many connected device types, such as the digital cameras of the tablet, smartphone, or other, to allow the audiences to see the virtual image in those situations. The working principle of the augmented reality technology is 1) the marker (or markup) is a mark, symbol, or image defined as a comparison with the marker database. 2) A video camera, webcam, cell phone camera, or other sensors are used to perform image analysis and various types of defined marker analysis. The system will calculate the pose estimation of the marker compared with the camera. 3) The display can be a computer monitor, telephone monitor, tablet monitor, etc. 4) Software or processing to create a picture or object in 3D. The creation process of a two-dimensional image from 3D rendering adds the data into the picture by using the 3D position, which is calculated as the image or overlay data on the visuals. Categorized by visual display format, they can be divided into 3 types. 1) Video See-Through Augmented Reality 2) Monitor-Based Augmented Reality 3) Optical See-Through Augmented Reality. (Dias, A. 2009)

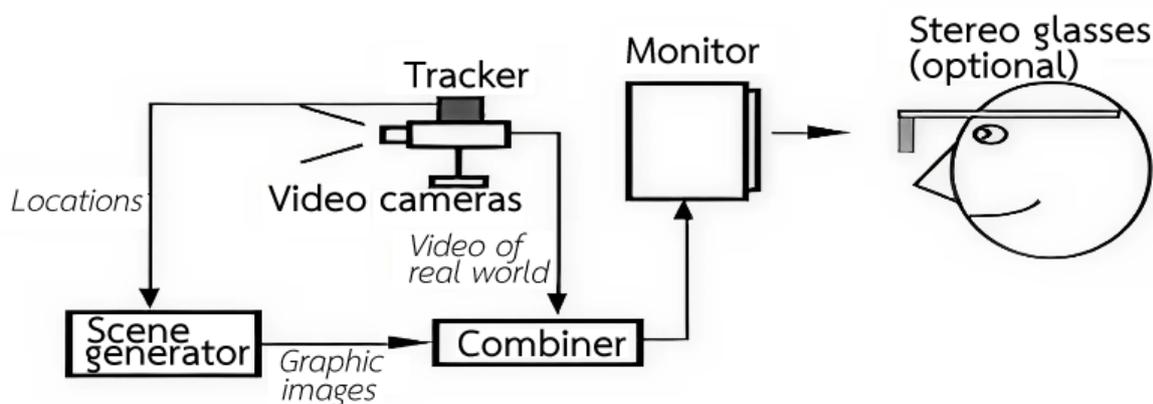


Figure 1 The schematic represented a monitor-based augmented reality system.

(Miller, & Dousay, 2015)

The use of vivid and memorable visualization in explaining various topics that can be done within basic knowledge and in various training formats in a lesson, lecture, seminar, or excursion can significantly increase the degree of selection of useful information as well as improve the process of perception. We are convinced that AR is a significant breakthrough in the way of providing educational material, as well as in the assimilation of information by schoolchildren and students. (Wang, 2020). Bright and significant results indicate the effectiveness of the AR and MR technology. Several experiments were conducted in this group. The result of the experiment: the level of perception was 90%, and the attention of the audience was at the level of 95%, while in the second group with standard conditions, these characteristics were 40% less. In addition to the fact that in three-dimensional images

mental processes are stimulated, motor skills, facial expressions, attention, and the degree of assimilation, memorization, and, most importantly, understanding of permissible information are developed. As part of our AR integration effort, we have adapted Real Eye, which is an electronic application based on augmented reality technology, providing a wide range of functionality for both the teacher and the student. Using this technology, the teacher can convey the necessary material in a more engaging and accessible form for students by basing classes on exciting games, demonstrations, and workshops. The ease of use of virtual 3D objects simplifies the process of explaining new material. At the same time, mastering the technology of augmented reality increases the level of information literacy of the teacher and student. "Real Eye" consists of a software environment, the interface, and a device, the AR controller. (Siregar, Ritonga, Darma, & Dongoran, 2022). The core of the application is a Flash module based in the Flash Develop programming environment, which combines the following files: 3ds file extension—a three-dimensional model of an object or phenomenon created in 3ds Max; - .jpg file extension—a texture for a model made in Photoshop, Canva .png file extension—a token implemented in CorelDraw; In addition, the platform Alternativa3D is connected, and the FLAR Manager tracker is used. Alternativa3D provides graphics support, and FLAR Manager tracks the marker in space and draws the 3D object.

The application has a simple and user-friendly interface, which is accessible even for a beginner without any instructions. The universal software shell for Windows was developed in an object-oriented programming environment. The conceptual framework for the proposed development of an effective electronic book for augmented reality technology learning at Thailand University has been established.

The learning scheme covers the following:

1. AR-classroom: The establishment of an Internet-based learning setting or a virtual classroom with an emphasis on the quality of class content and attractive presentation.
2. AR-lab: The establishment of an online/virtual laboratory or workshop to supplement the virtual classroom for courses requiring operational training.
3. AR-tutoring: The establishment of another virtual classroom to provide intensive supplementary classes for the students enrolling in the course. The tutoring classes are typically offered alongside the regular E-classes.
4. AR evaluation: The establishment of a platform on which both the instructors and learners are able to conduct online evaluations relevant to the course.

The quality assurance result of Electronic Books for learning with Augmented Reality Technology by media experts found that the media quality was at a good level ($\bar{x} = 4.4$, $S.D. = 0.47$) separating the design and the usability and can sum up that the quality of Electronic Books for learning with Augmented Reality Technology was good. The comparison results of the study achievement from the pre-posttest with electronic books for learning with augmented reality in geographic tools for grade 7 students found that the study achievement of 40 students after learning had the average score ($\bar{x} = 13.5$, $S.D. = 2.39$), higher than the previous study achievement ($\bar{x} = 7.8$, $S.D. = 2.46$) with statistical significance at the 0.05 level. The analysis results of student satisfaction value at the Electronic Books for learning with Augmented Reality in Geographic tools for Grade 7 students showed that satisfaction levels ($\bar{x} = 4.4$, $S.D. = 0.69$) and concluded that the level of student satisfaction was at a good level.

The effectiveness of the educational AR process depends entirely on the level of its organization. The research results show that 1) the quality of the development of an effective electronic book for learning augmented reality technology at a Thailand University is at the 82.50/80.10 criteria, and 2) the achievement score of student learning is higher than pre-test scores at the 0.05 level. 3) The students' satisfaction with the development was at good levels. A clear, consistent, and logically linked construction of roles, activities, and interactions between student and teacher can achieve the required level. One of the most important reasons for the high efficiency of augmented reality in education is that AR clearly shows the interconnection between the real and the virtual worlds. The three-dimensional image allows a person to be interested and stimulates his attention and sensitivity to the information component. Regardless of the given material, augmented reality helps to increase its attractiveness for students of different ages and increases the desire for knowledge. Also, the use of augmented reality technology is highly effective from a material point of view: costs for the manufacture of printed textbooks are reduced; the need to manufacture and use visual aids reduces. To obtain the effect of augmented reality, only a two-dimensional label and a device with a camera are needed. Now the work of applications that use technologies of augmented reality is available on a wide range of devices, from smartphones to computers with built-in cameras. Therefore, taking into account the availability of this kind of gadget, practically everyone's technical question of using AR in education is based on the selection and implementation of a specific unified platform, where the process of education will be carried out.

Conclusion and Discussion

Summarizing and discussing the research results of the development of the learning style Electronic Books for Learning with Augmented Reality Technology has a very suitable model for learning, as evidenced by the expert evaluation and the use of students in the university, especially the learners, who can study at any time and help to teach and learn in a normal room more effectively. In addition, it has been found that studying electronically can reduce costs and save a lot of time compared to studying in a regular room. The overall results show that learning consists of many subcomponents. Learners have the opportunity to review the lessons after class as needed, showing that learning is used as a component or supplementary media to make learning in the normal format more effective. It is important for learners to be disciplined and responsible for themselves and to increase the efficiency of the learning system.

The successful implementation of the Electronic Book for Learning Augmented Reality Technology in the Thailand University initiative necessitates a continuous upgrade of the technology and a constant update of content and class materials to maintain the appeal and attractiveness of this particular mode of learning.

References

- Aderogba, K. A., & Isele, T. O. (2025). Education in the 21st century: The quest for sustainable education in the Global South. In A. Esmail, B. Hamann, E. Agbai, H. M. Okoro, & S. Udeorah (Eds.), *Twenty-first century issues: Perspective on climate change, pandemic, and digital transformation* (pp. 109–140). <https://doi.org/10.5040/9780761880493.ch-006>
- Dias, A. (2009). Technology enhanced learning and augmented reality: An application on multimedia interactive books. *International Business & Economics Review*, 1(1), 69–79. Retrieved from https://www.researchgate.net/publication/228937240_Technology_Enhanced_Learning_and_Augmented_Reality_An_Application_on_Multimedia_Interactive_Books
- Dick, W., Carey, L., & Carey, J. O. (2015). *The systematic design of instruction* (8th ed.). Pearson.
- Lee, S. H., Choi, J., & Park, J. I. (2009). Interactive e-learning system using pattern recognition and augmented reality. *IEEE Transactions on Consumer Electronics*, 55(2), 883–890. <https://doi.org/10.1109/TCE.2009.5174470>
- Miller, D., & Dousay, T. (2015). Implementing augmented reality in the classroom. *Issues and Trends in Educational Technology*, 3(2), 1–11. Retrieved from <https://www.learntechlib.org/d/173552>

- National Institute of Educational Testing Service. (2017). *O-NET: Ordinary National Educational Test*. The National Institute of Educational Testing Service (Public Organization). Retrieved from <https://www.niets.or.th/en/catalog/view/2211>
- Siregar, T. M., Ritonga, A., Darma, J., & Dongoran, F. R. (2022). The development of digital books aided augmented reality (AR) to improve self-efficacy in favor of distance learning. *Journal of Education, Health and Sport*, 12(9), 61–67. <http://doi.org/10.12775/JEHS.2022.12.09.008>
- Srifa, P. (2007). *Free ebook constructionism online*. Retrieved from <https://www.gotoknow.org/posts/77635>
- Wang, Y. H. (2020). Integrating games, e-books, and AR techniques to support project-based science learning. *Educational Technology & Society*, 23(3), 53–67. Retrieved from <https://www.jstor.org/stable/26926426>