

Augmented Reality Tools for Integrative Science and Arts STEAM Education

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Abstract

Background/Objectives: In this paper, we propose a case study in which teachers apply AR education contents to STEAM education by using free applications without acquiring additional specialty or expert knowledge.

Methods/Statistical Analysis: In this study, we used the PDIE model proposed by Kim as the methodology to develop an effective STEAM class incorporating AR technology. Students use the Aurasma app to view a masterpiece pre-uploaded by the teacher, who explains the scope of AR. Next, they gain basic knowledge for making convergent artwork that reinterprets the art by utilizing Arduino, LED, servo motor, sensor, etc. with an AR e-book.

Findings: This study proposes the use of the 'Aurasma' application and its contents to the STEAM teaching-learning method to further promote AR technology. Augmented Reality has the potential to increase learning efficiency in classrooms by providing valuable information. Students will be able to interact with diverse digital content through AR

class materials that are geared to enhance imagination and creativity. When the 'Aurasma' app recognizes a portrait of Millet, 'Potato Planters' (Millet, 1862), or an Arduino image, respectively, 'Aurasma' overlays the information of the artist, 'Potato Planters' Art production methods onto the original image.

Improvements/Applications: Follow-up research will require teachers to apply AR to various materials and fields of study such as AR books, AR gaming, discovery-based learning, and 3D object modeling.

Key Words : Augmented Reality, AR, STEAM Education, Arduino, Information Technology.

1 Introduction

Due to the recent cutting edge ICT development, IT has become more accessible from homes to communities as people rush rapidly embrace diverse lifestyle changes. In 2016, Augmented Reality(AR) technology was under public spotlight as 'The Pokemon GO' game powered by AR technology gained mass popularity. The Pokemon GO game gained its popularity because one of the most compelling factors of AR is the fact that users can manipulate virtual objects while interacting with real-world surroundings in real time ^{1,2}. Augmented Reality is a cutting-edge technology that affects important elements of the education system, including the advantages of enhancing the level of interest, immersion, and situational awareness ^{3,4}. Due to such media characteristics, augmented reality is attracting attention as a tool that enables 'learning by doing' and authentic learning with an ever-increasing application ⁵.

Following the trend of such dynamic technology developments, the paradigm of education is shifting towards cultivating human resources structured with creative problem solving ability to meet the current digital era. Thus, the Korean government has been promoting STEAM, an education system which integrates Science, Technology, Engineering, Art, and Mathematics studies and aims to raise creative talents to lead the future society ⁶. The philosophy of STEAM integrated education is to provide students who are already accustomed to advanced technology, with creative education,

including cutting-edge technology, so that they do not lose interest in learning when it is unable to keep up with the pace of technology⁷.

STEAM education research using advanced technology was conducted through various studies, of which a number report the increase of teaching-learning methods using AR technology⁸⁻¹⁰. Studies that have adopted AR technology in class have witnessed positive effects in actual improvement of academic achievement and attitudes. Therefore, in this paper, we propose a case study in which teachers apply AR education contents to STEAM education by using free applications without acquiring additional specialty or expert knowledge.

2 Theoretical Framework

2.1 Educational use case of augmented reality

AR applications combine various virtual objects such as text, audio, and video with the 3D real world environment^{11,12}. AR is a field of virtual reality which enables a user to view the real world with various visual information in conjunction with a virtual world with its respective host of information all in one scene^{1,8,9}. Presently, there are growing number of cases where various fields of education have adapted AR. Table. 1 shows the cases of AR utilized in education.

Table 1. Analysis of Educational Use Case of AR

Case	Features
AR books	- Useful for enhancing traditional books using 3D images, videos and sounds.
AR gaming	- Games provide interesting and engaging educational content.
Discovery-based learning	- A simple way to explore places that are difficult to navigate and virtually interact.
Object modeling	- It is possible to receive immediate visual feedback in an interactive object modeling program
Skills Training	- Available as a virtual training tool for mastering specific skills

The STEAM class materials presented in this study are AR books used as student textbooks which emphasize the process of creating convergent artworks using masterpieces. These significant

teaching-learning materials promote authentic learning materials using open source AR software and offers learners the opportunity to interact with the learning materials.

2.2 Augmented reality in STEAM Education

AR is a technology which enables the integration, collaboration, and real-time interaction of real and virtual objects into reality. Educators support that applying the advantages of AR techniques to education can facilitate 4 facets of learning: practical, experiential, active, and cooperative⁴. Since the 1990s, AR has been used in advertising and for educational purposes in some large companies. Recently, cases of AR used in educational environments showed a steady increase due to improved processing capabilities of smart devices and display devices^{5,11,13}. Considering the facts herein, we have summarized the characteristics of AR application adaptable in the classroom environment in Table. 2.

Table 2 Comparisons of augmented reality applications

Icon	Application name	Features
	Augment	- Various 3D models can be uploaded via live-view. - Upload 3D models or videos user want only on Augment website.
	Aurasma	- It is possible to make photos and videos of personal devices into augmented reality contents through applications. - Intuitive augmented reality content creation without professional programming knowledge.
	circusAR	- Provides various augmented reality contents such as video, photo, e-book. - User can not upload marker image.
	Layar	- Trigger images for augmented reality content can only be uploaded via website. - All trigger images posted in Layar's publishing environment must be used for a fee.

In this study, we selected 'Aurasma' as the most appropriate AR software for classroom lessons and conducted the research¹⁴. The benefits of AR technology are applied to STEAM education with the goal of improving interest and involvement in science by using cutting-edge technology. In addition, AR is highly valuable for activity-centered STEAM education because it can assist learner-centered activities and help learners increase scientific knowledge and understand concepts.

3 Methodology

3.1 STEAM instruction design using AR

To fully utilize AR as a learning resource, the systematic instructional design for successful learning is important. In this study, we used the PDIE model proposed by Kim as the methodology to develop an effective STEAM class incorporating AR technology ⁷. The PDIE model is a systematic instructional design process that structures student-centered learning and can be applied to develop diverse STEAM classes. Figure. 1 shows the structuring process a STEAM class using AR.

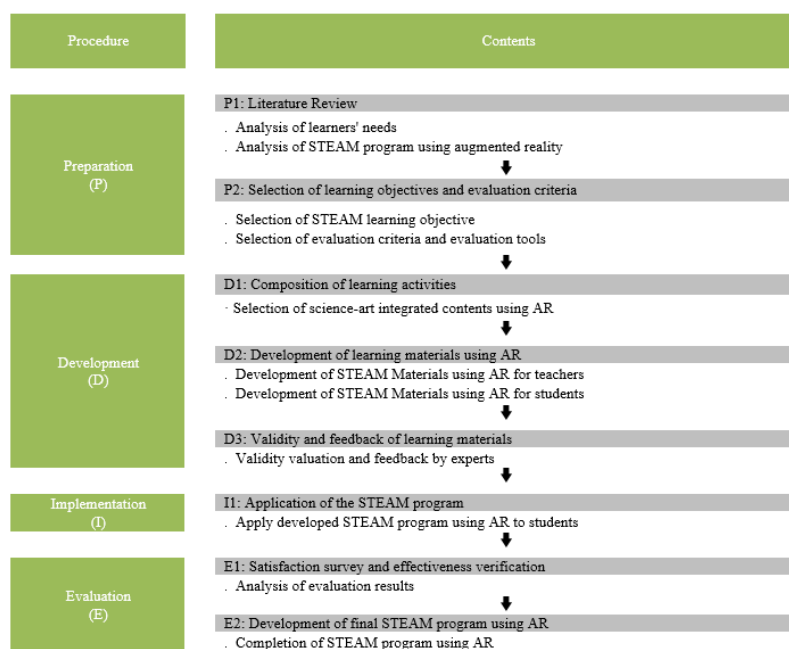


Figure 1. Procedure of STEAM Program development using AR

3.2 Composition of STEAM class contents based on augmented reality

This study was designed for a STEAM class of 6th graders at an elementary school. The emphasis of this STEAM class was science-

art convergence with the use of an AR application. Table. 3 shows example of how the STEAM class plans to adapt augmented reality. Students use the Aurasma app to view a masterpiece pre-uploaded by the teacher, who explains the scope of AR. Next, they gain basic knowledge for making convergent artwork that reinterprets the art by utilizing Arduino, LED, servo motor, sensor, etc. with an AR e-book. Finally, the motion image of the completed convergent artwork will be overlayed with the existing image of the masterpiece into an AR content with Aurasma.

Table 3. STEAM lesson plan using Augmented Reality

Grade	STEAM lesson topics and contents	STEAM related subjects
6 th grade	- Know the principles of electrical circuits and use simple electrical circuits to create simple electrical circuits. - Appreciate art works by utilizing augmented reality contents. - Make convergence art work that reinterprets the paintings by utilizing Arduino, LED, and sensors.	Science - Electrical Circuits Practical Arts - Elements and Structures of Programming Art - Works and Artists

4 STEAM Class Application Example of Augmented Reality Contents

This study posits that students can appreciate convergent artwork reinterpreted from an existing masterpiece through augmented reality using a mobile app called 'Aurasma'. Kim proposed the convergent artwork comprising Arduino, various sensors and actuators, and an Android-based control system¹⁵. Students were found to enjoy examples of renowned artworks presented in textbooks as AR-based convergent art. Figure 2 shows the study examples of AR-based instructional materials to be used in STEAM classes. When the 'Aurasma' app recognizes a portrait of Millet, 'Potato Planters' (Millet, 1862), or an Arduino image, respectively, 'Aurasma' overlays the information of the artist, 'Potato Planters' Art production methods onto the original image. This paper proposes a method of constructing a marker image of the AR-based STEAM class and its augmented reality contents in Table. 4.

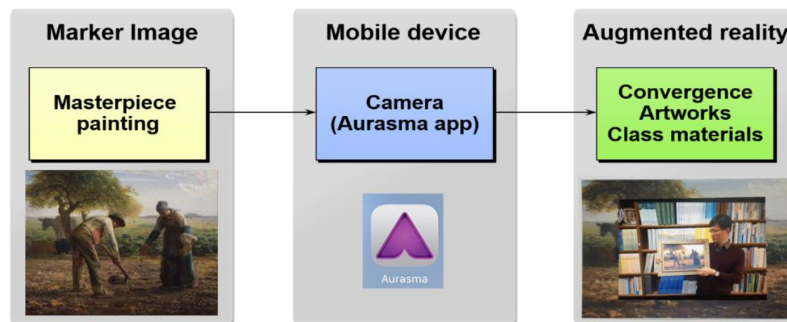


Figure 2. System architecture of augmented reality contents for STEAM class

Table 4 Augmented reality marker image STEAM content of instructional materials

Marker Image	Augmented reality	Contents
		- When students scan the portrait image of the artist, reading material about the artist will be enhanced and presented.

5 Conclusions

As IT technology becomes an integral part of classroom instruction, teachers and researchers strive to utilize cutting-edge technology to introduce efficient and engaging teaching and learning methods. Much research is conducted on AR, one of the most advanced technologies in the field of educational applications, in order to analyze its effect in learning by learners in diverse research environments. This study proposes the use of the 'Aurasma' application and its contents to the STEAM teaching-learning method to further promote AR technology. Augmented Reality has the potential to increase learning efficiency in classrooms by providing valuable information. Students will be able to interact with diverse digital content through AR class materials that are geared to enhance imagination and creativity. Future research will require teachers to apply AR to various materials and fields of study such as AR books, AR games, discovery learning, and 3D modeling.

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References

- [1] Godwin-Jones R. *Emerging Technologies Augmented Reality and Language Learning: from Annotated Vocabulary to Place-based Mobile Games*. Language Learning & Technology. 2016, 20(3), pp. 9-19.
- [2] Serino M, Cordrey K, McLaughlin L, Milanaik RL. *Pokemon Go and augmented virtual reality games: a cautionary commentary for parents and pediatricians*. Current opinion in pediatrics. 2016, 28(5), pp. 673-77.
- [3] Billingham M. *Augmented reality in education. New horizons for learning*. 2002, 12. Retrieved from http://www.solomonalexis.com/downloads/ar_edu.pdf. Date accessed: 01/02/2017.
- [4] Shelton BE. *Augmented reality and education: Current projects and the potential for classroom learning*. New Horizons for Learning. 2002, 9(1).
- [5] Lee K. *Augmented reality in education and training*. TechTrends. 2012, 56(2), pp. 13-21.
- [6] Ministry of Education, Science, and Technology (MEST). *Future Korea by Creative Human and Advanced Science and Technology*, Republic of Korea. 2010.
- [7] Kim, J. *STEAM Education Theory*. Yangseowon Publication Company : Seoul, 2012.
- [8] Kurniawan E, Lee BG, Lee SH. *An Implementation of a Cloud Service based Augmented Reality for Improved Interactivity*. Indian Journal of Science and Technology. 2016, 9(46), pp. 1-4.

- [9] Cho K, Kim H, Lee Y. *Augmented Reality Coloring Book with Transitional User Interface*. Indian Journal of Science and Technology. 2016, 9(20), pp. 1-5.
- [10] Hye KJ, Mi KY, Geun KM, Jee SE. *Kidult contents development using mobile augmented reality*. Indian Journal of Science and Technology. 2015, 8(S9), pp. 518-25.
- [11] Azuma RT. *A survey of augmented reality. Presence: Teleoperators and virtual environments*. 1997, 6(4), pp. 355-85.
- [12] Milgram P, Kishino F. *A taxonomy of mixed reality visual displays*. IEICE TRANSACTIONS on Information and Systems. 1994, 77(12), pp. 1321-9.
- [13] Asgari S, Mehrpouyan A. *IT Trends and Practices for E-Learning Development in Higher Education*. Indian Journal of Science and Technology. 2016, 9(48), pp. 1-9.
- [14] *Aurasma*. 2017. Retrieved from: www.aurasma.com. Date accessed: 01/02/2017.
- [15] Kim, J. *Study on SW Education and STEAM Education using Arduino for Technology Subject*. Korean Journal of Technology Education, 2015, 15(1), pp. 22-48.