

Motivating Secondary Science Learning through 3D Interactive Technology: From Theory to Practice Using Augmented Reality

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Abstract

Students' feelings and attitudes have much influence on the process of learning especially in science education. One element in the process of effective science learning is motivation and the use of interactive technology as effective learning media important to improve student's learning motivation and arouse their interest for better understanding of the information presented especially on abstract science concepts. This study reviews theories and pedagogical issues about science learning with discussion on challenges faced by educators and illustrations on exemplars to enhance students' learning motivation through Information and Communication Technology (ICT) using Augmented Reality (AR). AR is a technology in the interaction system encompasses all visual environments and has an entertainment aspect that can arouse students' motivation and understanding of general knowledge about science, e.g. 'The Bad Effects of Influenza' through visual interaction within a reinforced reality frame as illustrated in this article. Exemplary case will be reported on how the topic 'Influenza' could be introduced to promote effective science learning supported by AR tool with elaboration on the design of learning sequence incorporated following the Keller's 'Attention, Relevance, Confidence, Satisfaction' (ARCS) model. Pilot study was conducted in the school of the first author. Sample of students' activities with evidences of how the AR tool promote ARCS in science learning are illustrated with evidences on how an increase of their knowledge on topic 'The Bad Effects of Influenza' was achieved at the end of learning process. Implications and suggestions for the way forward will also be deliberated.

Keywords: Learning motivation; Effective science learning; Interactive technology; Augmented Reality; ARCS; Exemplary case

Introduction

Education is a conscious and systematic effort, undertaken by those who are held responsible for dealing with students in order to possess the nature and character of the educational ideals (Minib,2004). The conventional learning system (teaching faculty) is less flexible in accommodating material development compared to media usage (Keller,1999). Experts' research (Heinich, 1996) states that multimedia teaching provides enormous assistance to students in the learning process. One effort to generate student motivation in teaching and

learning process is by using media. Function and role of media in learning process (Maulana,2002), included among others, the ability to:

1. avoid the occurrence of verbalism;
2. generate interest or motivation;
3. attract attention;
4. overcome the limitations of space, time and size;
5. enable students in learning; and
6. streamline the stimulation of learning.

Advances in Information and Communication Technologies (ICT) have influenced various areas of human life, including education. One of the utilization of ICT in the field of education is the utilization of internet and intranet through e-learning system. The Strategic Plan of the Ministry of National Education (Renstra Depdiknas, 2005) mentions that education should always adapt and adjust to the development of modern science and advanced technological innovation, so that it remains relevant and contextual with the changing times (Renstra Depdiknas, 2005).

Augmented Reality (AR) technology was used as a medium that can support effective learning process to increase students' motivation for science learning in The Bad Effects of Influenza project. Augmented Reality (AR) technology has the following three advantages (Heinich, 1996) that cause this technology to be chosen by many developers of educational technological tools:

1. increase the user's perception of an object and provide a 'user experience' to a moderate 3D object;
2. enable users to do interactive activities that cannot be done in the real world;
3. allows the use of various tools (devices) as needed.

This study reviews theories and pedagogical issues about science learning with discussion on challenges faced by educators and illustrations on exemplars to enhance students' learning motivation through Information and Communication Technology (ICT) using Augmented Reality (AR) extracted from the project by Sari, Anakin, Annisa and Muhammad (2017) and presentation by Sari, Indarjani and Ng (2018).

Literature Review

A quick, effective and efficient process of learning is one of learning purpose to be achieved in this technologically advanced society. Literature revealed that among various technological tools available, Augmented Reality (AR) is one of the effective tool to achieve this goal.

Augmented Reality

Augmented reality (AR) is a live direct or indirect view of a physical, real-world environment which elements are "augmented" by computer-generated or extracted real-world sensory input such as sound, video, graphics, haptics or GPS data. It is related to a more general concept called computer-mediated reality, in which a view of reality is modified (possibly even diminished rather than augmented) by a computer (Wikipedia, 2018a).

Effective Learning

Effectiveness can be defined as the effect to learning is to bring results such as learning output and achievement. Implementation of effective activities should be well organized, in accordance with the provisions and content involving aspects of qualitative elements and art. The main elements for effective learning are shown in Figure 1 and elements of motivation are shown in Figure 2.

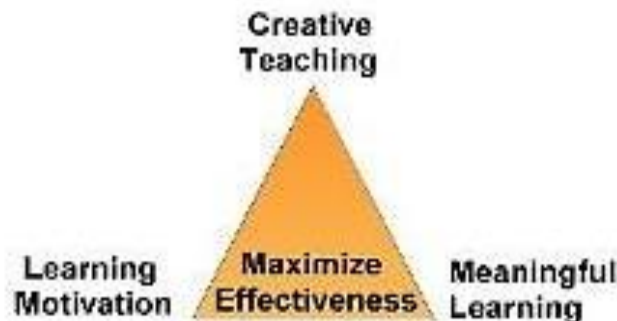


Figure 1. The main elements for effective learning (Orey, 2007).

The following are elaborations of the three aspects as illustrated in Figure 1:

1. Creative teaching
By using of innovative teaching methods, instructors will be easier to attract students or to improve students' learning motivation.
2. Learning motivation
Motivation gives a strength, curiosity and make the students take the decision to do something or to control their own learning.
3. Meaningful learning
Meaningful learning is very important to make connections with other previously known knowledge.

Motivation



Figure 2. Elements of Motivation (Webb, 2006).

Elements of motivation as shown in the Figure 2 include the following aspects:

1. Motivation begins with the needs, vision, desire to achieve something that seems impossible;
2. Success is the result of meaningful learning;
3. Development of the ability to overcome obstacles and learn from discouragement or failure.

Keller's Method

Various theories of motivation that were developed by Keller (Dabutar, 2008) have established a set of elements of motivation that can be applied in learning process, one of which is called the 'Attention, Relevance, Confidence, Satisfaction' (ARCS) model (Figure 3).

<p>a. Attention There are three basic ways (Keller, 2006) to get attention :</p> <ul style="list-style-type: none"> • perceptual arousal, • inquiry arousal, • variability 	<p>b. Relevance There are three basic methods to achieve relevance in learning (Keller, 2006) :</p> <ul style="list-style-type: none"> • familiarity, • goal orientation, • motive matching.
<p>c. Confidence There are three ways to build confidence in the study (Keller, 2006) :</p> <ul style="list-style-type: none"> • expectancy for success, • challenge setting, • attribution molding. 	<p>d. Satisfaction Some ways to increase satisfaction (Keller, 2006) include :</p> <ul style="list-style-type: none"> • natural consequences, • positive consequences, • equity.

Figure 3. The components of ARCS model.

The Bad Effects of Influenza

Influenza, commonly known as 'the flu', is an infectious disease caused by an influenza virus. Symptoms can be ranged from mild to severe. The most common symptoms (Figure 4) include: a high fever, runny nose, sore throat, muscle pains, headache, coughing, and feeling tired (Wikipedia, 2018b).

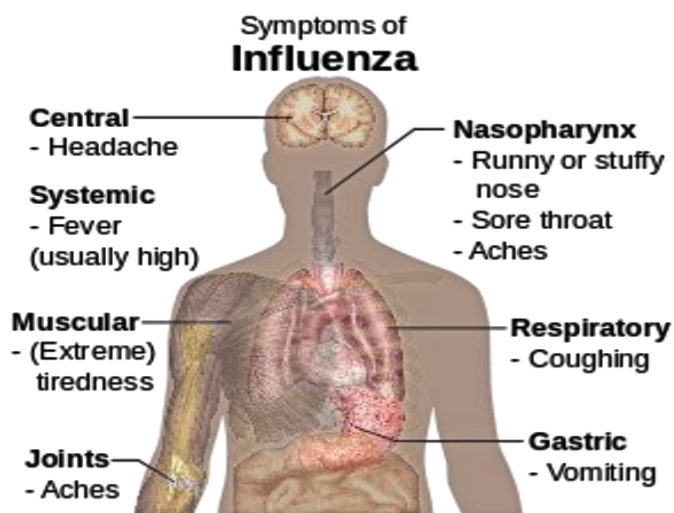


Figure 4. Symptoms of influenza (Wikipedia, 2018b).

Methodology and Implementation

Case study approach incorporating qualitative analysis is the methodology chosen to exemplify the implementation of AR in students' technology-enhanced science learning supported by various theories of motivation that can be applied in learning process. Screenshots of AR learning output and activities posted on Edmodo social learning platform are also illustrated (Appendix).

Illustrations on Exemplars on Theory into Practice

This section elaborates on a set of elements of motivation developed by Keller (1999) namely 'Attention, Relevance, Confidence, Satisfaction' (ARCS) model with elaboration on how each of the element was applied to motivate science learning integrating Augmented Reality (AR) technological tool.

a. Attention

The Bad Effects of Influenza project integrating AR was designed to encourage students to pay attention in learning science concepts through games and animated 3D web-based activities. The design of this AR project with variability of functions aiming at promoting perceptual and inquiry arousal (two sub-components of motivation) are summarised in the following Table 1.

Table 1

'Attention' in Learning to be Enhanced through System Design

Sub components	Design
Perceptual Arousal	<ul style="list-style-type: none"> • There is variability[#] of functions of tool, e.g. the use of variations on each color contrast display user interface. • 3D animation and students can interact directly
Inquiry Arousal	Students are encouraged to be engaged in problem-solving
Variability [#]	<ul style="list-style-type: none"> • Variations in the instructions on the touchscreen include: <ul style="list-style-type: none"> - General movement - Other movement • Variations on the media used include:

-
- the text
 - 3D animation
-

b. Relevance

The AR tool was designed to show relevance of curriculum content illustrating the relationship of learning materials with the needs and conditions of the students involved in the game system, as well as in the 3D animation web-based learning as listed in Table 2.

Table 2

Relevance of Curriculum Content in System Design

Sub components	Design
Goal orientation	The purpose of science learning is based on curriculum content in Indonesia (KTSP, 2006)
Motive matching	Customized 3D animated characters aims to encourage students to develop abstract thinking.
Familiarity	Examples and concepts that are presented in 3D animation are related to activities/scenarios in daily life.

c. Confidence

AR tool was designed to promote a sense of confidence and positive interaction with the environment which can be increased in line with the expectations for success as outlined in Table 3.

Table 3.

Confidence Enhanced through the System

Sub components	Design
Expectancy for Success	Students are given clear guidance on the following key user interfaces:
Challenge Setting	<ul style="list-style-type: none"> • 3D animations provide of sub-lesson materials. • There are various animations on the AR tool for The Bad Effects of Influenza, i.e. from easy to difficult level in accordance with the stages of user ability.
Feedback	<ul style="list-style-type: none"> • Users can interact with button in the 3D view of the object. • Students can interact in the 3D animation practice.

d. Satisfaction

Achieve satisfaction as affected by the consequences of the receipt, whether originating from inside or outside individuals. To improve and maintain student motivation, use of reinforcement (reinforcement) as a compliment, the gift of opportunity, and so forth.

Table 4

Satisfaction in System Design

Sub components	Design
Natural Consequences	use new knowledge of The Bad Effects of Influenza project animations.
Positive Consequences	In the project if the user pass through all the obstacles they will get a new knowledge about influenza

Equity Student can learn by themselves from the animation given to find the concept of learning.

Conclusion

The use of Augmented Reality (AR) technology in The Bad Effects of Influenza project is expected to increase learning motivation and students' knowledge of Influenza to achieve effective learning. We have many kinds of ideas to make multimedia learning using Augmented Reality (AR) technology. However as we have limited time and knowledge about its programming language, we were unable to implement it fully. Given more time to explore, we hope that this technology can be integrated in the curriculum content to make various media to achieve effective science learning in future.

References

- Dabutar, J. (2008). *Pengaruh Media Pembelajaran terhadap Hasil Belajar Pengelasan pada siswa yang berprestasi tinggi dan rendah di SMK Swasta 1 Trisakti Laguboti - Kabupaten Toba, Samosir*. Retrieved December 16, 2018 from <http://www.scribd.com/doc/3904721>
- Heinich, R. (1996). *Instructional Media and Technologies for Learning*. Prentice Hall, New Jersey.
- Keller, J. M. (1999). *Motivation in cyber learning environments*. *Educational Technology International*, 1(1), 7 - 30.
- Keller, J. M. (2006). *ARCS Categories - What Are the Elements of Learner Motivation*. Retrieved December 16, 2018 from <http://www.arcsmodel.com>
- KTSP (2006). *Panduan Umum*. Retrieved December 26, 2018 from https://bsnp-indonesia.org/wp-content/uploads/kompetensi/Panduan_Umum_KTSP.pdf
- Maulana (2002). *Alternatif Pembelajaran Matematika dengan menggunakan Media Komik untuk meningkatkan Motivasi Belajar dan prestasi Belajar Siswa*. Skripsi jurusan Pendidikan Matematika FPMIPA. Bandung, Indonesia: UPI.
- Minib (2004). *Pengantar Ilmu Pendidikan*. UPT MKK UNNES, Semarang.
- Orey, Michael (2007). *The Practice of Learning Theories*. University of Georgia, USA.
- Renstra Depdiknas (2005). *Rencana Strategis Departemen Pendidikan Nasional (Renstra Depdiknas) 2005-2009*, Retrieved May 5, 2018 from <http://www.depdiknas.go.id/renstra/ind/bag5.pdf>
- Sari, N., Anakin, T.W.P., Annisa, N.F., & Muhammad, D.D. (2017). *Serunai: The bad influence for effective learning*. Project proposal submitted for Augmented Reality (AR) online course (October to December 2017).
- Sari, N., Indarjani & Ng, K.T. (2018). *Enhancing effective science learning through Augmented Reality: Challenges and the way forward*. Presentation compiled in the refereed Proceedings of ICRTSTMSD-18, August 4-5, 2018 at Kuta Central Park Hotel, Bali, Indonesia. Retrieved December 17, 2018 from <https://drive.google.com/drive/folders/1DAUwL5K0OjaQEnMfP-rTLrimltPCDQ63?usp=sharing>
- Webb, C. (2006). *Elements of Motivation*. Goose Creek, Ibis Lane.
- Wikipedia (2018a). *Augmented Reality*. Retrieved December 28, 2018 from https://en.wikipedia.org/wiki/Augmented_reality
- Wikipedia (2018b). *Influenza*. Retrieved December 28, 2018 from <https://en.wikipedia.org/wiki/Influenza#Transmission>

Appendix

Screenshots of the Augmented Reality projects

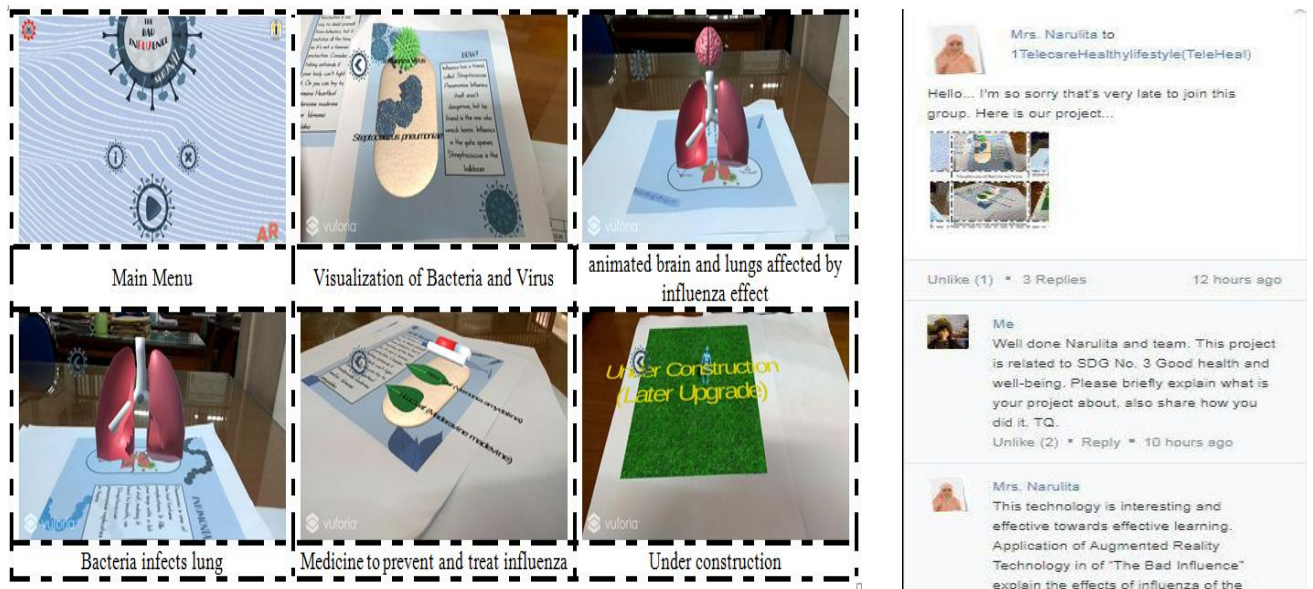


Figure A. Printscreens of Augmented Reality 3-D models on Edmodo social learning platform sub-theme ‘Telecare and Healthy Lifestyle’ (TeleHeal) with experience learnt to promote healthy lifestyle documented on web in e-forum [https://www.edmodo.com/home#/group?id=13658913, http://bit.ly/telehealarticle1, https://seaugmentedreality.wordpress.com/2018/01/31/project-proposal-announcement/]

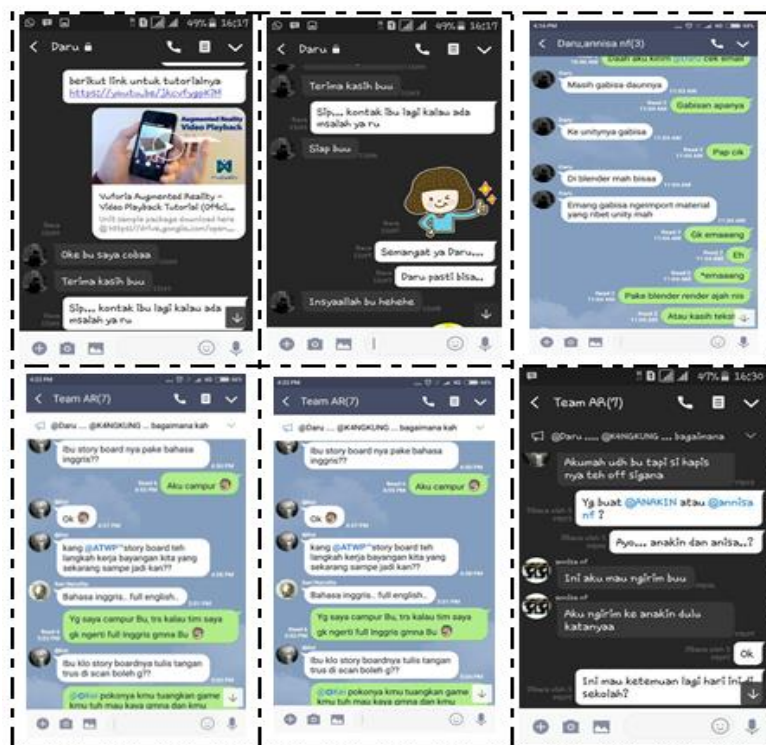


Figure B. Printscreens of students’ networking activities on social learning platforms.