

Development of STEAM Educational Games Focused on Aesthetic and Bodily Expression in K-12 Science Class

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Abstract. The purpose of this study is to introduce gesture recognition-based STEAM educational games using Kinect. The game is instructional media for evoking a student's interest and helping students understand in a STEAM education class. We suggested a STEAM education program that consisted of visualization of the science knowledge through aesthetic and bodily expression for middle school science class. In the development process of this STEAM program, the main challenge was an instruction method of scientific knowledge of human body anatomy and physiology. Gesture recognition-based game including science learning material should be an excellent educational tool to make student comprehend and understand complex science knowledge. In addition, the game is an excellent tool to visualize the contents. The gesture recognition-based educational game and the STEAM program were offered to model demonstration middle schools, entitled as 'STEAM leaders' schools' in South Korea. The result of the trial lesson is this game motivated and increased students' activities and learning. 55.8 % of the students responded that this program was satisfied and gesture-recognition based game were interesting. We believe that this educational game is suitable for STEAM education in science, dance and physical education class. Gesture recognition-based game by Kinect would be an excellent answer for the next generation's instructional media.

Keywords: Gesture recognition-based game · NUI · Bodily expression · STEAM education · Science · Dance · Kinect

1 Introduction

Nowadays, many researches were conducted to investigate the effect of educational games on students' learning in a variety of subjects, not only software engineering, computer science but also mathematics, language, and science [1, 2]. The previous researches have reported that educational games enhance the interest of students and

increase their learning motivation [3]. Computer games also are powerful tools for visualization and interaction. In the classroom, the teacher uses several visualization tools in learning scientific topics from a blackboard to TV because it helps students understand scientific conceptual relationship [4].

The classical style lecture which using passive communication media composed of only text and images is difficult for a student to visualize the topic of science class. To overcome this shortcoming in curricular delivery, many teachers use much animation and motion picture learning materials. These animated learning contents is more capable to attract student's interest than the text so that this visualized contents can help students comprehend and understand scientific knowledge. However, this approach could induce only students' passive learning.

The importance and benefits of active learning were accepted by education profession and teachers [5]. A computer game is the typical active communication media. A game is the best tool ever for active and interactive learning. While students are playing a game, they are doing, acting, and interacting with contents. In this idea is the main motivation of this study. We develop the educational contents for students to interact and learn the science class materials using Kinect. Using this gesture-recognition based game with NUI, students can move their body actively and receive the rapid feedback from a teacher and co-learners.

In the science class, many students feel difficulty and are boring to study the knowledge of the science curriculum. So, many teachers use the teaching method that is to introduce the elementary content firstly and to teach more difficult one gradually. In this process, the primary challenge is to conduct rapid and precisely evaluate and to give adequate feedback to the student about how exactly students understand it. There is an effective way that check of the result of playing an educational game with the Kinect and big screen with a projector in the science class.

Gesture recognition-based interface is an excellent educational tool to make students more active. Learning through body movement could be a good way to learn not only kids but also the high school students [6]. Kinect is an NUI device that offer the unique way to control the computer through the body movement. So, gesture recognition-based game including science learning material should be an effective educational tool to make student comprehend and understand complex science knowledge. In addition, body movement is related to Dance and Physical Education. So, we suggested a steam education program that consist of visualization of the science knowledge and aesthetic and bodily expression.

The purpose of this study is to introduce application using Natural User Interface (NUI) for evoke a student's interest in STEAM science class. The classical style lecture which using learning material composed of text and images is boring to students. To overcome this shortcoming, gesture recognition-based educational game could be the best option. Gesture recognition-based game including science learning material should be a good educational tool to make student comprehend and understand complex science knowledge. In addition, the game is an excellent tool to visualize the contents.

1.1 Adopting the Concept of Dance Your Ph.D.

'Dance your PhD' is an online contest that challenges scientists to explain their PhD thesis topic quickly with the Dance video. In 2008 Science Magazine and the American Academy for the Advancement of Science (AAAS) hosted the first ever 'Dance Your PhD Contest' in Vienna, Austria. Moreover, till now the competition has continued.

The rules are simple;

1. *You must have a Ph.D., or be working on one as a Ph.D. student.*
2. *Your Ph.D. must be in a science-related field.*
3. *You must be part of the dance.*
4. *Solo dancers or teams are allowed, but the prize goes to the PhD author.*

This contest concept is a good trial to explain easily and to visualize complicated science knowledge. This concept is a representative example of STEAM education. In science class, students learn and organize scientific knowledge, and they compose dance about that scientific knowledge in dance class.

2 Development of STEAM Education Program

2.1 STEAM Program for Bodily Expression for Science Education

We suggested a STEAM education program that consisted of visualization of the science knowledge through aesthetic and bodily expression for middle school science class. The program's scientific contents were the human body anatomy and physiology in middle school curricular level. This STEAM program designed by development team organized by artists, scientists, engineers, curriculum specialists, teachers.

STEAM education is an acronym referring to the academic fields of Science, Technology, Engineering, Art, and Mathematics. Nowadays STEAM fields become the most essential because the arts-based education offers opportunities for students to develop his creativity and imagination. Aesthetic and bodily expression based on scientific knowledge could be a good approach for designing STEAM education program.

In the development process of this program, the main challenge was an instruction method of scientific knowledge of human body anatomy and physiology. This content is not easy for students to comprehend the contents of the class. Before aesthetic and bodily expression of something, the student must understand that. In this point of view, gesture recognition-based game including science learning material should be a good educational tool to make student comprehend and understand complex science knowledge. In addition, the game is an excellent tool to visualize the contents.

In the class plan, student played first gesture recognition-based game in order to learn human body anatomy, such as organs name, location, function and physiological process. When students were using this game, they moved their body to control the gesture recognition-based game. This activity is helpful in two ways. First, it is more effective way to learn scientific knowledge through body movement with visualized contents than watching a scientific animation. Learning through the body movement is helpful to organize scientific knowledge. Second, it is a good preparation and practice

for aesthetic and bodily expression. Gesturing is a good warm-up to the bodily expression. Playing gesture recognition-based game pulled students out of their comfort zone by icebreaking activity.

So, we suggested a STEAM education program that consist of visualization of the science knowledge and aesthetic and bodily expression. In addition, body movement is related to dance and physical education. It could be an STEAM education including Science, physical education, and dance classes. Therefore, this gesture recognition-based education game is suitable for STEAM education.

2.2 Development of Educational Game

The game was developed using Windows Presentation Foundation (WPF) and Kinect for Windows Developer Toolkit ver. 1.8. In SDK, Control Basics of WPF – C# Sample was modified for creating main GUI of the educational game. The images of games are collected via the Google images searches.

The educational game is the human body anatomy and physiology in middle school curricular level. The game’s playing is matching and arranging the images and test blocks. The contents include that body anatomy, such as organs name, location, function and physiological process. Table 1 shows the summary of specific contents.

There are two kind of game to play. One is a drag-and-drop matching game. Another is an arrangement game. Kinect, NUI interface device, was used for the controller of the game. If the player wants to drag up the image, he should straighten the arm forward, palm facing towards the sensor and make a fist with his hand. Then he should move the images into right position along background image. To drop-down is the opening of the closed fist. The stopwatch measures the time from when the game is started until it is finished. The gameplay time is recorded in order to induce competition (Fig. 1).

Table 1. STEAM educational game contents

Level	Program	Contents
• Middle school	• Digestive system organs	Matching digestive organ images diagram along the anatomical body image (stomach, pancreas, small intestine, large intestine)
	• Components of blood cells	Matching blood cell images (white blood cell, red blood cell, platelets along) along appropriate text descriptions
	• Cell division – mitosis and meiosis	Arrange cell division phase images (mitosis: prophase, prometaphase, metaphase, anaphase, telophase, cytokinesis, meiosis: interphase, prophase, metaphase, anaphase, white blood cell, red blood cell, platelets along)
	• Embryonic and fetal development	Arrange embryonic and fetal development period images (2 cells, 16 cells, morula, blastocyst, implantation)

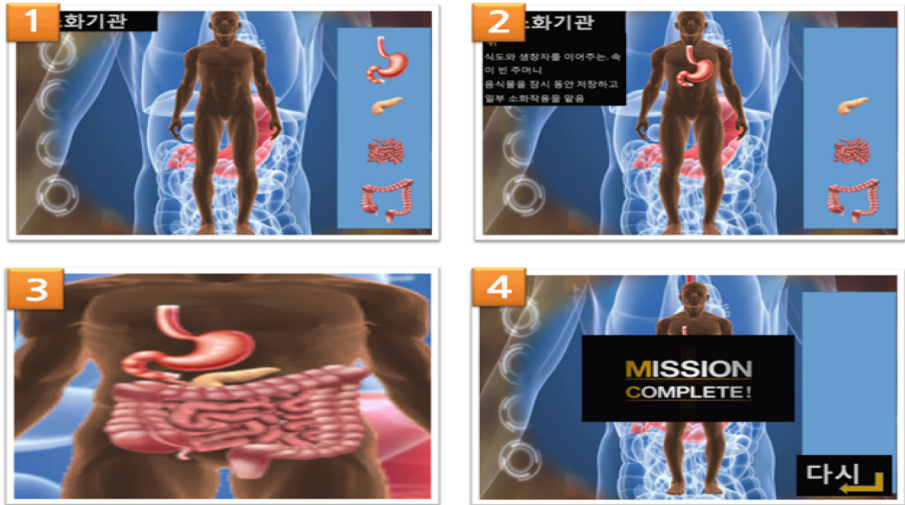


Fig. 1. The capture images of the educational game (digestive system organs)

3 Demonstration Lesson and Students' Feedback

The gesture recognition-based educational game and the STEAM program were offered to a demonstration middle school, entitled as ‘STEAM leaders’ school’ in South Korea. Lessons took place in the science laboratory and classroom. The instructional devices to set the lessons included a computer, a Kinect, a projector and screen, and speakers. After the demonstration lesson, the questionnaire was surveyed for program satisfaction of the students. The result of the survey was that 55.8 % of the students responded that this program was satisfied and gesture-recognition based game were interesting (Fig. 2).



Fig. 2. Students playing the educational game using Kinect during science class

4 Conclusion

The result of the trial lesson is this game motivated and increased students' activities and learning. 55.8 % of the students responded that this program was satisfied and gesture-recognition based game were interesting. We believe that this educational game is suitable for STEAM education in science, dance and physical education class. Gesture recognition-based game by Kinect would be a great answer for the next generation's instructional media. We confirm that the program that consist of visualization of the science knowledge and aesthetic and bodily expression is an excellent example of the STEAM education program. In addition, body movement is related to Dance and Physical Education. It could be an extended STEAM education class including Science, physical education, and dance classes.

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