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Effectiveness of Information Presentation using Augmented Reality Teaching Equipment for Statue Appreciation

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Abstract: In this study, we examined the effectiveness information presentation for statue appreciation using augmented reality teaching equipment. We clarified that the interest in statues can be improved by adding animation to computer graphics (CG) statues and presenting them at real size. On the other hand, we found that the interest in the information of a statue decreased as the interest in the statue increased. It is useful to present CG text to improve the interest in the information of the statue.

Keywords: Augmented reality, teaching equipment, information presentation

Introduction

In various fields, real-world oriented interfaces, which allow interaction between a computer and objects in the real world, is gaining attention [1]. These technologies are becoming more easily recently become available and hardware is becoming smaller and cheaper.
For instance, augmented reality (AR), which can synthetically present virtual objects in real environments [2], is studied in educational fields. Teshima et al.[3] and Shirouchi et al.[4] have conducted practical research on AR teaching equipment. It has been suggested that the learning ability could be improved by presenting virtual objects in regular textbooks. However, no study has examined the effectiveness of information presentation using AR teaching equipment.
The purpose of this study is to examine the effectiveness information presentation via AR teaching equipment using as an example of statue appreciation in art education.

1. Procedure

1.1 AR teaching equipment for statue appreciation

AR teaching equipment for statue appreciation was developed using an AR authoring software (metaio Unifeye SDK). The learner can observe computer graphics (CG) statues using a head- mounted display (HMD). The web camera unit in the HMD recognizes square- markers pasted on a piece of paper. In addition, a control PC processes information on the locations of the square- markers, and a CG statue is presented on paper.
Figure 1 compares four types of content generated by the AR teaching equipment. The "Standard type" which only generates CG statues on paper is compared to the three other types. For the "Animation type," the CG statue rotates at a constant speed. For the "CG Text type," the CG text is generated in addition to the CG statue. The "Real Size type" generates

a real-size CG statue. For this type, a cube-shaped marker consisting of six square markers was used so that the web camera can recognize the marker from about 1 m away.

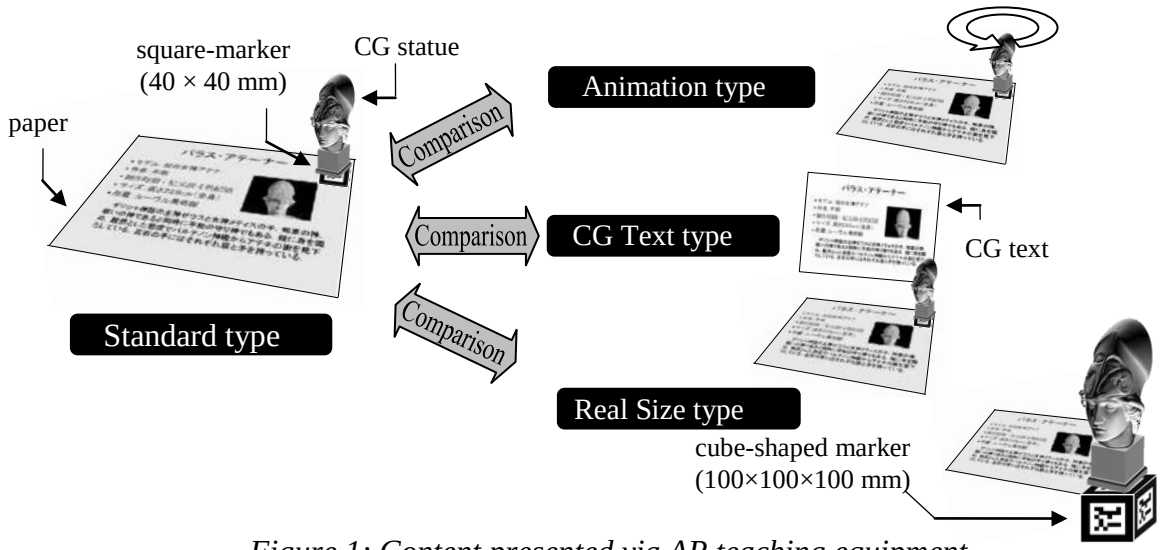

Figure 1: Content presented via AR teaching equipment

1.2 Subjective assessment by survey

Thirty undergraduate university students participated in the survey. After viewing all four presentation types simultaneously, the students responded to the items listed in Table 1. The questionnaire consisted of four categories: Statue Presentation, Information Presentation, Motivation, and Usefulness. The students compared each presentation type with the Standard type by selecting from the responses "Strongly agree," "Agree," "Neutral," "Disagree," and "Strongly disagree." The point scores were 5, 4, 3, 2, and 1, respectively. The mean value of the points in each category was then calculated and analyzed.

Table 1: Items in each category on the questionnaire

Statue Presentation	**Information Presentation**
• I actively appreciated the statues. • I concentrated on appreciating the statues. • I examined the statues' shapes. • The statues' CG representations were easy to see.	• I actively studied the statues' information. • I concentrated on appreciating the statues' information. • I understood the statues' information. • It was easy to see the statues' information.
Motivation	**Usefulness**
• I want to learn more about these statues. • I want to learn more about other statues. • I want to conduct a class using an AR textbook.	• I enjoyed using the AR teaching equipment. • AR textbooks are an effective teaching equipment for sculpture appreciation.

2. Results and Discussion

Figure 2 shows the results of the subjective assessment in each category. The data was analyzed using ANOVA and multiple comparisons using the least significant difference (LSD) method. The effect of the content type was statistically significant in each category: Statue Presentation [$F(2,58) = 26.89$, $p < 0.01$], Information Presentation [$F(2,58) = 71.21$, $p < 0.01$], Motivation [$F(2,58) = 12.73$, $p < 0.01$], Usefulness [$F(2,58) = 3.32$, $p < 0.05$].
In the "Statue Presentation" category, the LSD method showed that the mean values of the Animation and Real Size type data were higher than that of the CG Text type data ($MSe = 0.25$, $p < 0.05$). In the "Information Presentation" category, the LSD method showed that the

mean value of the CG Text type data was higher than that of the Animation and Real Size type data. Moreover, the mean value of the Animation type data was higher than that of the Real Size type data (MSe = 0.52, $p < 0.05$). In the "Motivation" category, the LSD method showed that the mean value of the Real Size type data was higher than that of the Animation and CG Text type data (MSe = 0.18, $p < 0.05$). In the "Usefulness" category, the LSD method showed that the mean value of the Real Size type data was higher than that of the CG Text type data (MSe = 0.18, $p < 0.05$).

The results show that presenting not only paper media but also CG textual information in the AR teaching equipment was effective for understanding of the content. Moreover, it was found that learners' interest increased when the CG statue displaying information was animated at its real size.

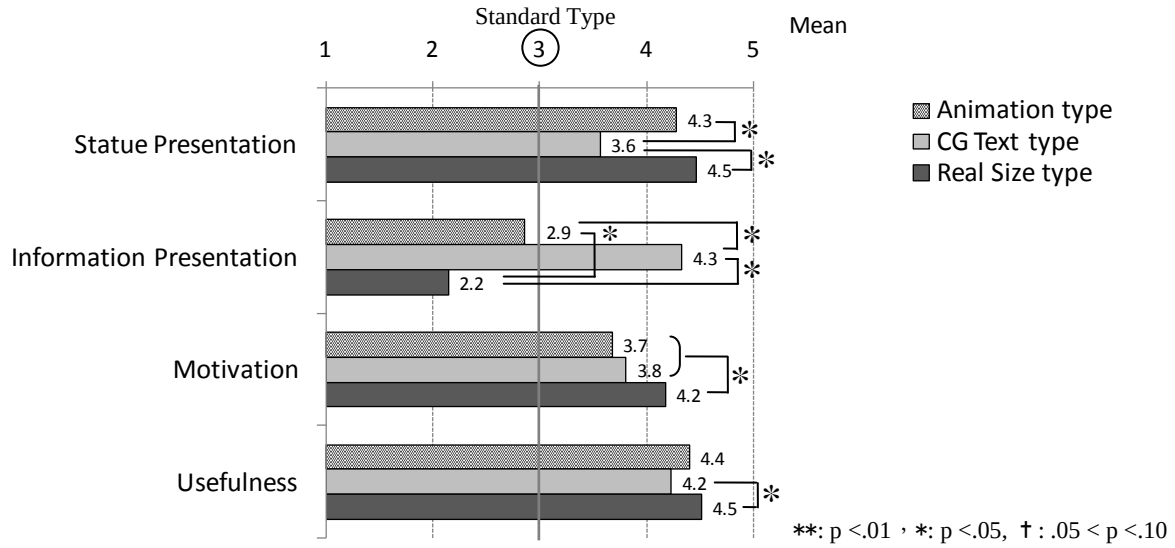

Figure 2: Results of the subjective assessment

3. Conclusion

In this study, we examined effectiveness information presentation using AR teaching equipment for statue appreciation. We found that students' interest in statues was increased by adding animation to the statues and presenting them at their real size. We also found that the interest in a statue's information decreased as the interest in the statue increased. Moreover, we found that students' motivation and the usefulness of the presentation could be improved by presenting real-size CG statues in an AR textbook. In the future, we will try to provide more evidence for these results by using an AR textbook in classes.

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