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A 2D Dental Morphological Image Augmented to Assist Improving Traditional Hand Carving Skills in Dentistry

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Abstract

This pilot study was to explore potential effects of outlining a 2D morphological tooth on a cubic plaster stick by implementing augmented reality (AR) technology before an actual dental carving, in comparison to a traditional carving exercise needed to memorize a true morphology of the tooth. The pilot result shows that a use of the AR technology could provide a potential visual graphic tool worked as a 2D visual guidance directly in drawing the tooth's outlines before carving exercise starts.

Keywords: augmented reality, dental morphology, and carving.

Introduction

To examine the knowledge of dental anatomy and tooth morphology as a basic requirement is often used for qualification and professional certificates in dental dentistry. Performing dental related laboratory procedures for students often cause the great stress among their study, such as mixing materials, grinding models, carving, and polishing crowns and dentures [1].

A study compared five dental anatomies related carving pedagogies and suggested some methods significantly effective for learning, for examples, dental morphology information received by the geometric method, combination of learning through teaching software, and step-by-step instructions [2]. Compared to conventional laboratory instruction in dental carving, computer-assisted instruction was much easier to enhance the carving performance and increase students' motivation because of the advantages of unlimited time using digital resource, attractive and interactive material, and along with visual guidance instruction [3]. Another study from Kilistoff's experiment demonstrated that pre-doctoral dental students' tooth carving skills were significant improved after technique instruction and simultaneously received visual feedback carving information [4].

Concerning the cost, number of students, and staff's difficulty, lessons of carving tooth models in wax or soap had been dropped in some university [5]. Alternatively, self-directed workshops using online handouts and digital tooth model to teach carving and tooth morphology was proposed to meet teaching requirements. In addition to this study, the majority of the students found the cyber pedagogy useful to guide tooth morphology, but thought the method should be integrated into hands-on carving session.

There were more studies focused on evaluation of using online-resources and computer-assisted instruction to enhance education, such as DVD, smartphone [6], and Virtual Reality (VR) [7-8]. These technologies could simulate the environment and provide more optimal practice conditions to smooth the transition from the traditional model-based laboratory to the clinic [9].

The literatures show that traditional step-by-step instructions and real-time visual guidance impact most to the students who attempt to learn curving session in dentistry. However, a visual outlining dental morphology directly placed upfront of the practice is still limited, although a recent technology, augmented reality (AR), provides a better eye-hand coordination to interact with computer generated 3D images to the real-world environment.

Therefore, this pilot study was to examine an overlap of a digital 2D morphology of a tooth directly outlined on a plastic carving stick in assisting the students' plotting according to the outlined morphology before a carving exercise begins. After the outline plotting, an AR usage related questionnaires were given, and the plotting results were also evaluated for the groups, who used with and without the AR technology in exploring its learning effects before carving practice on a cubic plaster stick, in comparison to a traditional pedagogy carving exercise attempted to memorize the morphology of a physical tooth model.

Methodology

This pilot study of plotting a 2D outline of the tooth before carving exercise was conducted at the Shu-Zen Junior College of Medicine and Management located in south of Taiwan. Three randomly recruited female subjects of the college (N=3, age 19 years old), were tested when they were in the 2nd year of a five year program at the department of dental technology. Dental carving skills were new to them.

The students were initially asked to fill in a basic information about their past experience in using AR related products, computers and in favoring specific visual, auditory, and kinesthetic (VAK) self-learning styles. Each student, then, was asked to operate an AR technology based system platform where a phone clamper, a cellular phone (Huawei P20,

EML-L29 model) and a black colored hardboard were set up (seen in the Fig. 1a).

Upper jaw central incisor tooth was selected working as a model morphology tested for the subjects. A physical actual incisor tooth model was scanned by a 3D scanner so that its digital 3D morphology outlining the tooth (Obj. format file) was created. The 3D object file was compensated and corrected its related 3D orientation seen in post-processing 3D Max software before being imported into post-processing AR based software like Unity (version 2017.03). An AR based 2D outline of the tooth and its operational interface were created while implemented into the cellular phone (seen the Fig. 1b).

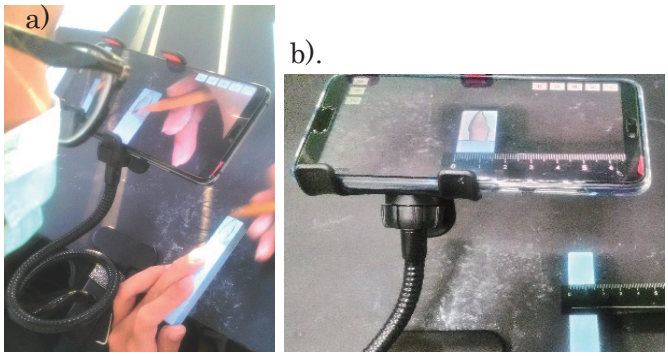

Fig. 1 a). A setting of an AR technology based system platform including a phone clamper, a cellular phone and a black hardboard. b). The operation AR interface was shown to have one of the five anatomical sections of the actual 2D outlined tooth.

After the setting was completed while leveling the interface of the cellular phone and the plaster stick placed on the blackboard, each subject was asked to outline the tooth on the plaster stick according to the given AR based graphic image seen in the operational interface of the phone. Each subject completed the 2D drawing of each five anatomical section on the stick, and its 2D outlined plotting completions were evaluated according to a scoring sheet graded as A, B and C by an in-class instructor (seen in the Table I).

TABLE I
A DENTAL MORPHOLOGY EVALUATION SCORING SHEET FOR INSTRUCTOR

Items	%
Symmetrical proportion	40
Location of eminence	20
Characteristics	40
Score	100

Grading: A:>90 ; B>80; C>70

Then, each subject was asked to answer the modified questionnaires [3], a Likert scale (1 to 5 points) based question evaluation after the plotting task on the stick with five scale points like strongly disagree (1)、disagree (2)、neutral (3)、agree (4) and strongly agree (5) as to answer the following questions: Q1: before dental school, I was well familiar with computer skills; Q2: before dental school, I had rich computer-based assisted learning experiences; Q3: before this course, I am familiar with AR related technology; Q4: the AR technology assisted 2D plotting worked well for my learning style; Q5: the AR technology assisted 2D plotting method indeed improved my self-directed learning; Q6: the AR technology assisted plotting method indeed was useful for my self-directed 2D plotting skills; Q7: the AR technology assisted 2D plotting method indeed was different from the other learning methods I experienced; Q8: considering my course load, the right amount of allocated time method for AR technology 2D outline plotting I was exposed to was useful; Q9: the AR technology assisted method for 2D outline plotting I was exposed to was adequate; Q10: I enjoyed the AR technology assisted method for 2D outline plotting I was exposed to.

Results

Based on the given subject's basic information sheet, none of the subjects had experienced with any AR based products while their VAK self-learning styles were different from one another. One was mixed VAK、kinesthetic and the other auditory styles. The plotting task evaluation scores of each subject showed average 3.7, 3.0, 2.0, 2.7, 3.0, 3.0, 3.3, 2.7, 3.0 and 3.0 points to the modified questionnaires Q1 to Q10 answered, respectively.

Each subject was also graded with C、A and B for the outlined results of the 2D plotting while their plotting task evaluation Likert scale with total scores 39、29 and 19 points, respectively. The subject with the Likert scale total scores 29 shows the A graded best result while a kinesthetic learning style was indicated. The mixed VAK self-learning style shows the highest 39 points for her plotting task evaluation.

Discussion

This pilot study of utilizing the AR technology by directly drawing the 2D outline as visual guiding information superimposed onto the plaster stick was feasible while the subjects could well practice plotting the actual 2D tooth morphology before actual carving on sticks. Thus, an utilization of the AR technology could provide a potential tool worked as a visual guidance in plotting 2D tooth on plaster sticks before a true carving exercise starts.

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