Development of a Teaching Material for the Human Skeleton using a Visual Information Compensation Function

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Abstract: We investigated the use of a talking pen (Touch Memo®) combined with a specially labeled model of the human skeleton as a self-learning material on anatomy for visually impaired students. The talking pen replays previously input information when a dot-code label (re-recordable label) is touched. This study aimed to obtain students' evaluations of sites at which the dot-code labels can be attached at the indicative positions on the skeleton model to ensure ease of use, thereby determining the most user-friendly ways to use the labels for visually impaired students. Twenty-two visually impaired students specializing in acupuncture and moxibustion participated in the study. Four sites of attachment of the dot-code label to the skeleton module were examined: (a) directly to the bone, (b) head of a wooden screw in the skeleton model, (c) inside a hole of a 3.5-mm diameter, and (d) inside a hole with a 5-mm diameter. The participants evaluated the talking pen using a 5-point scale on the basis of recognition of the dot-code label and the responsiveness of the talking pen to the dot-code label. The results showed that students experienced more difficulty in recognizing the dot-code label by touch and in getting the talking pen to respond when the label was attached to a 3.5-mm hole than when it was attached by other means. In addition, regardless of the degree of visual impairment, the most user-friendly sites were when the label was attached to the model directly and when it was attached to a 5-mm hole. However, attaching the label directly to the skeleton model often peeled off; therefore, we conclude that the use of the model with a 5-mm hole should be used and improved further.

Keywords: Anatomy, Bone, Self-learning, Skeleton model, Talking pen, Visual impairment

1. Introduction

In the study of anatomy, lectures and seminars draw information from the usual textbooks and also from life-size anatomical models of the human skeleton and each internal organ. For visually impaired students, the use of anatomical models is an effective method of learning because it aids understanding, which is often difficult with visual diagrams [1]. Students with severe visual impairment or those who are completely blind compensate for the lack of sight by using tactile exploration, which allows them to understand the three-dimensional composition of organs and the position of an organ in relation to others; therefore, anatomical models are indispensable tools for such students studying anatomy. However, visually impaired students who initially learn anatomy often find it difficult to identify the shape and position of the anatomical model because of their insufficient knowledge of the shapes of internal organs, because of which they spend more time in understanding this aspect than other students. In addition, such students may fail to learn anatomy appropriately if they cannot achieve an adequate understanding of the shapes and positions of internal organs. Failures at the beginning of the learning process can demotivate them and reduce their efficiency [2], and thus, it is one of the major challenges for university education.

We have been testing the use of a talking pen (Touch Memo®, UD Create Co. Ltd.) for self-learning of the skeleton model [3]. The talking pen is a pen-shaped digital voice speaker mainly used by the visually impaired, both in their daily lives and in learning situations. It records voices and replays the recorded information once a dot-code label is touched; the dot-code label is a label made with dot-code steganography. However, dot-code labels attached directly to a skeleton model tend to peel off easily because of the rough surface of the model. In addition, students often reattach peeled-off labels in incorrect positions; this has been pointed out as one of the obstacles in the effective use of this tool, and thus, effective learning.

This study therefore aims to examine the most user-friendly site of attachment of the label by asking visually impaired students to evaluate the ease of use of 4 different attachment sites of a dot-code label on a skeleton model.

2. Methods

2.1 Subjects

The study included 22 students enrolled in the acupuncture course at our university. The purpose of developing this teaching material was explained to the students, and their consent to participate in the study was obtained. Among the participants, 10 were completely blind or severely visually impaired students who could not fill in the questionnaire themselves (blind group), 6 students required the use of a 14-point-sized font (the 14P group), and 6 students required the use of an 18-point-sized font (the 18P group).

2.2 Material

The materials used were a talking pen (Touch Memo®, UD Create Co. Ltd., Figure 1) and its accessory, the dot-code label based on dot-code steganography (Figure 2). In addition, we used anatomical models of the femur and tibia bones (Sakamoto Model Corporation).

Fig. 1. Talking pen (Touch Memo®)

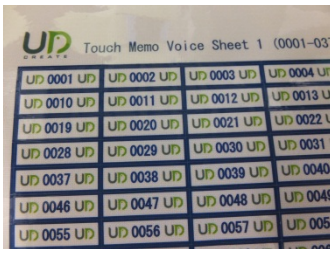


Fig. 2. Dot-code label (Touch Memo® Voice Sheet)

2.3 Development of the teaching materials

All the information required during learning, including anatomical terms necessary for learning the positions where the dot-code label was attached, was recorded previously so that the talking pen would respond to each dot-code label. We ensured that the talking pen would recognize the dot-code label and replay the relevant information when the label was touched.

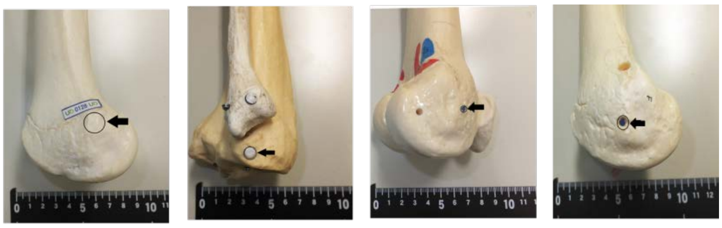
The dot-code labels were attached to the skeleton model for recognizing the learning points according to the following 4 methods (Figure 3):

a) “Direct”: Rectangular dot-code labels (7 × 20 mm) were directly attached to the lateral and medial epicondyles of the femur.

b) “Screw”: Round-head wood screws were inserted at the lateral and medial epicondyles of the tibia, and round dot-code labels (diameter, 5.3 mm) were attached onto the screw heads.

c) “3.5-mm hole”: Holes with diameters of 3.5 mm were drilled at the lateral and medial epicondyles of the femur, and round dot-code labels (diameter, 3 mm) were attached to the holes.

d) “5-mm hole”: Holes with diameters of 5 mm were drilled at the lateral and medial epicondyles of the femur, and round dot-code labels (diameter, 3 mm) were attached to the holes.



a) Direct b) Screw c) 3.5 mm hole d) 5 mm hole

Fig. 3. Attachment of the dot-code label to the skeleton model for recognizing the learning points. Arrow in a) refers to the index on the skeleton model; the label is pasted here. Arrows in d) from b) are labeled on the index.

2.4 Learning sessions and the questionnaire

The students were asked to activate the talking pen by touching the dot-code label after learning where the label was attached by sight or touch. The labels were attached to 4 different models at the abovementioned 4 sites such that each participant could try all the methods. After performing the task, the students were asked to evaluate the ease of confirming the site of the dot-code label and the ease with which the responsiveness of the talking pen to each label could be achieved; a 5-point Likert-type scale was used (1 = very difficult, 2 = difficult, 3 = neither, 4 = easy, 5 = very easy). In addition, the students were asked to comment without any hesitation about how each method could be improved and were asked to choose the method that was the easiest to use.

3. Results

3.1 Recognition of the label attachment site on each model by sight or touch

Figure 4 shows the ease of recognition of the label attachment site on each model according to the level of visual impairment. For the blind group, the average scores with the direct attachment, screw, 3.5-mm hole, and 5-mm hole methods were 3.3 ± 1.2, 2.7 ± 1.5, 2.0 ± 0.8, and 3.4 ± 1.1 points, respectively. They found it slightly more difficult to recognize the 3.5-mm hole compared with other methods, but there was no statistically significant difference. There was also a slight difference in the degree of touch recognition between the direct, screw, and 5-mm hole methods.

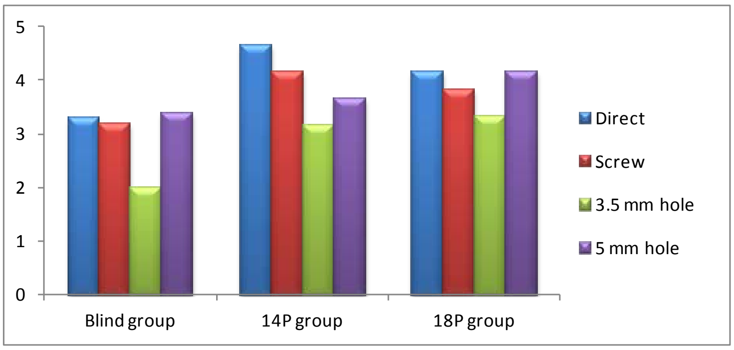


Fig. 4. Recognition of the label attachment site on each model by sight or touch

3.2 Response of the talking pen

Figure 5 shows a comparison of the ease of the responsiveness to the talking pen for each model. The students found it difficult to get the talking pen to respond by touching the 3.5-mm hole, regardless of the level of visual impairment. By contrast, the students could get the talking pen to respond with relative ease using the direct-attachment model, regardless of the level of visual impairment.

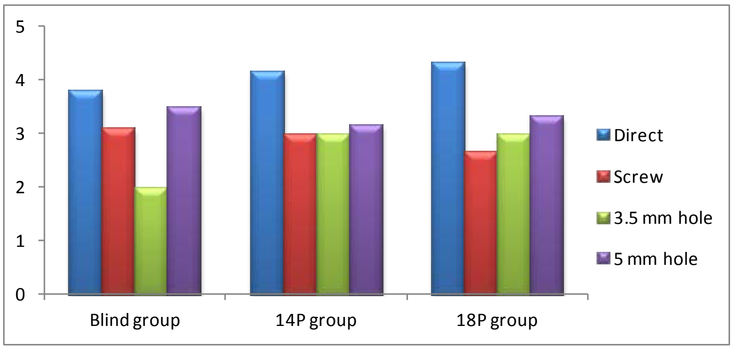


Fig. 5. Response of the talking pen

3.3 Ease of use for self-learning materials

In terms of the ease of use for self-learning materials, 11 students thought that the direct method was the best, whereas 8 students chose the 5-mm hole method, and 3 students opted for the screw method. Figure 6 shows the ease of the use of the materials according to the level of visual impairment. The students in the blind group found the direct-attachment method the easiest, followed by the 5-mm hole and screw methods. The students in the 14P group said that the direct label and screw methods were the easiest, and many students from the 18P group found the 5-mm model the easiest.

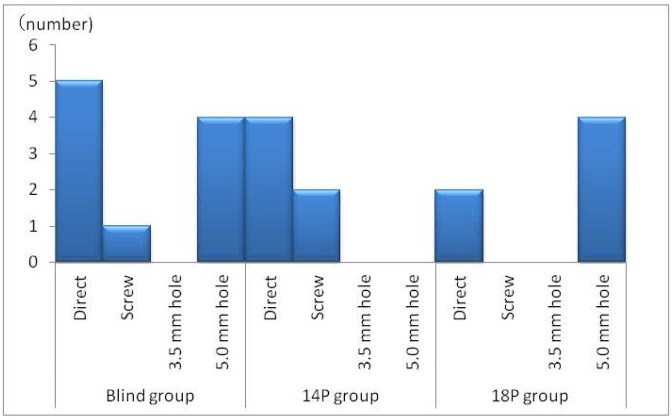


Fig. 6. Ease of use as self-learning materials

3.4 Improvements necessary for using the talking pen as a learning material

The students who recommended the direct method pointed out that the dot-code label easily peeled off, a problem that needs further attention. They also suggested that introducing other indicators such as Braille would be useful.

The screw method was sometimes evaluated as the easiest to touch with the talking pen and relatively easy to find as an indicator. However, students noted a few problems, including “the trouble of setting the wooden screw in the right place” and the “difficulty of distinguishing the screw from a projection of the bone.” Furthermore, 1 student said that although the screw method was the most user-friendly, the overall model was not an ideal learning material because the dot-code label easily peeled off and the talking pen did not respond very well to the label.

Regarding the 5-mm hole method, students pointed that the depth and size of the hole require further consideration. One student said, “If the hole is big enough for the head of the talking pen to fit into it, it would respond more easily.” Another commented, “The talking pen fails to respond at a certain angle, so it would be good to develop a hole which offers a single, consistent angle.”

4. Discussion

Previous studies have suggested that the use of the talking pen and dot-code labels is effective in aiding self-learning of skeleton models, but because the dot-code label peels off easily, it is not suitable for use as a learning material for long periods. Our study therefore proposed some alternatives to attaching the dot-code label directly to the skeleton model and examined their effectiveness using students' evaluations.

Most students chose the direct method as the most user-friendly learning material, although the label's tendency to peel off easily was still recognized as a problem, as in the previous study. In order to encourage the use of the direct method, it is necessary to add a better indicator to the dot-code label and to strengthen the label's adhesiveness.

The screw model was easy to find as an indicator, but the dot-code label easily peeled off the screw. In addition, repeated use wore down the dot-code label to the point where the pen could no longer read the code. Therefore, it seems necessary to apply a coating to the label to prevent wear so that this method can be used for learning.

We found that the 3.5-mm hole method was unsuitable for learning because it was difficult to recognize where the label was attached and to get the talking pen to respond. By contrast, many students in the 18P group supported the 5-mm hole method, although the 14P group did not find this method to be user friendly. Four students in the blind group said that the 5-mm hole method was the easiest, and therefore, the method attracted as many supporters as the direct model. To improve this model, students suggested that the talking pen should be able to respond regardless of the angle of its insertion. The head of the talking pen was bigger than the hole, which sometimes led to the pen not being able to read the code, depending on the angle of insertion. Students also thought that the size and depth of the hole should be increased such that it could be easily distinguished from naturally occurring dents in the bone. With these improvements, the 5-mm hole model can be developed as an effective self-learning material.

The use of dot-code labels that enable recording and replaying is indispensable when inputting voice data. However, when the dot-code label peels off easily, it can no longer serve as a voice recognition learning material. Therefore, the label should be less prone to peeling. In summary, methods involving the use of holes ≥ 5 mm diameter appear to be useful for learning materials.

5. Conclusion

A questionnaire was administered to 22 students on the use of a talking pen and dot-code label as self-learning materials on skeleton models. The results showed no statistically significant difference in the user-friendliness according to the site of attachment of the dot-code label, in terms of the degree of visual impairment of the participants. However, we found that the most user-friendly method for label attachment was the direct method, followed by the 5-mm hole method. We suggest that when using the dot-code label and talking pen, the dot-code label should be attached to a hole with a diameter of ≥5 mm so that it can be used as an effective learning material for a long period.

Acknowledgments

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