Sketch Learning Environment for Human Body Figure by Imitative Drawing

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Abstract. We developed an interactive learning environment for imitative figure sketching. Figure sketching is more difficult for novice than other sketching. People can easily find errors of figure sketch, since human is sensitive to human body figure. There are some important points to draw figure sketch. In this paper, we focus on length and angle between junctions. After learners draw human body figure by imitative sketching, the learning environment diagnoses the lengths and angles between junctions of drawn figure sketch. The environment shows scores of the learners' figure sketch and some advice. We evaluated the environment with some learners.

Keywords: Learning environment, Sketch, Imitative drawing, Figure painting, Skill.

1 Introduction

There exist many systems and software that support drawing or painting on computers. For example, Baxter developed an excellent system called DAB that assists a user in painting on a virtual paper on a computer [1]. Although DAB is an excellent system, it cannot be used for learning support, since it does not have a function for diagnosing the sketches by users. Learning support for drawing or painting is a task that differs from drawing support or painting support. Functions for diagnosis and advice are required for learning support. Our project was the first learning environment that could diagnose a learner's sketch and then provide advice.

We have previously developed various sketch learning support environments. [2-6] are the environments that use pre-defined motifs. Therefore, the learning environment is designed motif-dependently. The motifs are dish and glass. [7] is a learning environment that trains perspective. It is a motif-independent learning environment.

Although we developed various learning environment, there was no learning environment that trains learners to draw human figure sketch. Therefore, we developed a learning environment that trains learners to draw human figure sketch by imitative drawing. The target is novice learners for learning human body figure sketch. The novice learners could be students who studies arts, and also could be students who don't study arts.

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2 Cognitive Discussion for Figure Drawing

Human interactions with objects comprises three main stages, namely, recognition, selection (or decision), and action (Fig. 1). This process is explained for the task of drawing a sketch as follows.

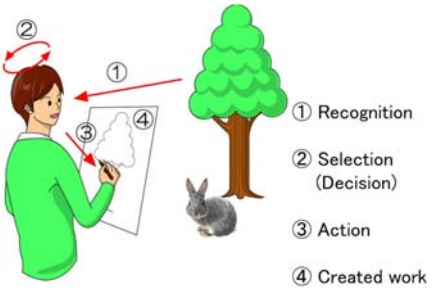


Fig. 1. Interaction between a learner and objects. The interaction comprises 3 stages, namely, (1) recognition, (2) selection (decision), and (3) action. A learner creates his/her work by repeating this process many times.

In the recognition stage, a learner perceives objects as a motif of drawing, and recognizes them. If the learner recognizes a tree, then he/she moves into selection (or decision) stage as follows. The learner thinks how to draw the tree. Then he/she decides to draw the edge of the tree first. He/she also decides to draw the shaft of the tree after drawing the edge. Thus, in the selection (or decision) stage, the learner selects (or decides) an appropriate action that he/she will acts in the next stage. Finally, in the action stage, the learner acts in accordance with the action that he/she selects (or decides) in the selection (or decision) stage.

If the motif is still objects like tree or dish, recognition of the motif is quite easy. However, if the motif is a human body, more precise recognition is required, since people can recognize the human body figure more sensitively than other still objects. Therefore, if a sketch of human body figure includes a small error, people easily find the error and feel the error larger than it really is.

To minimize the errors of human body figure sketch, the recognition stage is important for learners, since an error in the action stage often comes from an error in the recognition stage. Learners are required to recognize the human body figure more precisely to draw it without errors. A human body figure depends on a human pose. One of the most important matters to recognize a human pose is to recognize the junctions and the skeleton in the human pose. If learners can recognize the junctions and the skeleton precisely, he/she can draw them precisely quite easily on a paper. After drawing the junctions and the skeleton, he/she can quite easily draw the contours of the human body figure. Therefore, we focused on the junctions and the skeleton, and developed learning environment for drawing human body figure.

3 Learning Environment Design

Figure 2 shows the workflow of the learning environment. The learning environment consists of a PC, a monitor and a tablet Intuos 2 made by WACOM. The tablet

has a grip pen for a learner to put in position coordinate values on a paper on the tablet.

At the beginning, the environment shows an example of human body figure paintings on the monitor. Then, the learning environment requires the learner to recognize comparative positions between junctions and the angle between the bones. After recognition of the junctions and the skeleton, the learner draws the skeleton first, then draws contours of the human body figure on a paper on the tablet.

After completing drawing, next stage is self-diagnosis stage. The learner puts in the position coordinate values by putting grip pen on the junction positions in the sketch on the tablet. Three junctions are, for instance, shoulder, elbow and wrist. After putting in three junction positions, the learning environment calculates ratio of bone lengths between junctions and the angle of the middle junction between two bones. The learning environment diagnoses these values by comparing with correct values. Then, the learning environment shows advice on the monitor according to the results of the diagnosis. The learner modifies his/her sketch according to the advice, and tries diagnosis again. Repeating this process, the learner can get drawing skill of human body figure.

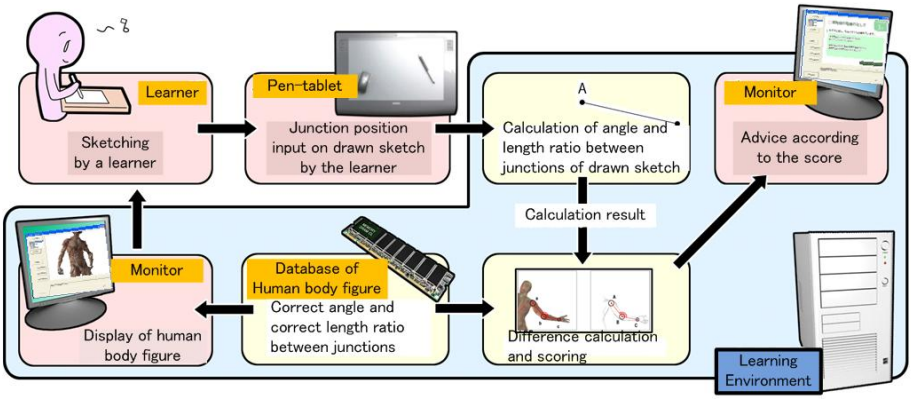
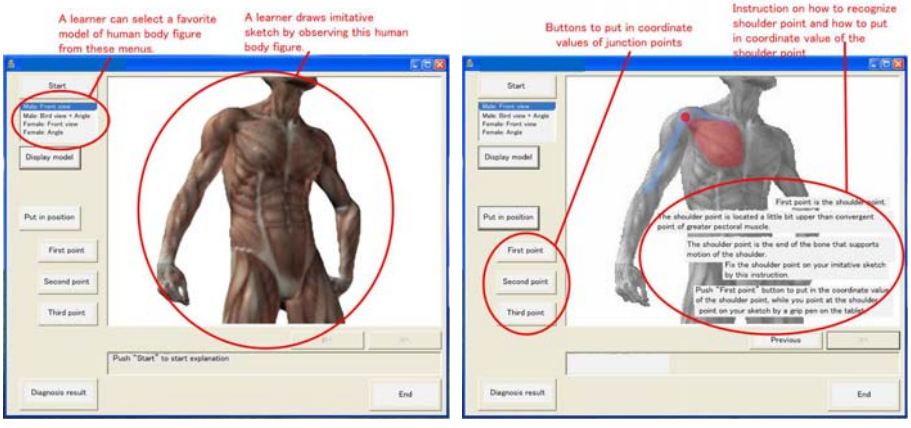


Fig. 2. Workflow of the learning environment

4 GUI of the Learning Environment

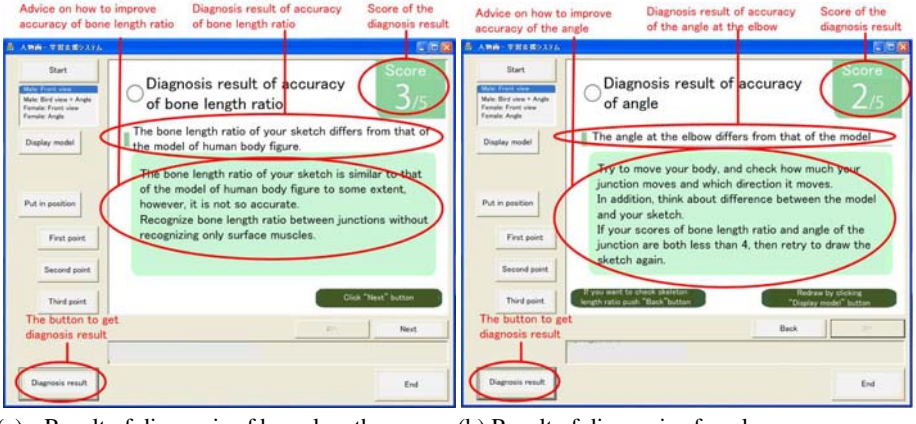
Figure 3 shows GUI of the learning environment. Actually, GUI of the original learning environment is made in Japanese. The GUI in figure 3 is indicated in English by synthesizing texts in English for explanation. Figure 3(a) shows a model of human body figure for imitative drawing. Figure 3(b) is a scene instructing the learner on how to put in each junction point coordinate value.

Actually, 2 sets of training and learning contents are prepared in the learning environment. One is male model sets and the other is female model sets. The learning environment can diagnose angle at elbow, and bone length ratio between shoulder, elbow and wrist for the male model set. On the other hand, the learning environment can diagnose angle at knee, and bone length ratio between hip, knee and ankle for the female model set.



(a)A model of human body figure (b) Instruction on how to put in shoulder position

Fig. 3. GUI of the learning environment



(a) Result of diagnosis of bone length (b) Result of diagnosis of angle

Fig. 4. Display of score and advice after diagnosis

Figure 4 shows examples of diagnosis result shown in English for explanation as well as figure 3. Figure 4(a) shows an example of diagnosis result of bone length ratio. The score indicates difference between drawn sketch and correct model. The score is indicated from 1/5 to 5/5. 5/5 is the best score, and it means there is almost no difference between drawn sketch and correct model.

5 Evaluation

We evaluated the learning environment by comparing experimental group with control group.

5.1 Goal of Evaluation Experiment

Goal of evaluation experiment is to confirm the learning effect by the learning environment compared with text instruction on printed papers. We tried to evaluate learning effect by not only novice but also experienced subjects.

5.2 Method of Evaluation Experiment

Figure 5 shows flow of evaluation experiment. 12 students in our university were subjects. 8 students of them were novice. The other 4 students were experienced subjects who had had experience of drawing sketches more than 30 hours totally. They were neither novice nor expert. 12 students were divided into two groups, experimental group and control group. Experimental group consists of 6 students. 4 students were novice, and 2 students were experienced subjects. Experimental group used the learning environment for training and learning. Control group also consists of 6 students. 4 students were novice, and 2 students were experienced subjects. Control group did not use the learning environment but read instruction on papers for training and learning.

Every student in every group had pre-test before training & learning, and had post-test after training & learning. Every student drew 3 different human body figures in training & learning. Models of human body figures in pre-test, post-test and training & learning are different. Every student answered questionnaire after post-test.

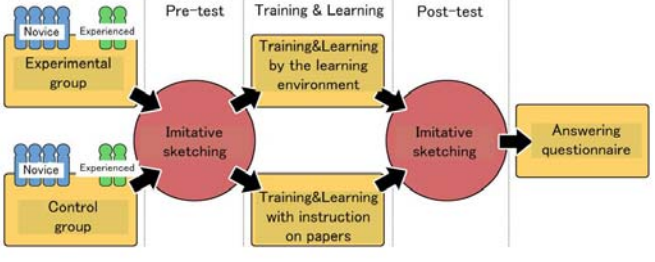


Fig. 5. Flow of evaluation experiment

5.3 Evaluation Method for Drawn Sketches

The learning environment has 2 sets of human body figure as training & learning contents. Figure 6 shows models of female human body figure with junctions and skeleton for evaluation and sketches by subject E in the experimental group (Most left: model for pre-test, Left: the sketch by subject E, Right: model for post-test, Most right: the sketch by subject E). Subject E had most learning effect in all subjects. Figure 7 shows models of male human body figure with junctions and skeleton for evaluation and sketches by subject I in the control group (Most left: model for pre-test, Left: sketch by subject I, Right: model for post-test, Most right: sketch by subject I) The sketch in post-test by subject I was worse than his sketch in pre-test in the evaluation by whole human figure. Skeletons and junctions in the figure 6 and 7 were not shown in the pre-tests and post-tests.

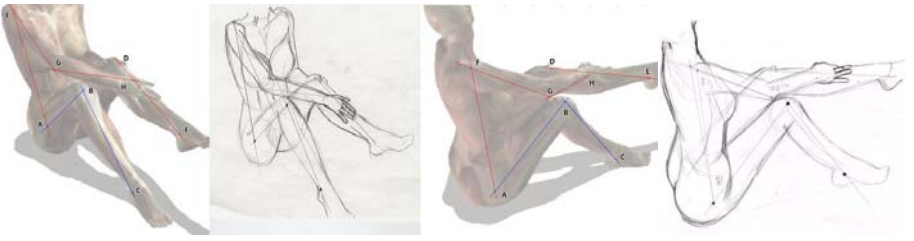


Fig. 6. Model of female human body figure with junctions and skeleton for evaluation and sketches by subject E in the experimental group (Most left: model for pre-test, Left: sketch by subject E, Right: model for post-test, Most right: sketch by subject E) Subject E had most learning effect in all subjects

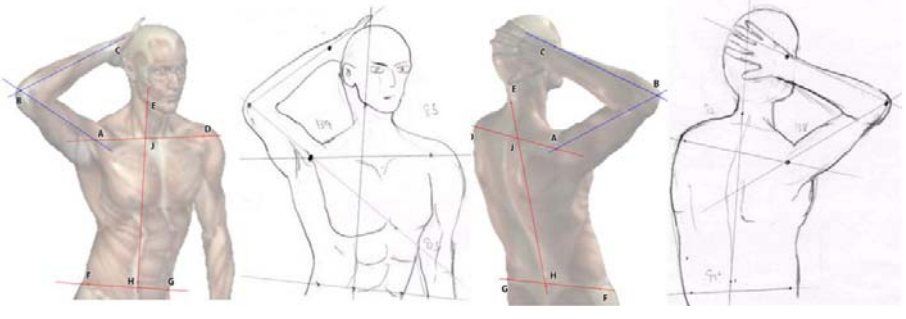


Fig. 7. Models of male human body figure with junctions and skeleton for evaluation and sketches by subject I in the control group (Most left: model for pre-test, Left: sketch by subject I, Right: model for post-test, Most right: sketch by subject I) The sketch in post-test by subject I was worse than his sketch in pre-test by evaluation of whole human figure

Table 1 shows results of skill learning effect in the experimental group about the part of human body figure where the learning environment was able to diagnose and advise the learner. Table 2 shows those in the control group.

Length ratio is the value calculated by BC/AB. Alphabets correspond those in figure 6 and 7. Score of length ratio means accuracy of the length ratio of subject's sketch to the model. Score of angle means accuracy of ∠ABC of subject's ketch to the model. If the scores of length ratio and angle are both 100, it means the skeleton and the angle of the part of the sketch correspond perfectly to those of the model.

Comparing table 1 and table 2, unfortunately learning effect cannot be proved. Each group had one subject who enhanced drawing skill in both length ratio and angle (Subject E and subject H).

We also compared the experimental group with the control group by other values to cover whole human body figure. Specifically, the other values are ∠BAJ, ∠EJD, ∠JHG, (AB/AD), (AD/FG), (FG/EH) for male figures, and ∠BAF, ∠AFG, ∠FGH, (AB/DE), (DE/AF), (AF/FG), (FG/GH) for female figures. Table 3 shows evaluation results of whole human body figure in the experimental group. Table 4 shows those in the control group. Scores in pre-tests and post-tests are averages of 6values for a male figure, and averages of 7 values for a female figure.

Table 1. Result of learning effect at the trained part of human figure in the experimental group

Subject ID	Model		Pre-test	Post-test	Skill
Subject A (novice)	Male figure	Score of length ratio Score of angle	99.5 88.7	94.3 93.9	Down Up
Subject B (Experienced)	Male figure	Score of length ratio Score of angle	92.9 96.2	90.5 84.8	Down Down
Subject C (Experienced)	Male figure	Score of length ratio Score of angle	73.2 96.9	94.2 63.6	Up Down
Subject D (novice)	Female figure	Score of length ratio Score of angle	99.2 87.6	96.5 94.0	Down Up
Subject E (novice)	Female figure	Score of length ratio Score of angle	80.5 90.4	92.6 96.6	Up Up
Subject F (novice)	Female figure	Score of length ratio Score of angle	87.8 87.6	92.1 74.2	Up Down

Table 2. Result of skill learning effect at the trained part of human body figure in the control group

Subject ID	Model		Pre-test	Post-test	Skill
Subject G (novice)	Male figure	Score of length ratio Score of angle	85.0 99.5	95.4 96.6	Up Down
Subject H (novice)	Male figure	Score of length ratio Score of angle	89.3 73.4	94.7 95.8	Up Up
Subject I (Experienced)	Male figure	Score of length ratio Score of angle	84.9 95.3	97.1 79.7	Up Down
Subject J (novice)	Female figure	Score of length ratio Score of angle	68.6 96.9	95.5 86.9	Up Down
Subject K (novice)	Female figure	Score of length ratio Score of angle	92.6 94.6	98.7 94.0	Up Down
Subject L (Experienced)	Female figure	Score of length ratio Score of angle	94.6 91.1	68.0 97.1	Down Up

Table 3. Evaluation result of whole human body figure in the experimental group

Subject ID	Model	Pre-test	Post-test	Skill
Subject A (novice)	Male figure	93.4	90.0	Down
Subject B (Experienced)	Male figure	90.0	92.6	Up
Subject C (Experienced)	Male figure	87.2	89.0	Up
Subject D (novice)	Female figure	91.1	92.7	Up
Subject E (novice)	Female figure	90.8	94.1	Up
Subject F (novice)	Female figure	87.1	93.4	Up

Table 4. Evaluation result of whole human body figure in the control group

Subject ID	Model	Pre-test	Post-test	Skill
Subject G (novice)	Male figure	95.0	88.8	Down
Subject H (novice)	Male figure	94.0	83.1	Down
Subject I (Experienced)	Male figure	92.6	86.2	Down
Subject J (novice)	Female figure	85.5	83.5	Down
Subject K (novice)	Female figure	95.2	81.8	Down
Subject L (Experienced)	Female figure	93.3	84.8	Down

Table 3 indicates that every drawn sketch in post-test is better than pre-test except subject A in experimental group. On the other hand, table 4 indicates every drawn sketch in post-test is worse than pre-test. From these results, the learning environment is effective to some extent for imitative sketching of human body figure.

Table 4 indicates that every sketch in post-test is worse than pre-test in control group. We think that the reason of this result comes from no review of drawing and fatigue. The experimental group also could be tired of drawing. However, review and learning effect by the environment exceeded fatigue in the experimental group.

6 Conclusion

In this paper, we described an interactive learning environment for imitative figure sketching. We focus on the length ratio and angle between junctions. After learners draw figure by imitative sketching, the learning environment diagnoses the length ratios and angles between junctions of learners' figure sketch. The environment shows scores of the learners' figure sketch and gives some advice.

We evaluated the environment with some learners. The learning environment is effective to some extent for imitative sketching of human body figure.

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