Shih, JL. et al. (Eds.) (2023). Proceedings of the 31st International Conference on Computers in Education. Asia-Pacific Society for Computers in Education

Estimation of Features and Skills of Drawing Experts by Tracing Figures

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Abstract: This paper focuses on estimating expert-specific characteristics and skills of art drawing, with use of figure tracing log data of pen strokes. In order to verify hypothesis, the authors acquired stroke data of simple figure drawing with use of Tablet PCs and digital pens. Afterwards, we compared the log data of novice learners with one of experts. As a result, we could not find significance between novices and experts in 8 target parameters. However, we found some tendencies of experts. These tendencies imply some training methods in art education.

Keywords: Drawings, Pen stroke, Learning analytics, Multimodal data, Skill estimation

1. Introduction

Learning of arts, including painting, pottery, calligraphy, music, and sports is called "skill learning" in general. Unlike learning activity of mathematics and language, identification of the target skill and assessment is rather different in the field of art education and skill learning. Some research challenge in the skill learning field to use digital tools. Singh (2019) discusses the importance of various tools for evaluating different art forms, including drawing. Aboalgasm (2014) focuses on the use of digital art tools for drawing and their potential to enhance artistic ability and creativity among junior school students. The approach to utilize digital tools and acquire objective data is similar to Learning Analytics (LA) approach.

The authors focus on treating “pen stroke data” of figure tracing. In the field of LA research, multimodal LA research treat this level of data granularity. Around this field, some preceding papers present a variety of approaches to assessing learners' drawing skills. Soga (2007) discusses the development of a learning support system for sketching, highlighting the need for learning support systems for skill-based domains like art. Xu (2020) focuses on distinguishing hand drawing styles using a multilevel analytics framework, emphasizing the importance of automatic recommendation tasks for different brushwork skill expressions. Additionally, Yijing (2009) proposes the use of radar charts to assess students' drawing ability, providing a visual and quantitative approach to evaluating drawing skill. These papers highlight the potential of learning analytics approaches in evaluating and supporting art drawing skill development.

This paper aims at drawing skill estimation with use of tracing skill of simple figures like simple line, triangle, circle etc. The authors set the following two hypotheses.

- Experts have unique handwriting characteristics compared to novice?
- Is there a difference in handwriting skill between experts and novice?
- Is it possible to find expert-specific characteristics and skills by analyzing tracing result of simple figures?

To verify these hypotheses, the authors utilized tablet PCs (Apple iPad) and digital pens (Apple Pencil) to obtain pen stroke data. With use of the pen stroke data, it is possible to objectively capture and assess characteristics of figure tracing. In addition, by clarifying the relationship between drawing proficiency and pen stroke skill, it will be a basis for

reconsidering whether practice methods of pen strokes, such as simply continuing to draw straight lines and circles, will lead to improvement in drawing.

In the art education field, many instructors tends to access learners' drawings outcomes with use of their own subjective feelings. Additionally, the assessments are not enough verbalized nor informed. The authors agree the necessity of sensitivity in the art education. However, objective evidence and verbalization of instructors' assessments will bring better agreement and effort of learners.

2. Method

The authors selected the following 13 types of simple shapes were selected: horizontal straight line (short, medium, long), vertical straight line (short, long), triangle (small, large), circle (small, large), sine wave (small, large), and square wave (small, large).

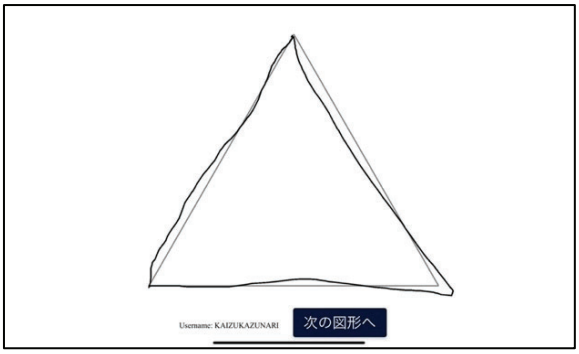

Figure 1: Sample Screenshot of Tracing

To measure pen strokes in quantitative manner, the authors developed a JavaScript hook that acquires pen stroke data using iPad and Apple Pencil. iPadOS originally provides the API (application Program Interface) to acquire the data of Apple Pencil. The developed JavaScript hooks the data via the API and transferred the data to a server with asynchronous http-request protocol. The acquired data includes event type (pen down, move, and up), timestamp, X-Y coordinate, pen pressure, and pen tilt.

Each of the 13 figures above is displayed on the iPad screen as shown in Figure 1 (triangle). The subject traces the referenced figure with Apple Pencil. The pen stroke data at this time is obtained as described above. In order to extract the feature of expert learners, the authors calculate 8 parameters below with use of the acquired pen stroke data.

- Average and standard deviation of pen pressure
- Average and standard deviation of pen angle
- Average writing speed
- Average overhang distance
- Number of strokes
- Average stroke length

3. Experiment

The experiments were conducted from November to December 2022. The subjects were 30 in total, including students at Sophia University, Japan (Department of Science and Engineering / Economics / Law, novice of drawing, 15 students) and Tokyo University of the Arts (Department of Arts, expert, 15 students). The subjects were requested to trace 13 shapes described above.

4. Results

The results of the t-test of the 8 parameters in Section 2 are shown below, to compare expert and novice subjects (total 28), excluding 2 subjects of data acquisition error. These result are of all 13 shape types. Unexpectedly, there were no significant difference of the feature values between expert and novice.

- Average pen pressure: t(28)=1.074, p=0.292
- Standard deviation of pen pressure: t(28)=0.785, p=0.439
- Average of pen angle: t(28)=0.887, p=0.383
- Angle standard deviation of pen angle: t(28)=1.229, p=0.229
- Average writing speed: t(28)=0.576, p=0.569
- Average overhang distance: t(28)=0.403, p=0.690
- Number of strokes: t(28)=0.855, p=0.400
- Average stroke length: t(28)=1.222, p=0.232

5. Discussion

The result in Section 4 shows that the t-tests were unable to distinguish expert and novice learners of drawing, especially tracing skill of simple figures. Regardless of the unexpected results above, the authors found some tendencies that were specific in expert learners. First, the average pen pressure tends to be lower for expert learners. It is thought that they are trained the drawing technique of layering thin lines to express shades. The standard deviation of the writing pressure also tends to be lower (the variation in writing pressure is smaller). It is thought that the expert learners draw lines by leveling the pen pressure of the lines. Second, Number of strokes tends to be fewer for expert learners (average stroke length tends to be longer). It suggests that the expert learners are accustomed to draw long lines in stable manner.

On the other hand, surprisingly, we could not find significance of average overhang distance between expert and novice. It shows that the accurate tracing is not the key competency for drawing expert. It implies one of training and assessment policies in art education. On the other hand, in the engineering education field, accurate line drawing in mechanical blueprint and electric circuit is an essential skill. Instructors and learners should understand these field-specific training and assessment policies.

6. Conclusion

The authors tried to extract expert-specific features in drawing activities. As a result, there were no significance between the expert and non-expert on focusing parameters. However, some tendencies were found to characterize the expert skills of drawing.

As a future task, it is necessary to reexamine the appropriateness of the types and sizes of figures used in the experiment. This is because the amount of drawing differs greatly depending on the figure, and it may not be suitable for analysis by integrating pen stroke data for all figures or analysis by comparison between figures.

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