

# Koto Learning Support Method Considering Articulations

Mayuka Doi<sup>1</sup>[0000-0003-3386-5396] and Homei Miyashita<sup>1</sup>[0000-0001-7533-8709]

<sup>1</sup> Meiji University, Nakano-ku Tokyo 1648525, Japan  
cs172030@meiji.ac.jp, homei@homei.com

**Abstract.** Playing the Koto requires various skills such as reading Koto scores and understanding string positions instantly. In addition, there are many articulations, and some of them have no information about the timing for switching fingers or pushing a string down in Koto scores. Therefore, learning to play the Koto is difficult. In this paper, we propose a method to support beginners in practicing the Koto considering articulations. The method directly presents information for effective Koto performance, such as the string positions color-coded by fingering, timing of picking, picking directions, and articulations to the strings and soundboard. An experimental system presents this information by using projection mapping. We evaluated its effectiveness for beginners and an experienced person by comparative experiments through three user studies. As a result of these studies, we found that beginners were able to learn the Koto more effectively than by the traditional method, but our system is not useful for experienced people.

**Keywords:** Koto, Music, Instrument Learning, Projection Mapping.

## 1 Introduction

A Koto [1–3] is a traditional Japanese 13-stringed<sup>1</sup> musical instrument. Koto players need to master play techniques such as hand shapes, how to pick strings, and how to apply power; to read Koto scores; and to understand string positions instantly. Koto scores are written in string names and unique articulation symbols (see Fig. 1). Therefore, it is difficult to read Koto scores and imagine the melodies. Moreover, there are over 20 articulations of the Koto [1, 2]. Mastering some of them is difficult because there is no information about the timing for switching fingers or pushing a string down in Koto scores. In addition, the Koto has 13 strings, but there is no sign that specifies string positions; thus, beginners are not able to play the Koto smoothly, and their motivation easily decreases.

In this paper, we propose a method to support learning to play the Koto including 20 articulations for beginners. The method directly presents useful information for Koto performances, such as the string positions color-coded by fingering, timing of picking,

---

<sup>1</sup> Strings are named “一,” “二,” “三,” “四,” “五,” “六,” “七,” “八,” “九,” “十,” “斗,” “為,” and “巾” from the back.

←	十	三 <sup>3</sup>	ヲ斗	ハ <sup>3</sup>	斗 <sup>+</sup>	一ニ <sup>4/4</sup>	総合練習 練習 23
	八	杭	十	ヲ斗	枕		
◎	△	△	九	ヲ斗	∟	五	
	八	杭	八	ス	∟		
サ	五 <sup>3</sup>	八	十	∟	∟	ヲ六	
	八	杭	九	∟	∟		
〰	△	△	八	∟	∟	七	
	八	杭	七	∟	∟		
六		三 <sup>3</sup>	九	為	十九	三 <sup>3</sup>	
◎	/	杭	八	ヲ斗	八		
		△	七	ヲ斗	∟	ノ	
		杭	六	ス	∟		

Fig. 1. Example of a Koto score<sup>2</sup>

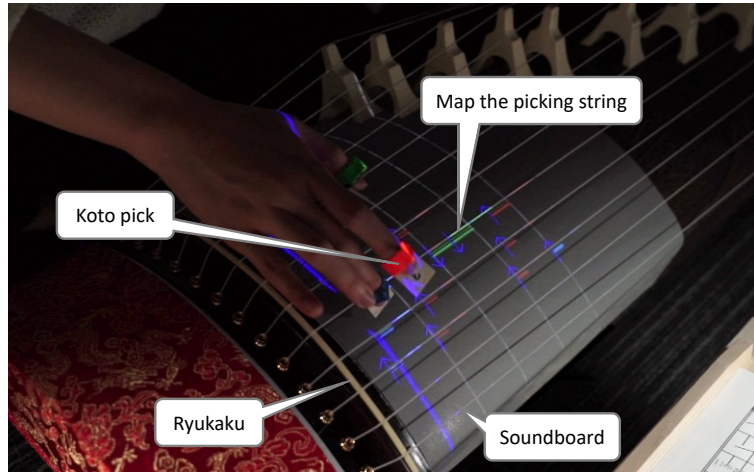


Fig. 2. Koto learning with the system

directions to move fingers, and articulations to the strings and soundboard called Ryukou. An experimental system indicates this information by using projection mapping (see Fig. 2). Therefore, beginners who are not able to read Koto scores and do not understand string positions are able to learn to play the Koto including articulations.

We conducted two user studies with beginners to evaluate their motivation for performance in their learning process. In addition, we conducted a user study with an experienced person to evaluate the learning efficiency when learning with the proposed method compared to that without it. The results of a week-long between-participants study show that the proposed method facilitates playing with fewer errors. However, it is not effective for experienced people.

The main contributions of this work are as follows:

<sup>2</sup> Soukyoku Gakufu "Sawai Tadao Koto Kyousokubon Daiichisyuu" © 2004 Sawai Tadao

1. We proposed a method to support the learning of the Koto considering articulations.
2. We conducted two user studies with beginners. One investigated the effectiveness of the proposed method while using it for a week and then not using it, and the other investigated the improvement in reading Koto scores.
3. We carried out a user study with an experienced person and provided an index for removing assistance.

## 2 Related Work

### 2.1 Augmented Pianos

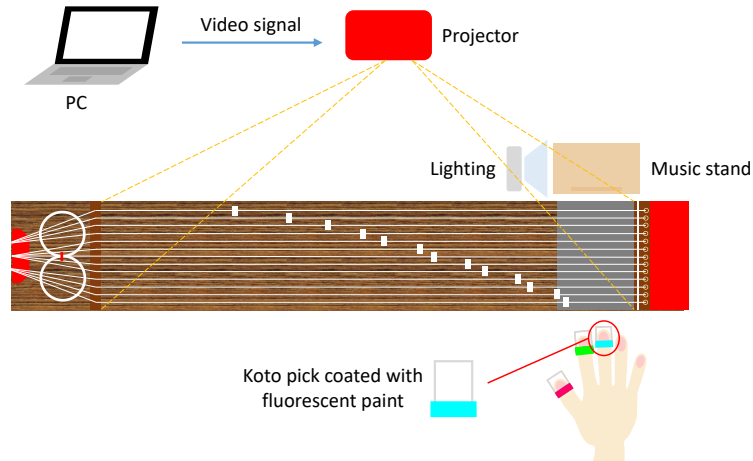
P.I.A.N.O. [4] projects a note-information-based piano roll onto the piano to facilitate the mapping of notes onto piano keys for beginners who do not have sight-reading knowledge. It supports correct fingering by showing different colors and some articulations. Takegawa et al. [5] constructed a system to support learning the correct keying and fingering for playing a piano using a fingering recognition technique in real-time for beginners. It projects information about the keys, fingers, and score onto the keyboard and a display. Moreover, they developed a system to support the understanding of the different durations of each note and rest and the reading of a music staff for beginners [6]. It superimposes a line indicating the length of a note or rest onto the staff and checks the length. MirrorFugue [7] presents the recoded hand gestures of a remote collaborator to support remote lessons for beginners. Andante [8] projects animated characters walking along the keyboard and pressing the physical keys with each step onto a fallboard to understand the rhythm and musical expression. Raymaekers et al. [9] constructed a system that presents the time until keying on keys and a shooting game with keys used as a game controller.

### 2.2 Augmented String Instruments

Sano and Go [10] proposed a system to support the playing of the Koto by projecting the string position and Koto score corresponding the current performance position onto the Koto for beginners. However, articulations were not considered, and players were not able to know the flow of piece. ChinAR [11] is an interactive system for learning the Guqin that indicates the gesture and position using simple shapes such as circles and triangles with fingering colors. guitAR [12] projects the finger positions and phrasing instructions for chords and melody sequences onto a fretboard.

### 2.3 Music Games

Rocksmith [13], Yousician [14], and Synthesia [15] are music games using real instruments. Guitar Hero [16] is a guitar game using a controller shaped in the form of a guitar. These games show note information on virtual instruments displayed on the screen; thus, players do not need to have score-reading skills. However, players need to map note information to the instruments or controller.



**Fig. 3.** System structure

### 3 System

#### 3.1 System Configuration

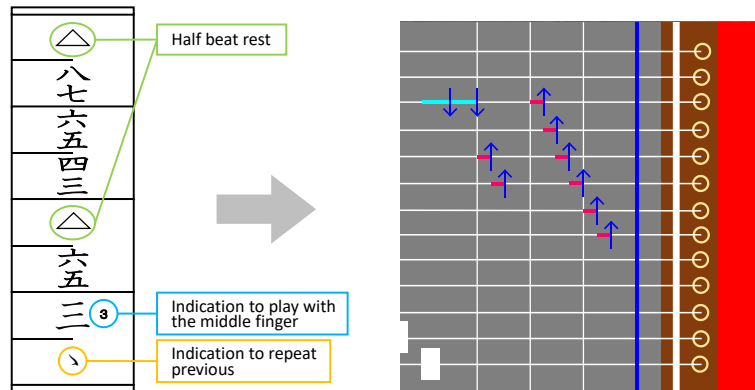
Figure 3 shows experimental system configuration. A projector is mounted above the Koto to show information along the entire lengths of the strings. Moreover, gray paper is placed on the soundboard near Ryukaku (see Fig. 2) in order to make it easy to see. In addition, the system is supposed to be used in a dark room. Therefore, lighting equipment is set near the music stand to read a Koto score, and the rings of the Koto picks for each finger are coated with different fluorescent paints.

#### 3.2 Presented Information

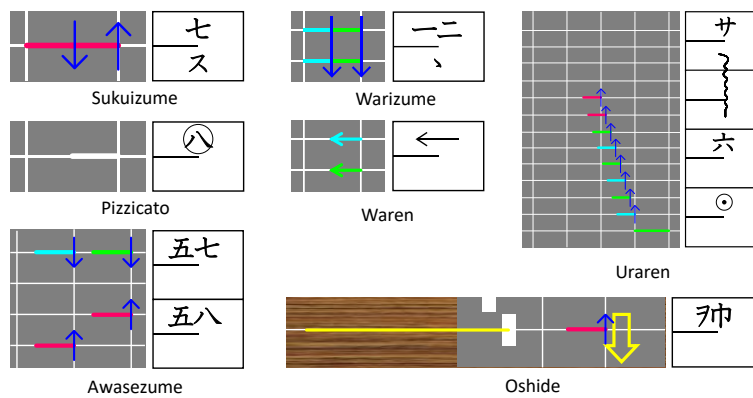
The composition of the information is as follows:

- Lines indicating the landmarks of the string positions color-coded by fingering
- Arrows showing the timing of picking and directions in which the fingers should be moved
- Simple symbols of the articulations
- Separation lines indicating the separation of the beat
- A line indicating the landmarks of the correct picking position

The system directly projects this information onto the strings and soundboard for a span of one measure flowing from the left to the right with the metronome. The tempo is able to be changed. In order to make it easy to understand the correspondence between the Koto score and the performance support information, the length of the line of the landmark is adjusted to the size of the string name on the Koto score, except for



**Fig. 4.** A Koto score and an example of the presentation of the performance support information corresponding to it



**Fig. 5.** Details of the articulations

five articulations: Nagashizume, Hireken, Uraren, tremolo, and arpeggio. The line of these exceptions is adjusted to the sound length. In addition, Koto players pick strings 2–4 cm to the left of Ryukaku with Koto picks. Therefore, the marker line is projected 3 cm to the left of Ryukaku to pick strings at the correct position. At the time at which an arrow overlaps the line showing the correct picking position, learners pick the specified string with the specified fingering and articulation. Thus, they are able to play the Koto correctly with the correct timing. Figure 4 shows an example of the correspondence between a Koto score and the performance support information. Figure 5 shows the details of some of the articulations and the corresponding presented information targeted by the method. The colors of the fingers in Figs. 4 and 5 correspond to those of the rings of Koto picks in Fig. 3.

### 3.3 Mapping

Although the strings of the Koto are thin and not horizontal, the system exactly maps information onto every string. In addition, it is able to save and read string positions.

### 3.4 Implementation

We used a NEC PC-LZ650NSS personal computer (PC), whose platform was Windows 10; a 6-foot-wide Koto; and a QUMI VIVITEK QUMI Q5-RD projector. In addition, we implemented the system using Processing and Pure Data.

## 4 Evaluation

We conducted two experimental studies to investigate the effectiveness of the proposed method in the elements of Koto performance when a Koto beginner is practicing the picking, fingering, and rhythm of a new score. In addition, we conducted an additional user study in order to assess whether the method for beginners is also useful for experienced people. In all user studies, tuning and alignment were carried out by the first author.

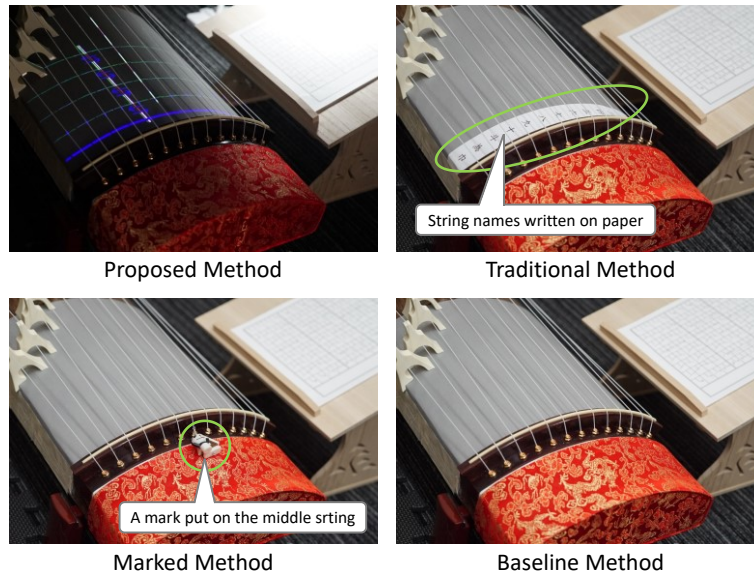
### 4.1 User Study 1: One-Week Performance

In this user study, we examined the learning effect of the proposed method compared that of the traditional method using the test performance, a subjective evaluation, a motivation score, and the performance delay time. Moreover, we investigated the transition from each method to other methods.

**Method.** In this evaluation, we compared the traditional method, which uses the string names written on paper. The paper was placed on the soundboard near Ryukaku (see Fig. 6). Both methods were able to change the marked method, which placed a mark on the middle string, or the baseline method of the original Koto (see Fig. 6). Regardless of the method that the participants used, the Koto score was placed on the music stand, and gray paper was placed on the soundboard near Ryukaku. In addition, we turned off the light so that learners were able to see the performance support information and their hands using the proposed method.

**Participants.** A total of six beginners for playing the Koto participated in the study, and three participants used each method considering their musical experiences. All participants were students recruited from a local university, 1 female and 5 males.

**Trial Piece.** We choose part 1 of “Huyunohi (Tadao Sawai)” from the beginning to bar 46, except for bars 29–42 as the trial piece. The total numbers of bars and notes are 32 and 331, respectively. It includes three articulations, Sukuizume, pizzicato, and



**Fig. 6.** Photographs showing the various methods

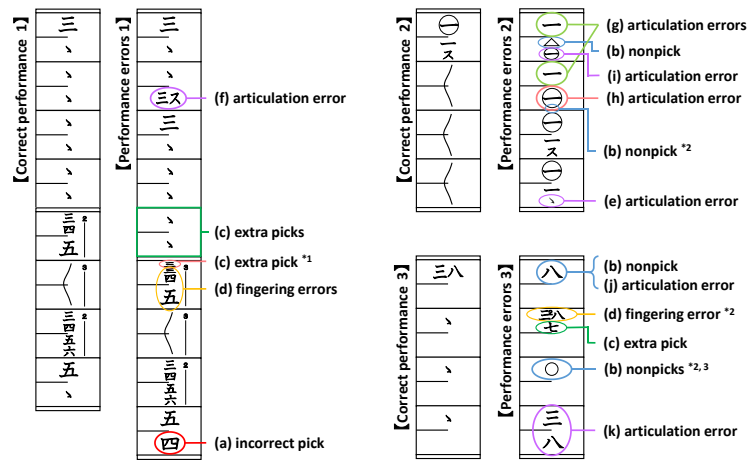
Awasezume. A Koto teacher confirmed that the degree of difficulty of the selection is appropriate. In the experiment, we used the Koto score, which extracted only this part.

**Flow of the User Study.** The user study was conducted for five consecutive days, and its schedule is summarized in Table 1. The study’s design was similar to that reported in a previous study [4]. This user study consisted of two phases, practice and test phases. Participants practiced the trial piece for 15 min and were able to change methods at any time freely during the practice phase (P1–P5). In the test phase (T1–T5), they played the Koto using the proposed or traditional method. All phases (P1–P6, T1–T7) were accompanied by the sound of a metronome, and its speed was set to 60 bpm. After the final test on each day, participants evaluated their motivation (P1–P6) with a seven-point Likert scale and a subjective performance evaluation (T1–T7) out of 10 with reasons. Finally, they freely articulated their opinions and impressions about the experiment.

**Judgment.** Figure 7 shows the method used to judge the performance mistakes and examples. There are seven types of articulation errors: change Sukuizume to basic (see Fig. 7(e)), change basic to Sukuizume (see Fig. 7(f)), change pizzicato to basic (see Fig. 7(g)), change basic to pizzicato (see Fig. 7(h)), change Sukuizume to pizzicato (see Fig. 7(i)), change multiple sounds to a single sound (see Fig. 7(j)), and a gap in picking multiple strings of 0.5 s or more (see Fig. 7(k)). The performance delay time was determined as the time caused by a tempo shift, repeat, and suspension. We judged mistakes on the basis of recorded videos and sound waveforms of the test performances.

Table 1. User study schedule

Day	Details
1 <sup>st</sup>	First introduction (taught how to put Koto picks on fingers, assume a posture, read a Koto score, and play the Koto including articulations) Confirmation of the trial piece (listen to a model performance, one time) Practice (P1) Test performance (T1)
2 <sup>nd</sup>	Confirmation of the trial piece Practice (P2) Test performance (T2)
3 <sup>rd</sup>	Confirmation of how to pick and the trial piece Practice (P3) Test performance (T3)
4 <sup>th</sup>	Similar to the second day (P4, T4)
5 <sup>th</sup>	Confirmation of the trial piece Practice (P5) Test performance (T5) Practice with the marked method (P6) Test performance with the marked method (T6) Test performance with the baseline method (T7)



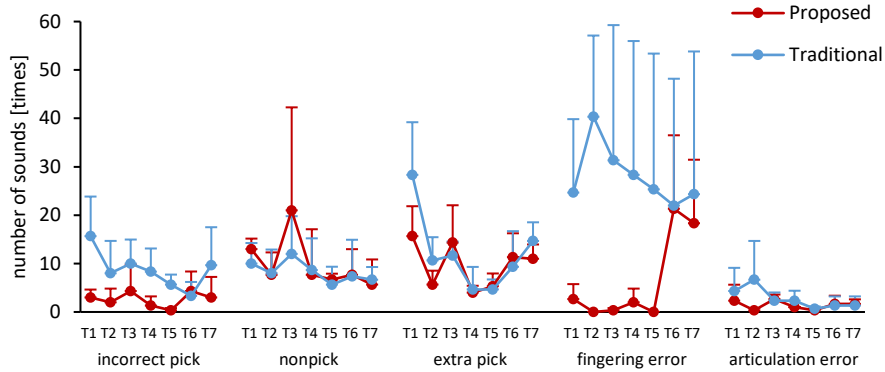
\*1 We do not judge fingering error. \*2 We do not judge articulation error. \*3 We judge two nonpicks.

Fig. 7. Judgement of errors

## Results and Considerations.

*Learning Performance.* Figure 8 shows the averages of the numbers of missed picks (incorrect picks, nonpicks, and extra picks), fingering errors, and articulation errors for each test performance by the participants for each method. Since the proposed method directly presents the string positions color-coded one-by-one, there were many





**Fig. 8.** Numbers of picking, fingering, and articulations errors in T1–T7

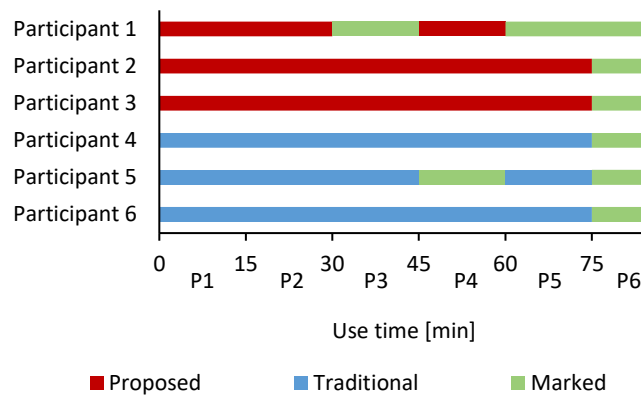
nonpicks because the participants fell behind the presented information. Nevertheless, the numbers of incorrect picks, fingering mistakes, and extra picks caused by rephrasing were few. We were concerned about inducing mistakes because the marker lines projected onto the strings were also projected onto the soundboard. However, it was concluded that the participants became used to it on the second day, and there was not a significant effect. With the traditional method, the correspondence between the position at which the string name is written and the string may be different from different viewpoints. Therefore, there were many incorrect picks and extra errors caused by repetition. In addition, one participant did not notice mistakes and finished T1–T5.

We used a  $t$ -test for the analysis, and a significant difference exists for incorrect picking in P5 at a significance level of 5%. We instructed the participants to play pizzicato with the middle finger or ring finger of the left hand. However, there was a participant who played with the left index finger. We regarded it as acceptable and did not count it as a fingering error. We are not able to confirm that a significant difference exists for fingering. However, participants using the proposed method played with fewer fingering errors, and there were trials in which they were able to play without mistakes. Moreover, the differences in the fingering errors were rather pronounced because the consciousness about the fingering was becoming weak when using the traditional method. In addition, all participants using the traditional method mistook the same part in all trials. A significant difference does not exist for articulation errors because articulations are not difficult. The number of mistakes in T3 increased because the participants were retaught how to play, and the number of nonpicks increased for the proposed method in T3 because a Koto pick fell off the finger.

In the trial with the marked method, there were more mistakes in the group using the proposed method than in that using the traditional method in T6. However, the number of mistakes in T7 with the baseline method decreased and was less than that for the group using the traditional method because participants in the group using the proposed method noticed their mistakes in T6 and corrected them.

**Table 2.** Performance delay times of each participant in T1–T7 [beat]

Participant	T1	T2	T3	T4	T5	T6	T7
1	0	0	0	0	0	0	0
2	0	0	0	0	0	10	4
3	0	0	0	0	0	27	27
4	31	3	7	4	1	1	6
5	40	1	3	0	1	6	4
6	87	34	9	4	0	2	6

**Fig. 9.** Times used for each method for each participant in P1–P6

*Performance Delay Time.* Figure 9 shows the times used for each method in the practice phases (P1–P6) for each participant, and Table 2 summarizes the performance delay time of each test for each person. We allowed participants to change methods during practice, but no one changed. The group with the proposed method, two in T6 and one in T7, repeated. The group with the traditional method—all in T1, T3, and T7, one in T2, and two in T5 and T6—repeated.

*Subjective Evaluation.* Figure 10 shows the average scores of the subjective performance evaluations of each participant for each method. The evaluations of the proposed method were higher than those of the traditional method. Significant differences were confirmed at a significance level of 5% in T1, T2, and T4. The evaluation of T3 decreased because participants were retaught how to play.

*Motivation Score.* Figure 11 shows the average motivation scores of each participant for each method. Although there are no significant differences, two participants using the traditional method said, “I did not feel like I made progress, except on the first day,” and there was a person that played phrases unrelated to the trial piece during practice.

From the reasoning provided from participants’ descriptions, the group using the proposed method was conscious of the tempo on the second day and was practicing with their attention focused on the part that was not played well on the second day at

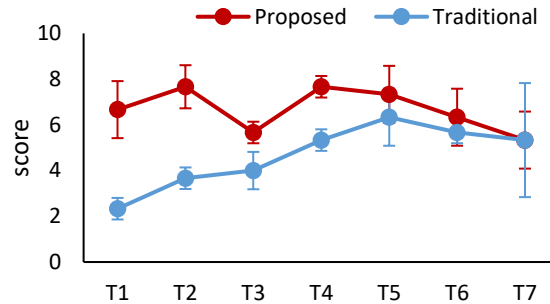


Fig. 10. Subjective performance evaluations in T1-T7

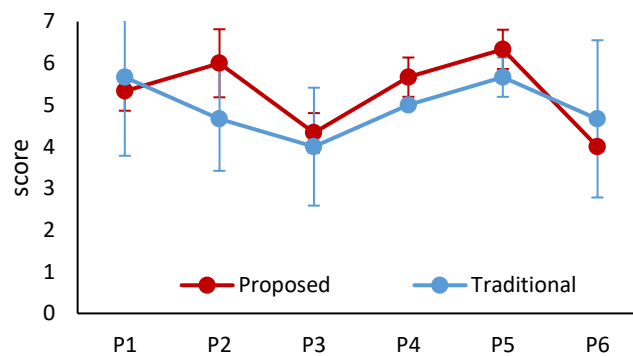


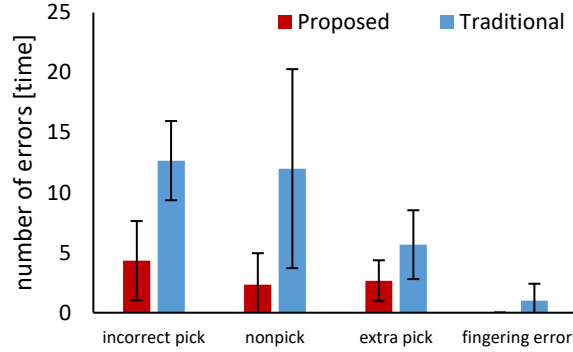
Fig. 11. Motivation scores in P1-P6

the earliest or the fourth day at the latest. On the other hand, the group using the traditional method practiced while conscious of the tempo on the third or fourth day. By using the proposed method, they were able to practice at a higher level.

#### 4.2 User Study 2: Verification of an Improvement in Reading Ability

We examined the improvement in reading Koto scores, where a Koto score was considered to be read after it became possible to play roughly using the proposed method, and the Koto score was read at the beginning using the traditional method. Participants using the proposed method watched the presented information rather than a Koto score. Therefore, our hypothesis was that the ability to read Koto scores would be higher for the traditional method than the proposed method.

**Experimental Design.** The participants were same as those in user study 1. We choose part 1 of “Akinohi (Tadao Sawai)” from bar 45 to bar 64 as the trial piece. The total numbers of bars and notes are 20 and 133, respectively. It includes two articulations, Kakizume and pizzicato. A Koto teacher confirmed that the degree of difficulty in the selection is appropriate. In this user study, we used the Koto score, which extracted



**Fig. 12.** Numbers of picking and fingering errors

only this part and added the fingering number to the part played with the middle finger. All the participants practiced with the marked method for 5 min. Afterwards, they played with the marked method as the test performance and clapped their hands at the timing of picking strings with a metronome (45 bpm) as a rhythm check.

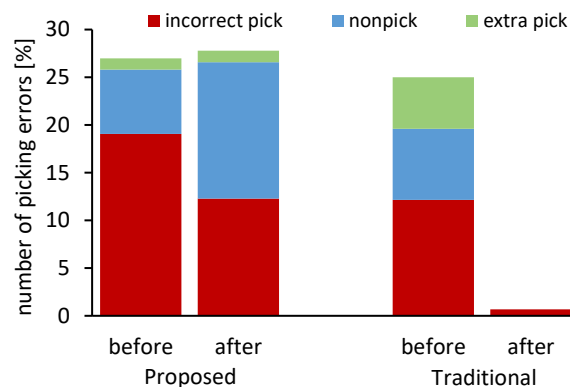
The metronome was not used in the practice and test phases in order to neglect consciousness except rhythm and confirm participants' understanding of the rhythm. Therefore, we instructed the participants to play with a natural tempo without rephrasing during the test performance. The judgement of errors was the same as that for user study 1.

**Results and Considerations.** The results are shown in Fig. 12. A significant tendency was observed for incorrect picking by a *t*-test at a significance level of 5%. There were no fingering errors, except for one participant, because there was no misleading fingering in the trial piece. Two people in the group using the traditional method were not able to read the places where the pizzicato and repetition symbols were written together. However, all participants using the proposed method were able to read and play correctly. In other words, the visualization of the articulations using the proposed method promoted the understanding of the symbols in the Koto score. In both groups, one person skipped part of the phrase that repeats a quarter of a beat twice and half of a beat once, and they were not able to clap their hands accurately in the rhythm check. We confirmed that the others were able to understand the rhythm.

### 4.3 User Study 3: Verification of the Usefulness for Experienced People

In this study, we investigated the effectiveness of the proposed method for experienced people.

**Experimental Design.** The first author of this paper, who has played the Koto for about 9 years, participated in this experiment, and we compared the proposed method with the baseline method. The trial piece of the proposed method was part 1 of



**Fig. 13.** The number of picking errors of before and after practice by experienced people

“Otokirara (Tadao Sawai)” from bar 56 to bar 75 (20 bars, 252 notes), and that of the baseline method was part 1 of “OKOTO (Hikaru Sawai)” from bar 115 to bar 134 (20 bars, 148 notes). A Koto teacher confirmed that the degrees of difficulty of the selections are the same. Experiments were first conducted with the baseline method and then carried out with the proposed method. Using both methods, the participant played a prepractice test after looking over each trial piece score once. After that, the participant practiced for 7 min and then played after the practice test. The proposed method was used only in the practice phase, and all tests were carried out using the baseline method. Regardless of the method used by the participant, the Koto score was placed on a music stand, and we turned off the light so that the performance support information and participant’s hands were able to be seen when using the proposed method. The judgement of mistakes was the same as that used for user study 1.

**Results and Considerations.** Figure 13 shows the results. For those who are familiar with Koto scores, the baseline method is more effective than the proposed method. When using the proposed method, the participant found that it was best to follow the presented information with her eyes. Therefore, it is impossible to memorize the performance during the practice phase. As a result, the number of errors increased. On the other hand, it was possible to memorize the Koto score with the string names to practice watching the Koto score with the baseline method. Thus, there were few errors. If experienced people use the proposed method, we find that it is only effective for basic practice sessions such as practicing articulations, practicing fast finger movements, and confirming picking or fingering mistakes after playing to some degree with the baseline method.

## **5 Discussion**

### **5.1 Limitations**

There were no rhythm mistakes in user study 1 when listening to the model performance. However, there were mistakes in user study 2 because there was no model performance. Participants using the proposed method said that it is effective for understanding the flow of the song, but we are not able to conclude that it was due to the effect of the proposed method completely because they were listening to pitches that were not able to be understood from the Koto scores. In general practice, learners play the Koto while being taught how to play by Koto teachers or by listening to sound sources. Therefore, the proposed method is expected to be useful for actual learning.

### **5.2 Comparison of the Proposed and Traditional Methods**

When using the proposed method, none of the participants were lazy and avoided practicing. Practices were semicompulsive, the pieces of performance support information moved left-to-right one-by-one. On the other hand, when using the traditional method, a participant did not concentrate on practicing because he was tired. Hence, he was not able to practice reading the Koto score and finding the corresponding string positions passively.

### **5.3 Usefulness of the Proposed Method**

Even if learners play the Koto by using the proposed method, they are not able to remember the string names in the Koto score. In addition, the sounds assigned to the strings change depending on tuning. Therefore, by only memorizing sounds, they must memorize the tuning and change that into the strings on that basis. In other words, an experienced person who is able to read Koto scores and understand the string positions learned more effectively with the baseline method than the proposed method. However, beginners are not able to read Koto scores and understand the string positions. Thus, they must perform actions that they are not used to at the same time. The proposed method is able to solve the problem of searching for string positions and to prevent the memorization of incorrect performances to notice picking and fingering errors. In addition, beginners are able to learn how to read Koto scores efficiently after playing with the proposed method. Although the motivation was lower using the proposed method than that using the traditional method, the number of mistakes was less than that for the traditional method in the test performance using the baseline method. Therefore, we consider that the proposed method is useful for beginners.

## **6 Conclusion and Future Work**

In this paper, we introduced a method to support beginners who are not able to read Koto scores and understand string positions instantly in learning the Koto. Our method

presents performance support information on the strings and soundboard directly by using projection mapping. This information is composed of the string positions color-coded by fingering, timing of picking, directions to pick, articulations, and the one beat separation lines of one measure. Moreover, the performance support information moves from left to right for one measure. We conducted two user studies with beginners to compare the learning performance, motivation, self-evaluation, and improvement in reading a Koto score when using the proposed method and traditional method, which uses string names written on paper. Further, a user study with an experienced person was also conducted to compare the learning performance of the proposed method to that with the baseline method.

The results showed that beginners were able to play the Koto including articulations and learn more efficiently by using the proposed method. Particularly, the presentation of the performance strings colored for fingering and the direction to pick was useful for understanding the string positions and flow of the song and maintaining motivation. Therefore, the numbers of incorrect picking and fingering errors were less than those of the traditional method. Moreover, by visualizing the performance support information, the experimental participants noticed mistakes by themselves, even though there was no judgment function. In addition, the skill in reading a Koto score and performing improved compared to that of the traditional method. However, the proposed method had the opposite effect for experienced people. We expect that the timing of the effect of the proposed method is reversed when players are able to understand Koto scores and find the string positions written on the Koto score. This finding is useful as an index for removing the assistance provided by the proposed method.

In the future, we will improve the proposed method to reduce the performance support information gradually and introduce a mechanism to increase the time for reading Koto scores at a stage at which a performance is stable. Moreover, we will construct an experimental system and conduct experiments to evaluate the hypothesis of the useful stage of the proposed method.

## Acknowledgments

We are grateful to Koto teacher Mayuko Kobayashi and all of the participants in this study.

## References

1. Hukunaga, C.: *Yasashiku manaberu Koto kyouhon* (in Japanese). Choubunsha, Tokyo (2003).
2. Yamaguchi, O., Tanaka, K.: *Hougaku Koto hajime* (in Japanese). Edition KAWAI, Tokyo (2002).
3. Wikipedia. [https://en.wikipedia.org/wiki/Koto\\_\(instrument\)](https://en.wikipedia.org/wiki/Koto_(instrument))

4. Rogers, K., Röhlig, A., Weing, M., Gugenheimer, J., Könings, B., Klepsch, M., Schaub, F., Rukzio, E., Seufert, T., Weber, M.: P.I.A.N.O.: Faster Piano Learning with Interactive Projection. In: Ninth ACM International Conference on Interactive Tabletops and Surfaces, pp. 149–158. ACM, New York (2014). doi: 10.1145/2669485.2669514
5. Takegawa, T., Terada, T., Tsukamoto, M.: Design and Implementation of a Piano Practice Support System using a Real-Time Fingering Recognition Technique. In: 37th International Computer Music Conference, pp. 387–394. (2011).
6. Takegawa, T., Terada, T., Tsukamoto, M.: A Piano Learning Support System considering Rhythm. In: 38th International Computer Music Conference, pp. 325–332. (2012).
7. Xiao, X., Ishii, H.: MirrorFugue: Communicating Hand Gesture in Remote Piano Collaboration. In: Fifth International Conference on Tangible, Embedded, and Embodied Interaction, pp. 13–20. ACM, New York (2011). doi: 10.1145/1935701.1935705
8. Xiao, X., Tome, B., Ishii, H.: Andante: Walking Figures on the Piano Keyboard to Visualize Musical Motion. In: International Conference on New Interfaces for Musical Expression 2014, pp. 629–632. (2014).
9. Raymaekers, L., Vermeulen, J., Luyten, K., Coninx, K.: Game of Tones: Learning to Play Songs on a Piano Using Projected Instructions and Games. In: The ACM CHI Conference on Human Factors in Computing Systems, pp. 411–414. ACM, New York (2014). doi: 10.1145/2559206.2574799
10. Sano, K., Go, K.: Koto performance support system for beginners (in Japanese). In: Forum on Information Technology 2012, vol. 11, no. 3, pp. 491–492 (2012).
11. Zhang, Y., Liu, S., Tao, L., Yu, C., Shi, Y., Xu, Y.: ChinAR: Facilitating Chinese Guqin learning through interactive projected augmentation. In: Third International Symposium of Chinese CHI, pp. 23–31. ACM, New York (2015). doi: 10.1145/2739999.2740003
12. Löchtefeld, M., Gehring, S., Jung, R., Krüger, A.: guitAR: Supporting Guitar Learning through Mobile Projection. In: The ACM CHI Conference on Human Factors in Computing Systems, pp. 1447–1452. ACM, New York (2011). doi: 10.1145/1979742.1979789
13. Rocksmith. <https://rocksmith.ubisoft.com/rocksmith/en-us/home/>
14. Yousician. <http://www.yousician.com/>
15. Synthesia. <http://www.synthesiagame.com/>
16. Guitar Hero. <https://www.guitarhero.com/>