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A Cluster Analysis of Creative and Cognitive Processes in a  
Distance Learning High School**



Research Article

# Four Thinking Patterns Promoted by “Musicking” Practice; A Cluster Analysis of Creative and Cognitive Processes in a Distance Learning High School

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## Abstract

*This study addresses the educational challenges associated with diverse learning needs in the AI era by redefining music activity based on the concept of "Musicking" and verifying its effectiveness when implemented in classes at a Distance Learning High School. Specifically, the research aimed to clarify the influence of "Musicking" activities on students' cognitive processes and creative thinking using a quantitative and objective method, namely cluster analysis. Applying cluster analysis to survey data collected after the intervention revealed that the activity promoted four statistically significant components of students' thinking patterns: Information Conversion Ability, Social Sensitivity, Structural Exploration, and Critical Immersion. The discussion further utilized protocol data to deeply analyze why and in which practice scenarios these thinking patterns were generated.*

*Crucially, the findings suggest that the facilitator's pedagogical flexibility—specifically the transition from an Initial Plan to Emergent Plans—played a key role in fostering these high-level thinking patterns. These results substantiated the academic validity of "Musicking" by demonstrating its potential to quantitatively promote creative thinking and socio-emotional skills, thereby offering an effective model for both Individualized Optimal Learning and collaborative learning, with potential implications for broader frameworks such as STEAM education.*

**Keywords:** Musicking, Distance Learning High School, Artificial Intelligence (AI), Pedagogical Flexibility, STEAM Education

## Introduction

Modern society is changing rapidly with the evolution of AI (Artificial Intelligence) and technological innovation [1]. Consequently, school education is urgently required to foster children's high adaptability, collaboration skills, and the ability to create new value [2]. Furthermore, the cultivation of these abilities is deeply related to the growing importance of STEAM education, which integrates science, technology, and the arts

to create new value [3]. Conventional education focused primarily on arriving at single correct answers makes it difficult to foster these abilities [4]. Therefore, "Japanese-Style School Education in the Reiwa Era" requires learning that draws out individual potential and promotes collaboration with others [5]. Considering these social demands, music education in Japanese schools should function as a space for self-expression and inquiry through music [6]. However, the current situation focuses almost

exclusively on the aspect of music as a skill-based subject [7]. Surveys indicate that high school students who believe music learning is useful in society are in the minority Rimas and Rimas Jr. (2024) point out that because "skillfulness" as a skill-based subject is overemphasized, students tend to fear making mistakes and become passive [8,9]. To address these issues, this study focuses on the possibility of realizing both individualized optimal learning and collaborative learning by redefining music practice through the concept of "Musicking." This concept, proposed by musicologist Christopher Small (1998), views music not as a "thing (work)" but as an "act." "Musicking" encompasses all acts related to music, including performing, rehearsing, dancing, and listening [10]. Its "crucible-like and fluid" nature is suitable for inclusive education, freeing students from the evaluation criteria of "skillfulness."

While it is suggested that "Musicking" deeply transforms students' creative thinking, research quantitatively verifying its effects within a planned school curriculum remains insufficient. In particular, the educational effects in distance learning high schools have not been clarified. Therefore, the purpose of this study is to elucidate how "Musicking" practice affects the cognitive processes and creative thinking of students in a distance learning high school, using cluster analysis to empirically clarify the transformation of thinking patterns.

## Method

### Participants

The practice for this study was conducted in a music class at a wide-area distance learning high school in Japan. In this school system, education is primarily centered on home-based study via correspondence, and face-to-face schooling is limited to approximately once a week. Consequently, the student body is characterized by significant diversity: while some students harbor feelings of rejection or fear toward interacting with others, others possess highly specialized interests and talents. Given these characteristics, this setting was selected to verify the effectiveness of "Musicking", which offers diverse methods of participation to realize inclusive and deep learning within limited face-to-face opportunities.

### Procedures and Intervention

The practice was conducted as a single class session of approximately 90 minutes on February 13, 2025. Based on the concept of "Musicking", the class was designed to maximize student-led activity time. To ensure intervention fidelity regarding the "fluid and inclusive" nature of "Musicking", the session was structured into four phases:

- **Phase 1:** Orientation (explanation of the concept and listening to Vivaldi's live performance)
- **Phase 2:** Ideation (viewing videos and brainstorming ideas based on the "Winter" sonnets)
- **Phase 3:** Exploration (creative activities in separate rooms)
- **Phase 4:** Performance (sharing outcomes in a concert format)

The specific task was to "Engage in activities with Vivaldi's The Four Seasons 'Winter' in mind." Students formed five groups based on their interests:

- Group a: Image Generation
- Group b: Dance

- Group c: Ensemble
- Group d: Composition
- Group e: Game Play

Students freely used digital devices and AI tools. For the game-play activity, students utilized various game applications on their smartphones, synchronizing their play with the music. "Artguru" and "ChatGPT" were used for image generation, and "Suno" was used for music generation. The instructor acted as a facilitator to guarantee psychological safety, adopting a flexible approach to lesson planning. While an Initial Plan of standard instructor-led tasks was prepared, the instructor actively embraced Emergent Plans—spontaneous student-led activities that arose during the session. For instance, when students spontaneously proposed adding dance or modifying game rules to synchronize with the music, the instructor authorized these changes immediately. This facilitation strategy was essential to realize the "crucible-like" environment where individualized optimal learning and collaborative learning coexist.

### Measures

To measure students' latent thinking characteristics, a questionnaire consisting of 10 items regarding creative thinking and socio-emotional learning was conducted after the practice. The questionnaire items were developed based on established theoretical frameworks in music psychology and education, and were further refined through discussions with experts in music education to ensure content validity. Items related to emotional empathy and imagery (Items 1, 2, 9) were derived from the mechanisms of musical emotion proposed by Juslin and Västfjäll (2008) [11]. To measure the cognitive understanding of musical structures and historical contexts (Items 3, 4, 5, 7), we referred to the musical development model by Swanwick and Tillman (1986) [12]. Item 6, which assesses deep concentration, was based on Custodero's (2002) application of flow theory to music education. Finally, items concerning creative thinking and novelty (Items 8, 10) were informed by Webster's (2002) model of creative thinking in music [13,14].

Responses were evaluated on a 5-point Likert scale (1: Strongly Disagree to 5: Strongly Agree). The specific items are listed in the Appendix.

### Data Analysis

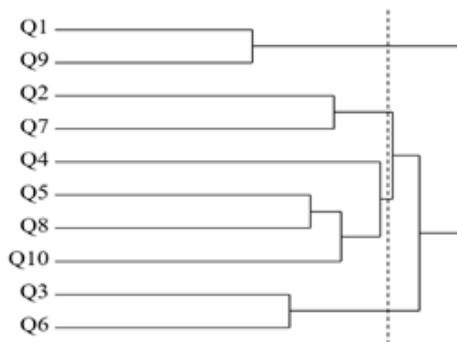
To evaluate the diverse cognitive transformations prompted by the "Musicking" practice, this study employed cluster analysis. While traditional statistical methods often focus on mean differences, cluster analysis allows for the identification of distinct "thinking patterns" that emerge among students [15]. Given the "fluid and inclusive" nature of "Musicking" (Small, 1998), student responses were expected to be heterogeneous rather than uniform [10]. Grouping based on response patterns was performed to extract latent thinking characteristics. Additionally, students' transcripts (utterance records) during the practice were collected and qualitatively analyzed to triangulate how the extracted thinking patterns manifested in specific scenes.

### Results

Although a total of 31 students participated in the practice, the final analysis was performed on data from 23 students. Eight participants were excluded because their responses to the web-

based questionnaire were incomplete or contained missing items. As a result of applying hierarchical cluster analysis to the questionnaire data of 23 valid responses, the students' creative

thinking and cognitive processes were classified into four statistically significant clusters (Figure 1). Table 1 presents the means and standard deviations for each question item.



**Figure 1: Dendrogram of Cluster Analysis Results**

The dendrogram shows the hierarchical clustering of the 10 questionnaire items using Ward's method. The vertical line indicates the cut-off point that divides the items into four distinct clusters: (Cluster 1) Information Conversion Ability (Q1, Q9),

(Cluster 2) Social Sensitivity (Q2, Q7), (Cluster 3) Structural Exploration (Q4, Q5, Q8, Q10), and (Cluster 4) Critical Immersion (Q3, Q6).

Q No.	Question Content	M	SD
Q1	I can clearly imagine a story by listening to music.	4.04	1.00
Q2	I have come to better understand other people's feelings through music.	3.83	1.10
Q3	Understanding differences in individuality.	4.65	0.71
Q4	Relation of music history to the world.	3.70	1.05
Q5	Discovery of mechanisms and elements.	4.39	0.93
Q6	Concentration during activities.	4.43	0.81
Q7	Finding similarities in different music.	3.83	0.90
Q8	Desire to try new music.	4.26	0.77
Q9	Expansion of scenes and emotions.	4.04	1.00
Q10	Generation of new ideas.	3.78	1.10

**Table 1: Means and Standard Deviations for Each Question (N=23)**

**Cluster 1: Information Conversion Ability**

Cluster 1 consists of Q1 and Q9 (M=4.04). This pattern indicates the ability to effectively translate abstract acoustic information into concrete outputs, such as images or stories.

**Cluster 2: Social Sensitivity**

Cluster 2 consists of Q2 and Q7 (M=3.83). This represents the ability to emotionally resonate with others' opinions and musical ideas, facilitating smooth collaboration.

**Cluster 3: Structural Exploration**

Cluster 3 consists of Q4, Q5, Q8, and Q10. Notably, Q5 shows a high mean (M=4.39). This indicates a continuous inquiry process where students grasp the structure of tasks and aim for higher quality through trial and error.

**Cluster 4: Critical Immersion**

Cluster 4 consists of Q3 and Q6. Q3 has the highest mean (M=4.65). This characterizes the ability to perform relative evaluations of one's own and others' outcomes from multiple perspectives while maintaining deep concentration.

**Discussion**

**Interpretation of the Four Thinking Patterns**

To ensure the validity of the findings, this study integrated multiple data sources, including quantitative cluster analysis and qualitative transcript data. This methodological triangulation allowed for a deeper understanding of how the students' internal thinking patterns were manifested in their actual behaviors during the practice.

**Cluster 1: Information Conversion Ability**

First, in Phase 2, the cluster identified as "Information conversion Ability" corresponds to the process of concretizing abstract information. This ability was fostered by the task of translating abstract themes into concrete forms. Protocol data showed that Group a (Image Generation) converted Vivaldi's music into specific visuals, such as "a Yeti eating ramen" (see Figure 2). This specific imagery was not random; rather, it functioned as a symbolic translation of the "warmth" described in the sonnet of the second movement (spending quiet days by the fireplace), which was introduced at the beginning of the session. This demonstrates a high-level cognitive transfer from auditory and

textual input to visual representation. This process is supported by the protocol data where students actively converted auditory information into visual prompts (see Excerpt 1).



**Figure 2: AI-Generated Image Visualizing the Music: "A Yeti Eating Ramen"**

This image was generated by a student using AI while listening to Vivaldi's "Winter." It serves as an example of Information Conversion Ability and facilitated Social Sensitivity as students shared the humorous interpretation of the music.

**Excerpt 1:** Process of concretizing music in Group a (Image Generation)

**Teacher:** What is this picture?

**Student 1:** I asked ChatGPT to generate it.

**Teacher:** Actually, look at the printout. This song has a "hidden lyric" (Sonnet). It describes scenes like "freezing wind" or "warmth by the fireplace." This picture visualizes that hidden meaning.

**Student 1:** (Looking at the sonnet) I see. Now that you mention it, the song does feel like this image.

### Cluster 2: Social Sensitivity

Second, in Phase 2 and Phase 3, "Social Sensitivity" refers to the emotional resonance mechanism. This was enhanced by the collaborative environment using digital tools. The Game group (Group e) synchronized their gameplay rules with the music's timeline. Although the original objective of the game was to survive as long as possible without a "Game Over," they intentionally created a paradoxical rule where "the game must end exactly when the music finishes". This synchronization demonstrated emotional resonance and non-verbal communication among students. Furthermore, the shared laughter and enjoyment over the visual imagery (as shown in Figure 2 in the previous section) strengthened their emotional connection. This process of resonance is supported by the protocol data where students actively aligned their activities with the musical progression (see Excerpt 2).

**Excerpt 2:** Emotional resonance and synchronization in Group e (Game Play)

**Teacher:** Now, let's move to the final performance.

**Student 2:** I added one more mission.

**Teacher:** Oh?

**Student 2:** The game must end in "Game Over" exactly when

the music finishes.

**Teacher:** That's amazing! Great idea. Okay, let's try it. (The students synchronized their gameplay with the timeline of the musical performance, sharing a sense of unity with Group c, Ensemble)

Moreover, the interaction between Group b (Dance) and Group c (Ensemble) provided a striking example of non-verbal synchronization. Initially, the students in Group b (Dance) were moving in their own way. However, as Group c (Ensemble) began their performance, the dancers spontaneously adjusted their movements to match the live tempo. The supporting student (conductor) noticed this and adjusted his conducting to bridge the gap between the musicians and dancers.

**Excerpt 3:** Interaction between Group b (Dance) and Group c (Ensemble)

**Supporting Student (Conductor):** (Noticing the ensemble is too fast for the dancers) Conducts slowly to adjust the tempo.

**Students (Group b, Dance):** (Cheering and adjusting their choreography to the stabilized rhythm)

**Students (Group c, Ensemble):** (Playing instruments while watching the conductor and dancers)

**Student 3 (Group b, Dance):** It fits perfectly now!

This scene illustrates how students in different modalities—movement and sound—achieved emotional resonance through the shared timeline of the music, reinforcing the cluster of Social Sensitivity.

### Cluster 3: Structural Exploration

Third, in Phase 2, "Structural Exploration" represents the circular process of time-axis thinking and experimental application. This corresponds to the students' ability to connect historical contexts (Vivaldi's original work) with modern interpretations (AI composition). Protocol data indicated that Group d (Composition) iteratively refined their prompts moving from "gentle" to "exciting" and adding "female vocals"—to match their internal image with the generated output. This trial-and-error process indicates a deep structural inquiry into musical elements. The dynamic interaction between the student's intent and the AI's output is illustrated in the following Excerpt (see Excerpt 4).

**Excerpt 4:** Trial and error in AI composition in Group d (Composition)

**Teacher:** What kind of atmosphere do you want for the song?

**Student 5:** Softly... but the previous part was intense. How should I say it... more exciting?

**Teacher:** Okay, let's try "Exciting." (Generates music)

**Student 5:** (Listening) Oh! But it should be faster.

**Teacher:** Let's add a "Speed up" instruction. How about the voice?

**Student 5:** Female vocals would be better.

### Cluster 4: Critical Immersion

Finally, in Phase 3 and Phase 4, "Critical Immersion" is defined as the ability to perform reflective evaluations through deep focus. This was observed in how students critically assessed

their performance against the musical structure. For instance, Group e (Game Play) analyzed the timing of obstacles based on sound changes to predict game outcomes. Similarly, students in Group c (Ensemble) adjusted their performance by critically observing the conductor's tempo and comparing it with their own rhythm. This indicates that immersion in "Musicking" fosters an objective viewpoint even while being deeply engaged in the activity (see Excerpt 5).

**Excerpt 5:** Critical immersion and relative evaluation in Group e (Game Play)

**Student 6:** (While playing) Ah, it didn't end. I missed the timing.

**Student 7:** It's hard to sync with the end of the song.

**Student 6:** I want to redo it. I can't clear it in one go.

**Supporting Student:** Let's do our best in the actual performance. Practice, practice. (Students were deeply immersed in the game structure, critically evaluating their timing against the musical progress.)

Furthermore, the psychological safety provided by the "Musicking" environment fostered a shift from passive observation to active immersion. When the teacher offered a "broken violin" for students who were afraid to play but wanted to mimic the appearance (Air Violin), one student expressed a desire to engage with the authentic instrument.

**Excerpt 6:** Transition from "Air Violin" to authentic engagement in Group c (Ensemble)

**Teacher:** If you are anxious about playing, you can use this "broken violin" just to mimic the look. It's okay to just do "Air Violin."

**Student 8:** Are there any non-broken ones?

**Teacher:** Yes, we have real ones that produce sound.

**Student 8:** Is this real? (Touches the instrument) I want to try the real one.

The student's question, "Are there non-broken ones?" reveals a transition from a "safe" distance to a desire for critical engagement with the actual musical experience. This demonstrates that the immersive nature of "Musicking" motivates students to step out of their comfort zones and critically evaluate their own potential, as suggested by Rimas and Rimas Jr. (2024) [9].

These diverse interactions and cognitive transformations suggest that the instructor's pedagogical flexibility—specifically, the willingness to allow a transition from the Initial Plan to Emergent Plans based on spontaneous student proposals—was a decisive factor in fostering the high-level thinking patterns observed in this study.

### Limitations and Future Prospects

This study has several limitations that should be noted. First, regarding the sample size and generalization, the study was conducted with a small sample (N= 23) in a specific environment of a wide-area distance learning high school. Consequently, the thinking patterns identified here may strongly reflect the characteristics of students who typically have limited opportunities for face-to-face interaction. Therefore, caution is required when generalizing these findings to full-time high

schools where students interact daily.

Second, regarding the intervention period, this research analyzed the effects of a single 90-minute session. While the cluster analysis successfully extracted distinct thinking patterns as immediate effects of the practice, it remains unclear whether these cognitive transformations are sustainable over the long term. Future research should examine whether these thinking patterns take root as stable "habits of mind" through continuous implementation of "Musicking".

However, despite these limitations, the analysis successfully identified distinct structures in the students' thinking patterns. Furthermore, these statistical results were strongly consistent with the qualitative protocol data derived from the students' actual behaviors and utterances. This triangulation of quantitative and qualitative data supports the internal validity of the findings within this specific context. Future research requires replication with larger samples and in different school types to further verify the model and generalize the findings.

### Conclusion

This study clarified that "Musicking" practice in a distance learning high school promotes four thinking patterns: Information Conversion Ability, Social Sensitivity, Structural Exploration, and Critical Immersion. These results quantitatively support the academic validity of "Musicking" as an educational intervention. The practice enabled the sharing of tacit knowledge and contributed to the acquisition of diverse musical experiences. The pedagogical success of this practice lies in the facilitator's flexibility to allow a gradual transition from the Initial Plan to Emergent Plans. Furthermore, this practice, in which Arts and Technology are fused, serves as a viable framework for implementation in school settings. It offers a practical model contributing to the advancement of STEAM education and the realization of "Japanese-Style School Education" that values both individual optimization and collaboration.

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### Appendix

#### Questionnaire Items

Note: The questionnaire was originally administered in Japanese. The items below are English translations.

- I can clearly imagine a story by listening to music.
- I have come to better understand other people's feelings through music.
- By listening to music from various artists, I can well understand their individuality and differences in expression methods.
- I vaguely understand how the history of music relates to changes in the world.
- I discovered new things about the mechanisms and elements of music.
- I was able to concentrate on the music activities to the point of forgetting the passage of time.
- I sometimes find similarities even in different types of music.
- I felt a desire to try new types of music.

- Listening to music has expanded the scenes and emotions within my heart.
- When creating or performing music, new ideas have come to mind.

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