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IEC Driven Guitar Etude Optimization System Considering Learner Preferences and Skills

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Abstract: While interest in playing musical instruments continues to grow, self-directed learning remains challenging, leading many learners to abandon their practice. Previous research on musical instrument learning support has primarily focused on performance evaluation and feedback, with insufficient attention given to practice materials themselves. This study proposes an Interactive Evolutionary Computation (IEC) based system that optimizes guitar practice materials according to individual learner preferences and skill levels to enhance learning motivation. Through experimental evaluation with 15 participants, we found that approximately 87% reported increased motivation when practicing with personalized materials. These results suggest that tailoring practice materials to individual preferences and abilities can significantly improve learning motivation for musical instrument learners.

Keywords: Guitar learning, Interactive Evolutionary Computation (IEC), Learning motivation, Personalized education

1. Introduction

Recent years have witnessed growing interest in playing musical instruments, driven by decreasing costs of electronic instruments, widespread internet access, and increased time at home during the pandemic. However, learning an instrument requires sustained practice over extended periods, and many novice learners struggle with maintaining motivation, ultimately leading to abandonment of their musical pursuits. Research on expert performance has shown that deliberate practice is essential for skill development, yet maintaining such practice requires significant self-regulation abilities that many amateur musicians lack (Lehmann & Ericsson, 1997; McPherson & Renwick, 2001). Moreover, both the quantity and quality of practice significantly predict performance outcomes, suggesting that optimizing practice materials could enhance learning efficiency (Williamon & Valentine, 2000).

Addressing this challenge, researchers have explored various approaches to enhance motivation in musical instrument learning. Phanichraksaphong and Tsai (2021) developed a piano performance evaluation system focusing on sound sustain characteristics. Motokawa and Saito (2006) created an augmented reality support system for guitar playing, demonstrating the potential of technology-enhanced learning for musical instruments. Alternative approaches have focused on the practice materials themselves. These studies suggest that aligning learning materials with both learner preferences and abilities may be key to sustaining motivation. Furthermore, research on musical creativity shows that musicians develop expertise through exploration of varied harmonic progressions and patterns, suggesting that exposure to diverse, personalized practice materials could accelerate skill development (Johnson-Laird, 2002).

Building on these insights, this study aims to improve learning motivation by optimizing practice materials to suit both learner preferences and skill levels. We employ Genetic Algorithms (GA) (Holland, 1992) and Interactive Evolutionary Computation (IEC) (Takagi,

2001) to generate personalized guitar etudes that adapt to individual learners' musical tastes and technical abilities.

2. Proposed System

2.1 System Outline

Our system evaluates the learner's playing skills and generates etudes tailored to their preferences and abilities through an iterative exploration process. Figure 1 illustrates the system flowchart, which comprises four main stages: skill evaluation, wide-area preference search, narrow-area preference search considering skills, and etudes comparison. Figures 2 and 3 show the skill evaluation and preference evaluation UI, respectively.

The genetic representation uses eight genes encoding a two-bar etude with chord changes every two beats, providing sufficient complexity for meaningful practice while maintaining computational efficiency.

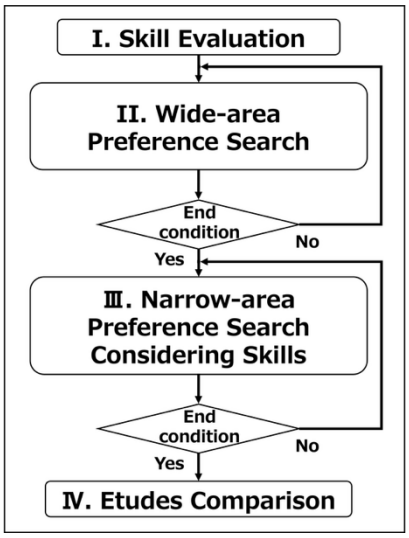

Figure 1. System Flowchart

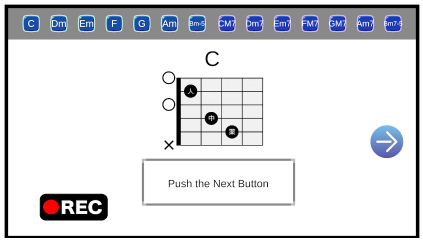

Figure 2. Skill Evaluation UI

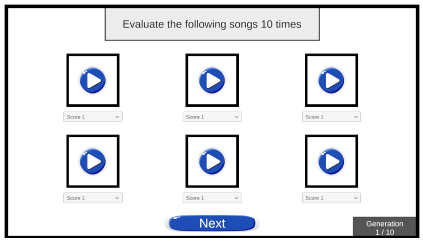

Figure 3. Preference Evaluation UI

2.2 Skill Evaluation

The skill evaluation module assesses performance accuracy through MIDI signal analysis. Learners play designated chord progressions on the guitar, and the system captures performance data as MIDI signals. The evaluation algorithm analyzes simultaneity of sound, note correctness, to generate a skill profile for each learner.

2.3 Wide-Area Preference Search

This phase employs an Interactive Genetic Algorithm (IGA) to explore the broad space of possible chord progressions. The system initially generates six random chord progression candidates and presents them to learners for evaluation on a 10-point preference scale. This approach aligns with Johnson-Laird's (2002) findings that musicians develop improvisational skills through exploration and mental representation of diverse harmonic structures. Based on these evaluations, the IGA performs selection, crossover, and mutation operations to generate new candidates. This iterative process continues for a predetermined number of generations, gradually converging toward chord progressions that match learner preferences.

2.4 Narrow-Area Search Considering Skills

Following the wide-area search, the system refines results by incorporating skill-level considerations. Elite individuals from the final generation of the wide-area search serve as starting points. The system identifies chords evaluated as difficult during skill assessment and replaces them with skill-appropriate alternatives from the same harmonic family. This maintains the musical character while adjusting technical difficulty.

Six modified individuals are generated and presented for learner evaluation. Subsequent generations apply IGA operations while constraining the search space to skill-appropriate chord substitutions. This dual consideration of preference and ability enables the system to generate etudes that are both engaging and technically accessible.

2.5 Etudes Comparison

The final stage presents learners with etudes from both the initial and optimized generations for direct comparison. Learners play and evaluate each etude without knowing which has been optimized, providing unbiased feedback on the system's effectiveness.

3. Experimental Evaluation

This experiment was approved by the Research Ethics Review Committee of Organization for Research and Development of Innovative Science and Technology (ORDIST) in Kansai University, Japan.

3.1 Experiment Overview

We conducted evaluation experiments with 15 participants (male and female university students) who were guitar beginners. Participants first played chords presented by the system, then evaluated generated etudes on a 10-point preference scale across multiple generations. Finally, they compared two etudes: their highest-rated first-generation etude and the system-optimized etude, without knowing which was which.

Post-experiment questionnaires assessed three aspects of the etudes (Table 1) and the overall system experience (Table 2). Additionally, participants provided free-form feedback about their experience.

Table 1. Questionnaire items regarding the two etudes

Number	Question
Q1	Which etude better suited your preferences?
Q2	Which etude better matched your skill level?
Q3	Which etude increased your motivation to practice?

Table 2. Questionnaire items regarding the experience of using the system

Number	Question
Q4	Did you feel an evaluation fatigue during the process?

3.2 Results

For Q1 and Q2, the majority of participants found the optimized etudes better suited to their preferences and skills compared to non-optimized versions as illustrated in Figure 4. Notably, Q3 revealed that 87% of participants experienced increased practice motivation with the optimized etudes.

However, as shown in Figure 4, Q4 indicated that over half the participants experienced evaluation fatigue. Moreover, free-form responses highlighted issues with etude monotony and difficulty distinguishing between similar chord progressions, suggesting that evaluation quality may have been compromised in some cases.

4. Discussion

The experimental results demonstrate the proposed system's potential for generating etudes aligned with learner preferences and abilities. The strong positive response regarding motivation improvement (87%) suggests that personalized practice materials can significantly

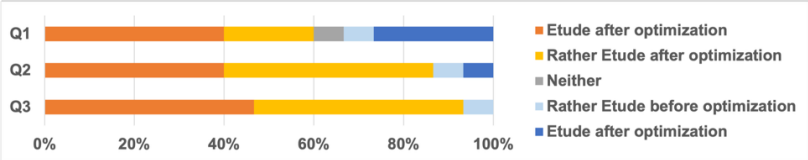

Figure 4. Results of etudes comparison questionnaire

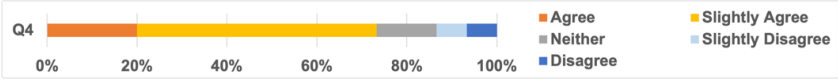

Figure 5. Result of system experience feedback

enhance engagement with musical instrument learning. This aligns with McPherson and Renwick's (2001) findings that self-regulation in musical practice is enhanced when learners have agency in selecting and shaping their practice materials.

Nevertheless, several participants reported that optimization was incomplete or ineffective. Comments about etude monotony and difficulty distinguishing between variations indicate that insufficient diversity in generated content may have hindered proper evaluation and, consequently, optimization effectiveness. This echoes Lehmann and Ericsson's (1997) observation that effective deliberate practice requires varied and progressively challenging materials that maintain learner engagement.

The evaluation burden reported by over half the participants reflects both the inherent challenge of IEC systems requiring multiple learner evaluations and the specific issue of limited musical variety in our current implementation. This fatigue could potentially undermine the system's effectiveness by reducing evaluation quality over time.

5. Conclusion

In this study, we developed and evaluated an IEC-based system for optimizing guitar etudes according to individual learner preferences and skills. Our findings indicate that personalized practice materials can substantially increase learning motivation, with 87% of participants reporting improved engagement.

However, the system's current implementation faces challenges regarding learner evaluation burden and content diversity. Future work should focus on reducing cognitive load through improved etude variety, more efficient evaluation interfaces, and potentially incorporating implicit feedback mechanisms. Additionally, expanding the musical complexity and stylistic range of generated etudes could enhance both learner engagement and optimization effectiveness.

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