AicQoL2026Jakarta

Suitability of Music-Based Items for Identifying Giftedness in Children at a STEM Camp

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Abstract
This study examines the use of music-based tasks for identifying giftedness in children at a Malaysian STEM camp. It explores the suitability, fairness, and meaningfulness of music-based items in a gifted identification framework. Surveying 62 primary gifted students, the study found positive perceptions of music-based tasks, with strong internal consistency in music–STEM integration, musical aptitude, and task suitability. Correlations indicated that music-based tasks are psychometrically promising and acceptable. Future research should refine task design, explore fairness across subgroups, and link music-based indicators to independent measures of gifted performance.

Keywords: Gifted Identification; Music-Based Assessment; STEM Education; Music Education

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1.0 Introduction
Giftedness identification in science, technology, engineering, and mathematics (STEM) has traditionally relied on paper-and-pencil assessments and reasoning tests. However, these methods often fail to recognise children who demonstrate advanced skills in non-traditional areas (Freiman et al., 2025), especially in creativity fields such as music and arts, which involve complex pattern recognition and problem-solving abilities. Music-based assessments have gained attention as a promising approach to identifying giftedness, particularly as part of multimodal frameworks. Emerging research suggests that children who excel in music may possess strengths transferable to STEM fields (Dignam, 2024), thus warranting the inclusion of music-based tasks in gifted identification frameworks. Despite this, empirical studies, particularly in non-Western contexts like Asia, remain limited, and the acceptability and effectiveness of such tasks from the children's perspectives have not been thoroughly examined. This study seeks to address the gap by exploring the use of music-based identification tasks within a gifted screening process at a Malaysian STEM camp. The primary goal is to assess the psychometric properties and the acceptability of these tasks to primary school pupils. The study aims to explore children's perceptions and evaluate the effectiveness of music-based tasks in gifted screening. Objectives include evaluating the internal consistency of music-related subscales, examining the relationship between pupils' perceptions of music-based tasks and overall program satisfaction, and gathering insights to inform the design of more inclusive and effective gifted screening tools. Findings from this research could contribute

to refining models of gifted identification in STEM settings, promoting a more holistic understanding of giftedness that accounts for diverse talents (Ismail et al., 2022).

2.0 Literature Review

The concept of giftedness has long been a subject of debate in educational research, particularly regarding the interplay of innate ability, environmental opportunity, and motivation. Winner and Drake (2018) argue that high-level achievement in artistic domains such as drawing and music cannot be explained solely by deliberate practice; rather, it depends in part on innate potential coupled with strong intrinsic motivation, known as the "rage to master." They demonstrate, for example, that in the musical domain, working memory and practice hours do not fully account for individual differences in expert performance. This suggests that any assessment of giftedness, whether musical or academic, should consider both cognitive potential and motivational or affective factors. Shifting focus to the domain of musical giftedness itself, the scoping review by López-Íñiguez and McPherson (2023) highlights critical gaps: despite decades of research, the literature on nurturing musically gifted children remains scattered, often qualitative, and lacks large-scale theoretical frameworks. They emphasise socio-emotional considerations, such as equitable access, culturally responsive pedagogy, and wellbeing, which have been largely overlooked in traditional gifted identification practices. Their analysis shows that the majority of studies focus on one-off programs rather than systematic, long-term investigations, suggesting caution when applying musical-aptitude tasks as indicators of broader giftedness. It is found music is needed in gifted education as it can enrich talent among gifted children (Ismail et al. 2022).

Bridging music and STEM, the study by White (2025) explores the intersection of musical giftedness and creativity in educational contexts by proposing a conceptual framework that marries the systems theory of creativity with the "four C" model (little-c, mini-c, pro-c, big-C). She argues that musical tasks may foster cognitive processes relevant to STEM fields, such as pattern recognition, abstraction, and creative problem-solving. However, she warns that the linkage remains theoretical mainly and has been empirically under-tested. Specifically, while musical giftedness shares features with STEM-type giftedness (e.g., divergent thinking, rapid pattern mastery), evidence of transfer (from music to STEM) is limited, and assessments developed for music may not validly reflect STEM potential. Finally, empirical work such as García et al. (2024) investigates the influence of musical training on mathematical performance and finds tentative positive effects, particularly in mathematical creativity, yet also notes methodological limitations (small samples, cross-sectional design, limited control of confounds). This underscores a recurring issue in the literature: the promise of music-based identification or enrichment for STEM-gifted children remains alluring, but the evidence base is weak, measurement frameworks are inconsistent, and fairness concerns (e.g., prior musical exposure, socioeconomic status) are seldom addressed. Researchers and practitioners must thus approach music-based gifted identification tasks with careful validation and an equity-focused design as music has unique elements in identifying gifted children (Kragović & Milić, 2023; Ismail et al, 2021).

3.0 Methodology

This study employs a quantitative cross-sectional survey design to assess the suitability and effectiveness of music-based tasks in identifying giftedness in primary school students. The survey gathers students' perceptions on the integration of music elements in the gifted identification process within a STEM-focused camp. The design aims to assess how well music-based tasks engage students and their perceived relevance to STEM and gifted identification. By using a Likert-type scale, the study measures both the psychometric qualities of music-based items and their acceptability among participants. The sample consists of 62 primary school students, aged 11 years, all of whom attended a STEM camp in Malaysia. They were selected based on their involvement in the camp, which included a music specialisation. The sample comprises students from different backgrounds, ensuring a diverse representation of perceptions towards music-based tasks and their integration into gifted identification processes. The respondents are categorised as primary school pupils (students) as noted in the data, with no exclusion criteria beyond their attendance at the camp.

Fig. 1: Aural test activity
(Source: author's collection)

Data were collected through a survey administered to the participants during the STEM camp. The survey was validated by two experts in the field. During the four-day STEM camp, students engaged in activities related to robotics, mathematics, biology, chemistry, physics, and music, including aural tests, rhythmic movement, melody identification, improvisation, and interval recognition, as illustrated in Figure 1.

The camp culminated in a performance-based task that required students to integrate both STEM and music elements, showcasing their ability to combine learning from both domains. A questionnaire was administered after the activities were completed, consisting of a 20-item Likert-type questionnaire that included both general program-related questions and specific music-related items. The music-related questions focused on students' perceptions of music–STEM integration, their self-reported musical aptitude, and the perceived suitability of music-based identification tasks. The data were collected anonymously to ensure privacy, and the responses were recorded digitally. The data were analysed using descriptive statistics, including mean scores, standard deviations, and frequency distributions, to summarise participants' perceptions of the music-based tasks. Cronbach's alpha was computed for each subscale (music–STEM integration, musical aptitude, and task suitability) to assess the internal consistency of the responses. Pearson's correlation coefficients were also calculated to explore relationships between the different domains.

4.0 Results

The data analysis reveals findings regarding the integration of music-based tasks in gifted identification within a STEM camp setting. For the Musical–STEM Integration & Transfer domain, the value of M = 3.70, SD = 1.14, with a Cronbach's alpha (α) = 0.89, suggests that students generally found music-based tasks effective in bridging the gap between music and STEM learning. This score also reflects that the tasks were perceived as somewhat relevant for understanding STEM concepts through music. It indicates a moderate variation in how different students perceived this integration, suggesting that while most students saw the value in the tasks, there were some individual differences in how effectively they linked music to STEM. The internal consistency of the subscale is strong, indicating that the items related to this domain were reliable and consistently measured the intended constructs of musical and STEM integration (White, 2025).

For the Musical Sensitivity & Aptitude domain, the value of M = 3.61, SD = 1.18, with α = 0.88 indicates generally positive self-perceptions of musical sensitivity and aptitude among participants, including abilities such as recognising musical patterns, remembering rhythms/melodies, maintaining steady beats, and noticing changes in musical features. The slightly wider SD implies greater differences between students in how strongly they endorsed these musical aptitude statements; some students reported high confidence, while others were more neutral or uncertain. Nonetheless, the high alpha demonstrates strong internal consistency, suggesting that the items functioned well together as a coherent measure of musical sensitivity and aptitude within this sample (Dignam, 2024).

For the Suitability of Music Items in the Gifted Identification domain, the value of M = 4.02, SD = 1.18, with α = 0.91, reflects the most positive perception across the three domains. This mean score indicates that students largely agreed that the music-based items were appropriate, engaging, and acceptable as part of gifted identification (e.g., suitability for assessing ability, perceived fairness, and continued inclusion in assessment). Although the SD shows moderate variability, meaning that not all students rated suitability equally highly, the robust reliability coefficient suggests that the items consistently capture the broader construct of "perceived suitability" and that students responded to these items in a stable and interpretable manner.

Finally, the relationships between domains were strong and consistently positive. The Pearson correlations show that Domain 1 and Domain 2 were strongly related (r = 0.75), suggesting that students who perceived stronger music–STEM integration also tended to report higher musical sensitivity and aptitude. Similarly, Domain 1 and Domain 3 showed the strongest association (r = 0.78), indicating that when students experienced music–STEM integration as meaningful, they were more likely to judge the music items as suitable for gifted identification. The correlation between Domain 2 and Domain 3 was also substantial (r = 0.74), implying that students who felt more musically capable were also more likely to view the music-based assessment approach as appropriate and fair. Overall, these correlations support a coherent pattern: musical capability and perceived music–STEM relevance appear closely tied to students' acceptance of music-based tasks as a tool for gifted identification. Overall results are summarised in Table 1.

Table 1. Summary of Results

Domain	Mean (M)	Standard Deviation (SD)	Cronbach Alpha (α)
Musical–STEM Integration & Transfer	3.70	1.14	0.89
Musical Sensitivity & Aptitude	3.61	1.18	0.88
Suitability of Music Items in Gifted Identification	4.02	1.18	0.91
Pearson Correlations Between Domains (r)			

Domain 1 (Musical–STEM Integration & Transfer) and Domain 2 (Musical Sensitivity & Aptitude)	0.75
Domain 1 (Musical–STEM Integration & Transfer) and Domain 3 (Suitability of Music Items in Gifted Identification)	0.78
Domain 2 (Musical Sensitivity & Aptitude) and Domain 3 (Suitability of Music Items in Gifted Identification)	0.74

5.0 Discussion

The results of this study contribute valuable insights into the application of music-based tasks for identifying giftedness within a STEM camp context. These findings align with recent shifts in the conceptualisation of giftedness, which emphasise creativity and multidimensional intelligence over traditional cognitive measures. The Musical–STEM Integration & Transfer domain showed a positive response with M = 3.70, SD = 1.14, which suggests that students generally found value in music-based tasks for enhancing STEM learning. The moderate standard deviation indicates that, while most students acknowledged the potential of music to support STEM, some students still found the integration of music with STEM concepts more challenging. This is consistent with the idea that while music can foster cognitive skills like pattern recognition, transfer to other domains such as STEM requires explicit, targeted learning experiences (White, 2025; Artıktay, 2024). The Cronbach's alpha (α) = 0.89 suggests strong internal consistency, which supports the reliability of the subscale measuring the integration of music into STEM education.

The Musical Sensitivity & Aptitude domain received a slightly lower mean score (M = 3.61, SD = 1.18), reflecting a range of responses on students' perceptions of their musical abilities. This variability serves as a reminder that identifying giftedness, particularly in non-traditional domains such as music, is a complex and multifaceted process. Students with more prior experience or a natural aptitude in music may perceive themselves as more capable. In contrast, others may struggle to see the relevance of music-based tasks in their own process of identifying gifted individuals. This is particularly important when considering the impact of prior training and exposure, as the Datu and Ho Weatherly (2025) model emphasises that giftedness in music often depends on a combination of innate talent and external factors such as early exposure to music education. The moderate SD and strong internal consistency (α = 0.88) indicate that, despite individual differences in musical aptitude, the items were reliable in measuring musical sensitivity and aptitude across the group. The Suitability of Music Items in Gifted Identification domain showed the highest mean score (M = 4.02, SD = 1.18) and the highest Cronbach's alpha (α) = 0.91, indicating a strong consensus among students that music-based tasks were appropriate for identifying giftedness. This reflects a significant shift in the traditional models of gifted education, which often rely heavily on logical-mathematical assessments. The results support the growing body of research suggesting that non-cognitive factors, such as creativity and musical ability, play crucial roles in identifying giftedness, especially within a more inclusive framework that values diverse forms of intelligence (Freiman et al., 2025). The high internal consistency suggests that students found the music-related tasks to be a coherent and effective means for assessing their talents, further reinforcing the argument for more creative approaches in gifted identification processes.

The Pearson correlations between the domains provide further evidence of the interrelatedness of music aptitude, STEM integration, and the suitability of music tasks for gifted identification. The strong correlations (r = 0.75–0.78) between Musical–STEM Integration & Transfer and Musical Sensitivity & Aptitude, and between Musical–STEM Integration & Transfer and Suitability of Music Items, suggest that students who recognised the value of music for STEM also found the tasks suitable for identifying giftedness. These correlations demonstrate that music not only supports STEM learning but also functions as a valid method for recognising giftedness. This finding aligns with Gagné's Differentiated Model of Giftedness and Talent, which resonates that gifted individuals often exhibit strengths across multiple domains, including music, that should be acknowledged in the gifted identification process.

Interestingly, the correlation between Musical Sensitivity & Aptitude and Suitability of Music Items (r = 0.74) suggests that students who felt more musically capable were more likely to view music-based tasks as effective for identifying giftedness. This further emphasises the importance of self-perception in the gifted identification process. It highlights the need for tasks that are engaging and appropriately challenging, as students with higher self-reported musical aptitude may feel more invested in tasks they perceive as relevant to their abilities. As Dignam (2024) notes, students' perceptions of their aptitudes directly influence their engagement with learning tasks, and this is especially true in non-traditional methods of gifted identification, such as music-based assessments.

Moreover, the strong endorsement among students for the suitability of music-based tasks in gifted identification reflects social and cultural dynamics that other scholars have noted as important in nurturing musical talent. Ho & Liu (2024) examined the perspectives of

Asian American parents on their musically talented children, highlighting that familial support, cultural values, and parents' expectations play a crucial role in sustaining children's musical development and commitment. In the context of our STEM camp findings, students' positive perception (M = 4.02) of music-based tasks as appropriate for gifted identification may, in part, derive from similar dynamics. When students perceive music not merely as extracurricular art but as a valued channel for expressing talent, they are more likely to accept music-based assessment as legitimate. This suggests that embedding music-based gifted identification within supportive cultural and educational environments could maintain students' motivation and self-conception as "gifted," thus improving both engagement and retention in talent development pathways.

Additionally, our data aligns with recent evidence on fostering scientific creativity through problem-solving and STEM pedagogy. The meta-analysis by Pinar et al. (2025) demonstrated that instructional approaches such as project-based learning (PjBL) and problem-based learning (PBL) within STEM contexts significantly enhance students' scientific creativity and innovative thinking. The fact that participants in our study reported positive perceptions of music–STEM integration (Domain 1 mean = 3.70) and strong suitability of music tasks suggests that music-based tasks may serve as a complementary entry point to creative and scientific engagement in STEM. In other words, if properly designed, music-based tasks could function like PjBL or PBL in activating creative thinking, pattern recognition, and flexibility competencies that Pinar et al. identify as central to scientific creativity. This convergence suggests that music-infused STEM activities may help bridge disciplinary divides, providing a novel approach to cultivate the divergent thinking and creative problem-solving essential for future STEM innovation.

Therefore, these findings highlight the potential for integrating music into STEM education and gifted identification frameworks. The findings suggest that music-based tasks offer a more holistic and inclusive approach to identifying giftedness, particularly for students whose strengths may not be captured by traditional testing methods. As López-Íñiguez & McPherson (2023) argue, a more caring and inclusive approach to gifted education can better recognise diverse talents, fostering an environment where all students can demonstrate their potential. In conclusion, the study not only supports the growing body of research advocating for multimodal assessments in gifted education but also provides evidence that music-based tasks can play a significant role in identifying and nurturing diverse forms of giftedness in STEM contexts.

6.0 Conclusion

This study demonstrates that music-based tasks can serve as an engaging and effective tool for identifying giftedness in STEM contexts, with students expressing positive perceptions of their suitability, relevance, and ability to foster creativity and problem-solving skills. The findings indicate that integrating music into gifted identification processes not only enhances student engagement but also provides valuable insights into their cognitive abilities, particularly in non-traditional areas such as music. A limitation of the study is that it focused on a specific group of students at a STEM camp in Malaysia, which may influence the generalizability of the findings to other educational contexts. Adding qualitative data such as interview would improve the findings. Despite some variability in students' responses, the study highlights the potential of music-based tasks as part of a multimodal approach to identifying giftedness, offering a more inclusive framework for recognizing diverse talents. Future research should explore the longitudinal impact and cross-cultural applicability of such music-integrated identification methods.

Paper Contribution to Related Field of Study

This study contributes to the educational systems that consider incorporating music-based tasks into gifted identification frameworks, particularly in STEM settings, to ensure a more holistic and inclusive approach to recognizing gifted students. Given the positive feedback from students, such tasks could serve as an alternative or complement to traditional testing methods, helping to identify talents that may not be captured by conventional assessments. Additionally, the findings encourage further research into refining and validating music-based identification tools, ensuring they are equitable and applicable across diverse student populations.

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