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Original

The core features, internal relations, and gender differences in music academic engagement: A network analysis

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ABSTRACT

The existing research results on gender differences in academic engagement are confusing, coupled with the lack of research focusing on gender differences in music academic engagement, this leads to a lack of strong evidence for music teachers when designing specific academic engagement improvement strategies. Therefore, the purpose of this study is to explore the gender differences in music academic engagement. In order to achieve this purpose, this study used network analysis to estimate the network of male and female music academic engagement, and on this basis, determined the core features and differences of male and female music academic engagement. A total of 515 students majoring in music from Chinese universities participated in this study (38.4% were female, 61.6% were male, the mean age was 19.16 years old, and the standard deviation was 1.55). The results showed that *low persistence* and *look forward to music class* were the core features unique to men, while *avoidance of difficult work* was the core feature unique to women. *Feel good in music class* was a core feature shared by both men and women. The academic engagement of male and female in the field of music were both the same and different. This study is one of the first attempts to examine gender differences in academic engagement in the field of music. Music teachers should grasp the unique core features of male and female, and design academic engagement promotion strategies in a targeted manner.

Las características centrales, las relaciones internas y las diferencias de sexo en el compromiso académico musical: un análisis de redes

Palabras clave:
Compromiso académico musical
Diferencias de género
Análisis de redes

RESUMEN

Los resultados de la investigación existente sobre las diferencias de género en el compromiso académico son confusos. A esto se suma la falta de investigación que se centre en las diferencias de género en el compromiso académico musical, lo que conlleva a una falta de evidencia sólida para el profesorado de música al diseñar estrategias para mejorar el compromiso académico. Por lo tanto, el objetivo de este estudio es explorar las diferencias de género en el compromiso académico musical. Para lograr este objetivo, este estudio utiliza análisis de redes para estimar la red de compromiso académico musical masculino y femenino y, sobre esta base, determinar las principales características y diferencias del compromiso académico musical entre estudiantes de género masculino y femenino. Un total de 515 estudiantes de la carrera de música de universidades chinas en este estudio (38.4% de mujeres, 61.6% de hombres, con una edad media de 19 años y una desviación estándar de 1.75). Los resultados revelan que “Baja persistencia” y “Anhelar con ansias la clase de música” son características principales exclusivas del género masculino, mientras que Ëvitar el trabajo difícilsön características principales exclusivas del género femenino. Ësentirse bien en la clase de músicaës una característica central compartida por ambos géneros. El compromiso académico de hombres y mujeres en el campo de la música es igual y diferente. Este estudio es uno de los primeros intentos para examinar las diferencias

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de género respecto del compromiso académico en el campo de la música. El profesorado de música debe captar las características centrales y únicas de hombres y mujeres, y diseñar estrategias de promoción del compromiso académico de manera específica.

Introduction

Numerous studies have proven that there are significant differences between males and females in key areas of learning, such as academic motivation (Skinner & Pitzer, 2012), less self-disciplined (De Bolle et al., 2015), persistence (Lietaert et al., 2015) and learning strategies (Ruffing et al., 2015). These findings helped educators to develop differentiated and tailored teaching strategies and pedagogies based on gender differences (Aguillon et al., 2020; Åhslund & Boström, 2018). In addition to the above variables, academic engagement has received attention from many educators as one of the important variables that influence learning outcomes (Cents-Boonstra et al., 2021). However, research findings on gender differences in academic engagement remain unclear (Abulela & Bart, 2021; Bru et al., 2021). This has resulted in a lack of robust evidence for educators to develop teaching strategies and select pedagogical approaches based on gender differences and characteristics of males and females in terms of academic engagement. In the field of music, Jian (2022) noted that gender differences in academic engagement in music have received less research attention. Bang et al. (2020) and Korlat et al. (2021) highlighted that identifying gender differences in academic engagement helps teachers to personalize their teaching to enhance students' academic engagement. Therefore, it is important to explore what differences exist between males and females in music academic engagement. However, there is limited research on this topic and the studies that have been conducted on gender differences in the area of academic engagement are heavily influenced by cause-effect framing (Yin, 2018), mainly exploring the cause-effect relationship between academic engagement and external variables such as teacher perception (Bru et al., 2021), peer engagement (Mendoza & King, 2020) and student motivation (Li et al., 2022). The connections among the internal features within the academic engagement system, especially the core features, have been neglected (Bru et al., 2021). Core features are the key elements within a system (i.e., a network of variables) that determine its nature and properties (James et al., 2013), for example, *inspiration*, *maintain*, and *direct* are the three core features of motivation. Identifying core features within a system could reveal its operating mechanisms, design precise and effective interventions, and allow for the removal of confounding information to facilitate comparisons between systems (Liu et al., 2021). In summary, the questions in this study include: (RQ1) From an internal perspective of music academic engagement, what are the core features of the academic engagement networks of male and female who major in music respectively?; and, (RQ2) From an internal perspective of music academic engagement, what are the differences between the academic engagement networks of male and female who major in music?

Literature review

Internal structures of academic engagement and its relationships

Academic engagement refers to students' cognitive, affective, and behavioral responses to the learning process and to educational activities in and out of the classroom (Gunuc & Kuzu, 2015). Fredricks et al. (2004) reported that academic engagement is a multidimensional "meta-construct" that consists of three components: cognitive engagement, emotional engagement, and behavioral engagement. Cognitive engagement refers to attention to learning, concentration, investment in learning, valuing learning, self-regulation, and the use of effective learning strategies (Jones, 2020). Emotional engagement is related to students' internal feelings which is often difficult to observe (Ansong et al., 2017). These emotions typically include interest in learning, boredom, happiness, sadness, and anxiety. Behavioral engagement refers to students' behaviors in the school setting and classroom and usually includes effort, intensity, persistence, and perseverance when facing difficulties (Jones & Carter, 2019). Findings suggested that cognitive and emotional engagement positively predicts behavioral engagement (Kim et al., 2015; Wang & Holcombe, 2010). However, fewer studies have explored the relationship between cognitive and emotional engagement, which may be due to the fact that both cognitive and emotional engagement are intraindividual and difficult to observe directly (Balasooriya et al., 2017; Hartono et al., 2019). While the internal structure and interrelations of academic engagement are relatively clear, there is a lack of research identifying the core features within the academic engagement system. In particular, within the field of music, Guo et al. (2023) noted that music students' academic engagement is unique, such as being more engaged in music education activities than students in other disciplines. Boccaletti et al. (2018) noted that identifying the core features within a system is a key part of gaining insight into complex systems. Therefore, it is important to explore the core features within academic engagement in music.

Gender differences in music academic engagement

So far, there is still a debate as to whether there are differences between males and females in academic engagement. Some studies reported that there is no significant difference (Abulela & Bart, 2021; Harper et al., 2004). For example, Abulela and Bart's (2021) survey of Egyptian college students showed no statistically significant differences in cognitive engagement, emotional engagement, and behavioral engagement by gender; and Harper et al.'s (2004) study of U.S. college students found no significant differences between male and female students in terms of engagement. However, some studies have reported significant differences (Bru et al., 2021; Hartono et al., 2019). For example, Hartono et al. (2019) found significant differences in the level of student engagement across genders in a study of Indonesian university students, with female students having higher levels of engagement than male students; Bru et al. (2021) found higher levels of behavioral engagement in females than in males in a study of high school students in Norway. Regarding the reasons for gender differences in academic engagement, Abulela and Bart (2021) suggested that this is due to differences in the interests and motivations of males and females in different disciplines. Males are more interested in STEM (science, technology, engineering and mathematics), while females are more inclined towards languages, arts and social sciences (Lazarides & Lauermann, 2019). The results of the studies that have been conducted have come from the disciplines of history (Hartono et al., 2019), mathematics (Korlat et al., 2021) and medicine (Wu et al., 2020). However, less research has focused on gender differences in academic engagement in music. Some studies simply mentioned that males are generally reluctant to engage in music education

(Orton & Pitts, 2019), but did not make comparisons between males and females. Therefore, it is important to explore the gender differences in music academic engagement. The results of previous studies on gender differences in academic engagement in other disciplines provided a reference to reveal the specificity of the music discipline. In addition, the research methods used in existing studies also provided a reference for the selection of research methods for this study. These methods treated all characteristics within academic engagement as interchangeable. Meanwhile, when composing subscales or total scores, all features were aggregated as items (Borsboom, 2008).

Considering that existing studies have mainly used methods to determine gender differences in academic engagement by comparing male and female means, such as multivariate analyses of variance (Abulela & Bart, 2021; Mendoza & King, 2020), two-way multivariate analysis of variance (Hartono et al., 2019). This may also be one of the reasons for the confounding of findings on gender differences in academic engagement. More importantly, there is a lack of evidence on the central component as well as the core features of academic engagement traits. This study therefore innovatively aims to use network analysis to explore the core features of male and female academic engagement in the field and the differences between them. Network analysis is a new method that allows for the identification of core features and relationships within the network (Liu et al., 2021). Network analysis has unique advantages in exploring gender differences, not only in identifying the core features of male and female networks, but also in conducting a comparative analysis of the differences between the two networks (Castellanos et al., 2020; Maccallum et al., 2021). Therefore, this study used network analysis to conceptualize male' and female' music academic engagement into two networks, which allowed for the identification of the core features of male and female students' music academic engagement, and also provided a comparative analysis of the two networks.

Network analysis methods

Network analysis is an emerging analysis technique developed based on dynamic system models, which are constructed with a network model that includes two elements: nodes and edges between nodes (Epskamp et al., 2017). In the network structure, the nodes represent the different components (elements), the edges represent the interrelationships between the components, and the weights of the edges represent the strength of the correlation between two nodes. On the one hand, network analysis provides a visual graph of relationships among features and identifies the core features in the network structure. In network analysis features with high cardinality appear with a large number of connections with other features (Borsboom & Cramer, 2013). Stimulating features with high cardinality activates other features in the network. Features with high cardinality not only plays a dominant role in the overall network, but also anticipates the development of the network structure better than features with low centrality (Cao et al., 2019). Therefore, network analysis is able to identify the core features in the network structure of male and female student' academic engagement.

On the other hand, network analysis allows comparing whether there are differences in network structure between subgroups in a group. Network analysis could check whether multiple networks are significantly different in terms of network structure (whether the nodes are connected in the same way between subsamples), global strength (the sum of the strengths of all edges), and edge strength (whether the strengths of specific edges in subsamples are the same) by using network comparison tests (Van Borkulo et al., 2015). If the networks have no differences in overall structure, it indicates that the interactions between features are similar across the board. Thus, network analysis allows for a comparison of the differences in the network structure of male and female students' music academic engagement.

The present study

Understanding and identifying gender differences in academic engagement could help teachers provide personalized instruction and improve students' academic engagement. Although this topic has been preliminarily explored in many disciplines, gender differences in music have not received sufficient attention which can be inferred based on the common learning-based characteristics of the other subjects. Therefore, this study used network analysis to explore the core features of male and female students' music academic engagement and its differences. The findings of the study not only help music teachers gain insight into the internal structure of academic engagement, but also provide them with evidence to support the design of differentiated academic engagement enhancement strategies. More importantly, this study potentially contributes to broaden the methodological perspective of academic engagement research.

Method

Participants

This study used cluster random sampling to select one school from all universities in Shanxi Province, China. Most schools in Shanxi Province have music major, so music students are distributed over a wider geographical area. Bougie and Sekaran (2019) argued that cluster random sampling is useful when the relevant respondents are distributed over a wide area. By employing this sampling technique, a substantial portion of the population can be covered, thus rendering the sample representative. Therefore, cluster random sampling was chosen for this study.

The school is a well-known comprehensive university in Shanxi Province, enrolling high school graduates from all over the country. Students entering this school need to have a total score of 492 or above in the entrance examination, and the school has music majors such as vocal music, piano, music performance, and composition and technical theory of composition. The college currently has a total of approximately 24,000 students. There were about 600 students major in music at this college, and ultimately 515 college students volunteered to participate in this study. In order to be eligible for participation in our study, individuals had to meet several specific criteria. Firstly, they needed to be enrolled as college students, thus ensuring that they were currently pursuing higher education. Secondly, it was essential that their chosen field of study aligned with music, indicating their specialization in this domain. Lastly, all participants were required to provide comprehensive and complete data, guaranteeing the integrity and reliability of the information gathered for analysis. By establishing these criteria, this research aimed to ensure the relevance and suitability of the participants for our research objectives. The sample size for this study ($N = 515$) is consistent with statistical power based on previous research experience (Blanco et al., 2020; Hardy et al., 2021; Liu et al., 2022). The mean age of the participants was 19.16 years old with a standard deviation of 1.55. There were 198 female students (38.4%) and 317 male students (61.6%). The average score of participants' last semester's grades was 487 (95%) above 60 and 28 (5%) below 60.

Instruments

Following the criterion of applicability, the Chinese version of the *Music Academic Engagement Scales* by Guo et al. (2023) was used for measurement in the selection of the scales. The scale was developed from Wang et al.'s (2016) *The Math and Science Engagement Scales* with 197 citations in Web of Science as of 26th May 2023. The Chinese version of the scale has shown good reliability in previous studies of Chinese music universities (Guo et al., 2023). *The Music Academic Engagement Scales* include three subscales of *cognitive engagement, emotional engagement,* and *behavioral engagement,* with a total of 30 questions. *Cognitive engagement* (8 questions; e.g., I go through the work for music class and make sure that it's right), *behavioral engagement* (11 questions; e.g., I stay focused in music class), and *emotional engagement* (11 questions; e.g., I look forward to music class). Respondents answered on a 5-point Likert scale from 1 = *Strongly disagree* to 5 = *Strongly agree*. In *The Music Academic Engagement Scales*, the fit index displayed the good structural validity (χ^2/df = 401.385/95, CFI = 0.960, TLI = 0.950, RMSEA = 0.079, SRMR = 0.028, CR = 0.971, AVE = 0.528). Cronbach's α for the total scale was 0.899. Cronbach's α for *cognitive engagement* was 0.793; Cronbach's α for *behavioral engagement* was 0.847; Cronbach's α for *emotional engagement* was 0.684.

Procedure

The data for this study were collected from March 24th to May 10th in 2022 through the electronic questionnaire website of Questionnaire Star (https://www.wjx.cn/). First, the research project and questionnaire were approved by the academic ethics committee of the investigating university. Second, informed consent for the study was provided to the participants. For the 23 students under the age of 18, permission for this study was obtained from their parents. Participants were informed that all their responses would be kept confidential and that the data collected would be used for academic research purposes only. Finally, academically trained research assistants (the counsellors of the participating students were invited to act as research assistants in this study) used Questionnaire Star (a classic online survey platform) to release and collect the questionnaire, and participants spent an average of 20 minutes completing the online questionnaire. The online survey was conducted by the tutors during class meetings. The counsellor provided additional guidance and instructions to the students before they began the survey. This included explaining the purpose and meaning of the study, stating ethic related questions of this study, providing assistance as needed during the survey process.

Data analysis

The option settings of the online question did not allow participants to skip any items, so no question data were missed. Prior to data analysis, this study examined the normal distribution of the data by Skewness and Kurtosis. Skewness ranged from -0.874 ~ 0.252; Kurtosis ranged from -0.940 ~ 2.816; both values were acceptable (Skewness < 3 and Kurtosis < 10 (Kline, 2016). Descriptive statistical analyses were first conducted in this study with SPSS, v. 23.0 (IBM Corp, 2015), and then R, v. 3.6.3 (R Core Team, 2020) in RStudio, v. 1.2.5033 (RStudio Team, 2020) was used to analyze the core features of the music academic engagement and to compare them. The network analysis methods in this study followed the standard guidelines from Epskamp et al. (2017).

Network estimation

According to the guidelines of Epskamp et al. (2017), the EBICglasso function of the *qgraph, v. 1.9.2* (Epskamp et al., 2012) package was used to evaluate the network structure. In this study, a Gaussian graphical model (GGM; Costantini et al., 2015) was estimated by using graphical lasso (i.e., glasso) combined with the extended Bayesian information criterion model (EBIC; Chen & Chen, 2008). The GGM is applied to non-binary data, in which all nodes are assumed to be positively too distributed. The thickness of the edge represents an estimate of the bias correlation coefficient, indicating the interrelationship between two nodes. The blue line of the edge represents positive correlation and the red line represents negative correlation. In this study, the estimates were performed separately for the male sample and the female sample. In addition, the average layout function in the graphics package was applied in order to provide a clear visualization of the two networks.

Estimation of centrality indicators

The centrality Plot function in the *qgraph, v. 1.9.2* (Epskamp et al., 2012) package is used to compute the centrality metrics indices of centrality: strength, closeness and expected influence. The strength of a node is the sum of the weights of all edges directly connected to that node. The higher the strength level the stronger the direct connection of a node to other nodes. The closeness of a node is calculated by taking the reciprocal of the sum of the shortest path lengths between all nodes to evaluate, which is used to measure the average distance between the node and all other nodes in the network. Higher closeness of a node indicates that the influence of that node spreads quickly to other nodes (Borgatti et al., 2009). Expected influence weighted out by the absolute size of the relevant edges, both positive and negative (Robinaugh et al., 2016). A node having a high expected influence implies higher centrality and importance in the network (Blanchard et al., 2021).

Network stability and accuracy

The *bootnet, v. 1.5* (Epskamp et al., 2017) package was used to assess the accuracy and stability of the network structure. The accuracy assessment consisted of two main steps: firstly, the accuracy of edge-weights was estimated by bootstrapping the 95% confidence intervals (CIs) of the edge weights. Narrow bootstrapped CIs denoted low sampling variability in the edge-weights, indicating that the estimated network was accurate. Secondly, the stability of the node centers was evaluated by case-dropping subset bootstrap. The correlation stability coefficient (CS-coefficient) was used to quantify this stability. CS-coefficient above 0.25 indicates acceptable and above 0.5 indicates excellent (Epskamp et al., 2017).

Network comparison

The *NetworkComparisonTest, v. 2.2.1* (van Borkulo et al., 2021) package was used to detect differences between the male and female networks (iterations = 1000; seed = 1234). To assess the differences between networks, three aspects were tested in this study: a network structure invariance test, a global strength invariance test, and an edge strength invariance test (Van Borkulo et al., 2015). The network invariance test evaluates the difference in the maximum edge strength of the network by assessing the difference in the sum of the edge strengths; the global strength invariance test evaluates the difference between specific edges in the network by assessing the edge strength invariance test; and the edge invariance test was evaluated by the differences between specific edges in the network (Van Borkulo et al., 2015).

Results

Network estimation of male and female students' music academic engagement

The two networks yielded 435 (30*(30-1)/2) edges, with 150 and 153 nonzero-weighted edges in males and females respectively, as shown in Figure 1. Although the overall structures are similar, there

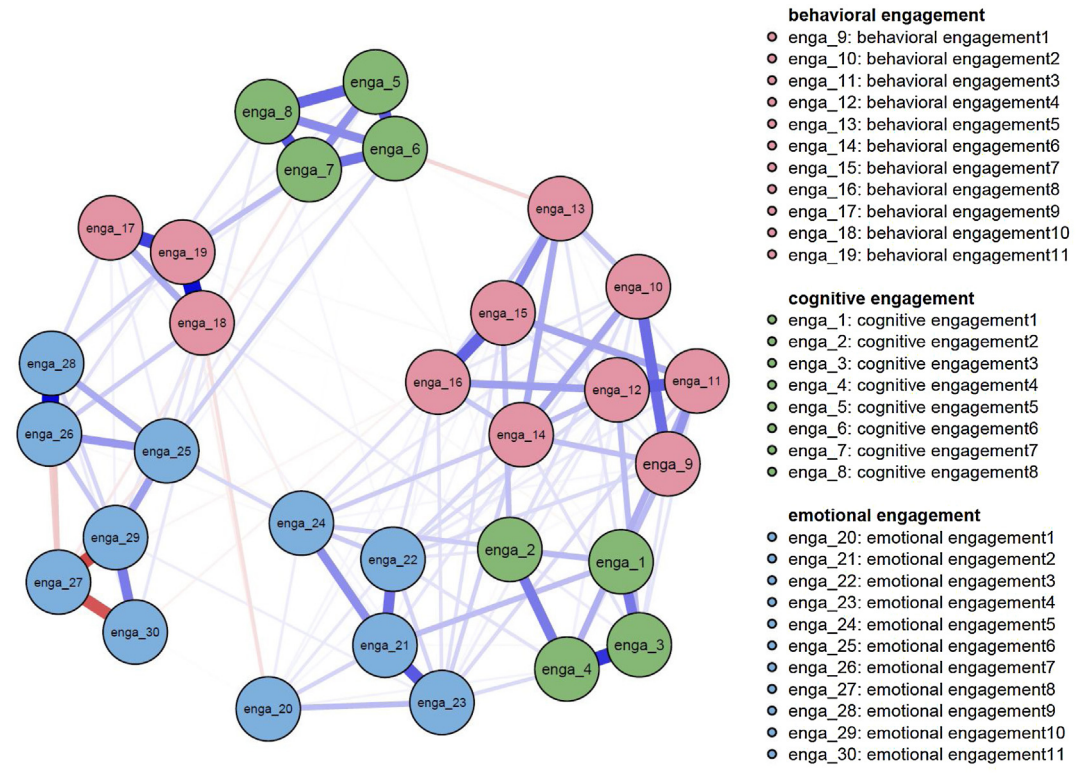

Figure 1. The networks of male (A) and female (B) students' music academic engagement were analyzed and visualized in Figure 1. Nodes in the figures represent specific music academic engagement features, while edges depict the correlations between them. The width of the edges indicates the strength of the partial correlations, and their color represents the correlation valence: blue for positive, red for negative. Features within the same feature clusters are shown in the same color; red represents *behavioral engagement*, green represents *cognitive engagement*, and blue represents *emotional engagement*. For detailed descriptions of the music academic engagement items, please refer to Table 1.

Table 1
Network nodes of music academic engagement

Item	Component cluster	Feature of music engagement	Abbreviation
Enga1	Cognitive engagement	I go through the work for music class and make sure that it's right	Check the work for music class
Enga2	Cognitive engagement	I think about different ways to solve the problem of music class	Use multiple cognitive strategies
Enga3	Cognitive engagement	I try to connect what I am learning about music to things I have learned before	Use deep processing strategy
Enga4	Cognitive engagement	I try to understand my mistakes when I get something wrong in my music learning	High self-regulation
Enga5	Cognitive engagement	I would rather be told the answer than must do the work in music learning	Low investment in music learning
Enga6	Cognitive engagement	I don't think that hard when I am doing work for music class	High self-efficacy
Enga7	Cognitive engagement	When work is hard, I only study the easy parts	Avoidance of difficult work
Enga8	Cognitive engagement	I do just enough and don't do more than is required in music class	Do only what is required
Enga9	Behavioral engagement	I stay focused in music class	Stay focuse
Enga10	Behavioral engagement	I answer questions in music class	Answer question
Enga11	Behavioral engagement	I put effort into learning music	Put effort
Enga12	Behavioral engagement	I keep trying even if music is hard	Keep trying
Enga13	Behavioral engagement	I ask questions in music class	Ask question
Enga14	Behavioral engagement	I complete my music homework on time	Complete homework
Enga15	Behavioral engagement	I talk about music outside of class	Talk about music outside of class
Enga16	Behavioral engagement	I try to learn more about music	Learn more about music
Enga17	Behavioral engagement	I am not keen on music learning	Not keen on music learning
Enga18	Behavioral engagement	I do other things when I am supposed to be paying attention to music learning	Low self-discipline
Enga19	Behavioral engagement	If I don't understand music, I give up right away	Low persistence
Enga20	Emotional engagement	I like the challenge of learning music	Like the challenge of learning music
Enga21	Emotional engagement	I look forward to music class	Look forward to music class
Enga22	Emotional engagement	I enjoy learning new things about music	Enjoy the music class
Enga23	Emotional engagement	I want to understand what is learned in music class	Focus on the music classroom
Enga24	Emotional engagement	I feel good when I am in music class	Feel good in music class
Enga25	Emotional engagement	I often feel frustrated in music class	Feel frustrated in music class
Enga26	Emotional engagement	I think that music class is boring	Music class is boring
Enga27	Emotional engagement	I can't keep up with the music lessons	Can't keep up with music lessons
Enga28	Emotional engagement	I don't care about learning music	Don't care about learning music
Enga29	Emotional engagement	I often feel down when I am in music class	Feel down in music class
Enga30	Emotional engagement	I get worried when I learn new things about music	Worry about music learning

were differences in the way nodes are connected and the strength of edges in the two networks.

Centrality estimation of male and female students' music academic engagement

Figure 2 displayed centrality indices of music academic engagement features in both groups. Among male, Enga 19 (low persistence) had the highest strength centrality, Enga 24 (feeling good in music class) had the highest closeness centrality, and Enga 21 (looking forward to music class) had the highest expected influence. Among female, Enga 7 (avoidance of difficult work) had the highest strength and expected influence, while Enga 24 (feeling good in music class) had the highest closeness centrality.

Network accuracy of male and female students' music academic engagement

The accuracy of the two-group networks was moderately supported by the results of edge-weight bootstrapping (Figure 1, A1). The centrality indices for the male group were 0.596 (strength), 0.126 (closeness), and 0.672 (expected influence), as shown by the CS coefficients (Figure 1, A2). In comparison, the female group had centrality indices of 0.672 (strength), 0.517 (closeness), and 0.751 (expected influence).

Network comparison of music academic engagement in male and female

Three network comparisons were conducted between male and female. The first test, a network structure invariance test, found no significant differences in network structure between the two groups ($p_{male-female} = 0.879$), indicating that the overall structures were similar. The second test, a global strength invariance test, also showed no significant differences in the strength of student engagement networks (male = 14.50, female = 14.51; $p_{male-female} = 0.982$). However, the third test, an edge invariance test, revealed that several edges were significantly different between the two groups.

The edge invariance test showed that 19 edges were significantly different between male and female. Of note, the edge connecting Enga2 (use multiple cognitive strategies) and Enga16 (learn more about music) was significantly stronger in female than male ($p = 0.020$), as was the edge connecting Enga2 (use multiple cognitive strategies) and Enga20 (like the challenge of learning music) ($p = 0.042$). Table A1 presented all significant differences found in the edge invariance test.

Discussion

This study identified the core features and the internal relations of music academic engagement of college students, further examined the differences between the male and female samples on this basis.

On the one hand, basing on the core indicators estimated in the male and female samples, it can be found that the core features of the male sample are Enga19 (low persistence), Enga21 (look forward to music class) and Enga24 (feel good in music class). The core features of the female sample are Enga7 (avoidance of difficult work) and Enga24 (feel good in music class). For males, Enga19 (low persistence) is a feature unique to males, which is consistent with the findings of Lam et al. (2012) and Lietaert et al. (2015) that males tended to show less effort in learning and show lower levels of attention and persistence. Furthermore, Enga21 (look forward to music class) is also a core feature unique to males, which is inconsistent with existing research findings. Trollinger (2021), through a review of existing research on differences in attitudes between male and female students in the music classroom, concluded that male students have lower attitudes and interest in the music classroom. This inconsistency may be due to the age of the literature reviewed by Trollinger (2021), such as MacGregor (1968) and Nolin (1973), and the fact that these studies were conducted

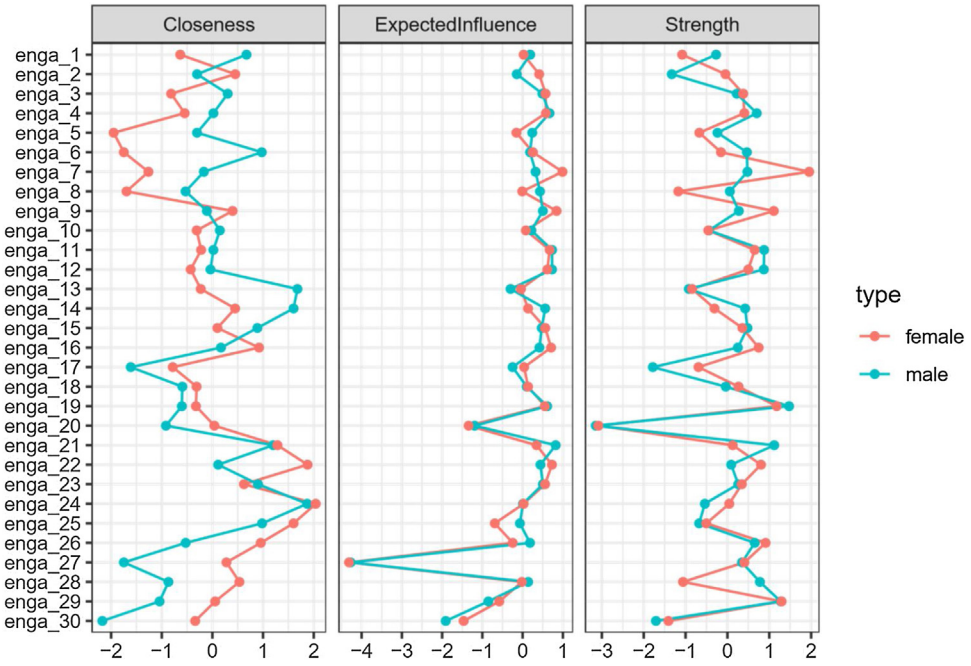

Figure 2. Standardized estimates of centrality for music academic engagement features by two groups. The red line represents female. The blue line represents male.

at the primary school level. McPherson and Hendricks (2010) suggested that age is an important factor in an individual's interest in the music discipline, and that interest in music increases with age. Therefore, the expectations, interests and attitudes towards music are different for males at university level and those at the primary level. For females, Enga7 (avoidance of difficult work) is a female unique feature. This is consistent with the findings of existing research. This is because female in the field of music tend to show a lower sense of self-efficacy, compared to male (Egilmez, 2015; Wehr-Flowers, 2006). Self-efficacy is considered to be the degree to which people believe they are capable of performing and successfully completing a task (Bandura, 1982). Furthermore, Enga24 (feel good in music class) has been found as a core feature shared by both male and female, which is consistent with previous research. Martín et al. (2021) stated that, for all people, music has a prominent role in alleviating loneliness, negative emotional states, and self-confidence. The above answers *Question One* of this study.

On the other hand, the results of this study showed that male and female students' music academic engagement are identical in terms of network structure and overall strength, while being different in terms of edge strength (the way in which particular features interact with other features). In particular, the association between Enga2 (use multiple cognitive strategies) and Enga16 (learn more about music) is stronger in female than that of male. This is consistent with the results of existing studies. Okyar (2021) believed females use more metacognitive and affective strategies in music learning, such as self-monitoring, self-evaluation, and seeking. These multiple cognitive strategies will enable women learn more about music. Moreover, the association between Enga2 (use multiple cognitive strategies) and Enga20 (like the challenge of learning music) is stronger in female than that of male. This is also consistent with the findings of existing research. In addition to the fact that females use more cognitive strategies in music learning than males, females also show more interest in and more attention to music learning than males (McPherson et al. 2015). This would enhance their willingness to embrace the challenges associated with music learning. The above discussion answers *question Two* of this study.

Implications

This study is innovative in two main ways. Firstly, this study is the first to explore gender differences in music academic engagement. Therefore, this study contributes to this field in the face of the lack of research in this area. Secondly, this study is innovative in its use of network analysis to analyze gender differences in academic engagement. Network analysis is a promising method and has been increasingly used in recent years in the study of gender differences (Castellanos et al., 2020; Maccallum et al., 2021). The present study identifies core features of male and female music academic engagement by using network analysis and comparing the two networks. The findings not only explain the differences between male and female academic engagement in music from the perspective of network structure and features, but also help to bridge the debate about the gender differences in academic engagement.

For the practical implications of this study, the findings indicate that academic engagement in music varies in some aspects between males and females. These findings hold significance for music teachers, as they can utilize this information to develop personalized teaching strategies aimed at enhancing students' academic engagement. Since academic engagement is positively related to attention, attendance, academic performance, self-regulation, and academic achievement (Gershenson, 2016), the question of how to improve students' academic engagement has become a key concern for teachers (Khlaif et al., 2021). Music teachers could design music teaching activities and deliver instruction based on the core features of male and female students' academic engagement and its differences.

Specifically, when it comes to male students, music teachers could make use of Enga19 (low persistence) and Enga21 (look forward to music class) as key indicators of academic engagement that are commonly displayed by males. Music teachers could avoid coercing boys to increase their behavioral engagement because of the Enga19 (low persistence) they exhibit when designing teaching activities. This may cause them to withdraw from emotional and cognitive engagement, such as simply going through the motions and disruptive noncompliance (Finn et al., 1995). At the same time, music teachers could take advantage of the core features of male

students' expectations of the music classroom to design novel, interesting and challenging music activities. For example, integrating technologies such as music production software and digital instruments into the music classroom could significantly increase male students' academic engagement (Lee & Chang, 2021).

For female students, music teachers could refer to the core features of Enga7 (avoidance of difficult work) that are specific to females. Music teachers should focus on improving their self-efficacy and self-evaluation, as female students are more likely to underestimate themselves in these abilities, compared to male students (Hewitt, 2015). Success is an important factor in improving self-efficacy (Bandura, 1977), therefore music teachers could help female students to set achievable goals so that they can reap the benefits of accomplishment and improve their self-efficacy in the process of completing the tasks. In addition, music teachers could provide female students with self-efficacy scales to enable them to evaluate themselves correctly and objectively, such as *General Musical Self-Efficacy Scale* (Casanova et al., 2022) and *Music Performance Self-Efficacy Scale* (Börekci. et al., 2023).

Limitations and future study

This study examined the core features of male and female students' academic engagement and its differences, providing important evidence for music teachers to improve students' academic engagement. Despite the novelty of the results and the value of the findings, the study still has several limitations. First, like most other network studies (Cao et al., 2019), the analysis in this study is based on cross-sectional and group-level data. However, whether the core features of male and female students' music academic engagement vary with age, i.e., whether the core features vary at primary school, secondary school, high school, and university levels. Therefore, longitudinal intra-individual analyses, such as dynamic networks, are needed to validate the result (Bos et al., 2017). Secondly, this study employed self-report methods to determine participants' academic engagement, which may be limited by self-report bias (Caputo, 2017), particularly for behavioral engagement. Future research could use teacher-reported methods to measure students' behavioral engagement. Finally, the participants in this study all came from music majors, and Brint et al. (2008) noted that there were also differences in students' academic engagement across disciplines, and future research could further compare the differences in students' academic engagement in music majors versus other majors. Future studies, therefore, are encouraged to use a more comprehensive sample and a diverse range of methods.

Conclusions

This study aimed to explore gender differences in music academic engagement and make contributions to this area that lacks sufficient research. By network analysis, the study identified core features and differences in male and female music academic engagement. The findings shed light on several important aspects. Firstly, the core features unique to male music academic engagement were identified as *low persistence* and l*ook forward to music class.* "Secondly, the core feature unique to female music academic engagement was found to be *avoidance of difficult work*. Additionally, the shared core feature of both male and female students was *feel good in music class.* Furthermore, the study revealed that while the overall network structure and strength of music academic engagement were similar between genders, differences were observed in the strength of specific connections (edges). Female students demonstrated stronger associations between using multiple cognitive strategies and learning more about music, as well as between using multiple cognitive strategies and liking the challenge of learning music. This study contributes to the field as the first to examine gender differences in music academic engagement by utilizing network analysis to analyze these differences. The findings not only provide insights into the structure and features of male and female music academic engagement but also contribute to the ongoing debate on gender differences in academic engagement. In summary, this study provides valuable insights into gender differences in music academic engagement. The identified core features and their implications offered opportunities and methods for music teachers to enhance students' academic engagement and improve students' overall educational experience.

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Appendix A. Supplementary data

Supplementary material related to this article can be found, in the online version, at doi: https://doi.org/10.1016/j.psicoe.2023.06.003.

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