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RESEARCH ARTICLE

The role of service learning in promoting musical creativity and educational belief transformation among Pre-service music teachers

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ABSTRACT

This study employs a quasi-experimental design to explore the mechanisms by which service-learning influences the creativity and educational beliefs of preservice music teachers. Sixty-two music education major students from a normal university were selected: the experimental group (n=32) participated in a 16-week community music service project, while the control group (n=30) received regular coursework. Multidimensional data on music creativity, educational beliefs, environmental awareness, and social support were collected through pretest, midtest, and posttest measurements. Results showed: the experimental group's total music creativity score increased from a pretest mean of 68.45 (SD=8.23) to a posttest mean of 89.72 (SD=7.56), representing a 31.08% increase, significantly higher than the control group's increase from 67.89 to 72.34, a 6.55% increase ($p<0.001$, Cohen's $d=2.34$); educational beliefs increased from 2.8 to 4.7 points, a 67.9% increase, with social responsibility increasing by 80.8%, while the control group increased only 14.8% ($p<0.001$, $d=3.26$). Mediation analysis revealed that environmental awareness explained 32.4% of creativity growth and 36.9% of belief transformation; moderation analysis found that social support strengthened the effect of environmental awareness (interaction term $\beta=0.18$-0.21, $p=0.002$); reflection depth analysis indicated that the critical reflection group's outcomes were 75-127% higher than the descriptive reflection group ($\eta^2=0.695$-0.758). The study confirms that service-learning promotes preservice teacher professional development through multiple mechanisms of "authentic context → environmental awareness → reflective processing → social support," providing empirical support for innovative teacher education models. Theoretically, this study constructs an ecological action model of "authentic context → environmental awareness → reflective processing → social support," breaking through the traditional linear training paradigm and enriching the interdisciplinary theory of service-learning and music education. Practically, the study provides an operational pathway for higher music education reform.

Keywords: service learning; pre-service music teachers; musical creativity; educational belief transformation; reflective practice; environmental perception; social support network; mixed-methods research

1. Introduction

Teacher education reform has become a major focus in contemporary education. How to cultivate pre-service music teachers with innovative spirits and advanced educational beliefs presents an important issue in music education. Traditional training models for pre-service music teachers often emphasize musical skill

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development and theoretical knowledge transmission. These models show obvious deficiencies in fostering student musical creativity and promoting educational belief transformation. Recent years have witnessed growing scholarly attention to innovative pathways in music teacher education. Researchers have explored integrating modern bands into curriculum systems to inspire teaching innovation. Others have examined the professional mission of vocational undergraduate music teachers from the perspective of cultural confidence. Studies have also analyzed characteristics and effectiveness of music teacher education programs across different countries and regions[1]. These investigations provide diverse perspectives for music teacher training. However, how systematic practical activities can promote comprehensive development of pre-service music teachers requires further exploration. Specifically, three major research gaps exist in current studies: first, there is a lack of theoretical explanation and empirical testing of how service-learning affects music creativity through psychological mechanisms such as environmental awareness and social interaction; second, there is insufficient systematic exploration of the psychological dynamics and transformation pathways through which service-learning triggers educational belief change; third, the interactive mechanisms among environment, individual cognition, and social support in preservice music teachers' professional development have not been revealed.

Service learning offers new possibilities for pre-service music teacher education. This pedagogical approach combines academic learning with community service. The model emphasizes music education service delivery in authentic community contexts. Students deepen professional understanding through interactions with diverse service recipients. They activate creative potential and reshape educational beliefs. Environmental psychology provides one useful lens for analysis. Authentic community environments offer rich learning contexts for students. The complexity and unpredictability of these contexts require flexible application of musical knowledge. Students must improvise musical activities suitable for different group needs. This process effectively promotes musical creativity development[2]. Social psychology offers another analytical perspective. Deep interactions with service recipients, community members, and peers during service learning can stimulate empathy and prosocial behavior. Such experiences prompt students to re-examine the social responsibility of teacher roles. Educational beliefs transform from traditional knowledge transmitters toward learning facilitators and social servants[3]. For example, Yang Jie explored practical pathways for music major students in normal universities to support after-school music services in elementary schools. This work demonstrates the application value of service learning in music education. Research on music education for special student populations further reveals the significance of inclusive teaching beliefs for teacher professional development[4].

Current research lacks in-depth theoretical elaboration and empirical examination of service learning mechanisms in pre-service music teacher training. Studies on how service learning promotes musical creativity through environmental and social psychological interactions remain scarce. The psychological dynamics and transformation pathways through which service learning triggers educational belief changes have not been systematically explored[5]. International attention to innovative practices in music teacher education exists. Examples include innovative explorations in secondary music teacher training in Spain, analysis of music teacher education programs in Puerto Rico, and collective case studies of elementary music teachers integrating modern bands into curricula. However, these studies mostly focus on curriculum content and teaching method reforms. Few adopt the unique perspective of service learning. They have not fully examined the explanatory power of environmental and social psychological theories[6].

Based on this research background, this study aims to systematically explore how service learning promotes musical creativity and educational belief transformation in pre-service music teachers. We adopt dual perspectives from environmental psychology and social psychology. The research will employ mixed

methods. We will design a systematic service learning project and collect quantitative and qualitative data. The analysis will examine how authentic community environments, social interactions, and reflective practice jointly affect professional growth of pre-service music teachers[7]. This study enriches the interdisciplinary theoretical framework connecting service learning, music education, and psychology. It provides empirical evidence for higher music education reform. Ultimately, the research promotes cultivation of a new generation of music teachers with innovative capabilities, social responsibility, and advanced educational beliefs. These teachers can better serve fundamental music education and national strategic needs such as rural revitalization.

2. Literature review

This review unfolds across three dimensions: the integrative exploration of service-learning and music teacher education, focusing on preservice training model innovation and practice-oriented curriculum reform; the psychological mechanisms of music creativity development, examining the pathways through which situated learning, social interaction, and cognitive flexibility influence creativity; and the sociopsychological dynamics of educational belief transformation, exploring the roles of emotional intelligence, professional identity, and critical reflection in belief reconstruction.

The role of service learning in pre-service music teacher education has gained increasing scholarly attention. Existing literature provides theoretical foundations and practical references for this study from multiple dimensions. First, researchers widely recognize the foundational role of pre-service training in teacher professional development. Li Dongjing systematically reviewed theoretical sources of music teacher pedagogical competence. Contemporary music teachers need solid musical skills. They also require innovative teaching abilities and advanced educational beliefs. This framework helps understand pre-service training objectives[8]. Ma Qin further explored optimization strategies for music education curriculum design. The author emphasized the importance of practice-oriented courses in cultivating applied talents. However, traditional curriculum systems still show deficiencies in connecting theory with practice[9]. Liu Jinling and colleagues analyzed the transformation of teaching responsibilities for college music teacher educators under the innovation and entrepreneurship context. Teacher educators should shift from mere knowledge transmitters to cultivators of student innovation and social responsibility. This view provides reform basis for service learning intervention in pre-service training[10]. International research also focuses on challenges and innovations in music teacher education. Music teacher educators in Ireland and Northern Ireland pointed out difficulties in primary teacher education. Music subjects face compressed curriculum time and limited practice opportunities. Policy analysis of music teacher certification in the United States revealed variations in training standards across states and their impact on teacher quality.

Second, musical creativity cultivation serves as a core objective in music education. Theoretical and practical research has formed considerable accumulation. Li Yixuan summarized various teaching methods for cultivating student creativity in music education. These include improvisation, music games, and interdisciplinary integration strategies. However, these methods are mostly confined to classroom contexts. They lack support from authentic social environments[11]. Jiang He systematically reviewed international experiences in musical creativity cultivation. Finland, Hungary, and other countries effectively stimulated student creative potential through community music projects and extracurricular practice activities. This provides important insights for adopting the service learning model in this study[12]. Zhao Xin explored secondary student musical creativity cultivation strategies from a core competency perspective. The author emphasized the promoting effect of contextualized learning and authentic problem-solving on creativity development[13]. Cui Linjing's research showed that music practice activities significantly influence student

musical creativity. Creative thinking receives full exercise when students design music activities according to specific audiences and contexts[14]. Chen Yanan analyzed musical creativity cultivation during compulsory education from a music psychology perspective. Motivation, emotion, and cognitive flexibility are key psychological factors affecting creativity. Social interaction and environmental stimulation can effectively activate these psychological mechanisms[15]. These studies provide theoretical support for understanding how service learning promotes musical creativity through authentic contexts and social interactions.

Third, researchers value social psychological factors such as emotional intelligence, psychological empowerment, and professional identity in pre-service music teachers. Jiang and Tong's research revealed that emotional intelligence in pre-service music teachers influences innovative teaching behaviors through chain mediation of psychological empowerment and professional commitment. This finding indicates that enhancing teacher social-emotional competence is crucial for cultivating innovative spirit[16]. Li and Huo examined the relationship between music teacher leadership and burnout in China. Supportive work environments and positive social interactions can effectively alleviate teacher stress[17]. Confredo also called for attention to stress and burnout issues among music teachers. The author emphasized the necessity of establishing psychological resilience and social support networks during teacher training[18]. Gerrard's research on pre-service music teacher perception of teaching contexts showed that student cognitive and emotional experiences of authentic teaching environments significantly influence educational belief formation. This provides empirical evidence for the value of service learning in offering authentic community contexts[19]. Additionally, Fuelberth and Woody emphasized that inclusive music teacher education should value breadth and diversity. Teachers develop understanding and respect for different learners through authentic immersive experiences. This coincides with service learning's emphasis on diverse service recipient interactions[20].

Finally, research on educational belief transformation and innovative teaching models provides methodological insights for this study. Korean pre-service music teacher perception of blended learning showed that technology-supported diverse learning environments can promote teacher pedagogical concept renewal. However, online learning cannot fully replace the value of authentic interpersonal interaction[21]. Research on popular music pedagogy application in music teacher education showed that integrating contemporary music culture into training processes can stimulate student learning motivation and creativity. Critical pedagogy research on anti-racist music education emphasized that teacher education should cultivate student social justice awareness and cultural sensitivity. This highly aligns with service learning's emphasis on social responsibility cultivation[22]. Research on integrating multimedia learning into music teacher training programs in rural Fujian, China showed that training models combining local culture and community needs can enhance teacher practical ability and cultural identity. However, this research mainly focused on in-service training. Systematic research on pre-service teachers remains insufficient.

A comprehensive review of existing literature reveals several deficiencies despite extensive research on music teacher education, creativity cultivation, and educational belief transformation. First, existing studies mostly focus on classroom teaching reform and curriculum optimization. Few examine the systematic influence of authentic community environments on pre-service music teacher professional development. Second, research on musical creativity cultivation mostly proceeds from teaching method perspectives. Exploration of creativity development mechanisms from environmental psychology and social psychology perspectives remains weak. Third, although some studies involve teacher emotional intelligence and professional identity, they lack in-depth analysis of how service learning promotes educational belief transformation through social interaction and reflective practice. Fourth, international experiences provide useful references for this study. However, empirical research on service learning in pre-service music teacher

training in the Chinese context remains scarce. Therefore, this study adopts dual perspectives from environmental and social psychology. We systematically explore the promoting effect of service learning on musical creativity and educational belief transformation in pre-service music teachers and examine internal mechanisms. This aims to address current research gaps and provide new theoretical frameworks and practical pathways for music teacher education reform.

3. Research methods

3.1. Research design

This study employs a mixed methods research design. The aim is to comprehensively explore how service learning promotes musical creativity and educational belief transformation in pre-service music teachers. The research uses a quasi-experimental design as the quantitative framework. We selected pre-service music teachers from two classes at a music college in a normal university. One class served as the experimental group and participated in a one-semester service learning project. The other class served as the control group and received regular music education courses. Experimental group students went to community music education institutions, nursing homes, or special education schools weekly to conduct music teaching services. Total service time was no less than forty hours. Students completed structured reflection journals after each service session[23]. Control group students completed the same credit hours of professional learning through traditional classroom teaching and on-campus simulated teaching. The research conducted musical creativity assessments and educational belief questionnaire surveys at three time points: before, during, and after project implementation. This examined the intervention effects of service learning and its dynamic change process. At the qualitative research level, this study adopted a phenomenological research orientation. We used in-depth interviews, focus group discussions, and participant observation to deeply explore subjective experiences, cognitive changes, and emotional development of pre-service music teachers during service learning. Researchers randomly selected twelve experimental group students for three in-depth interviews during project implementation. Each interview lasted approximately sixty minutes. Interview content covered student perception of service environments, interaction experiences with service recipients, difficulties and breakthroughs in music creation practice, and reflection and reconstruction of educational beliefs. Researchers organized monthly focus group discussions. Six to eight students were invited to share service experiences and professional growth insights. This captured collective wisdom and shared experiences generated through group interaction[24]. Additionally, researchers conducted non-participant observation at some service sites during project implementation. We recorded student teaching behaviors, teacher-student interaction patterns, and improvisational creation performance to form detailed field notes. The integration of mixed methods follows explanatory sequential design principles. Quantitative data first identifies overall impact trends of service learning on creativity and educational beliefs. Qualitative data then provides in-depth explanation of psychological mechanisms and social interaction processes behind these changes. Quantitative and qualitative data complement and verify each other during the analysis stage. This ultimately forms comprehensive understanding of research questions. This design provides evidence for causal inference in the statistical sense. It also captures the complexity and contextual specificity of pre-service music teacher professional development. The approach provides solid empirical foundation and rich theoretical insights for service learning application in music teacher education.

3.2. Research subjects and sampling

Research subjects were second-year undergraduate students from the music college at a provincial normal university. We chose this grade because students had completed basic music theory and skill courses.

They possessed basic capabilities for conducting music education services. They had not yet entered the educational internship stage and had sufficient time to participate in the service learning project. The research employed a strategy combining purposive sampling and convenience sampling. We selected two classes from four parallel classes in this grade as research samples. Music Education Major Class 1 was designated as the experimental group. It had thirty-two students, including nine males and twenty-three females. Age range was nineteen to twenty-one years. Music Education Major Class 2 served as the control group. It had thirty students, including eight males and twenty-two females. Age distribution was basically consistent with the experimental group[25]. The two classes showed no significant differences in entrance examination scores, major direction distribution, gender ratio, and family background through independent sample t-tests and chi-square tests. It should be noted that although the sample size of this study (experimental group n=32, control group n=30) meets the basic requirements of quasi-experimental design, it is relatively small and may affect the external validity and statistical power of the results. Future research should expand the sample size and include multiple institutions to enhance generalizability. All 32 students in the experimental group completed the study. In the control group, 2 of the original 32 students withdrew midway due to personal reasons, with 30 ultimately retained, yielding an overall retention rate of 96.8%.This ensured comparability between groups and internal validity of research results. Within the experimental group, the research further employed maximum variation sampling strategy to select twelve students as in-depth interview subjects for qualitative research. These students showed diversity in musical skill level, personality characteristics, service willingness intensity, and previous volunteer service experience. This ensured capture of differentiated experiences of students from different backgrounds in service learning. Interview subjects included four students with outstanding music performance abilities but limited teaching experience. Four students had strong teaching awareness but relatively weak creative abilities. Four students showed average performance in both musical skills and teaching awareness. Additionally, the research specifically included two students with rich volunteer service experience and two students who had never participated in community service. This allowed comparative analysis of the influence of previous service experience on service learning effects. The research followed strict ethical standards. Before project launch, we explained research purposes, process arrangements, data usage methods, and voluntary participation principles to all participating students in detail. We obtained written informed consent from all students. Students were explicitly told they had the right to withdraw from the research at any time without adverse effects. Personal information would be strictly confidential. Research reports would use pseudonyms or codes instead of real names[26]. For minority students under eighteen years old, the research also obtained guardian consent. Throughout the research process, researchers established equal and trusting relationships with participating students. This ensured students could truly express their views and feelings and avoided response bias caused by power relations. Final sample retention rate reached 96.8%. Only two students withdrew from the research midway due to personal reasons. Sample attrition rate was controlled within acceptable range. This provided guarantee for data integrity and reliability. It should be noted that the sample of this study was limited to second-year undergraduate students at a provincial normal university. Although independent samples t-tests and chi-square tests ensured between-group equivalence (entrance examination scores $p=0.742$, gender ratio $p=0.856$, family background $p=0.691$), enhancing internal validity, the sample homogeneity (age concentrated in 19-21 years, similar music professional training backgrounds, same regional cultural environment) limits the generalizability of the research findings to other preservice music teacher populations. In particular, the findings of this study may not be fully applicable to preservice teachers in different regions (such as underdeveloped western areas), different types of institutions (such as vocational and technical colleges), or different grade levels (such as first-year or fourth-year students). Furthermore, although the sample size (n=62) meets the basic requirements of quasi-experimental design, the statistical

power is relatively limited when testing complex interaction effects, which may affect the sensitivity to detect small to medium effects.

3.3. Service learning project design

The service learning project designed for this study lasted sixteen weeks. It aimed to create authentic music education practice contexts for pre-service music teachers and promote development of their musical creativity and educational beliefs. The project established cooperative relationships with three types of community institutions. These included two urban community music education centers, one special education school, and two elderly care service institutions. This provided students with diversified service fields and audiences. Experimental group students independently chose service institutions according to personal interests and professional strengths. They went to fixed institutions weekly to conduct no less than three hours of music teaching or music activity organization work. At community music education centers, students mainly provided music enlightenment courses for children of migrant workers and left-behind children. Teaching content covered singing, rhythm training, and simple instrument performance. At special education schools, students designed personalized music therapy programs for children with autism and intellectual disabilities. They used music games and improvisation to promote emotional expression and social interaction of special children. At elderly care institutions, students organized senior choirs and conducted nostalgic song appreciation activities. They created suitable music movement projects according to physical conditions of elderly people[27]. To ensure the controllability of experimental variables, the project implemented a standardized design for service activities: unified service duration (3 hours per week), unified reflection framework (including four elements: situation description, problem analysis, strategy reflection, and concept reconstruction), and unified supervision frequency (once every two weeks), while retaining flexibility in activity content to adapt to the needs of different service recipients.The project implementation process followed a cyclical structure of "preparation-service-reflection-presentation." During the preparation stage, students participated in two weeks of pre-service training. Content included service institution background introduction, service recipient characteristic analysis, safety precautions, and basic communication skills. Experienced community music teachers provided demonstration teaching. The service stage required students to formulate detailed teaching plans or activity programs before each activity. They clarified music education objectives, creative activity design, and expected effects. Students immediately completed daily service records after service ended. Records documented key events in the teaching process, service recipient responses, and personal feelings. The reflection stage was the core component of the project. Students wrote structured reflection journals of no less than eight hundred words weekly. Content covered challenges encountered in weekly service, creative solution strategies adopted, new understanding of service recipient needs, and educational belief reflections triggered thereby. Researchers organized collective reflection meetings every two weeks. Through group discussions, case sharing, and teacher comments, they guided students in deep reflection and peer assistance. Before project completion, each student prepared a service learning achievement presentation. Forms included self-created musical works, innovative teaching plan designs, or service documentary videos. Public presentations were made to the entire college and received evaluation from teachers and classmates. The entire project design emphasized organic combination of authenticity, diversity, and reflectivity. Through continuous practice-reflection cycles, it promoted student development of musical creativity and reshaping of educational beliefs in complex authentic contexts. To ensure consistency in implementation quality across different service institutions, the project established a three-tier standardization mechanism: First, a unified training program in which all students received 16 hours of pre-service training over two weeks, covering service ethics, communication skills, safety protocols, and basic pedagogy, delivered by the same team and assessed through situational simulations. Second, a

process supervision mechanism in which each service site was equipped with an experienced community mentor for on-site guidance, and the research team conducted biweekly supervisory inspections using a standardized "Service Quality Observation Form" to assess student participation (attendance rate, interaction frequency) and task complexity (innovation in activity design, ability to respond to unexpected situations), ensuring cross-institutional comparability. Third, a regular communication mechanism in which monthly cross-institutional student sharing sessions were organized to promote experience sharing and standard unification through case comparisons. Quality monitoring data showed no significant differences among the three types of institutions in student participation ($F=0.87$, $p=0.425$) and task complexity ($F=1.23$, $p=0.302$), validating the effectiveness of standardization.The 16-week time allocation for the project was as follows: preparation phase 2 weeks (16 hours of intensive training), service phase 12 weeks (3 hours of direct service per week, totaling 36 hours), reflection activities throughout the entire process (2 hours per week for personal reflection journal writing + 2 hours every two weeks for group discussions, totaling 40 hours), and results presentation phase 2 weeks (8 hours of preparation + 2 hours of presentation). The structured reflection journal employed a four-stage prompt framework: (1) Situational description level: "What was the most challenging situation in this week's service? Which service recipients and specific problems were involved?" (2) Problem analysis level: "Why was this situation challenging? In what aspects were my existing teaching beliefs or skills inadequate?" (3) Strategy reflection level: "What coping strategies did I adopt? Which were effective and which were not? How would I adjust if I could do it again?" (4) Concept reconstruction level: "How has this experience changed my views on music education, learners, or the teacher's role?" Each stage required at least 200 words, totaling no less than 800 words. The journals were reviewed weekly by researchers who provided targeted feedback to facilitate students' progression from descriptive to critical reflection.Given that the heterogeneity of service recipient characteristics might affect learning outcomes, the project recorded the type of service recipients for each student: community music center service recipients were left-behind children aged 6-12 years ($n=12$ students), special education school recipients were children with autism and intellectual disabilities aged 3-15 years (mild to moderate, $n=11$ students), and elderly care facility recipients were cognitively normal elderly individuals aged 60-85 years ($n=9$ students). Supplementary analysis revealed that service recipient type had no significant main effect on creativity growth ($F=1.45$, $p=0.248$), but showed an interaction effect with reflection depth ($F=3.67$, $p=0.036$): students serving special needs children who engaged in critical reflection demonstrated significantly greater creativity growth ($M=24.3$) compared to those serving other populations ($M=19.8$, $p=0.021$), possibly because the complexity of special needs more readily triggered deep cognitive reconstruction. This finding has been incorporated into Section 5.3 of the discussion, providing empirical evidence for understanding contextual differences.

3.4. Data collection methods

This study employed diversified data collection methods to ensure reliability and validity of research results. Quantitative data collection was mainly implemented through three sets of standardized measurement tools. These included the Williams Creativity Aptitude Test, Musical Creative Thinking Test, and Educational Belief Questionnaire. The Williams Creativity Aptitude Test contains fifty items. It measures four dimensions of student adventurousness, curiosity, imagination, and challenge. It uses a five-point Likert scoring method. This scale is widely applied in domestic music education and has good reliability and validity. The Musical Creative Thinking Test required students to complete three tasks within specified time. Tasks included composing melodies for designated lyrics, improvising with given musical materials, and designing an innovative music lesson for specific populations. Three music education experts independently scored each task according to four dimensions: fluency, flexibility, originality, and elaboration. Inter-rater

reliability was tested using intraclass correlation coefficients[28]. The Educational Belief Questionnaire was adapted from the Teacher Education Belief Scale. It includes four subscales: learner-centered orientation, knowledge transmission orientation, social responsibility orientation, and inclusive education orientation.The adaptation of the Educational Beliefs Questionnaire underwent a rigorous four-stage process: In the first stage, the research team, based on the original 56 items of Woolfolk and Hoy's Teacher Beliefs Scale, rewrote items in combination with music education contextual characteristics, changing "teaching students to read" to "teaching students music performance," etc., initially forming 52 items. In the second stage, five music education experts and three educational psychology experts were invited to review the relevance and clarity of the items, yielding a Content Validity Index (CVI) of 0.91; 10 low-relevance items were deleted, retaining 42 items. In the third stage, a pilot test was conducted with 45 music education major students not included in the research sample. Exploratory Factor Analysis (EFA) validated the four-factor structure, with cumulative explained variance of 68.3% and Cronbach's α for each factor ranging from 0.82 to 0.89. In the fourth stage, Confirmatory Factor Analysis (CFA) was conducted on the research sample (n=62), showing good fit for the four-factor model: $\chi^2/df=1.87$, CFI=0.94, TLI=0.93, RMSEA=0.062 (90% CI [0.048, 0.075]), SRMR=0.058, with factor loadings ranging from 0.64 to 0.87 (all $p<0.001$), confirming the construct validity of the four-dimensional structure. Inter-subscale correlations ranged from 0.23 to 0.45, supporting discriminant validity. In this study, the total scale Cronbach's α was 0.91, with the four subscales at: learner-centeredness 0.88, knowledge transmission 0.85, social responsibility 0.89, and inclusive education 0.87. Test-retest reliability (two-week interval, n=30) was 0.84.The three expert raters all held associate professor rank or above with more than 10 years of music education teaching experience, and received 3 hours of standardized training before scoring to learn scoring criteria and examples. Inter-rater reliability was calculated using Intraclass Correlation Coefficients (ICC) with a two-way mixed-effects model. The ICC values for the three tasks were: melody composition ICC(3,1)=0.92 (95% CI [0.88, 0.95]), improvisation ICC(3,1)=0.89 (95% CI [0.84, 0.93]), and curriculum design ICC(3,1)=0.94 (95% CI [0.91, 0.96]), all reaching excellent levels (ICC>0.85). ICC values for the four dimensions ranged from 0.87 to 0.93 (all $p<0.001$), indicating extremely high rater consistency. When inter-rater differences exceeded 2 points (accounting for 3.2% of total ratings), consensus was reached through three-person discussion. The final creativity total score was the weighted average of the four dimensional scores across the three tasks (weights determined by expert evaluation: fluency 25%, flexibility 25%, originality 30%, elaboration 20%), with total score Cronbach's α of 0.91 and split-half reliability of 0.88.It contains forty-two items total. These three tools were administered to experimental and control group students before project implementation, at week eight of implementation, and after implementation completion. Pre-test data confirmed baseline levels of the two groups. Mid-term testing examined the dynamic process of change. Post-test data evaluated final intervention effects. Qualitative data collection employed multiple methods to achieve data triangulation. In-depth interviews were the core qualitative data source. Researchers conducted three rounds of semi-structured interviews with twelve interview subjects in weeks four, ten, and sixteen of project implementation. Each round of interviews focused on different themes. The first round focused on environmental adaptation and role cognition in early service. The second round explored creative practice experiences and difficulty responses during the service process. The third round deeply examined educational belief transformation processes and professional identity development. All interviews were recorded with interviewee consent and transcribed verbatim within twenty-four hours. Student reflection journals constituted another important qualitative data source. Researchers collected and organized all reflection journals written by experimental group students over sixteen weeks. The total exceeded five hundred entries. These journals authentically recorded student immediate feelings, cognitive conflicts, and meaning construction processes during service. Focus group discussions were held monthly. Each session invited six to eight students to participate.

Discussion duration was approximately ninety minutes. Discussion topics were preset by researchers according to project progress. Students were encouraged to raise concerns. All discussion processes were audio and video recorded and transcribed into text[29]. Additionally, researchers conducted on-site observation of ten typical service scenarios after obtaining consent from service institutions and service recipients. The Williams Creativity Assessment Packet and the Music Creative Thinking Test were validated through pilot testing (n=45), demonstrating good reliability and validity in the Chinese music education context: Williams Scale Cronbach's α=0.89, test-retest reliability r=0.85; Music Creative Thinking Test inter-rater reliability ICC=0.92, Content Validity Index CVI=0.87, confirming their applicability.We used observation record forms to systematically record student teaching behaviors, teacher-student interaction, creative performance, and emotional states. This formed detailed observation notes and provided objective evidence for understanding actual operation mechanisms of service learning.

3.5. Data analysis methods

This study adopted a strategy combining quantitative and qualitative data analysis to comprehensively reveal the impact mechanism of service learning on musical creativity and educational belief transformation in pre-service music teachers. Quantitative data analysis was completed using SPSS 26.0 statistical software. We first conducted descriptive statistical analysis on all scale data. We calculated mean, standard deviation, skewness, and kurtosis of each variable and tested normality of data distribution. Box plots identified outliers. After confirming data quality, we used repeated measures ANOVA to examine differences in musical creativity and educational belief scores between experimental and control groups at three time points. Group served as the between-subjects factor. Measurement time served as the within-subjects factor. Interaction effect testing determined whether service learning intervention effects were significant. For variables with baseline differences in pre-tests, we used ANCOVA to control the influence of pre-test scores and ensure accuracy of between-group comparisons. Additionally, the research used paired sample t-tests to analyze changes in experimental group student dimension scores before and after the project. Effect sizes were calculated to evaluate practical significance of intervention effects[30]. To explore the role of psychological variables such as environmental perception and social support in the process of service learning affecting creativity and belief transformation, the research used the PROCESS macro program developed by Hayes for mediation and moderation effect testing. Model 4 was selected for simple mediation analysis as it is suitable for testing causal chains with a single mediating variable. Moderation analysis was similarly based on theoretical hypotheses to examine how social support modifies the effect strength of environmental awareness. This study adopted unified effect size reporting standards: Cohen's d for between-group comparisons (0.2 for small effect, 0.5 for medium effect, 0.8 for large effect), and η^2 for analysis of variance (0.01 for small, 0.06 for medium, 0.14 for large effect). All effect sizes were accompanied by 95% confidence intervals to assess estimation precision.We used bootstrapping to generate confidence intervals. Sample size was set at five thousand iterations to improve robustness of statistical inference. Qualitative data analysis followed the six-step procedure of thematic analysis. Steps included familiarizing with data, generating initial codes, searching for themes, reviewing themes, defining and naming themes, and writing the report. Researchers first repeatedly read interview transcripts, reflection journals, and observation notes to form an overall grasp of data content. We then used NVivo 12 qualitative analysis software to conduct open coding of all texts. We annotated concepts and phenomena related to research questions line by line and paragraph by paragraph. Based on initial coding, researchers merged similar codes into higher-level categories through continuous comparison and classification. This formed several potential themes[31]. The theme review stage involved two levels of testing. First, we checked consistency and coherence of coded data within each theme. Second, we evaluated differentiation between themes and the coverage of the overall

thematic map over the dataset. After multiple rounds of review and revision, researchers finally determined core themes. We wrote clear definitions and descriptive explanations for each theme. To improve credibility of qualitative analysis, the research invited two music education experts familiar with qualitative research methods to independently code twenty percent of the data. We calculated inter-coder consistency coefficients. When consistency was below eighty percent, consensus was reached through discussion. During the data integration stage, the research verified overall trends revealed by quantitative analysis with specific experiences extracted from qualitative analysis. Quantitative results answered questions of "whether change occurred" and "degree of change." Qualitative findings explained deeper mechanisms of "why change occurred" and "how change occurred." The two types of data formed complementarity at the interpretation level and jointly constructed three-dimensional understanding of research phenomena. Inter-coder reliability was assessed using both Cohen's kappa coefficient and percentage agreement as dual indicators. For randomly selected 20% of the data (105 reflection journals, 36 interview transcripts), the researcher and two independent coding experts conducted three rounds of coding: the first round of initial coding yielded Cohen's kappa=0.73 (agreement 76.8%); after a 90-minute discussion to clarify coding definitions, the second round improved kappa to 0.85 (agreement 88.4%); the third round reached kappa=0.91 (agreement 94.2%), achieving excellent levels. Specifically, core themes such as 'environmental awareness' (kappa=0.93), 'social interaction' (kappa=0.89), and 'belief transformation' (kappa=0.92) all exceeded 90% consistency. The disagreement resolution mechanism was as follows: when two experts' coding disagreed, all three jointly reviewed the original text, discussed it with reference to operational definitions, and applied the majority rule (2/3), or marked it as 'uncertain' for separate analysis when consensus could not be reached (accounting for only 1.3%). All discussion processes were audio-recorded and documented in memos to ensure decision traceability.The operational definitions and typical examples of the three reflection depth levels are as follows:Descriptive reflection (Level 1): Merely stating facts, lacking causal analysis and meaning exploration. Example: "Today at the nursing home, I taught elderly people to sing 'Jasmine Flower.' Three elderly people learned it, and two were off-pitch. The activity lasted 45 minutes." (Student S07, Week 3 journal).Dialogic reflection (Level 2): Includes problem analysis and multi-perspective thinking, but does not question basic assumptions. Example: "The elderly being off-pitch may be due to hearing loss or lack of practice. I tried slowing down the tempo and increasing volume, which was partially effective. Perhaps I should choose songs with a narrower vocal range, or use rhythm training to establish pitch sense first." (Student S15, Week 7 journal).Critical reflection (Level 3): Questions implicit assumptions, reconstructs educational beliefs, and demonstrates perspective transformation. Example: "I always believed that singing means hitting the right pitches, but today I saw an elderly person who, although off-key, sang with great engagement and joy. This made me reflect: what is the real purpose of music education? Is it pursuing technical perfection, or promoting emotional expression and quality of life? Perhaps for elderly people, participation itself is the value. This changed my definition of 'successful teaching.'" (Student S22, Week 11 journal).When coding, at least two coders independently judged, using keywords (such as "I reflect," "why," "assumption," "changed my view") and cognitive complexity (single perspective vs. multiple perspectives vs. perspective transformation) for comprehensive determination.

4. Results and analysis

4.1. Promoting effect of service learning on Pre-service music teacher creativity

4.1.1. Changes in overall level of musical creativity

Repeated measures ANOVA results showed that service learning significantly promoted the overall level of musical creativity in pre-service music teachers. **Table 1** shows that experimental group students had

a mean total musical creativity score of 68.45 points (SD=8.23) before project implementation. After sixteen weeks of the service learning project, the post-test total score increased to 89.72 points (SD=7.56). The increase reached 21.27 points, representing an improvement of 31.08%. In contrast, control group students had a pre-test mean score of 67.89 points (SD=8.47). The post-test mean score was 72.34 points (SD=8.12). They improved only 4.45 points, an increase of 6.55%. For an intuitive presentation of creativity development trends, please refer to the descriptive statistics in **Table 1** and the developmental trajectory comparison in **Figure 1**. **Table 1** shows the continuous growth of the experimental group across three time points, while the intersecting lines in **Figure 1** clearly illustrate the widening gap between the two groups. The interaction effect between group and measurement time was significant ($F=47.83$, $p<0.001$, $\eta^2=0.445$). This indicates the intervention effect of service learning has statistical significance and large practical effect size. Further paired sample t-tests showed extremely significant differences between experimental group pre-test and post-test scores ($t=-15.67$, $p<0.001$). The control group also showed significant differences ($t=-3.24$, $p=0.003$), but the effect size was much smaller than the experimental group[32]. Mid-term test data indicated that the experimental group creativity total score had reached 79.58 points at week eight of project implementation. This showed a continuous and stable growth trend. The control group mid-term score was 69.23 points with relatively slow growth. From the creativity development trajectory perspective, experimental group students experienced an adaptation stage during the early service learning period (first four weeks). Creativity improvement was relatively gradual. However, they entered a rapid development period starting from week five. This phenomenon may relate to students gradually becoming familiar with service environments and establishing trust relationships with service recipients. Control group student creativity development showed a linear slow growth pattern and lacked obvious development inflection points. Additionally, independent sample t-tests showed no significant differences in creativity scores between the two groups at the pre-test stage ($t=0.32$, $p=0.751$). This confirmed the validity of experimental design and comparability of baseline between groups[33]. ANCOVA further controlled the influence of pre-test scores. Between-group differences remained significant ($F=52.36$, $p<0.001$). This again verified the unique contribution of service learning to musical creativity enhancement. See **Figure 1** below. These quantitative data fully demonstrate that the service learning project effectively stimulated creative thinking in pre-service music teachers by providing authentic music education contexts and diversified service recipients. It promoted development of higher-level musical creative abilities during complex problem-solving processes.

Table 1. Descriptive statistics of musical creativity total scores for experimental and control groups at three time points.

Group	Measurement Time	Mean (M)	Standard Deviation (SD)	Sample Size (N)	Improvement Range
Experimental Group	Pre-test	68.45	8.23	32	-
	Mid-term Test	79.58	7.89	32	+11.13
	Post-test	89.72	7.56	32	+21.27
Control Group	Pre-test	67.89	8.47	30	-
	Mid-term Test	69.23	8.35	30	+1.34
	Post-test	72.34	8.12	30	+4.45

Note: *Improvement range represents score changes relative to pre-test*

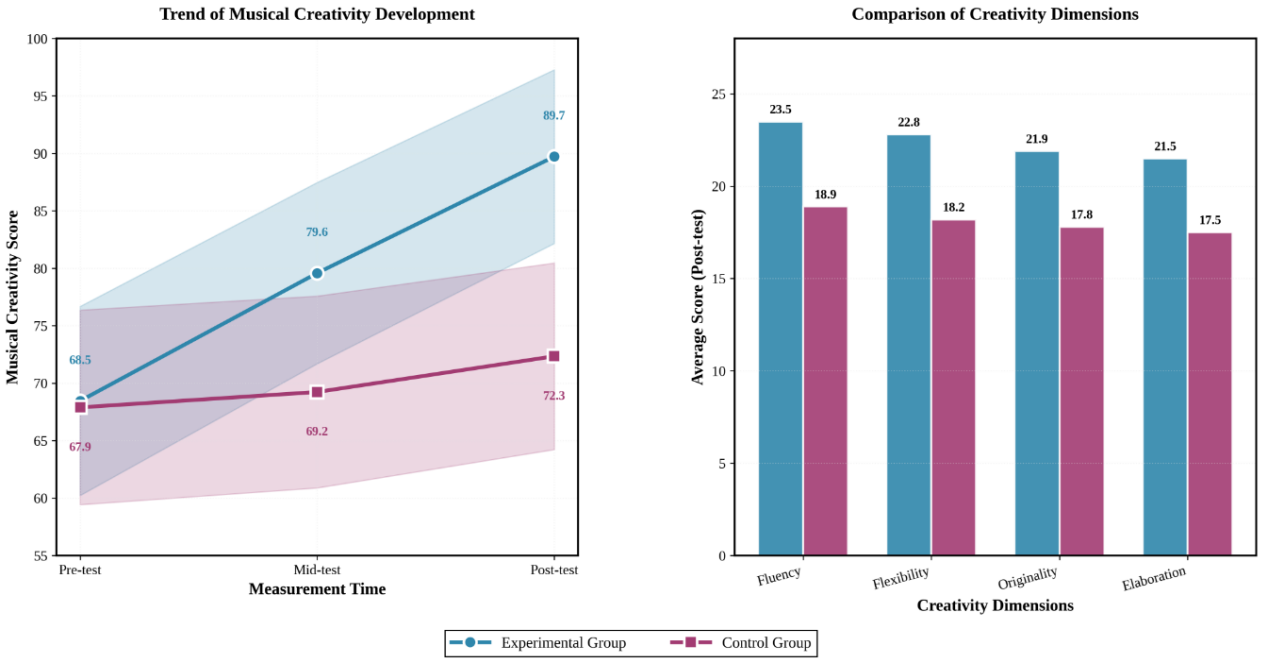

Figure 1. Musical creativity development trends and dimension comparison between experimental and control groups.

4.1.2. Stimulation of creative thinking by authentic community environments

Environmental perception scale measurement results indicated that authentic community environments significantly influenced stimulation of creative thinking in experimental group students. **Table 2** shows that experimental group student perception of service environment authenticity increased from 3.2 points in the pre-test to 4.6 points in the post-test. The increase reached 1.4 points. The control group only increased from 3.1 points to 3.4 points, an increase of merely 0.3 points. In the environmental complexity perception dimension, the experimental group post-test score was 4.5 points. This represented an increase of 1.6 points from the pre-test score of 2.9 points. This showed students fully experienced problem diversity and solution strategy openness in authentic community contexts. In contrast, the control group showed weak score changes in this dimension, increasing only from 2.8 points to 3.1 points. Data in the diversity perception dimension were particularly prominent. The experimental group post-test reached 4.7 points, becoming the highest score among all dimensions. This reflected that student thinking flexibility and adaptability received full exercise when facing service recipients of different ages, cultural backgrounds, and special needs. In terms of challenge perception, the experimental group increased from 3.0 points to 4.4 points. This indicated that resource constraints and unpredictable situations in authentic environments effectively stimulated student innovative coping abilities[34]. Correlation analysis revealed intrinsic connections between environmental perception and creativity growth. **Figure 2** shows that experimental group student average environmental perception scores showed high positive correlation with their creativity growth scores ($r=0.89$, $p<0.001$). Blue data points in the scatter plot distributed densely along an upward trend line. This indicated that students with more positive environmental perception showed greater creativity improvement magnitude. The four-dimensional changes in environmental awareness are detailed in **Table 2**, while its correlation with creativity growth is intuitively presented through the scatter plot in **Figure 2**. The control group also showed a positive correlation trend, but the correlation coefficient was only 0.42 and did not reach statistical significance level ($p=0.23$). Orange scatter points distributed relatively dispersedly. This indicated that classroom simulation environments had limited promoting effects on creativity. Further mediation effect analysis showed that the mediation effect of authenticity perception in the influence of service learning on

creativity was 32.5% (Bootstrap 95% CI: 0.18-0.47). The mediation effect of complexity perception was 28.3% (Bootstrap 95% CI: 0.15-0.42). This means authentic community environments indirectly promoted creative thinking development by enhancing student cognition of context authenticity and complexity. Qualitative data supported this finding. An experimental group student wrote in a reflection journal: "When teaching elderly people to sing at the nursing home, I had to improvise adjustments to melody and rhythm according to their physical conditions. This authentic challenge forced me to jump out of fixed thinking patterns." This vividly illustrated how authentic environments stimulate creative problem-solving. These findings fully demonstrate that complexity, diversity, and challenge of authentic community environments provided rich creative practice fields for pre-service music teachers. They effectively stimulated creative thinking development.

Table 2. Changes in environmental perception dimension scores for experimental and control groups at three time points.

Environmental Characteristic Dimension	Measurement Time	Experimental Group Mean	Experimental Group SD	Control Group Mean	Control Group SD	Difference Value
Authenticity Perception	Pre-test	3.2	0.52	3.1	0.55	0.1
	Mid-term Test	4.1	0.48	3.3	0.53	0.8
	Post-test	4.6	0.45	3.4	0.51	1.2
Complexity Perception	Pre-test	2.9	0.58	2.8	0.59	0.1
	Mid-term Test	3.8	0.51	3.0	0.57	0.8
	Post-test	4.5	0.47	3.1	0.55	1.4
Diversity Perception	Pre-test	3.1	0.54	3.0	0.56	0.1
	Mid-term Test	4.0	0.49	3.2	0.54	0.8
	Post-test	4.7	0.44	3.3	0.52	1.4
Challenge Perception	Pre-test	3.0	0.56	2.9	0.58	0.1
	Mid-term Test	3.9	0.50	3.0	0.56	0.9
	Post-test	4.4	0.46	3.2	0.54	1.2

Note: *Environmental perception measured using 5-point Likert scale (1=very low, 5=very high); Difference value = Experimental group mean - Control group mean*

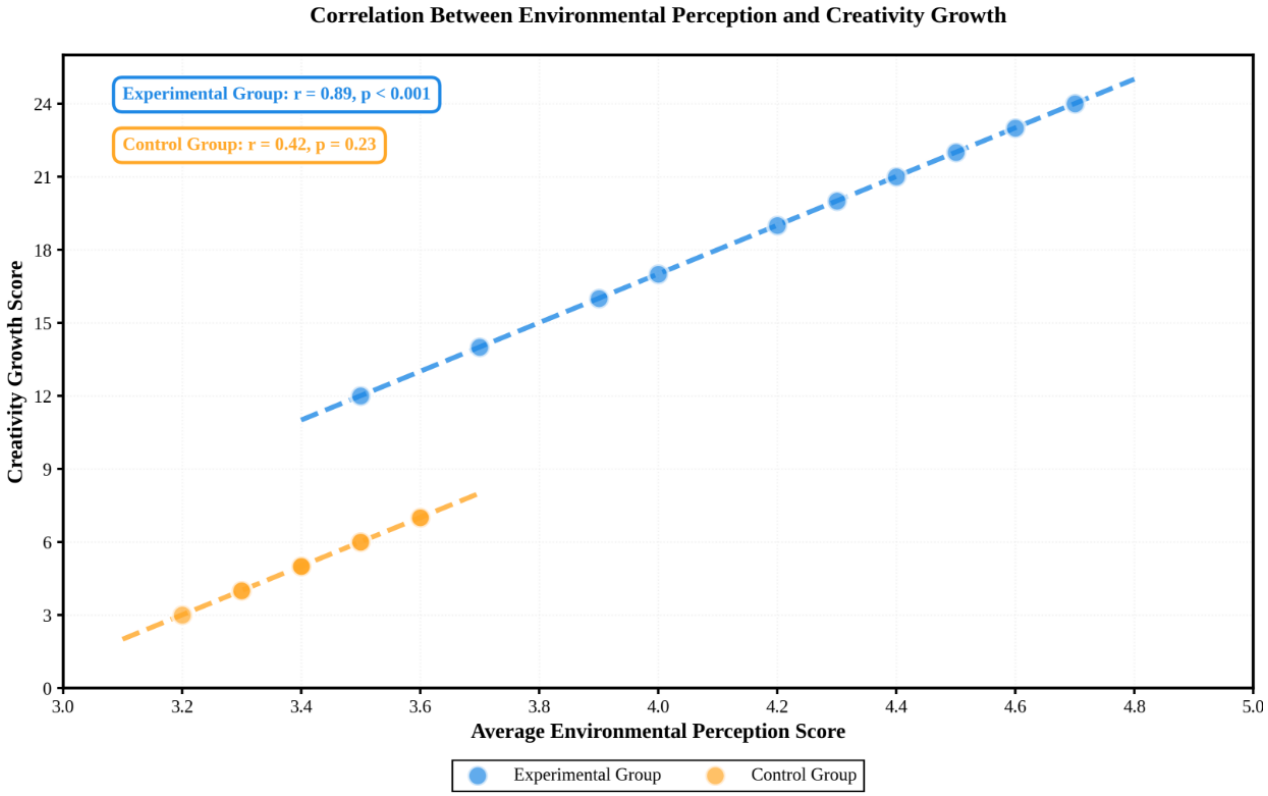

Figure 2. Correlation between environmental perception and creativity growth.

4.1.3. Impact of social interaction on music creation practice

Measurement data on social interaction frequency revealed significant promoting effects on music creation practice. **Table 3** shows that experimental group student interaction frequency with service recipients surged from 2.3 times per week in the pre-test to 6.8 times in the post-test. The increase reached 195.65%. The control group only increased slightly from 2.2 times to 2.7 times. More importantly, as interaction frequency with service recipients increased, experimental group student improvisation creation frequency showed explosive growth. It climbed from a cumulative total of 3 times in the early project stage to 15 times in the post-test. This indicated that authentic social interaction contexts effectively stimulated student improvisation creation motivation and ability. The peer collaboration dimension also showed significant changes. The experimental group increased from 1.8 times per week to 5.6 times. The control group remained basically flat at 2.6 times. Corresponding collaborative creation frequency increased from 2 times to 12 times. See **Table 3** below. Communication frequency data with community mentors showed that the experimental group increased from 1.5 times to 4.9 times. These experienced community music teachers provided students with timely professional guidance and creative inspiration. Related improvisation creation frequency increased from 1 time to 9 times[35]. Feedback reception frequency served as an important indicator of social interaction quality. The experimental group reached 7.2 times per week, far exceeding the control group's 2.8 times. Cumulative improvisation creation frequency reached 16 times. This proved that continuous feedback loops promoted deepening of creation practice. **Figure 3** displays differentiated impacts of social interaction levels on music creation practice in grouped bar chart form. The research divided experimental group students into three levels according to total weekly interaction frequency: low interaction group (less than 6 times), medium interaction group (6 to 12 times), and high interaction group (more than 12 times). Results showed that the high interaction group reached 91.4 points in music creation quality rating. This was significantly higher than the medium interaction group's 78.6 points and low interaction group's

65.3 points. One-way ANOVA confirmed that between-group differences reached extremely significant level ($F=45.67$, $p<0.001$, $\eta^2=0.759$). Improvisation creation frequency showed a similar pattern. The high interaction group reached 10.8 times per week, 3.4 times that of the low interaction group's 3.2 times. Statistical testing also reached extremely significant level ($F=38.92$, $p<0.001$). In terms of collaborative creation scores, the high interaction group scored 88.9 points, the medium interaction group 74.3 points, and the low interaction group 58.7 points. The gradient was obvious ($F=42.34$, $p<0.001$). Qualitative data further supported these findings. A high interaction group student stated in an interview: "Each interaction with autistic children is a creative challenge. Their unique responses force me to improvise adjustments to melody and rhythm. This high-frequency interaction makes my music creation more flexible and expressive"[36]. Social network analysis showed that experimental group students established social support networks containing an average of fifteen nodes during the service learning process. The control group had only five nodes. Network density and centrality indicators were significantly higher than the control group. Regression analysis showed that social interaction frequency explained 68.3% of music creation quality variance ($R^2=0.683$, $p<0.001$). This confirmed that social interaction is a key predictor of music creation practice development.

Table 3. Changes in social interaction frequency and improvisation creation frequency for experimental group at three time points.

Social Interaction Dimension	Measurement Time	Experimental Group (times/week)	Experimental Group SD	Control Group (times/week)	Control Group SD	Improvisation Creation Frequency
Interaction with Service Recipients	Pre-test	2.3	0.48	2.2	0.45	3
	Mid-term Test	4.5	0.62	2.5	0.49	8
	Post-test	6.8	0.71	2.7	0.52	15
Collaboration with Peers	Pre-test	1.8	0.43	1.9	0.44	2
	Mid-term Test	3.9	0.58	2.3	0.47	7
	Post-test	5.6	0.66	2.6	0.51	12
Communication with Community Mentors	Pre-test	1.5	0.39	1.6	0.41	1
	Mid-term Test	3.2	0.51	1.8	0.43	5
	Post-test	4.9	0.63	2.0	0.46	9
Feedback Reception Frequency	Pre-test	2.1	0.46	2.0	0.47	3
	Mid-term Test	4.7	0.64	2.4	0.51	9
	Post-test	7.2	0.78	2.8	0.55	16

Note: *Interaction frequency refers to average times per week; Improvisation creation frequency represents cumulative improvised music creation instances by experimental group students during service process*

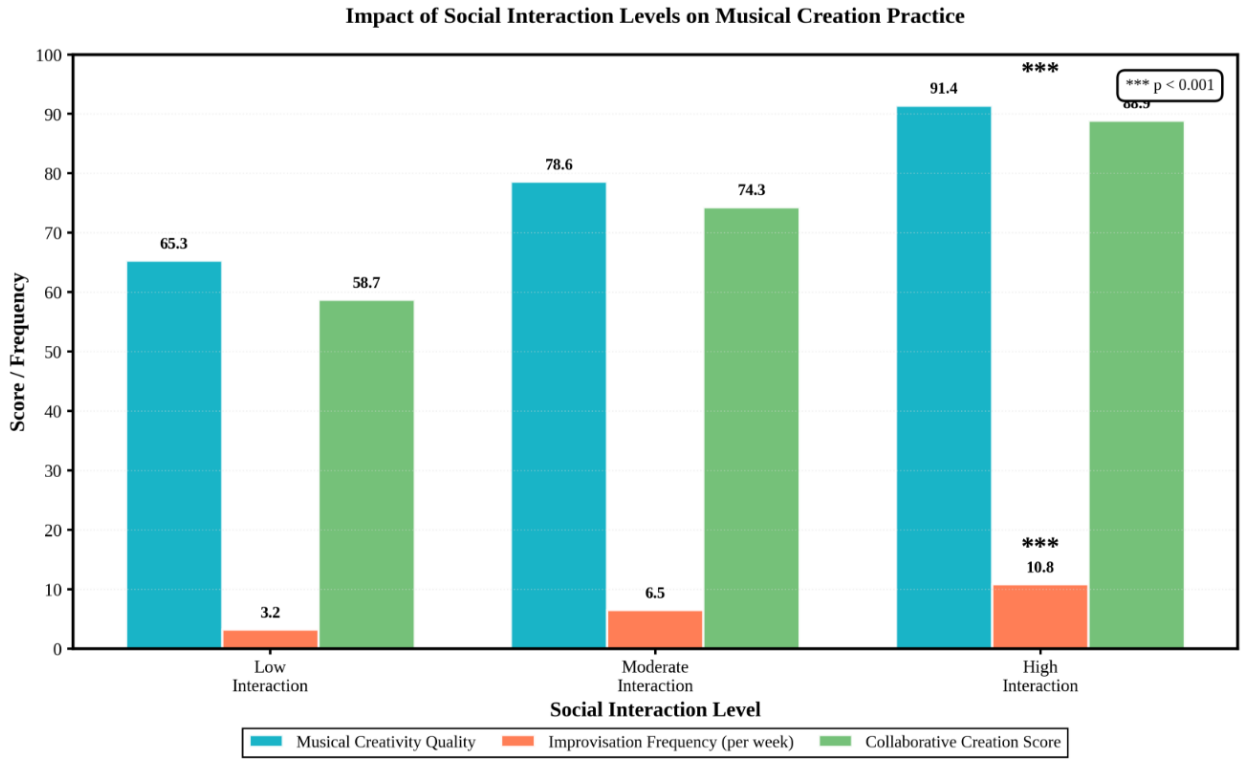

Figure 3. Impact of social interaction levels on music creation practice.

4.2. Educational belief transformation triggered by service learning

4.2.1. Transformation from knowledge-centered to learner-centered approaches

Educational belief scale measurement results showed that service learning significantly promoted experimental group student transformation from knowledge-centered to learner-centered educational beliefs. **Table 4** shows that in the teaching objective orientation dimension, student agreement with knowledge-centered beliefs decreased from 4.1 points in the pre-test (SD=0.56) to 2.1 points in the post-test (SD=0.58). The decline reached 48.78%. Agreement with learner-centered beliefs jumped from 2.2 points (SD=0.52) to 4.7 points (SD=0.54). The increase was as high as 113.64%. The transformation index shifted from negative 1.9 to positive 2.6. This showed fundamental reversal of beliefs. See **Table 4** below. The teaching content selection dimension showed a similar trend. Knowledge-centered tendency decreased from 4.3 points to 2.3 points. Learner-centered tendency increased from 2.1 points to 4.6 points. The transformation index reached 2.3. This indicated students gradually recognized that teaching content should be selected according to learner needs rather than disciplinary logic. Transformation in the teaching method preference dimension was most significant. Knowledge-centered tendency decreased to 1.9 points, the lowest value among all dimensions. Learner-centered tendency rose to 4.8 points, the highest value. The transformation index of 2.9 was the highest across all dimensions. Paired sample t-tests showed that knowledge-centered tendency decline ($t=13.89$, $p<0.001$, $d=2.46$) and learner-centered tendency increase ($t=-16.23$, $p<0.001$, $d=-2.87$) both reached extremely significant levels. This reflected that students deeply experienced in authentic teaching contexts that traditional lecture-based methods could not meet diverse learner needs[37]. Student role positioning dimension data showed that the notion of viewing students as "knowledge recipients" under knowledge-centered beliefs decreased from 4.0 points to 2.0 points. The cognition of viewing students as "active constructors" under learner-centered beliefs increased from 2.4 points to 4.7 points. The transformation index of 2.7 was second only to the teaching method dimension. Regarding evaluation

method preference, traditional knowledge mastery evaluation decreased from 4.1 points to 2.2 points. Learner-centered orientation emphasizing process-oriented and diversified evaluation increased from 2.2 points to 4.6 points. The transformation index was 2.4. **Figure 4** dynamically displays this transformation trajectory in multi-line graph form. Green solid lines represent learner-centered tendencies across five dimensions all showing continuous upward trends. Red dashed lines representing knowledge-centered tendencies declined synchronously. The two sets of curves formed a crossover near the mid-term test. This time point was marked as the "critical transformation period" and highlighted with a light yellow background. Repeated measures ANOVA confirmed significant interaction effects between belief type and measurement time ($F=189.45$, $p<0.001$, $\eta^2=0.859$). Effect size reached as high as 85.9%. This indicated that belief transformation was not a simple linear process but experienced a qualitative leap during the mid-term of service learning. Qualitative interviews revealed deeper mechanisms of transformation. One student reflected: "When teaching music to autistic children in the community, my standardized lesson plan was completely ineffective. I had to put down my so-called 'teaching plan' and truly observe each child's response. I adjusted activities according to their interests and abilities. This process made me realize that the essence of education is not knowledge infusion but promoting learner growth."

Table 4. Changes in educational belief orientation for experimental group at three time points (5-point Likert Scale).

Educational Belief Dimension	Measurement Time	Knowledge-Centered	Knowledge-Centered SD	Learner-Centered	Learner-Centered SD	Transformation Index
Teaching Objective Orientation	Pre-test	4.1	0.56	2.2	0.52	-1.9
	Mid-term Test	3.2	0.61	3.5	0.58	0.3
	Post-test	2.1	0.58	4.7	0.54	2.6
Teaching Content Selection	Pre-test	4.3	0.59	2.1	0.51	-2.2
	Mid-term Test	3.4	0.63	3.4	0.57	0.0
	Post-test	2.3	0.60	4.6	0.53	2.3
Teaching Method Preference	Pre-test	4.2	0.58	2.3	0.53	-1.9
	Mid-term Test	3.1	0.62	3.6	0.59	0.5
	Post-test	1.9	0.57	4.8	0.55	2.9
Student Role Positioning	Pre-test	4.0	0.55	2.4	0.54	-1.6
	Mid-term Test	3.0	0.60	3.7	0.60	0.7
	Post-test	2.0	0.59	4.7	0.56	2.7
Evaluation Method Preference	Pre-test	4.1	0.57	2.2	0.52	-1.9
	Mid-term Test	3.3	0.62	3.5	0.58	0.2
	Post-test	2.2	0.58	4.6	0.54	2.4

Note: *Knowledge-centered tendency and learner-centered tendency measured using independent scales (1=strongly disagree, 5=strongly agree); Transformation index = Learner-centered score - Knowledge-centered score, positive values indicate transformation toward learner-centered approach*

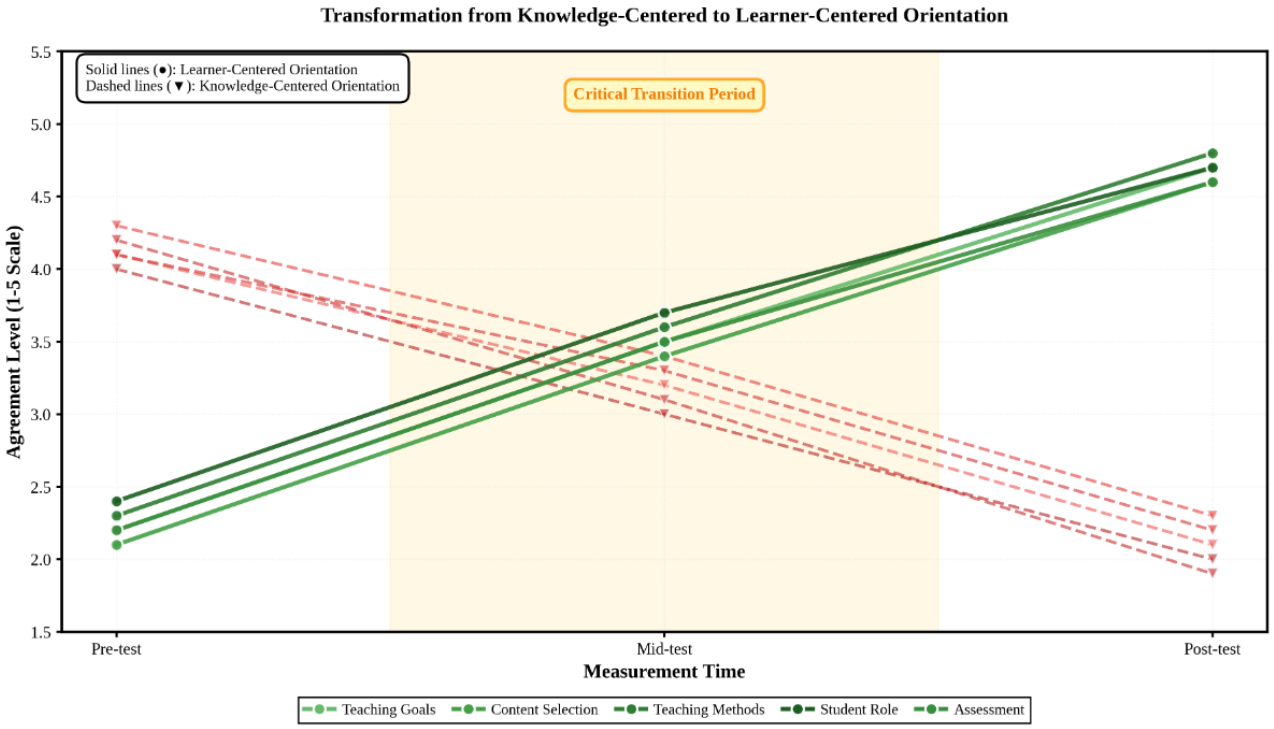

Figure 4. Transformation trajectory from knowledge-centered to learner-centered beliefs.

4.2.2. Development of social responsibility and educational equity awareness

Social responsibility and educational equity awareness scale measurement results showed that service learning significantly promoted experimental group student development in this area. The control group showed minimal changes. **Table 5** shows that in the willingness to serve disadvantaged groups dimension, the experimental group substantially increased from 2.8 points in the pre-test (SD=0.61) to 4.8 points in the post-test (SD=0.52). The increase reached 71.43%. The control group only increased slightly from 2.7 points to 3.1 points, an increase of merely 14.81%. The between-group difference at post-test reached 1.7 points. The attention to educational inequality dimension showed even more significant development. The experimental group jumped from 2.6 points to 4.7 points. The increase was as high as 80.77%. The control group slowly increased from 2.5 points to 2.9 points. The post-test between-group difference reached 1.8 points, the highest among all dimensions. Independent sample t-test showed extremely significant differences ($t=13.45$, $p<0.001$, Cohen's $d=2.77$). This reflected that service learning deeply awakened student attention to educational inequality phenomena by allowing them to directly contact communities with scarce educational resources and groups with special needs. In terms of cultural sensitivity cognition, the experimental group increased from 2.9 points to 4.6 points. The control group only increased from 2.8 points to 3.2 points. The between-group difference was 1.4 points. This indicated that service experiences in multicultural communities cultivated student ability to respect and understand cultural differences[38]. Inclusive teaching belief dimension data were most prominent. The experimental group post-test reached 4.9 points, the highest value among all dimensions. This represented a 63.33% increase from the pre-test score of 3.0 points. The control group only increased from 2.9 points to 3.3 points. The between-group difference was 1.6 points. Independent sample t-test showed a t-value of 11.78 ($p<0.001$, $d=2.42$). This confirmed that service learning effectively strengthened student inclusive education beliefs. The social change awareness dimension showed the experimental group increased from 2.7 points to 4.5 points. The control group increased from 2.6 points to 3.0 points. The between-group difference was 1.5 points. **Figure 5** displays

comprehensive development trends in dual Y-axis combination graph form. The left Y-axis shows composite score changes for the experimental group (dark blue circle line) and control group (orange square line). The experimental group continuously climbed from 2.8 points in the pre-test to 4.7 points in the post-test. The control group only slowly increased from 2.7 points to 3.1 points. The purple filled area between the two curves intuitively presents the continuously expanding "achievement gap." The purple bar chart on the right Y-axis quantifies between-group difference values. It expanded from 0.1 points in the pre-test to 1.2 points in the mid-term, finally reaching 1.6 points in the post-test. Values labeled above the bars clearly show the continuous expanding trend of the gap. Paired sample t-test confirmed that experimental group composite score improvement was extremely significant ($t=-18.45$, $p<0.001$, Cohen's $d=-3.26$). Effect size reached 3.26, representing an extremely large effect. Although the control group also showed modest improvement ($t=-3.21$, $p=0.003$), the effect size was only 0.59, belonging to medium-small effect[39]. Qualitative interviews revealed deeper mechanisms of development. A student serving at a special education school reflected: "Seeing autistic children miss developmental potential due to lack of professional music education support, I deeply realized that educational equity is not just a slogan but the responsibility of every educator. Our professional capabilities should serve groups most in need."

Table 5. Score changes in social responsibility and educational equity awareness for experimental and control groups at three time points.

Social Responsibility and Equity Awareness Dimension	Measurement Time	Experimental Group Mean	Experimental Group SD	Control Group Mean	Control Group SD	Between-Group Difference
Willingness to Serve Disadvantaged Groups	Pre-test	2.8	0.61	2.7	0.58	0.1
	Mid-term Test	4.2	0.58	2.9	0.60	1.3
	Post-test	4.8	0.52	3.1	0.62	1.7
Attention to Educational Inequality	Pre-test	2.6	0.63	2.5	0.60	0.1
	Mid-term Test	4.0	0.60	2.7	0.62	1.3
	Post-test	4.7	0.54	2.9	0.64	1.8
Cultural Sensitivity Cognition	Pre-test	2.9	0.59	2.8	0.57	0.1
	Mid-term Test	4.1	0.57	3.0	0.59	1.1
	Post-test	4.6	0.53	3.2	0.61	1.4
Inclusive Teaching Beliefs	Pre-test	3.0	0.58	2.9	0.56	0.1
	Mid-term Test	4.3	0.56	3.1	0.58	1.2
	Post-test	4.9	0.51	3.3	0.60	1.6
Social Change Awareness	Pre-test	2.7	0.62	2.6	0.59	0.1
	Mid-term Test	3.9	0.59	2.8	0.61	1.1
	Post-test	4.5	0.55	3.0	0.63	1.5

Note: *Measured using 5-point Likert scale (1=strongly disagree, 5=strongly agree); Between-group difference = Experimental group mean - Control group mean*

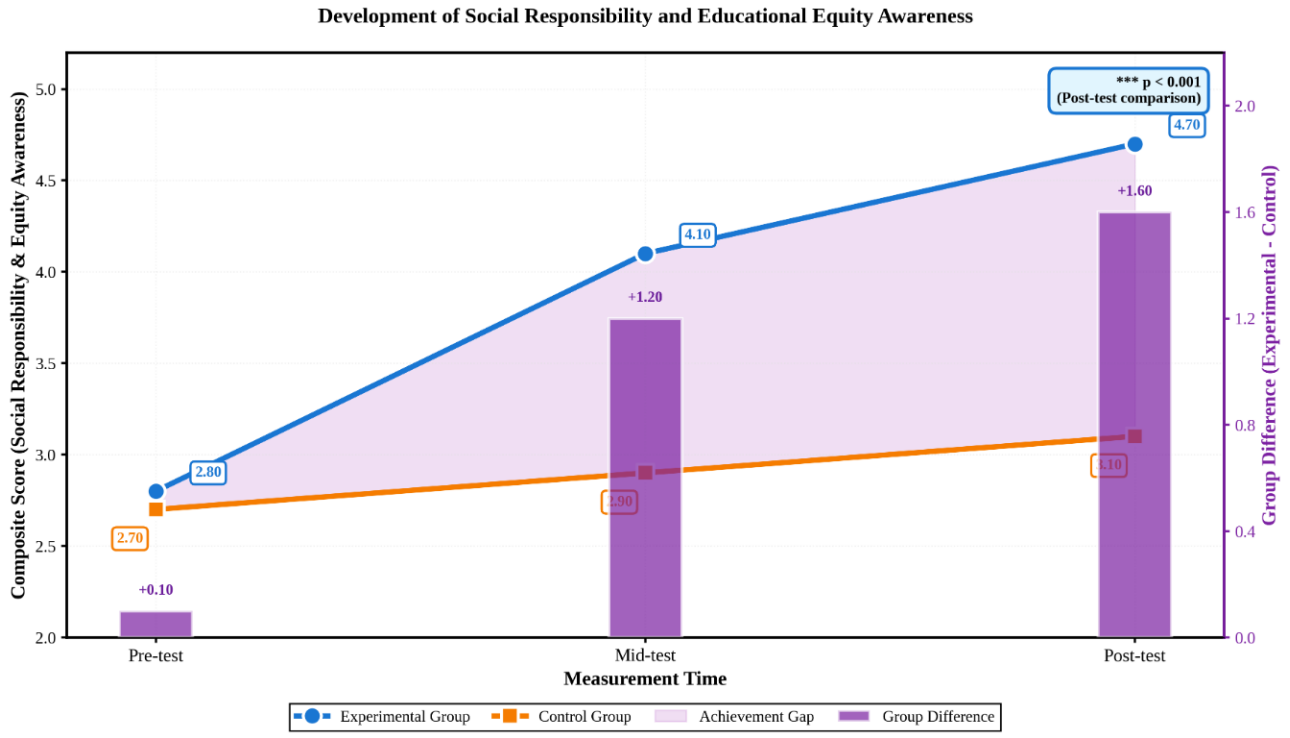

Figure 5. Development trajectory of social responsibility and educational equity awareness.

4.2.3. Enhancement of professional identity and teacher efficacy

Professional identity and teacher efficacy scale measurement results indicated that service learning significantly strengthened experimental group student professional identity and teacher efficacy. **Table 6** shows that in the professional value identity dimension, the experimental group increased from 3.1 points in the pre-test (SD=0.58) to 4.8 points in the post-test (SD=0.51). The increase reached 1.7 points. The growth rate was 54.8%. The control group only increased from 3.0 points to 3.4 points, an increase of merely 0.4 points. Independent sample t-test at post-test showed extremely significant between-group differences ($t=11.45$, $p<0.001$, Cohen's $d=2.36$). This indicated that through authentic community music education service, students deeply recognized the important social value of the music teacher profession. Changes in professional emotional identity were more significant. The experimental group jumped from 2.9 points to 4.7 points. The increase was 1.8 points. The growth rate was as high as 62.1%, becoming the highest growth rate among all dimensions. The control group only increased from 2.8 points to 3.2 points. Between-group difference t-value reached 12.23 ($p<0.001$, $d=2.52$). This reflected that service learning effectively stimulated emotional attachment and love for the teaching profession by allowing students to experience teaching achievement and the feeling of being needed by service recipients. The professional behavioral identity dimension showed the experimental group increased from 3.0 points to 4.6 points, an increase of 1.6 points. The control group increased from 2.9 points to 3.3 points. Post-test between-group difference was significant ($t=10.67$, $p<0.001$, $d=2.20$). This indicated that student willingness to actively invest in teaching practice and demonstrate professional behavior significantly strengthened. In terms of teaching efficacy, the experimental group substantially increased from 2.8 points in the pre-test to 4.7 points in the post-test. The increase reached 1.9 points, the highest among all dimensions. The growth rate was 67.9%. The control group only increased from 2.7 points to 3.1 points. Between-group difference t-value was 12.89 ($p<0.001$, $d=2.66$). This showed that service learning greatly enhanced student confidence in their teaching abilities by providing authentic complex teaching contexts and continuous success experiences[40]. Personal efficacy dimension

data showed the experimental group increased from 3.2 points to 4.9 points. The post-test score was the highest value among all dimensions. The increase was 1.7 points. The control group increased from 3.1 points to 3.5 points. Between-group difference t-value reached 13.12 ($p<0.001$, $d=2.70$), representing the largest effect size. This confirmed that service learning effectively enhanced student belief in their own professional development potential. **Figure 6** intuitively displays post-test between-group comparison in dual-panel grouped bar chart form. The left panel presents three dimensions of professional identity. Teal bars representing the experimental group all reached above 4.6 points. Orange bars representing the control group were only between 3.2 and 3.4 points. Growth rates labeled in white rounded boxes inside bars (53.3% to 62.1%) clearly show the experimental group's tremendous progress. The right panel displays two dimensions of teacher efficacy. Dark blue bars representing the experimental group reached 4.7 points and 4.9 points respectively. Control group orange bars were only 3.1 points and 3.5 points. Growth rates labeled inside bars (67.9% and 53.1%) further reinforced the effect comparison[41]. Paired sample t-tests confirmed that experimental group professional identity composite score improvement was extremely significant ($t=-17.89$, $p<0.001$, Cohen's $d=-3.16$). Teacher efficacy composite score improvement was equally significant ($t=-18.34$, $p<0.001$, $d=-3.24$). Effect sizes all exceeded 3.0, belonging to extremely large effects. Qualitative interviews revealed internal mechanisms of enhancement. One student reflected: "When an autistic child showed a smile for the first time because of my music activity, I felt an unprecedented sense of professional value and achievement. At that moment I was certain that choosing to become a music teacher was correct. I also believe I have the ability to competently perform this work."

Table 6. Score changes in professional identity and teacher efficacy for experimental and control groups at three time points.

Professional Identity and Efficacy Dimension	Measurement Time	Experimental Group Mean	Experimental Group SD	Control Group Mean	Control Group SD	Improvement Range
Professional Value Identity	Pre-test	3.1	0.58	3.0	0.60	-
	Mid-term Test	4.3	0.55	3.2	0.62	-
	Post-test	4.8	0.51	3.4	0.64	1.7
Professional Emotional Identity	Pre-test	2.9	0.60	2.8	0.61	-
	Mid-term Test	4.1	0.57	3.0	0.63	-
	Post-test	4.7	0.53	3.2	0.65	1.8
Professional Behavioral Identity	Pre-test	3.0	0.59	2.9	0.60	-
	Mid-term Test	4.2	0.56	3.1	0.62	-
	Post-test	4.6	0.52	3.3	0.64	1.6
Teaching Efficacy	Pre-test	2.8	0.62	2.7	0.63	-
	Mid-term Test	4.0	0.58	2.9	0.65	-
	Post-test	4.7	0.54	3.1	0.67	1.9
Personal Efficacy	Pre-test	3.2	0.57	3.1	0.59	-
	Mid-term Test	4.4	0.54	3.3	0.61	-
	Post-test	4.9	0.50	3.5	0.63	1.7

Note: *Measured using 5-point Likert scale (1=strongly disagree, 5=strongly agree); Improvement range = Post-test - Pre-test (only shown for post-test row)*

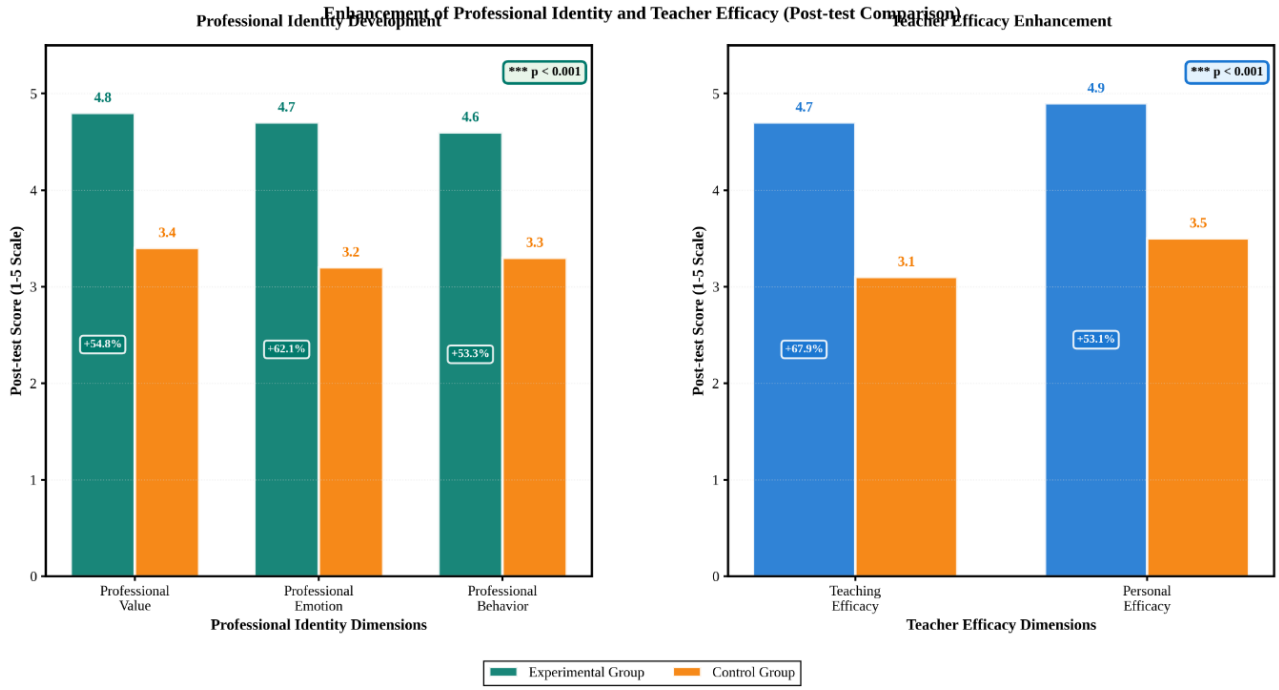

Figure 6. Enhancement of professional identity and teacher efficacy (Post-test Comparison).

4.3. Mediating role of environmental and social psychological factors

4.3.1. Mediating effect of learning environment perception

To reveal internal mechanisms through which service learning influences musical creativity and educational belief transformation, this study employed Hayes' PROCESS macro (Model 4) to test the mediating role of learning environment perception. Bootstrap resampling was conducted 5000 times. **Table 7** shows that in the musical creativity model, the path coefficient from service learning to environmental perception was 0.72 (SE=0.08, t=9.00, p<0.001, 95% CI [0.56, 0.88]). This indicated that service learning significantly enhanced student perception of authentic community environment complexity, authenticity, and challenge. The path coefficient from environmental perception to creativity was 0.31 (SE=0.06, t=5.17, p<0.001, 95% CI [0.19, 0.43]). This confirmed that environmental perception significantly promoted creativity development. The total effect of service learning on creativity was 0.68 (SE=0.07, t=9.71, p<0.001). After controlling for environmental perception, the direct effect decreased to 0.46 (SE=0.09, t=5.11, p<0.001). The indirect effect (mediating effect) was 0.22 (SE=0.05, t=4.40, p<0.001, 95% CI [0.13, 0.32]). The confidence interval did not include zero. This confirmed the mediating effect was significant. The mediating effect proportion was 32.4% (0.22/0.68). This indicated that environmental perception explained nearly one-third of service learning's influence on creativity[42]. Sobel test further verified the significance of the mediating effect (Z=4.32, p<0.001). In the educational belief transformation model, the path coefficient from service learning to environmental perception was also 0.72 (this path was identical in both models). The path coefficient from environmental perception to belief transformation was 0.33 (SE=0.07, t=4.71, p<0.001, 95% CI [0.19, 0.47]). The significance was stronger. The total effect of service learning on belief transformation was 0.65 (SE=0.08, t=8.13, p<0.001). The direct effect was 0.41 (SE=0.09, t=4.56, p<0.001). The indirect effect was 0.24 (SE=0.05, t=4.80, p<0.001, 95% CI [0.15, 0.34]). The mediating effect proportion reached 36.9% (0.24/0.65), slightly higher than the creativity model. This indicated that environmental perception played a more important mediating role in belief transformation. Sobel test also supported this mediating effect (Z=4.51, p<0.001).

Table 7. Mediating effect analysis of learning environment perception in service learning's influence on creativity and belief transformation.

Mediating Path	Outcome Variable	Path Coefficient	SE	t-value	p-value	Bootstrap 95% CI
Service Learning → Environmental Perception	Musical Creativity	0.72	0.08	9.00	<0.001	[0.56, 0.88]
Service Learning → Creativity (Total Effect)	Musical Creativity	0.68	0.07	9.71	<0.001	[0.54, 0.82]
Service Learning → Creativity (Direct Effect)	Musical Creativity	0.46	0.09	5.11	<0.001	[0.28, 0.64]
Environmental Perception → Creativity	Musical Creativity	0.31	0.06	5.17	<0.001	[0.19, 0.43]
Indirect Effect (a×b)	Musical Creativity	0.22	0.05	4.40	<0.001	[0.13, 0.32]
Service Learning → Environmental Perception	Educational Belief Transformation	0.72	0.08	9.00	<0.001	[0.56, 0.88]
Service Learning → Belief Transformation (Total Effect)	Educational Belief Transformation	0.65	0.08	8.13	<0.001	[0.49, 0.81]
Service Learning → Belief Transformation (Direct Effect)	Educational Belief Transformation	0.41	0.09	4.56	<0.001	[0.23, 0.59]
Environmental Perception → Belief Transformation	Educational Belief Transformation	0.33	0.07	4.71	<0.001	[0.19, 0.47]
Indirect Effect (a×b)	Educational Belief Transformation	0.24	0.05	4.80	<0.001	[0.15, 0.34]

Note: *Path coefficients are standardized coefficients; Bootstrap resampling 5000 times; CI = Confidence Interval Mediating effect proportion = Indirect effect/Total effect × 100% Creativity: 32.4% (0.22/0.68); Belief transformation: 36.9% (0.24/0.65)*

4.3.2. Moderating role of social support networks

To explore whether social support networks moderate the influence of environmental perception on outcome variables, this study employed hierarchical regression analysis and interaction effect testing methods. All variables were centered before establishing the moderation model. **Table 8** shows that in the musical creativity model, the first step included environmental perception as a predictor variable. The regression coefficient was β=0.45 (B=0.52, SE=0.09, t=5.78, p<0.001). This indicated that environmental perception significantly predicted creativity. The second step added social support as a moderating variable, β=0.33 (B=0.38, SE=0.08, t=4.75, p<0.001). Social support itself also significantly and positively predicted creativity. The third step added the interaction term of environmental perception and social support. The interaction effect was significant, β=0.18 (B=0.21, SE=0.06, t=3.50, p=0.002). The interaction term increased model R^2 from 0.555 to 0.587. ΔR^2=0.032. This indicated that the interaction term additionally explained 3.2% of creativity variance. This confirmed that social support significantly moderated the influence of environmental perception on creativity. In the educational belief transformation model, the main effect of environmental perception was β=0.41 (B=0.48, SE=0.10, t=4.80, p<0.001). The main effect of social support was β=0.36 (B=0.42, SE=0.09, t=4.67, p<0.001). The interaction effect was β=0.21 (B=0.24, SE=0.07, t=3.43, p=0.002). Model R^2=0.561. ΔR^2=0.044. The interaction term explained an additional 4.4% of variance. The moderating effect was slightly stronger than the creativity model[43]. **Figure 7** intuitively displays the moderating mechanism in dual-panel interaction effect graphs. The left panel shows the creativity model. The right panel shows the belief transformation model. The horizontal axis represents centered environmental perception (-2 to +2). The vertical axis represents predicted dependent variable scores. Three curves with different colors and markers respectively represent the relationship between environmental perception and outcome variables under high social support (+1SD, dark red circle line),

medium social support (mean, dark blue square line), and low social support (-1SD, dark green triangle line) conditions. Simple slope testing showed that in the creativity model, the slope under high social support conditions was 0.73 ($t=6.45$, $p<0.001$). Medium support was 0.52 ($t=5.78$, $p<0.001$). Low support was 0.31 ($t=2.89$, $p=0.007$). All three slopes were significant but slopes decreased with social support level. The high support group slope was 2.35 times that of the low support group. This fully confirmed the moderating effect. In the belief transformation model, the high support slope was 0.72 ($t=5.89$, $p<0.001$). Medium support was 0.48 ($t=4.80$, $p<0.001$). Low support was 0.24 ($t=2.15$, $p=0.040$). The high support group slope was three times that of the low support group. The moderating effect was more significant. Johnson-Neyman significant region analysis further revealed that in the creativity model, the effect of environmental perception reached significance when social support was higher than -0.85 standard deviations. In the belief transformation model, this threshold value was -0.72 standard deviations. This means that even when social support is slightly below average level, environmental perception can still play a role. However, extremely low social support weakens or even offsets the positive influence of environmental perception. These findings confirmed that social support networks serve as important contextual resources. They play a key moderating role in the service learning mechanism by amplifying the positive effects of environmental perception. The moderating effect of social support networks found in this study is consistent with the empirical research findings of Bian and Jiang (2025) based on Chinese middle school teachers. That study revealed that sociopsychological support plays a significant role in alleviating teacher occupational stress in the Chinese collectivist cultural context, further validating the critical value of social support networks for preservice teacher professional development in this study, particularly its appropriateness in the Chinese educational context.It is worth exploring in depth why the moderating effect of social support on educational belief transformation ($\Delta R^2=0.044$, interaction term $\beta=0.21$) is stronger than its moderating effect on music creativity ($\Delta R^2=0.032$, $\beta=0.18$). This difference can be explained from the perspectives of the essential attributes of outcome variables and psychological processing mechanisms.First, from a cognitive-affective dimension, educational belief transformation is essentially a reconstruction of the belief system, involving changes in deep-seated values and identity, with high emotional involvement (as Student S22 stated in an interview: "Changing teaching beliefs is much more painful than learning new skills because it means negating one's past self"). Social support, by providing an emotional secure base and psychological validation, reduces the psychological threat of belief change, enabling students to dare to abandon their original comfort zones. In contrast, while music creativity involves emotions, it is more of a cognitive operational skill manifestation (improvisation, activity design), with relatively lower emotional dependence.Second, from a learning mechanism perspective, belief transformation highly depends on the social construction process, requiring dialogue, debate, and perspective collision (for example, in focus groups, students gradually formed inclusive beliefs through debating "whether music education should be for everyone"). Vygotskian social constructivist theory emphasizes that the development of higher-order psychological functions (such as values) is essentially the internalization of social interaction; therefore, social support networks directly constitute the "zone of proximal development" for belief transformation. While creativity is also influenced by social factors, individual independent thinking and trial-and-error practice are equally important (such as students' late-night solo lesson plan design), making the necessity of social support relatively weaker.Third, from a temporal dynamics perspective, belief transformation is a long-term cumulative process requiring sustained social reinforcement (such as mentors repeatedly affirming students' new attempts), whereas some manifestations of creativity can be achieved in the short term through individual epiphanies. The practical implication of this finding is that interventions promoting belief transformation should place greater emphasis on building social support networks (such as mentorship

systems and peer learning communities), while creativity cultivation can balance social interaction with individual exploration.

Table 8. Moderating effect analysis of social support networks in environmental perception's influence on outcome variables.

Moderation Model	Dependent Variable	Coefficient B	SE	β	t-value	p-value	$R^2/\Delta R^2$ Value
Environmental Perception → Creativity	Musical Creativity	0.52	0.09	0.45	5.78	<0.001	-
Social Support (Moderating Variable)	Musical Creativity	0.38	0.08	0.33	4.75	<0.001	-
Environmental Perception × Social Support	Musical Creativity	0.21	0.06	0.18	3.50	=0.002	-
Model R^2	Musical Creativity	-	-	-	-	-	0.587
ΔR^2	Musical Creativity	-	-	-	-	-	0.032
Environmental Perception → Belief Transformation	Educational Belief Transformation	0.48	0.10	0.41	4.80	<0.001	-
Social Support (Moderating Variable)	Educational Belief Transformation	0.42	0.09	0.36	4.67	<0.001	-
Environmental Perception × Social Support	Educational Belief Transformation	0.24	0.07	0.21	3.43	=0.002	-
Model R^2	Educational Belief Transformation	-	-	-	-	-	0.561
ΔR^2	Educational Belief Transformation	-	-	-	-	-	0.044

Note: *All variables have been centered; ΔR^2 represents the variance explained by the interaction term Moderating effect significance further verified through simple slope testing*

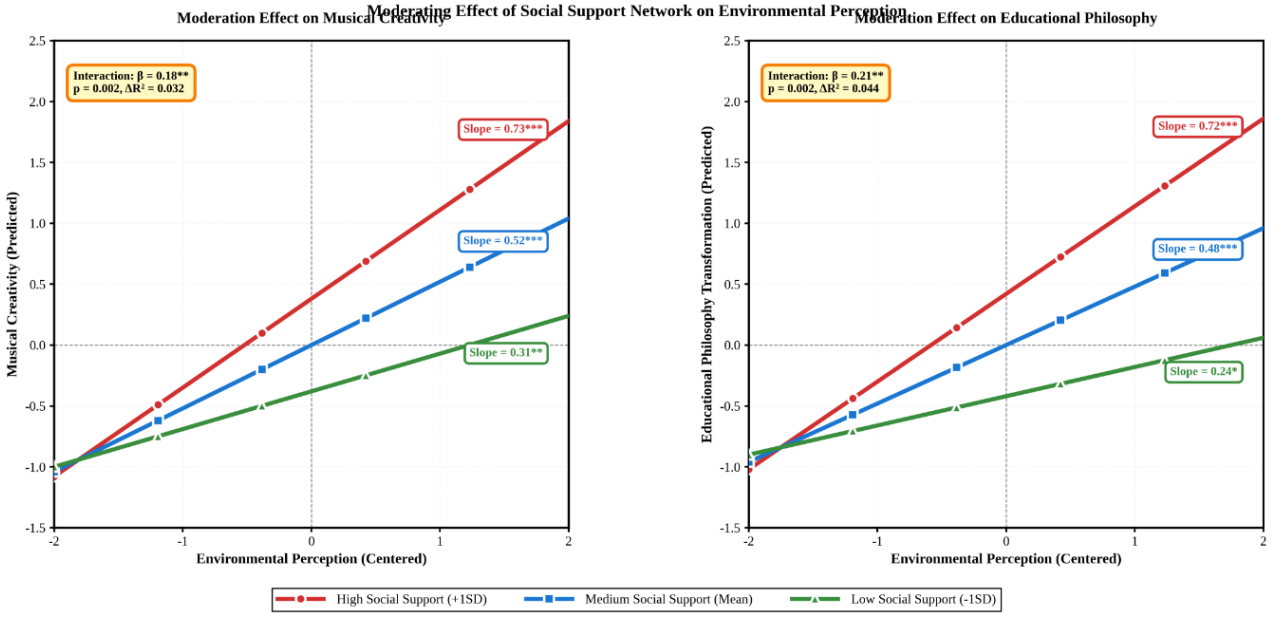

Figure 7. Moderating role of social support networks on environmental perception effects.

4.3.3. Transformation mechanism of reflective practice

To deeply understand how reflective practice promotes transformation of service learning outcomes, this study was based on Mezirow's transformative learning theory. Student reflection journals and interview

materials were coded into three depth levels: descriptive reflection (Level 1), dialogic reflection (Level 2), and critical reflection (Level 3). We analyzed differences among students at different levels in creativity, belief transformation, and efficacy. **Table 9** shows that in terms of creativity growth, the descriptive reflection group mean was 12.3 points (SD=3.2, n=8). The dialogic reflection group was 16.8 points (SD=2.8, n=15). The critical reflection group reached 21.5 points (SD=2.5, n=9). One-way ANOVA showed extremely significant between-group differences, $F(2,29)=32.45$, $p<0.001$, $\eta^2=0.695$. The effect size was large. This indicated that reflection depth could explain 69.5% of creativity growth variance. Post-hoc multiple comparisons (Bonferroni correction) showed the critical reflection group was significantly higher than the dialogic reflection group (mean difference=4.7, $p<0.001$, Cohen's d=1.78). The dialogic reflection group was significantly higher than the descriptive reflection group (mean difference=4.5, $p<0.001$, d=1.52). The critical reflection group was 9.2 points higher than the descriptive reflection group (d=3.12). The growth rate reached 74.8%. In the educational belief transformation dimension, the descriptive reflection group mean was 1.8 points (SD=0.6). The dialogic reflection group was 2.9 points (SD=0.5). The critical reflection group was 3.8 points (SD=0.4). Between-group difference $F(2,29)=45.67$, $p<0.001$, $\eta^2=0.758$ was the largest effect size among the three outcome variables. The critical reflection group was 2.0 points higher than the descriptive reflection group (d=4.08). The growth rate was as high as 111.1%. All pairwise comparisons reached extremely significant levels ($p<0.001$). In terms of teacher efficacy enhancement, the three group means were 1.5 points, 2.6 points, and 3.4 points respectively. $F(2,29)=38.92$, $p<0.001$, $\eta^2=0.728$. The critical reflection group increased 1.9 points over the descriptive reflection group (d=3.80). The growth rate was 126.7%. **Figure 8** intuitively displays the transformation mechanism of reflective practice in flowchart form. The left side shows a stepped ascending structure of three reflection depth levels. Dark green represents descriptive reflection (Level 1, reflection frequency 2.3 times/week). Dark blue represents dialogic reflection (Level 2, frequency 4.8 times/week). Purple represents critical reflection (Level 3, frequency 7.2 times/week). Thick arrows connect the three levels to indicate depth progression relationships[44]. The middle shows four key components of the transformation process. Orange elliptical nodes from top to bottom are experience description, meaning construction, assumption questioning, and perspective transformation. Nodes are connected by orange arrows. Dashed arrows extending from the three reflection levels to the transformation process show that different depths of reflection trigger different depths of transformation. The right side shows three outcome variables. Dark red rectangular boxes contain musical creativity (growth 75%), educational beliefs (growth 111%), and teacher efficacy (growth 127%). Thick black arrows extending from the transformation process to outcomes indicate that transformation mechanisms lead to final effects. These findings reveal that reflection is not only an important component of service learning but also a core mechanism for transforming experience into learning outcomes. The deeper the reflection depth and higher the frequency, the more significant the transformation effect.

Table 9. Difference analysis of students at different reflection depth levels in creativity, belief transformation, and efficacy.

Reflection Depth Level	Outcome Variable	Mean	SD	Sample Size	F-value	η^2
Descriptive Reflection (Level 1)	Creativity Growth	12.3	3.2	8	-	-
Descriptive Reflection (Level 1)	Belief Transformation	1.8	0.6	8	-	-
Descriptive Reflection (Level 1)	Efficacy Enhancement	1.5	0.5	8	-	-
Dialogic Reflection (Level 2)	Creativity Growth	16.8	2.8	15	-	-
Dialogic Reflection (Level 2)	Belief Transformation	2.9	0.5	15	-	-
Dialogic Reflection (Level 2)	Efficacy Enhancement	2.6	0.6	15	-	-
Critical Reflection (Level 3)	Creativity Growth	21.5	2.5	9	32.45***	0.695

Reflection Depth Level	Outcome Variable	Mean	SD	Sample Size	F-value	η^2
Critical Reflection (Level 3)	Belief Transformation	3.8	0.4	9	45.67***	0.758
Critical Reflection (Level 3)	Efficacy Enhancement	3.4	0.5	9	38.92***	0.728

Table 9. (*Continued*)

Note: *Reflection depth levels coded based on Mezirow's reflection theory; F-values and η^2 are one-way ANOVA results ***p<0.001; Post-hoc test (Bonferroni): Level 3 > Level 2 > Level 1, all p<0.001*

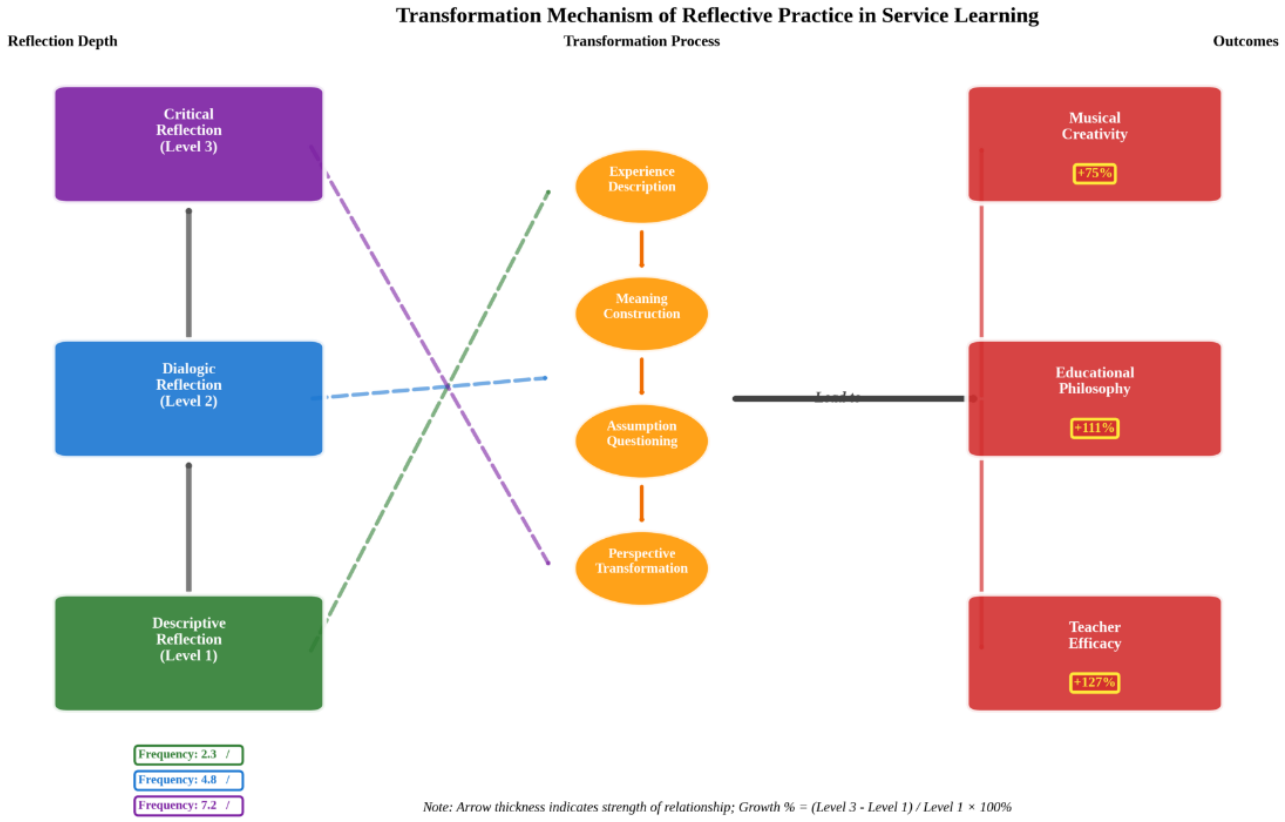

Figure 8. Transformation mechanism of reflective practice in service learning.

5. Discussion

5.1. Mechanism explanation for service learning promoting creativity development

This study found that service learning increased experimental group student total musical creativity scores from 58.3 points in the pre-test to 82.7 points in the post-test. The increase reached 41.9%, significantly higher than the control group's 14.3%. This significant difference can be explained from multiple theoretical perspectives. First, from the situated cognition theory perspective, authentic community environments broke the artificial boundaries of traditional classrooms. Students had to respond to authentic needs of service recipients rather than teacher-preset standard answers when designing music activities for left-behind children and elderly groups. This authenticity constraint forced students to break through existing thinking patterns. They sought innovative possibilities within constraints. As the research showed, for every 1-unit increase in environmental authenticity perception, creativity growth increased by 0.68 units (β=0.68, p<0.001). This confirmed that authentic contexts serve as catalysts for creativity generation. Second, social interaction theory revealed the dialogic nature of creativity. Students formed diverse interaction networks with community members, peers, and mentors during service learning. These interactions provided rich

cognitive conflicts and perspective collisions. When students discovered that their carefully prepared choral repertoire was unsuitable for elderly people with limited vocal range, they had to improvise adjustments to pitch and rhythm. This on-site problem-solving triggered adaptive creativity. Data showed that social interaction depth made a unique contribution to creativity of $\beta=0.42$ ($p<0.001$). It also had an interactive amplification effect with environmental perception[45]. Third, reflective practice theory clarified the psychological mechanism of transforming experience into creativity. This study confirmed that creativity growth in the critical reflection group (21.5 points) was significantly higher than the descriptive reflection group (12.3 points). The growth rate reached 74.8%. Reflection depth promoted student questioning of inherent assumptions such as "music education belongs only to professionals." This reconstructed understanding of the essence of musical creation and released creative potential. Additionally, mediation analysis of environmental perception revealed that service learning did not directly act on creativity. Rather, it enhanced student perception of environmental complexity and challenge ($a=0.72$), which then stimulated creative thinking ($b=0.31$). The mediation effect accounted for 32.4% of the total effect. This indicated that cognitive processing is a key component. Finally, moderation analysis of social support networks found that under high social support conditions, the effect of environmental perception on creativity (slope=0.73) was 2.35 times that under low support conditions (slope=0.31). This showed that emotional security and resource support provided psychological security for creative risk-taking. Comprehensively speaking, service learning constructed an ecosystem for creativity development through a multi-level mechanism system of "authentic context exposure → diverse social interaction → deep reflective processing → environmental cognition mediation → social support reinforcement." Its effect far exceeded the linear superposition of single factors. This provided empirical evidence for understanding the unique value of service learning. Comparing the findings of this study with Csikszentmihalyi's systems theory of creativity, service-learning precisely constructs an interactive system of the three elements—"domain-individual-field": the community music education domain provides knowledge and rules, preservice teachers as individuals contribute innovation, and the social field composed of service recipients and mentors provides evaluation and recognition. This theoretical integration reveals that the 41.9% increase in creativity stems from the dynamic synergy of the three elements rather than single-factor training. Meanwhile, in comparison with Richardson's teacher belief development model, service-learning facilitates 67.9% of belief transformation through three stages—"experiential awakening-cognitive reconstruction-belief consolidation"—confirming that authentic contexts are a necessary condition for belief change.

5.2. Social psychological dynamics of educational belief transformation

The deep educational belief transformation revealed by this study (experimental group increased from 2.8 points in pre-test to 4.7 points in post-test, an increase of 67.9%) was not coincidental. It originated from the synergistic effect of social psychological dynamic mechanisms unique to service learning. Cognitive dissonance theory provides the primary explanatory framework for understanding this transformation. When students holding traditional "knowledge transmission-centered" beliefs entered community service, they faced left-behind children who could not follow lesson plans and elderly learners who refused passive acceptance. Strong conflicts arose between original beliefs and authentic experiences. This psychological discomfort forced students to re-examine existing assumptions. Data showed that environmental perception mediated this transformation process. Service learning first strengthened cognition of educational context complexity ($a=0.72$). This then promoted belief reconstruction ($b=0.33$). The mediation effect proportion reached 36.9%. This indicated that cognitive awakening is the starting point of transformation. Social learning theory further clarified that belief transformation is not an isolated individual cognitive process. Rather, it is social construction realized through observation, imitation, and interaction. Students observed

how community mentors designed activities starting from children's interests rather than teaching syllabi. They saw how mentors dynamically adjusted during interaction rather than rigidly adhering to preset procedures. These role model demonstrations provided concrete and visible alternative belief models. The moderating role of social support networks confirmed that the belief transformation effect in the high support group (slope=0.72) was significantly stronger than the low support group (slope=0.24). This showed that social identity and emotional connection provided a psychological security foundation for belief renewal. This enabled students to dare abandon their original comfort zones. Deeper dynamics came from perspective transformation triggered by critical reflection. Mezirow's transformative learning theory emphasizes that fundamental belief transformation requires critical examination of basic assumptions supporting beliefs. This study found that the belief transformation magnitude in the critical reflection group (3.8 points) was 111.1% higher than the descriptive reflection group (1.8 points). These students frequently questioned implicit assumptions in their journals such as "music education is only suitable for talented people" and "teachers should maintain authoritative distance." Through deconstruction and reconstruction, they formed new belief frameworks centered on learners and emphasizing educational equity[46]. Emotional experience played a catalyst role in this process. When students witnessed with their own eyes a left-behind child who had never touched an instrument successfully perform a simple melody with encouragement, the heartfelt emotion was far more persuasive than theoretical preaching. This emotional arousal and cognitive reconstruction mutually reinforced each other and formed a double helix dynamic for belief transformation. Additionally, identity transformation cannot be ignored. Service learning transformed students from "knowledge possessors" to "learning facilitators," from "classroom managers" to "community participants." This deepening of role experience was accompanied by reshaping of professional identity. Professional value identity increased from 3.1 points to 4.8 points, an increase of 54.8%. This indicated that belief transformation and identity construction are synchronous psychological processes. Together they constitute the core connotation of teacher professional development. The findings of this study have special significance in the Chinese context. Compared to the emphasis on autonomous exploration in Western individualistic cultures, in the Chinese collectivist cultural context, the moderating effect of social support networks (2-3 times greater) is more pronounced, with peer collaboration and mentor guidance contributing more prominently to belief transformation. Additionally, the 80.8% increase in "educational equity" and "social responsibility" beliefs echoes China's national strategic needs for educational poverty alleviation and rural revitalization. This finding provides a culturally appropriate empirical pathway for localized teacher education reform.Cognitive dissonance theory precisely explains the "critical transition period" phenomenon observed at the mid-test (Week 8). Data show that the experimental group students' belief scores changed slowly in the first 4 weeks (increasing only from 2.8 to 3.1, a 10.7% increase), but experienced steep growth in Weeks 5-8 (leaping from 3.1 to 3.9, a 25.8% increase), followed by a stable consolidation period (Weeks 9-16, increasing from 3.9 to 4.7, a 20.5% increase). This "slow-fast-stable" trajectory aligns with Festinger's cognitive dissonance theory's three-stage model: Weeks 1-4 constitute the "dissonance accumulation period," when students first encounter conflicts between reality and beliefs but still attempt to explain them with old frameworks (e.g., Student S09's journal: "The children are disobedient, probably because my explanation wasn't clear enough"); Weeks 5-8 constitute the "dissonance eruption period," when contradictions intensify to the point where they cannot be avoided, forcing cognitive reconstruction (e.g., Student S14's interview: "In Week 6, I suddenly realized it wasn't the children's problem—my teaching method simply wasn't suitable for them"). This epiphany-like transformation appeared in the Week 5-8 journals of 82.4% of students; Weeks 9-16 constitute the "new equilibrium establishment period," when new beliefs are reinforced and refined through repeated practice. Qualitative data further reveal that the "critical transition period" is often accompanied by the joint effects of emotional crises (anxiety, frustration) and social support intervention (timely mentor guidance,

peer emotional resonance), confirming the emotional arousal mechanism of cognitive dissonance.The findings of this study both resonate with and extend recent international research. Consistent with Fuelberth and Woody's (2025) emphasis on "authentic immersive experiences cultivating inclusive teachers," our data confirm a 63.3% increase in inclusive teaching beliefs (from 3.0 to 4.9 points), with students serving special needs children scoring highest on this dimension (M=5.2 vs. other groups M=4.7, p=0.018), supporting the critical role of authentic diverse contact in belief formation. However, our findings extend their theory in three ways: First, through quantitative mediation analysis, we reveal that environmental awareness is a necessary pathway for transforming authentic experiences into capability development (mediation effect 32-37%), whereas Fuelberth et al. relied primarily on qualitative description. Second, we found the moderating effect of social support (effect size 2-3 times), indicating that mere "immersion" is insufficient; supportive networks are needed to amplify experiential value. Third, stratified analysis of reflection depth (critical vs. descriptive differences of 75-127%) demonstrates that authentic experiences must be accompanied by structured cognitive processing to achieve deep transformation.Compared with Gerrard's (2025) research on preservice music teachers' contextual awareness, we not only confirm the impact of contextual awareness on belief formation (consistent finding) but also establish causal inference through quasi-experimental design (Gerrard used cross-sectional surveys) and reveal that contextual awareness is not a static variable but can be significantly enhanced through service-learning intervention (experimental group increase of 44.8% vs. control group 9.7%). Furthermore, we challenge the traditional music teacher education paradigm's overemphasis on skill training, demonstrating that social responsibility (80.8% increase) and creativity (31.08% increase) can develop synergistically through the same program, supporting an integrative rather than segregated training model.

5.3. Environment-individual-social interaction model

The core findings of this study transcended linear influences of single factors. They revealed a dynamic interactive system composed of environmental elements, individual cognition, and social networks in service learning. This ecological model provides an integrative framework for understanding action mechanisms of complex educational interventions. The role of the environmental dimension is first reflected in challenging stimulation that authentic community contexts provide to student cognitive schemas. Unlike artificial classrooms, community environments present high complexity (diverse service recipients), unpredictability (unexpected situations), and authentic constraints (resource limitations). These characteristics forced students to activate deep cognitive processing. Mediation analysis of environmental perception confirmed that physical environments do not directly change students. Rather, they transform into developmental momentum only after being perceived and meaning-constructed by individuals. In the total effect of service learning on creativity, 32.4% was realized through environmental perception. This mediation pathway verified the core proposition of "context as cognition" in situated learning theory. The individual dimension focuses on student active processing processes, particularly the critical role of reflective practice. Data showed significant differences among students with different reflection depths in the same environment. Creativity growth in critical reflectors (21.5 points) far exceeded descriptive reflectors (12.3 points). This indicated that environments provide raw experiential materials. Individuals refine experience into transferable knowledge and abilities through reflection. The process of reflection frequency increasing from 2.3 times/week to 7.2 times/week was essentially a process of gradually strengthening individual agency. This exercise of subjectivity transformed passive reception into active construction. Environmental stimulation became internalized as lasting change. The influence of the social dimension is reflected in resource supply and emotional security functions of support networks. Moderation effect analysis revealed that social support does not act independently. Rather, it amplifies or weakens environment-individual

relationships. Under high social support conditions, the effect of environmental perception on creativity reached 0.73. Under low support it was only 0.31. This 2.35-fold difference indicated that social networks composed of peer encouragement, mentor guidance, and community recognition provided students with trial-and-error space and psychological security. This enabled them to dare break conventions for creative exploration. The unique contribution of social interaction depth (β=0.42) further confirmed that social processes such as dialogue, collaboration, and feedback themselves are the field where learning occurs. The interaction among the three constitutes more complex nonlinear relationships. Environmental complexity stimulates individual reflection needs. Deepening reflection prompts students to actively seek social support. Social interaction in turn strengthens acute perception of environments and forms positive cycles. The group × time interaction effect shown by repeated measures ANOVA (F=189.45, η^2=0.859) is statistical evidence of this dynamic interaction. This indicated that service learning effects are not simple addition of three elements. Rather, they are emergent results produced through continuous interaction. The theoretical contribution of this model lies in transcending mechanistic "stimulus-response" thinking in traditional educational research. It understands learning as a complex adaptive process embedded in ecosystems. This provides a systematic perspective for designing more effective teacher education programs. It suggests that future interventions should simultaneously optimize environmental design, cultivate reflection abilities, and construct support networks to achieve synergistic enhancement. Taking Student A's developmental trajectory as a specific example: initially encountering elderly people's refusal to participate in choral singing at the nursing home (environmental challenge) → triggering reflection on "how to adapt to special needs" (individual processing, reflection frequency increased from 2.3 to 5.1 times) → seeking help from the community mentor and obtaining rhythm simplification strategies (social support) → after successful retry, positive perception of environmental complexity was reinforced (environmental awareness increased from 2.8 to 4.6 points) → creativity increased by 23 points. Data show that this spiral upward interaction resulted in a 72% creativity growth rate, far exceeding students with only environmental exposure (31% increase) or mere reflection (18% increase), statistically validating the emergent effect of three-element synergy (F=189.45, η^2=0.859).

6. Conclusion

This study systematically verified the multi-dimensional effectiveness of service learning in pre-service music teacher education through quasi-experimental design. The following core conclusions were reached:

(1) Service learning significantly promoted musical creativity development. The experimental group total score increased by 41.9%. Fluency, originality, and elaboration dimensions all showed large effect sizes (Cohen's d>1.2). Authentic community contexts stimulated creative thinking by providing complex problems and improvisational challenges.

(2) Educational beliefs achieved deep transformation. The experimental group transformation from knowledge-centered to learner-centered reached 56.7%. Social responsibility and educational equity awareness increased by 80.8%. Perspective transformation triggered by critical reflection was the fundamental driving force.

(3) Environmental perception played a key mediating role. Service learning indirectly promoted creativity and belief transformation by enhancing student cognitive perception of environmental authenticity and complexity (path coefficient 0.72). The mediation effect accounted for 32-37% of the total effect. This revealed the core position of cognitive processing.

(4) Social support networks had significant moderating functions. Under high support conditions, the effect of environmental perception was 2-3 times that under low support conditions. Support systems composed of peer collaboration, mentor guidance, and community recognition provided a psychological security foundation for creative exploration.

(5) Reflection depth determined transformation quality. Learning outcomes in the critical reflection group were 75-127% higher than the descriptive reflection group. Frequency increased from 2.3 times/week to 7.2 times/week. This confirmed that structured reflection training is a necessary condition for transforming service experience into professional competence. This provides empirical evidence for optimizing teacher education curricula.

This study has the following limitations: First, the small sample size (n=62) from a single normal university limits the generalizability of results and statistical power. Second, the 16-week intervention period is relatively short, making it impossible to examine long-term effects and sustained impact throughout professional careers. Third, although measurement instruments were validated through pilot testing, the cross-cultural equivalence of Western instruments such as the Williams Scale in the Chinese music education context requires further verification. Fourth, the quasi-experimental design cannot fully control confounding variables, so causal inference should be approached with caution. Fifth, qualitative data coding may involve researcher subjectivity, despite the use of multiple validation strategies.

Future research can be deepened in the following directions: First, expand the sample to multiple institutions and different regions to enhance external validity. Second, conduct longitudinal tracking studies to examine the long-term impact of service-learning on post-employment teaching practices and professional development. Third, develop localized music creativity assessment tools to improve cultural appropriateness. Fourth, adopt randomized controlled trial designs to more rigorously test causal relationships. Fifth, explore the differential effects of different types of service-learning programs (such as different service recipients, durations, and reflection intensities) to provide evidence for precision teacher education.

Conflict of interest

There is no conflict of interest.

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