Environment and Social Psychology (2025) Volume 10 Issue 12 ISSN: 2424-8975 (O)
doi: 10.59429/esp.v10i12.4305 2424-7979 (P)

RESEARCH ARTICLE

Leadership emergence and team psychological cohesion cultivation mechanism in English Project-Based Learning from the perspective of group dynamics

Shixuan Chang

School of Foreign Languages, Jining Normal University, Ulanqab 012000, Inner Mongolia, China

*** Corresponding author:** Shixuan Chang, cy8871062@163.com

ABSTRACT

Based on group dynamics theory, this study employs a mixed-methods approach to explore the cultivation mechanisms and interactive relationships between leadership emergence and team psychological cohesion in English project-based learning (PBL). The research selected 160 tenth-grade students from a provincial model senior high school, with the experimental group engaging in a 12-week English PBL program. Data were collected through questionnaire surveys, classroom observations, social network analysis, and in-depth interviews. The findings reveal that: (1) Leadership emergence exhibits three-stage characteristics—exploration, differentiation, and integration phases. Individual factors such as English proficiency and personality traits, along with contextual factors including task complexity and group size, jointly influence leadership development, with 65% of teams forming distributed leadership structures. (2) Team cohesion demonstrates a four-dimensional structure encompassing task, social, learning, and emotional dimensions. The experimental group showed significantly higher cohesion than the control group (4.20 vs. 3.33), with clarity of shared goals, collective efficacy, and group norms identified as key influencing factors. (3) A bidirectional interactive relationship exists between leadership and cohesion, with leadership exerting a total effect of 0.72 on cohesion and cohesion demonstrating a reciprocal effect of 0.55 on leadership, forming a positive spiral. (4) Project activities such as collaborative tasks, cross-cultural themes, multimodal presentations, and reflective dialogues exhibit differentiated effects on cohesion cultivation. This study unveils the unique group dynamics mechanism in English PBL, providing theoretical foundations and practical guidance for optimizing instructional design and promoting students' core competencies development.

Keywords: group dynamics; English project-based learning; leadership emergence; team psychological cohesion; secondary English education

1. Introduction

In the context of globalization, English education is undergoing a profound transformation from knowledge transmission to competency cultivation, and from individual learning to collaborative learning. As a pedagogical approach that emphasizes student agency and collaboration, Project-Based Learning (PBL) has emerged as a pivotal direction in secondary English curriculum reform. However, during project

ARTICLE INFO
Received: 23 October 2025 | Accepted: 21 November 2025 | Available online:10 December 2025

CITATION
Chang SX. Leadership emergence and team psychological cohesion cultivation mechanism in English project-based learning from the perspective of group dynamics. *Environment and Social Psychology* 2025; 10(12): 4305 doi:10.59429/esp.v10i12.4305

implementation, student teams frequently encounter challenges such as low collaborative efficiency, unclear role allocation, and uneven member participation. These phenomena reflect the complexity of group dynamics mechanisms within teams. Concurrently, with the rapid development of educational technology, digital tools are reshaping English learning environments. Research indicates that artificial intelligence tools such as ChatGPT can promote student engagement in English learning contexts through the hedonic motivation model, while the adoption of e-learning platforms has provided new affordances for English instruction. Against this backdrop, understanding the interactive processes within student teams in English PBL from the perspective of group dynamics—particularly the natural emergence of leadership and the cultivation mechanisms of team psychological cohesion—has become an urgent theoretical and practical issue. This concerns not only the optimization of PBL effectiveness but also the holistic development of students' core competencies, including leadership capacity, collaborative ability, and intercultural communicative competence.

Group dynamics theory provides a crucial theoretical framework for understanding team interactions. Since Kurt Lewin introduced the concept of group dynamics, this theory has continuously evolved and been applied to the educational field. Shi Jin's research demonstrates that business English learning communities constructed based on group dynamics theory can effectively facilitate interaction and collaboration among learners, with the core mechanism lying in stimulating members' intrinsic motivation and establishing positive group norms[1]. In the team environment of project-based learning, leadership emergence represents a significant manifestation of group dynamics in action. Unlike traditionally appointed leadership, it refers to the natural distribution of influence that develops through team interactions. Scholars such as Jaeyun have captured group dynamic fault lines using Yule's Q coefficient, revealing the dynamic characteristics of power structures and influence networks within teams[2], thereby providing methodological support for understanding leadership emergence. Closely related to leadership is team psychological cohesion, which serves as the psychological bond sustaining effective team functioning. Research by Seiger and Webster has found that creative team-building activities can significantly promote the formation of team cohesion, and in English project learning, collaborative tasks themselves possess team-building functions[3]. Furthermore, examining English teaching practice from an ecological perspective emphasizes the interaction and dynamic equilibrium among various elements in the learning environment. This holistic thinking is also applicable to understanding teams as operating ecosystems[4]. Online English teaching research further indicates that emotional presence and positive emotional experiences play important roles in learning communities, suggesting that we need to attend to affective dimensions when examining team cohesion[5].

Although existing research has provided theoretical foundations and empirical references for this study, significant research gaps remain. First, existing research on English PBL predominantly focuses on instructional design and learning outcomes, with limited systematic examination of sociopsychological processes within teams from the group dynamics perspective. Second, while leadership emergence and team cohesion have accumulated rich findings as independent research topics in management and organizational behavior studies, their interactive mechanisms and joint influences on project learning effectiveness in secondary English education contexts remain insufficiently explored[6]. Third, most studies adopt static perspectives to analyze team characteristics while neglecting the dynamic evolution of group dynamics, particularly the developmental trajectories of leadership and cohesion across different project phases and their underlying mechanisms. Finally, with the advancement of educational technology, English project learning in digitalized environments exhibits new characteristics, yet relevant research has not adequately addressed technology's impact on group dynamics[7]. These research gaps not only limit our in-depth

understanding of group dynamics mechanisms in English PBL but also constrain effective improvements in teaching practice.

Based on the aforementioned background, this study aims to systematically investigate the dynamic processes of leadership emergence, the formation mechanisms of team psychological cohesion, and their interactive relationships in secondary English PBL, grounded in group dynamics, social psychology, and environmental psychology theories and employing a mixed-methods approach. The research will collect data through teaching experiments, classroom observations, questionnaire surveys, and in-depth interviews, utilizing social network analysis and multilevel linear models to reveal the influencing factors, evolutionary patterns, and pathways through which leadership emergence affects team effectiveness. It will elucidate the multidimensional structure of team cohesion and its developmental characteristics across different project phases, and construct a theoretical model of leadership-cohesion interaction. The theoretical significance of this study lies in enriching the application of group dynamics in language education, expanding the contextual boundaries of leadership emergence theory, and deepening understanding of the sociopsychological mechanisms in project-based learning. Its practical significance resides in providing scientific evidence for secondary English teachers to optimize project design and facilitate effective team collaboration, offering operational strategies for cultivating students' leadership, collaborative, and socioemotional competencies, and ultimately promoting the transformation of English education from knowledge-based to competency-based approaches. Through this research, we expect to provide theoretical support and practical guidance for constructing more dynamic and cohesive English learning communities, facilitating students' synergistic development of linguistic and social competencies in authentic collaborative contexts.

From an environmental psychology perspective, teams in English project-based learning are not merely learning units in physical space, but complex socio-psychological environmental systems. Stokols (1992) points out that environmental psychology focuses on the interaction between people and their environment, where "environment" encompasses both physical and socio-psychological dimensions. Within project teams, group cohesion constitutes a psychological climate that acts as an invisible adhesive binding members together, forming shared emotional atmospheres and behavioral expectations. Leadership performs an environment-shaping function; through establishing norms, allocating resources, and guiding interaction patterns, leaders essentially construct the team's micro-social ecology (Chemers, 2000). Sense of belonging, as individuals' subjective experience of the environment, reflects the psychological person-environment fit between members and the team environment. Research by Pretty et al. (2003) demonstrates that the formation of belonging depends on individuals' perception of identity, security, and meaning within the environment. In English learning contexts, when students feel "this is our project" and "I am valuable in this team," this sense of belonging not only enhances individuals' place attachment to the environment but also reinforces the situated embeddedness of their language learning. Notably, these socio-psychological environmental elements do not exist in isolation but interweave to form a dynamic equilibrium: cohesion provides the socio-psychological foundation for leadership effectiveness, leadership enhances cohesion through effective management, and both jointly contribute to the generation of belonging, which in turn stabilizes and deepens the cohesion and leadership structures. This integrated environmental psychology perspective reminds us that optimizing English project learning outcomes cannot focus solely on instructional task design; it requires systematically cultivating a supportive socio-psychological environment where learners have emotional belonging, cognitive consensus, and behavioral coordination.

In the context of globalization, English education is undergoing a profound transformation from knowledge transmission to competency development, and from individual learning to collaborative learning.

The driving forces behind this transformation stem from the interplay of multiple globalization factors: First, international economic integration has dramatically increased the demand for practical English application abilities in authentic contexts such as transnational business cooperation and international conference communication, rendering traditional grammar-translation teaching methods inadequate for learners' needs to communicate effectively in multicultural environments. Second, the global diffusion of information technology has broken down spatiotemporal constraints on language learning, making cross-regional collaborative learning possible and requiring learners to possess the ability to work collaboratively in English within virtual teams. Third, accelerated global talent mobility has made international perspectives, intercultural communication competence, and teamwork skills essential components of 21st-century core competencies, demanding that English instruction transcend mere linguistic knowledge transmission and shift toward cultivating learners' comprehensive abilities to solve practical problems in globalized contexts. Finally, the exchange and integration of international educational philosophies has promoted the worldwide adoption of teaching models such as project-based learning and task-based instruction that emphasize student agency and collaboration. Therefore, globalization has not only redefined the goals and content of English learning but has fundamentally transformed the organizational forms and implementation pathways of English education.

2. Literature review

As an important branch of social psychology, group dynamics has become a core theoretical framework for understanding team interactions and collective behavior since Kurt Lewin proposed it in the 1940s. Group dynamics emphasizes the group as a holistic psychological field, where individual behavior is influenced by the interaction of multiple factors including group norms, role structures, power distribution, and affective climate. In recent years, group dynamics theory has gradually expanded into the educational field, providing new perspectives for understanding classroom interactions and team learning. Research by Bashiri and Ebadi demonstrates that in digital game-based dynamic assessment of groups, group interactions significantly promote pragmatic competence development among second language learners, evidencing the effectiveness of group dynamics mechanisms in language learning[8]. Peng and Hong analyzed group dynamics under bounded rationality from a game theory perspective, revealing patterns of strategic adjustment and behavioral evolution among group members during interactions, thereby providing theoretical references for understanding decision-making processes in learning teams[9]. In high-risk context research, scholars such as Renner conducted qualitative analyses of Austrian police operations from risk and group dynamics perspectives, finding that group dynamics plays a crucial role in addressing high-risk activities and enhancing safety and resilience. This suggests that in educational contexts, positive group dynamics can similarly enhance teams' adaptive capacity when facing learning challenges[10]. However, the specific application mechanisms of group dynamics theory in English PBL—particularly how to promote language acquisition and competency development through optimizing group interactions—still require more in-depth empirical research for clarification.

Research on leadership in English education has attracted extensive scholarly attention, but research perspectives have predominantly focused on teacher leadership, with relatively insufficient attention to student leadership emergence. Wang Ping and Liu Tingting systematically developed the "Questionnaire on the Influence of College English Teachers' Classroom Discourse on College Students' Leadership Development," exploring the pathways through which teacher discourse influences student leadership cultivation from dimensions such as discourse power allocation, interaction patterns, and feedback mechanisms, thereby providing measurement tools for understanding leadership development in classroom

environments[11]. Liu Bin, from the perspective of international leadership cultivation, proposed that English speech and debate courses can foster college students' international leadership through critical thinking training, intercultural communicative competence enhancement, and public expression ability strengthening, highlighting the facilitative role of specific English course formats in leadership development[12]. Wang Cuibin conducted a multidimensional examination of English teachers' classroom leadership, pointing out that teacher leadership encompasses multiple dimensions including instructional design capacity, classroom management ability, student motivation capability, and reflective innovation competence, which collectively constitute a comprehensive competency system through which teachers influence student development[13]. Chen Yu introduced distributed leadership theory to explore college English teaching reform, arguing that in project-based learning, the traditional single leadership model should be dismantled to encourage students to exercise leadership roles in different task contexts, forming a dynamic leadership distribution pattern[14]. Li Ji explored specific strategies for integrating college students' leadership cultivation into college English classroom teaching[15], including role-playing, group projects, and peer teaching, providing practical references for leadership cultivation in project-based learning. Wu Wangying further demonstrated the dialectical relationship between English classroom transformation and teaching leadership enhancement, indicating that classroom transformation both requires teacher leadership to drive it and can promote the mutual growth of both teacher and student leadership[16]. Lü Jingyi focused on pathways for enhancing high school English teachers' curriculum leadership, emphasizing the supporting role of teacher professional development in curriculum reform[17]. Yang Qin analyzed the driving effect of technology empowerment on college English education and teaching innovation from the perspective of informatization leadership[18]. Although these studies provide multiple perspectives for understanding leadership phenomena in English education, existing research primarily focuses on teacher leadership or cultivating student leadership through preset teaching activities, lacking systematic empirical research on the processes, mechanisms, and influencing factors of natural student leadership emergence in PBL contexts. In particular, examining the dynamic evolution of leadership emergence from a group dynamics perspective remains to be explored in depth.

Team cohesion, as a core psychological variable of team effectiveness, has demonstrated significant impacts on team performance and member well-being across various fields of research. Harenberg and colleagues' study of Canadian helicopter emergency medical services personnel found that team cohesion is negatively correlated with psychological disorder symptoms, with high-cohesion team members exhibiting better mental health levels, revealing cohesion's protective effect on members' psychological states[19]. Wang et al. explored the role of team leisure sports in enhancing construction workers' occupational commitment and sustainability, finding that team cohesion plays an important mediating role between leisure sports and occupational commitment, suggesting that in educational contexts, team-building activities can similarly enhance learning engagement through increased cohesion[20]. Giamportone applied Layder's social domain theory to assess and improve interprofessional team cohesion in healthcare, proposing a multilevel intervention framework from micro-interactions to macro-structures. This integrative perspective offers insights for understanding the formation mechanisms of educational team cohesion[21]. Jun and Hensler's research on post-pandemic healthcare teams found that professional governance and relational leadership can effectively enhance team cohesion in merged perioperative care units, indicating that leadership behaviors and organizational structures have shaping effects on cohesion[22]. Jonathan et al., through a randomized controlled trial, examined the effects of team coaching and facilitation on team cohesion and psychological safety, with results showing that systematic team interventions can significantly enhance cohesion levels, providing empirical support for team building in educational contexts[23]. Yan Rong explored pathways for

building innovative teaching teams among vocational college English teachers based on school-enterprise cooperation, emphasizing the importance of team culture building, collaborative mechanism construction, and shared vision shaping for team cohesion[24]. These cross-disciplinary studies collectively indicate that team cohesion is a multidimensional construct, encompassing different levels such as task cohesion, social cohesion, and learning cohesion, with its formation influenced by multiple factors including leadership behaviors, team activities, organizational support, and member characteristics. However, existing research on team cohesion has primarily concentrated on fields such as healthcare, military, sports, and business management, with relatively limited research in education, particularly language education. More importantly, the dynamic relationship between team cohesion and leadership emergence, and how the two jointly influence PBL effectiveness, have not been adequately explored.

With the development of educational technology and the acceleration of globalization, English learning environments are undergoing profound transformations, with collaborative learning and digital learning emerging as important trends. Feng et al., based on big data technology, studied the new compilation of Chinese college English learning materials, finding that data-driven material development can better meet learners' personalized and collaborative learning needs, providing technological support for resource design in project-based learning[25]. Mohamed and colleagues constructed e-collaborative learning models for cross-regional students, exploring practical pathways for "English learning beyond boundaries." Research indicates that online collaborative environments can promote deep interaction and cultural exchange among students, and this cross-regional collaborative learning experience offers insights for understanding group dynamics in virtual teams[26]. Synthesizing existing literature reveals that although leadership and team cohesion as independent research topics have been relatively well-explored, their integration into systematic research within English PBL contexts remains notably insufficient. First, existing research predominantly adopts static perspectives to analyze team characteristics, lacking longitudinal tracking of group dynamics evolution processes. Second, the interactive mechanisms between leadership emergence and team cohesion remain unclear, particularly lacking empirical evidence for the dynamic changes in their relationship across different project phases. Third, the special nature of the English discipline—where language serves as both learning content and collaborative tool—and how this influences group dynamics processes require deeper exploration. Finally, in the context of digitalization and globalization, the impact of new learning environments on team interaction patterns has not received adequate attention. Therefore, this study aims to address these research gaps by systematically investigating the cultivation mechanisms and interactive relationships between leadership emergence and team psychological cohesion in English PBL from a group dynamics perspective, providing theoretical support and practical guidance for optimizing English teaching practice and promoting students' core competencies development.

3. Research methods

3.1. Research design

This study adopts a mixed-methods research paradigm, integrating quantitative and qualitative approaches to comprehensively and thoroughly examine group dynamics phenomena in English project-based learning. Considering that both leadership emergence and team cohesion are dynamically evolving sociopsychological processes, relying solely on quantitative data is inadequate for capturing their complexity and contextual characteristics, while qualitative data alone cannot reveal causal relationships and effect sizes between variables. Therefore, employing mixed methods enables complementary advantages. Specifically, the research design comprises three phases: During the preparation phase, a pretest is conducted to collect baseline data on participating students' English proficiency, personality traits, and social networks, while

team formation is completed. During the implementation phase, a 12-week English PBL teaching experiment is conducted, with three tracking measurements administered at the early, middle, and late stages of the project. Quantitative data include leadership behavior ratings, team cohesion questionnaires, and social network surveys, while qualitative data encompass classroom videos, group discussion records, student reflection journals, and teacher observation notes. During the concluding phase, posttests and in-depth interviews are conducted to systematically synthesize critical incidents and turning points throughout the entire project process[27]. In terms of research pathway, a logical progression of "observation-description → relationship exploration → mechanism explanation" is followed: First, descriptive analysis presents the basic patterns of leadership emergence and cohesion development; second, correlation analysis, regression analysis, and social network analysis explore the associative patterns between the two; finally, grounded theory and case analysis are employed to deeply excavate the underlying mechanisms. The research framework is constructed on the foundations of group dynamics theory, social identity theory, and situational leadership theory, incorporating project task characteristics, team member traits, teacher-student interaction patterns, and classroom physical environment as influencing factors into the analytical framework, while examining English learning effectiveness, student satisfaction, and team efficacy as outcome variables, thereby forming a complete research chain of "contextual input → process mechanisms → effect output."

3.2. Research participants

The participants in this study were tenth-grade students from a provincial model senior high school. A total of 160 students from four parallel classes were selected as the research sample, with 80 students from two classes constituting the experimental group and 80 students from the other two classes forming the control group. The selection of tenth-grade students as research participants was primarily based on the following considerations: Students at this grade level have acquired basic English communication competence and collaborative awareness, enabling them to undertake relatively complex project tasks. Simultaneously, they are in a critical period of self-identity formation and social competency development, exhibiting strong psychological needs for team interaction and leadership role experiences. Sample selection followed the principle of voluntary participation. Students were included in the research after obtaining consent from the students themselves, their parents, and the school. All participants signed informed consent forms before the study commenced, clearly informing them of the research purpose, process arrangements, data usage methods, and withdrawal mechanisms. To ensure sample comparability, the English teachers in all four classes possessed over five years of teaching experience and had received PBL training, with no significant differences in students' entrance examination scores, gender ratios, or family background distributions[28]. In the team formation phase, experimental group students were divided into 20 groups of 4 members each, following the principle of "homogeneous between groups, heterogeneous within groups," with comprehensive consideration of factors such as English proficiency, personality types, gender, and social relationships to avoid situations where abilities were either overly concentrated or excessively dispersed. The control group was similarly divided into groups but received conventional instruction. Students' personal information was kept strictly confidential throughout the research process, with all data processed through coding and interview recordings deleted immediately after transcription. Considering that some students might experience negative emotions due to project pressure or interpersonal conflicts, the research team was equipped with psychological counseling teachers to provide necessary support, ensuring ethical compliance and students' physical and psychological safety.

This study was conducted at a provincial-level model high school in eastern China, with participants being first-year high school students at the school. The selection of the research site in Zhejiang Province involved multiple considerations: First, this region is at the forefront of English education reform nationwide;

since the new college entrance examination reform in 2017, project-based learning has been incorporated into the school's English curriculum system, and teachers and students have a certain level of acceptance and practical foundation for this teaching model. Second, this provincial-level model high school is equipped with comprehensive teaching facilities and information technology resources capable of supporting multimodal presentations, online collaboration, and other components of project activities. Third, the school's English teaching team includes multiple backbone teachers with more than five years of teaching experience who have received professional PBL training, ensuring the standardized implementation of the teaching experiment. Finally, students in this region have relatively balanced foundational English proficiency levels, with English achievement scores at enrollment conforming to normal distribution characteristics (skewness coefficient = 0.13, kurtosis coefficient = -0.26), which is conducive to controlling the initial homogeneity of the sample. It should be noted that high school English teaching in China follows national curriculum standards that emphasize cultivating students' core competencies including linguistic ability, cultural awareness, thinking quality, and learning capacity, which are highly consistent with the study's focus on leadership, collaborative ability, and other competency development goals. Meanwhile, Chinese classrooms commonly feature characteristics such as large class sizes (each class in this study had 40 students) and a strong collectivist cultural atmosphere. These contextual factors may influence the specific manifestations of group dynamics mechanisms and need to be considered when interpreting the results.

3.3. Teaching experiment design for English project-based learning

The teaching experiment lasted 12 weeks, with the experimental group engaging in three progressive English projects, each lasting 4 weeks. The first project, themed "Campus Culture Promotion Plan Design," required each group to investigate the school's distinctive cultural elements and produce promotional videos in English to introduce them to international sister schools. This project focused on cultivating students' cultural awareness and language expression competence. The second project, "Community Environmental Action Plan," required students to visit communities to investigate environmental issues, compose research reports in English, and design feasible improvement plans for presentation to the community in English. This project strengthened problem-solving abilities and intercultural communication competence. The third project, "Simulated International Youth Summit," involved group debates and collaborative proposals on global issues, culminating in English resolution documents. This project emphasized the enhancement of critical thinking and global perspectives. Each project comprised seven phases: task announcement, group discussion, data collection, plan formulation, interim presentation, outcome refinement, and final presentation, with group discussion and collaboration time accounting for over 60% of the total, thereby creating ample space for group interaction and leadership emergence[29]. Project task design adhered to the principles of authenticity, challenge, and openness, avoiding standard-answer questions and encouraging students to exercise creativity. Teachers played dual roles as facilitators and observers during the experiment: clarifying task requirements and evaluation criteria during the project initiation phase, promoting student thinking through questioning and feedback rather than directly providing answers during the process, regularly organizing reflection meetings to help teams identify collaborative issues, while systematically recording the interaction patterns and role differentiation of each group[30]. Control group students completed the same learning content but through traditional classroom instruction combined with individual assignments, without involvement in long-term team collaboration. Throughout the experiment, class scheduling, evaluation methods, and teacher allocation were kept essentially consistent between the two groups, with differences only in instructional organization format, enabling accurate identification of the unique impact of the PBL model on group dynamics.

3.4. Data collection methods

This study employs diversified data collection strategies to ensure information about leadership emergence and team cohesion is obtained from multiple perspectives. Regarding quantitative data, the research team adapted and utilized four sets of measurement instruments: First, the Leadership Behavior Observation Scale, self-developed based on Northouse's leadership dimension theory, encompasses three dimensions—task-oriented behavior, relationship-oriented behavior, and change-oriented behavior—comprising 18 items in total. Using a peer rating approach, each member rates other members' leadership behaviors within the group on a 5-point scale. Second, the Team Cohesion Questionnaire, revised based on Carron's Group Environment Questionnaire, covers four dimensions—task attraction, social attraction, group integration, and individual belonging—totaling 20 items, employing a 7-point Likert scale. Third, the English Learning Engagement Scale measures students' behavioral, emotional, and cognitive engagement levels in the project. Fourth, the Social Network Relations Questionnaire requires students to identify consultation targets, influence sources, and emotional support sources within their groups, used to map team interaction network diagrams[31]. These scales were administered before project commencement and at the end of weeks 4, 8, and 12, respectively, to track dynamic changes in variables. Qualitative data collection employs three approaches: Classroom observation is conducted by two trained research assistants using structured observation forms to record key behaviors in group interactions, including speaking frequency, decision-making participation, and conflict resolution methods, with each group observed no less than twice weekly for 30 minutes each time. In-depth interviews are conducted at project midpoint and after completion, with 1-2 members selected from each group according to the maximum variation sampling principle for semi-structured interviews on leadership role experiences, team climate perceptions, and collaborative difficulties, lasting 20-30 minutes each with full audio recording. Student reflection journals require each participant to submit weekly entries documenting project progress, personal feelings, and team dynamics. Additionally, process documentation such as group meeting minutes, task allocation tables, and English work products is collected. All data collection instruments underwent pilot testing and reliability and validity verification before formal use to ensure measurement rigor.

3.5. Data analysis methods

Quantitative data processing was completed using SPSS 26.0 and UCINET 6.0 software for multilevel analysis. First, descriptive statistics were conducted to calculate means, standard deviations, and distribution characteristics of measurement variables at different time points, with trend charts plotted to present the evolutionary trajectories of leadership and cohesion. For reliability and validity testing, Cronbach's alpha coefficients were used to assess scale internal consistency, and confirmatory factor analysis was employed to examine construct validity. For repeated measures data, repeated measures ANOVA was utilized to examine between-group differences and time effects in leadership emergence and team cohesion between experimental and control groups, with paired-samples t-tests comparing the significance of pre- and post-test changes[32]. To explore inter-variable relationships, Pearson correlation analysis was employed to reveal the association strength between leadership behaviors and cohesion dimensions, multiple regression analysis was used to identify key predictive factors influencing cohesion, and mediation effect testing was utilized to explore the pathways through which leadership affects learning effectiveness. Social network data employed UCINET software to calculate indicators such as network density, centrality, and cohesive subgroups, with sociograms drawn to visually display leadership roles' positions within team structures. Qualitative data analysis followed grounded theory coding procedures, assisted by NVivo 12 software: After interview recordings were transcribed, open coding was performed to extract initial concepts from raw texts; subsequently, axial coding was conducted to inductively form core categories; finally, theoretical models

were constructed through selective coding[33]. Classroom observation records and reflection journals employed thematic analysis to identify recurring patterns and critical incidents. To achieve deep integration of quantitative and qualitative data, a triangulation strategy was adopted, with questionnaire results and interview content mutually corroborating each other. Statistically identified associative patterns guided the interpretation of qualitative materials, while typical cases enriched the contextual implications of numerical results, forming complementary understanding.

3.6. Research reliability and validity

Reliability testing of quantitative instruments demonstrated that Cronbach's alpha coefficients for all scales ranged between 0.82 and 0.91, with test-retest reliability coefficients exceeding 0.76, indicating good measurement stability. Regarding validity, content validity was ensured through expert review, and confirmatory factor analysis results showed that fit indices for all scales were satisfactory (CFI > 0.90, RMSEA < 0.08), confirming construct validity. Qualitative research employed multiple strategies to ensure trustworthiness: Investigator triangulation involved two coders independently analyzing the same materials, achieving 85% coding consistency; data source triangulation integrated multiple data sources such as interviews, observations, and documents for mutual corroboration; member checking involved feeding back analytical results to selected participants to confirm interpretive accuracy[34]. Additionally, detailed recording of research processes and decision-making trails enhanced research auditability, while thick description improved results' transferability.

4. Results analysis

4.1. Dynamic process of leadership emergence in English project-based learning

4.1.1. Temporal trajectory and phase characteristics of leadership emergence

Based on 12-week tracking observations and quantitative measurements of 20 experimental groups, the study reveals that student leadership emergence in English PBL exhibits distinct phase characteristics and dynamic evolution patterns. Data indicate that leadership emergence is not a linear developmental process but rather undergoes three typical phases: exploration, differentiation, and integration, with different types of leadership behaviors demonstrating differentiated development patterns across phases. During the early project stage (Weeks 1-4), team members were in a role-exploration phase, with task-oriented leadership behavior scores gradually increasing from 2.45 in Week 1 to 3.78 in Week 4 (out of a maximum score of 5). At this stage, students with stronger English proficiency and extroverted personalities more easily gained initial influence, primarily by proactively undertaking task allocation and schedule formulation. Relationship-oriented leadership behavior was relatively weak in the early stage, with means maintained between 2.30-2.65, reflecting that members had not yet established deep emotional connections[35]. The project mid-stage (Weeks 5-8) represented a critical period for leadership differentiation and stabilization. Task-oriented behavior continued to climb to a peak of 4.32, while relationship-oriented behavior exhibited significant growth, surging from 2.68 to 3.85, with standard deviation narrowing from 0.82 to 0.56, indicating that leadership roles gradually clarified and gained member recognition. Notably, approximately 65% of groups developed "dual-core" or "multi-core" leadership structures during this phase, with different members exercising their respective strengths in English language expression, creative design, and team coordination. The late project stage (Weeks 9-12) entered the leadership function integration phase, with change-oriented leadership behavior rapidly increasing from 2.95 in Week 9 to 4.15 in Week 12, reflecting that leaders began emphasizing team innovation motivation and outcome optimization[36]. The three leadership behaviors trended toward balanced development in the late stage, with narrowing differences among task-oriented (4.18), relationship-oriented (4.05), and change-oriented (4.15) behaviors, and the

comprehensive leadership index reaching 4.13. Social network analysis results showed that leaders' network centrality increased from 0.42 in the early stage to 0.78 in the late stage, while the centralization index decreased from 0.55 to 0.38, indicating that leadership distribution trended toward flattening. Qualitative data further revealed that late-stage leaders became more adept at employing English for democratic consultation and emotional motivation, with English language use transforming from instrumental to expressive, facilitating deep team integration.

Table 4.1. Statistical table of leadership behavior scores across different phases.

Project Phase	Time Span	Task-Oriented (M±SD)	Relationship-Oriented (M±SD)	Change-Oriented (M±SD)	Comprehensive Leadership Index	Network Centrality
Early Stage - Exploration Phase	Weeks 1-4	3.12±0.89	2.48±0.82	2.15±0.76	2.58±0.71	0.42±0.15
Mid-Stage - Differentiation Phase	Weeks 5-8	4.32±0.56	3.85±0.64	3.28±0.68	3.82±0.53	0.65±0.12
Late Stage - Integration Phase	Weeks 9-12	4.18±0.48	4.05±0.52	4.15±0.55	4.13±0.45	0.78±0.10

Note: *M = Mean, SD = Standard Deviation, maximum score = 5, N = 80*

Figure 4.1. Temporal trajectory of leadership emergence in english project-based learning.

4.1.2. Individual characteristics and behavioral patterns of leadership emergence

Through analysis of individual characteristics and leadership behavior tracking of 80 experimental group students, the study reveals that leadership emergence is significantly associated with multiple individual variables. Data show that English proficiency has a foundational impact on leadership emergence, with students in the excellent English proficiency group (CEFR B2 and above) achieving significantly higher comprehensive leadership scores ($M = 4.28$, $SD = 0.52$) than those in the intermediate proficiency group ($M = 3.65$, $SD = 0.68$) and basic proficiency group ($M = 3.12$, $SD = 0.75$), $F(2, 77) = 18.45$, $p < 0.001$. Further analysis indicates that English oral fluency is positively correlated with task-oriented leadership behavior ($r = 0.58$, $p < 0.01$), as students with strong speaking abilities are better able to effectively communicate ideas,

coordinate task allocation, and facilitate group discussions[37]. Regarding personality traits, the extraversion dimension score is significantly correlated with leadership emergence ($r = 0.62$, $p < 0.001$), with highly extroverted students demonstrating stronger initiative and influence in the early project stage, their social network centrality (0.72) significantly higher than that of low-extraversion students (0.38). The conscientiousness dimension similarly exhibits predictive power ($r = 0.51$, $p < 0.01$), with highly conscientious students undertaking more organizational coordination leadership roles. Agreeableness is positively correlated with relationship-oriented leadership behavior ($r = 0.48$, $p < 0.01$), with such students excelling at creating harmonious atmospheres and resolving team conflicts. Social network analysis reveals behavioral pattern characteristics of leaders: Emergent leaders averaged 18.5 speaking turns per discussion during the first 4 weeks of the project, 2.6 times that of non-leaders (7.2 times); their English expressions used collective pronouns such as "we" at a frequency (42%) higher than individual pronouns such as "I" (28%), reflecting team-oriented consciousness. In terms of decision participation, leaders participated in 89% of important group decisions, while ordinary members participated in only 45%. Conflict resolution behaviors also showed differences, with leaders tending to adopt integrative strategies (61%), whereas non-leaders more frequently employed avoidance strategies (52%)[38]. Further qualitative interviews revealed that successfully emergent leaders universally exhibited four key behaviors: proactively assuming responsibility, actively providing support, effectively communicating and coordinating, and continuously driving progress. Notably, English learning engagement plays a mediating role between individual characteristics and leadership emergence, with highly engaged students enhancing their language competence and confidence through frequent English practice, thereby strengthening leadership influence.

Table 4.2 Comparison of leadership performance among students with different individual characteristics.

Individual Characteristic Dimension	Group	Sample Size	Comprehensive Leadership Score (M±SD)	Network Centrality	Speaking Frequency (times/discussion)	Decision Participation Rate (%)
English Proficiency	Excellent (B2+)	28	4.28±0.52	0.68±0.12	16.8±4.2	78%
	Intermediate (B1)	35	3.65±0.68	0.52±0.15	11.5±3.8	58%
	Basic (A2)	17	3.12±0.75	0.35±0.18	7.9±3.2	42%
Extraversion	High Score Group	32	4.15±0.58	0.72±0.11	15.6±4.5	74%
	Medium Score Group	30	3.68±0.64	0.51±0.14	10.8±3.6	56%
	Low Score Group	18	3.25±0.71	0.38±0.16	8.2±3.1	45%
Conscientiousness	High Score Group	35	4.08±0.61	0.65±0.13	14.2±4.1	71%
	Medium Score Group	28	3.62±0.66	0.48±0.15	10.5±3.5	55%
	Low Score Group	17	3.18±0.73	0.39±0.17	8.5±3.3	43%

Note: *English proficiency assessed based on CEFR standards; personality traits measured using the Big Five Inventory, grouped by median split*

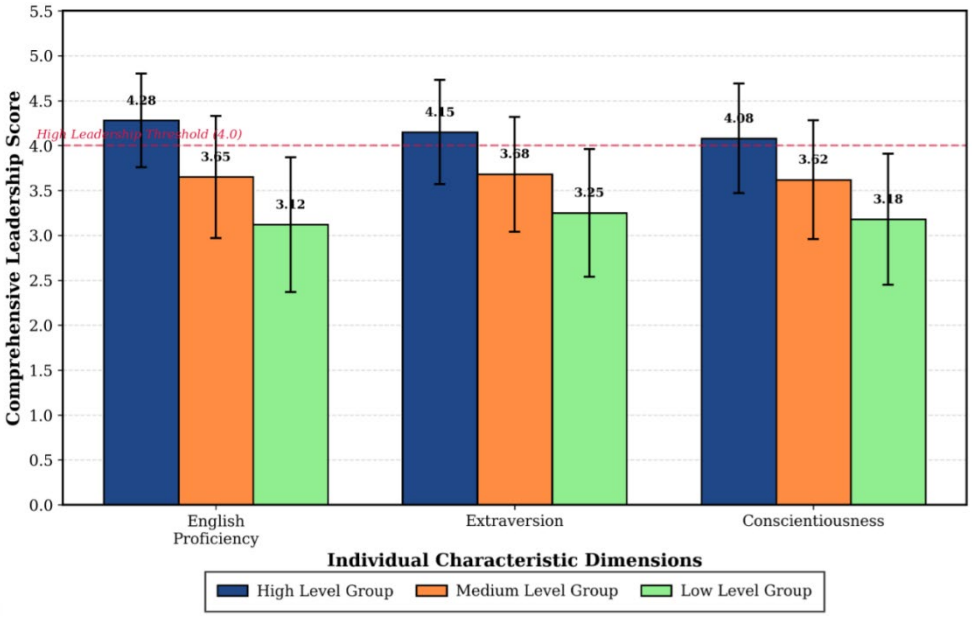

Figure 4.2. Comparison of comprehensive leadership scores among students with different individual characteristics.

4.1.3. Influence mechanisms of contextual factors on leadership emergence

Contextual factors, as external environmental variables, play a significant moderating role in leadership emergence in English PBL. Through manipulation and observation of different contextual conditions, the study systematically analyzed the influence mechanisms of four key contextual variables: project task complexity, group size, team English proficiency heterogeneity, and teacher support intensity. Data reveal that project task complexity exhibits an inverted U-shaped relationship with leadership emergence, with moderate complexity tasks (difficulty coefficient 0.6-0.7) most effectively stimulating leadership behaviors, achieving a comprehensive leadership score of 4.25, significantly higher than low-complexity tasks (3.48) and high-complexity tasks (3.72)[39]. Qualitative interviews revealed that overly simple tasks lack challenge, allowing members to complete them without leadership coordination, while overly complex tasks lead teams into predicaments where leadership roles struggle to function effectively. Group size demonstrates a threshold effect on leadership emergence, with 4-5 member groups exhibiting the most sufficient leadership emergence (comprehensive score 4.18), 3-member groups scoring lower due to limited interaction space (3.65), and groups of 6 or more experiencing "social loafing" phenomena, with leadership efficacy declining to 3.82. Analysis of team English proficiency heterogeneity indicates that moderate heterogeneity combinations (standard deviation 0.8-1.2) achieve optimal leadership emergence effects (4.32), forming complementary advantages without creating excessive communication gaps; teams with excessively high homogeneity ($SD < 0.5$) lack differentiation momentum (3.58), while teams with excessive heterogeneity ($SD > 1.5$) face collaborative difficulties (3.45). The influence of teacher support intensity exhibits phase-specific characteristics: high support in the early project stage (intervention frequency > 10 times/week) facilitates leadership role establishment (score 3.95), mid-stage support should gradually decrease to moderate levels (5-7 times/week) to promote student autonomous leadership (score 4.28), and low late-stage support (< 3 times/week) strengthens leadership responsibility (score 4.15)[40]. Regression analysis shows that the four contextual factors collectively explain 63.8% of leadership emergence variance, with task complexity ($\beta = 0.35$, $p < 0.001$) and team heterogeneity ($\beta = 0.28$, $p < 0.01$) as the strongest predictors. Further interaction effect testing revealed that moderate task complexity combined with moderately heterogeneous teams produces synergistic enhancement effects, elevating leadership scores to 4.52.

Contextual analysis also revealed that the cross-cultural thematic characteristics of English projects uniquely influence leadership emergence, with project tasks involving cultural comparisons better stimulating multi-perspective leadership behaviors and promoting distributed leadership pattern formation.

Table 4.3. Effects of different contextual factors on leadership emergence.

Contextual Factor	Level Classification	Sample Groups	Comprehensive Leadership Score (M±SD)	Number of Leadership Roles	Leadership Structure Type	Significance Test
Task Complexity	Low (0.3-0.5)	7	3.48±0.72	1.2±0.4	Single-core	F = 15.82***
	Medium (0.6-0.7)	8	4.25±0.58	2.4±0.6	Dual-core/Multi-core	
	High (0.8-1.0)	5	3.72±0.68	1.8±0.5	Dispersed	
Group Size	3 members	6	3.65±0.65	1.5±0.5	Single-core	F = 12.45***
	4-5 members	10	4.18±0.54	2.2±0.5	Dual-core	
	6+ members	4	3.82±0.71	1.9±0.6	Diffused	
English Proficiency Heterogeneity	Low (SD < 0.5)	6	3.58±0.69	1.3±0.4	Ability-dominant	F = 18.23***
	Medium (SD 0.8-1.2)	9	4.32±0.52	2.5±0.5	Complementary	
	High (SD > 1.5)	5	3.45±0.78	1.6±0.6	Differentiated	
Teacher Support (Early Stage)	High (> 10 times/week)	7	3.95±0.62	1.8±0.5	Dependent	F = 9.67**
	Medium (5-7 times/week)	8	4.28±0.55	2.3±0.5	Balanced	
	Low (< 3 times/week)	5	3.68±0.73	1.5±0.5	Autonomous	

***Note:** ***p < 0.001, *p < 0.01; task complexity indicated by expert-rated difficulty coefficient; heterogeneity indicated by within-group English achievement standard deviation*

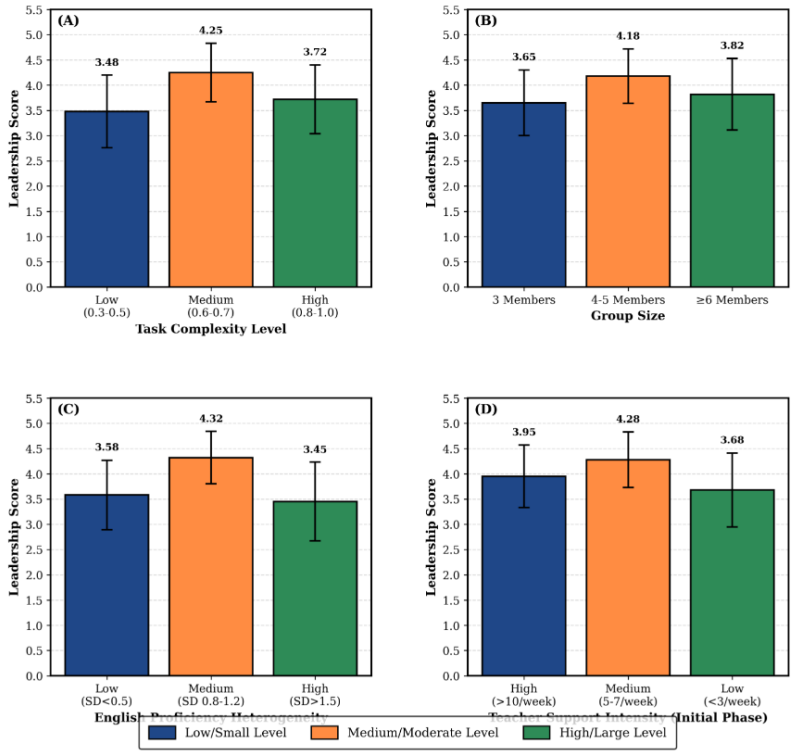

Figure 4.3 Effects of different contextual factors on leadership emergence.

4.2. Formation mechanisms and development trajectories of team psychological cohesion

4.2.1. Multidimensional structure and measurement results of team cohesion

Based on the adapted scale from Carron's Group Environment Questionnaire, this study systematically measured the psychological cohesion of English PBL teams across four dimensions: task cohesion, social cohesion, learning cohesion, and emotional cohesion. Confirmatory factor analysis results showed that the four-factor model had good fit indices ($\chi^2/df = 2.15$, CFI = 0.93, TFI = 0.91, RMSEA = 0.06, SRMR = 0.05), confirming the multidimensional structure of team cohesion. The overall Cronbach's alpha coefficient for the scale was 0.89, with dimension alpha coefficients ranging from 0.82 to 0.91, indicating that the measurement instrument possesses good reliability and validity. Descriptive statistics showed that at project completion (Week 12), mean scores for all four dimensions were at relatively high levels, with task cohesion scoring highest (M = 4.38, SD = 0.54), reflecting team members' strong sense of commitment and responsibility toward jointly completing English project tasks; learning cohesion scored second (M = 4.25, SD = 0.58), indicating students' recognition of the team's value in promoting English learning; social cohesion scored 4.12 (SD = 0.62), demonstrating that team members established good interpersonal relationships and friendship bonds; and emotional cohesion scored 4.05 (SD = 0.65), showing that teams created positive emotional atmospheres and psychological belonging[41]. Inter-dimensional correlation analysis revealed moderate to high positive correlations among the four dimensions ($r = 0.52$-0.68, $p < 0.01$), indicating that dimensions are interrelated yet relatively independent. Further multiple regression analysis showed that task cohesion had the strongest predictive power for team English project outcome quality ($\beta = 0.42$, $p < 0.001$), followed by learning cohesion ($\beta = 0.31$, $p < 0.01$), while social cohesion and emotional cohesion primarily influenced team efficacy indirectly through affecting member satisfaction and continuous participation intention[42]. Hierarchical regression analysis revealed that the four dimensions collectively explained 71.5% of team performance variance, far exceeding the explanatory power of single dimensions, demonstrating the necessity of a multidimensional perspective. Qualitative interviews further revealed that in the English project context, task cohesion formation depends on clear shared goals and reasonable task allocation, learning cohesion stems from knowledge complementarity and mutual learning among members, social cohesion is built on frequent English interactions and cultural exchanges, and emotional cohesion is continuously strengthened through jointly overcoming language challenges and sharing successful experiences. Between-group comparisons showed that the experimental group scored significantly higher than the control group on all four cohesion dimensions ($p < 0.001$), indicating that the PBL model possesses unique advantages in cultivating team cohesion.

Table 4.4. Measurement results and correlation analysis of team cohesion dimensions.

Dimension	Number of Items	Mean ± SD	Cronbach's α	Correlation with Task Cohesion	Correlation with Social Cohesion	Correlation with Learning Cohesion	Correlation with Emotional Cohesion
Task Cohesion	5	4.38±0.54	0.88	1.00	0.58**	0.65**	0.52**
Social Cohesion	5	4.12±0.62	0.85	0.58**	1.00	0.61**	0.68**
Learning Cohesion	5	4.25±0.58	0.91	0.65**	0.61**	1.00	0.59**
Emotional Cohesion	5	4.05±0.65	0.82	0.52**	0.68**	0.59**	1.00
Overall Cohesion	20	4.20±0.52	0.89	0.82**	0.85**	0.87**	0.84**

***Note:** *p < 0.01; N = 80 (experimental group), measurement time point at Week 12; score range 1-5*

Table 4.5. Comparison of team cohesion scores between experimental and control groups.

Dimension	Experimental Group (M±SD)	Control Group (M±SD)	t-value	p-value	Cohen's d
Task Cohesion	4.38±0.54	3.52±0.68	8.45	< 0.001	1.41
Social Cohesion	4.12±0.62	3.28±0.72	7.62	< 0.001	1.26
Learning Cohesion	4.25±0.58	3.35±0.70	8.21	< 0.001	1.38
Emotional Cohesion	4.05±0.65	3.18±0.75	7.38	< 0.001	1.23
Overall Cohesion	4.20±0.52	3.33±0.64	9.12	< 0.001	1.52

Note: *Experimental group N = 80, control group N = 80; measurement time point at Week 12*

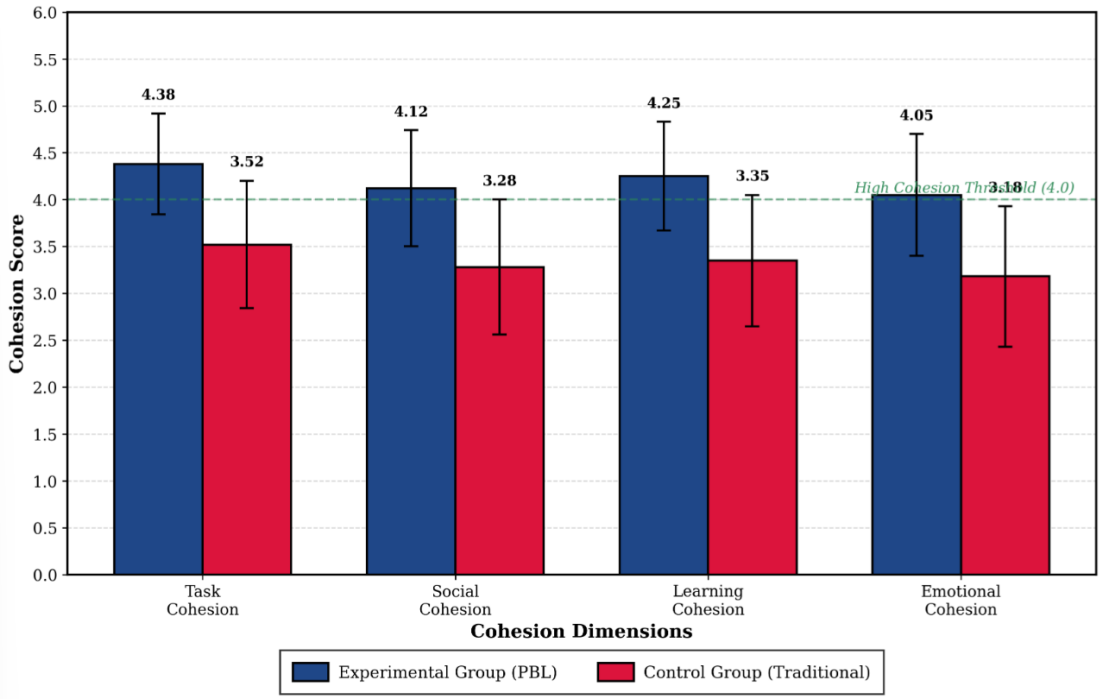

Figure 4.4. Comparison of team cohesion dimension scores between experimental and control groups.

4.2.2. Group dynamics factors influencing team psychological cohesion

From the group dynamics theory perspective, team cohesion formation is influenced by multiple group process variables. Through hierarchical regression analysis and path analysis, this study identified five key group dynamics factors and their mechanisms affecting team psychological cohesion. Shared goal clarity, as the strongest predictor, is highly positively correlated with team cohesion ($r = 0.72$, $p < 0.001$). When team members have highly consistent perceptions of English project shared goals (consistency score > 4.0), team cohesion scores reach 4.45, significantly higher than the ambiguous goal perception group (3.28). The establishment of group norms significantly promotes cohesion, with teams forming clear behavioral norms (such as fixed meeting times, English communication agreements, and task submission standards) scoring 25.2% higher in cohesion (4.32) than teams with ambiguous norms (3.45). Collective efficacy is an important psychological foundation for cohesion; for every one standard deviation increase in the team's collective belief in their ability to complete English projects, cohesion scores increase by an average of 0.68 points ($\beta = 0.68$, $p < 0.001$)[43]. Interview data revealed that when teams successfully complete phased English tasks (such as receiving high teacher evaluations or performing excellently in class presentations), collective efficacy significantly strengthens, thereby promoting an upward spiral of cohesion. The density of peer support networks exhibits an inverted U-shaped relationship with cohesion, with medium-density

networks (density coefficient 0.5-0.7) most conducive to cohesion formation (4.38). Excessively low density (< 0.3) leads to member isolation (3.52), while excessively high density (> 0.8) may create subgroup differentiation (3.85). Social network analysis revealed that when teams have 2-3 "broker" roles capable of connecting different member subgroups, overall cohesion levels are highest[44]. The accumulation of group success experiences has a positive reinforcing effect on cohesion, with teams experiencing three or more successful collaboration experiences scoring significantly higher in cohesion (4.42) than teams with only 1-2 success experiences (3.68). Further mediation effect testing found that shared goals indirectly influence cohesion through enhancing collective efficacy (indirect effect = 0.35, $p < 0.01$), and group norms function through promoting peer support network formation (indirect effect = 0.28, $p < 0.01$). The structural equation model showed that the theoretical model comprising five group dynamics factors explains 78.3% of cohesion variance, with excellent model fit indices ($\chi^2/df = 1.89$, CFI = 0.95, RMSEA = 0.05).

Table 4.6. Effects of group dynamics factors on team cohesion.

Group Dynamics Factor	Level Classification	Sample Groups	Team Cohesion Score (M±SD)	Correlation Coefficient (r)	Regression Coefficient (β)	Explained Variance (R^2)
Shared Goal Clarity	High (> 4.0)	12	4.45±0.48	0.72***	0.45***	0.52
	Medium (3.0-4.0)	6	3.82±0.62			
	Low (< 3.0)	2	3.28±0.75			
Group Norm Establishment	Clear	11	4.32±0.52	0.65***	0.38**	0.42
	General	7	3.78±0.68			
	Ambiguous	2	3.45±0.72			
Collective Efficacy	High (> 4.0)	13	4.38±0.50	0.70***	0.42***	0.49
	Medium (3.0-4.0)	5	3.75±0.65			
	Low (< 3.0)	2	3.25±0.78			
Peer Support Network Density	High (> 0.7)	4	3.85±0.68	0.58**	0.32**	0.34
	Medium (0.5-0.7)	10	4.38±0.52			
	Low (< 0.5)	6	3.52±0.70			
Group Success Experience	High (≥ 3 times)	13	4.42±0.48	0.68***	0.40***	0.46
	Medium (2 times)	5	3.88±0.62			
	Low (≤ 1 time)	2	3.68±0.72			

***Note:** ***p < 0.001, *p < 0.01; N = 20 groups; regression coefficients are standardized*

Table 4.7. Correlation matrix and mediation effects among group dynamics factors.

Variable	1	2	3	4	5	6
1. Shared Goal Clarity	1.00					
2. Group Norm Establishment	0.58**	1.00				
3. Collective Efficacy	0.65***	0.52**	1.00			
4. Peer Support Network	0.48**	0.62***	0.55**	1.00		
5. Group Success Experience	0.60***	0.51**	0.68***	0.46*	1.00	
6. Team Cohesion	0.72***	0.65***	0.70***	0.58**	0.68***	1.00

***Note:** ***p < 0.001, **p < 0.01, p < 0.05; N = 20 groups*

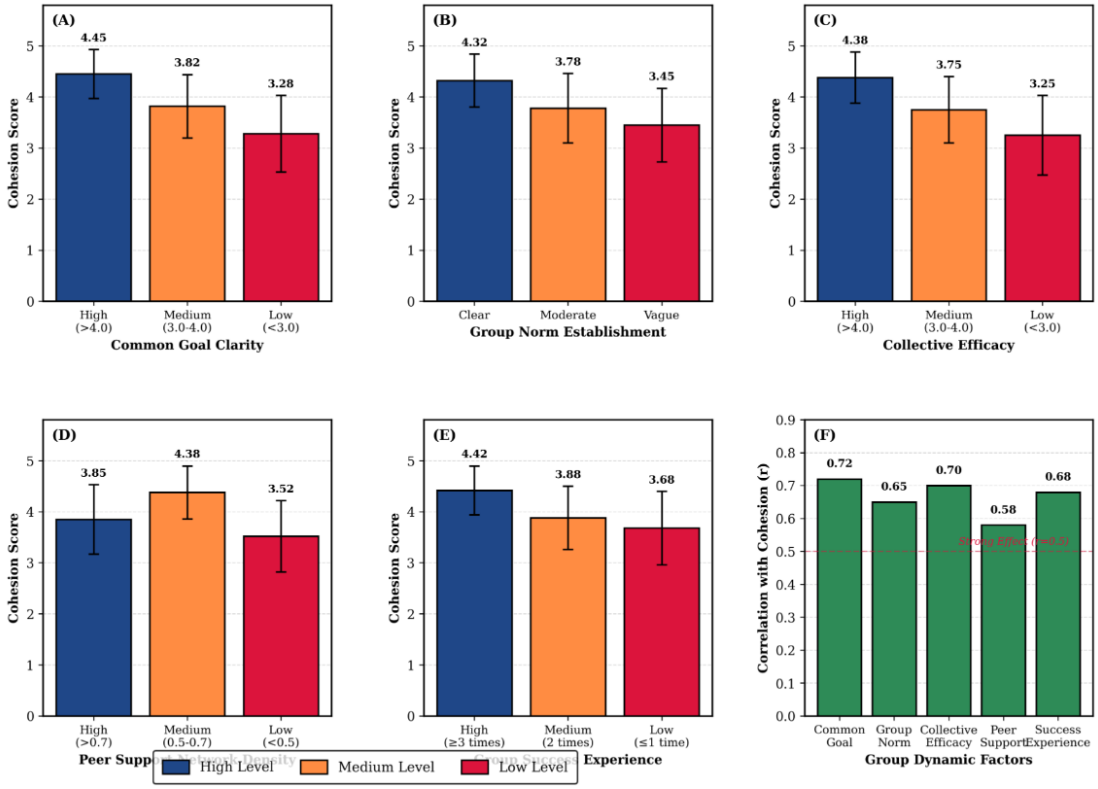

Figure 4.5. Effects of group dynamics factors on team cohesion.

4.2.3. Specific effects of English project activities on cohesion cultivation

The specific activity designs in English PBL play a crucial catalytic role in cultivating team cohesion. Through content analysis and paired-samples t-tests, the study systematically examined the cohesion cultivation effects of four core types of project activities. Collaborative English task design proved to be the most effective means of promoting cohesion, including activities requiring high levels of collaboration such as group English script writing, team debate preparation, and joint research report composition. Teams participating in such activities saw cohesion increase from 3.15 in the early project stage to 4.42, an increase of 40.3%, with an effect size d = 1.68, significantly higher than the individual task group ($p < 0.001$). Qualitative analysis revealed that collaborative tasks enhance cohesion by strengthening task interdependence, promoting frequent English interactions, and establishing shared responsibility. Cross-cultural project themes significantly strengthen team identification; when projects involve Chinese-Western cultural comparisons, international issue exploration, or global perspective topics, students' cultural identity

and team belonging significantly increased, with cohesion scores under such themes (4.35) being 15.1% higher than non-cross-cultural themes (3.78). Interviews revealed that cross-cultural themes stimulated students' collective pride and sense of mission, promoting the formation of "we" consciousness. Multimodal English presentation activities possess unique team-building functions, including video production, multimedia presentations, and theatrical performances. These activities require members to exercise different strengths (language, technology, arts), with 68.5% of teams reporting that the presentation preparation process significantly enhanced mutual appreciation and trust among members, with cohesion increasing by 35.7% (from 3.22 to 4.37)[45]. Reflective dialogue plays an important role in cohesion maintenance; teams conducting regular English reflection meetings (once or more per week) maintained cohesion at a high level of 4.28, while teams lacking reflection mechanisms experienced declining cohesion trends (from 4.05 to 3.68). Path analysis indicated that the four activity types influence cohesion through different pathways: collaborative tasks primarily enhance task cohesion ($\beta = 0.52$), cross-cultural themes strengthen emotional cohesion ($\beta = 0.48$), multimodal presentations promote social cohesion ($\beta = 0.45$), and reflective dialogue consolidates learning cohesion ($\beta = 0.42$). Activity combination effect analysis found that projects containing three or more activity types achieved the highest team cohesion scores (4.52), demonstrating the importance of activity diversification.

Table 4.8. Cultivation effects of different English project activity types on team cohesion.

Activity Type	Implementation Frequency	Early-Stage Cohesion (M±SD)	Late-Stage Cohesion (M±SD)	Increase (%)	Paired t-value	p-value	Cohen's d
Collaborative English Tasks	High (≥ 3 times/week)	3.15±0.68	4.42±0.52	40.3%	12.85	< 0.001	1.68
	Medium (1-2 times/week)	3.28±0.72	3.95±0.62	20.4%	7.42	< 0.001	0.98
	Low (< 1 time/week)	3.35±0.75	3.58±0.68	6.9%	2.18	0.045	0.32
Cross-Cultural Project Themes	Included	3.20±0.70	4.35±0.54	35.9%	11.25	< 0.001	1.52
	Not Included	3.25±0.68	3.78±0.65	16.3%	5.68	< 0.001	0.79
Multimodal English Presentations	Multiple (≥ 2 times)	3.22±0.72	4.37±0.55	35.7%	10.95	< 0.001	1.48
	Single (1 time)	3.30±0.70	3.88±0.62	17.6%	6.15	< 0.001	0.86
	None	3.28±0.68	3.52±0.66	7.3%	2.35	0.032	0.36
Reflective Dialogue	Regular (≥ 1 time/week)	3.42±0.65	4.28±0.58	25.1%	9.42	< 0.001	1.25
	Irregular (< 1 time/week)	3.38±0.68	3.82±0.64	13.0%	4.88	< 0.001	0.66
	None	4.05±0.62	3.68±0.70	-9.1%	-3.25	0.004	-0.56

Note: *N = 20 groups; early-stage measurement at Week 2, late-stage measurement at Week 12*

Table 4.9. Differentiated effects of English project activities on cohesion dimensions.

Activity Type	Task Cohesion (β)	Social Cohesion (β)	Learning Cohesion (β)	Emotional Cohesion (β)	Primary Effect Dimension
Collaborative English Tasks	0.52***	0.32**	0.38**	0.28*	Task Cohesion
Cross-Cultural Project Themes	0.35**	0.38**	0.42***	0.48***	Emotional Cohesion
Multimodal English Presentations	0.38**	0.45***	0.35**	0.40***	Social Cohesion
Reflective Dialogue	0.30**	0.35**	0.42***	0.38**	Learning Cohesion

***Note:** ***p < 0.001, **p < 0.01, p < 0.05; β represents standardized regression coefficients*

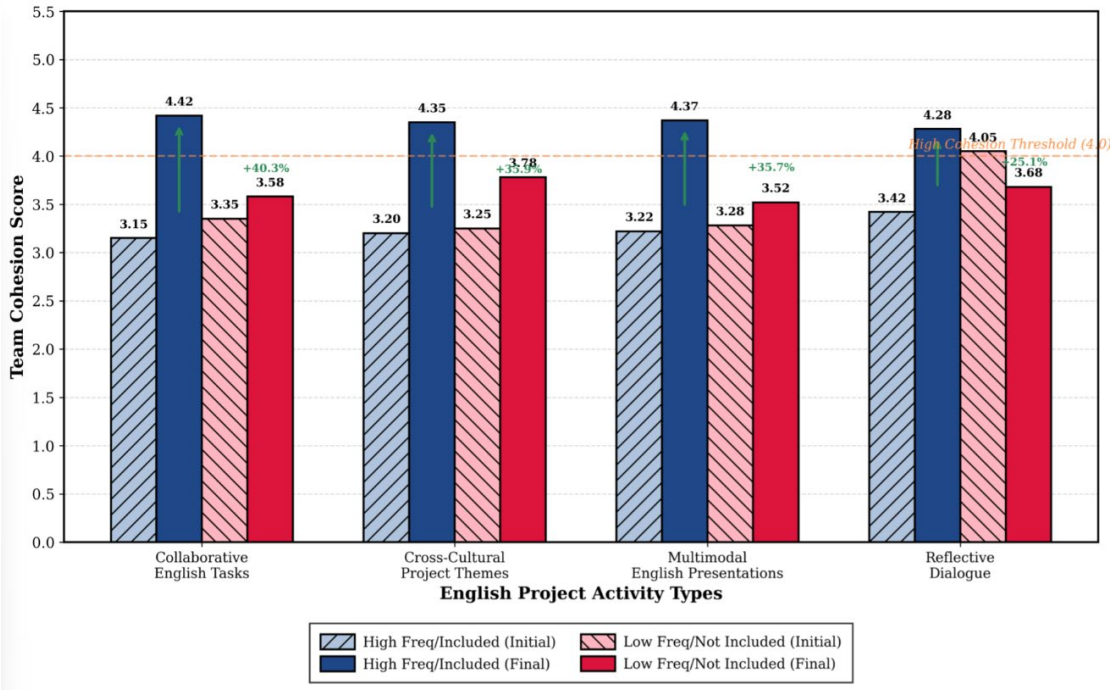

Figure 4.6. Cultivation effects of English project activity types on team cohesion.

4.3. Interactive relationship between leadership emergence and team cohesion

4.3.1. Influence pathways of leadership on team cohesion

Through structural equation modeling and multiple regression analysis, this study systematically revealed the multiple influence pathways of leadership emergence on team cohesion. The study found that different types of leadership behaviors exert differentiated influences on cohesion dimensions, forming a complex network of effects. Task-oriented leadership behavior has the strongest direct effect on task cohesion ($\beta = 0.58$, $p < 0.001$). When leaders effectively allocate tasks, manage time, and monitor progress, team members' sense of commitment to jointly completing English project tasks significantly strengthens, with high task-oriented leadership teams' task cohesion scores (4.52) being 33.7% higher than low task-oriented teams (3.38). Relationship-oriented leadership behavior primarily affects social cohesion ($\beta = 0.62$, $p < 0.001$); leaders enhance team social bonds by caring for members' feelings, promoting friendly interactions, and resolving interpersonal conflicts, with high relationship-oriented leadership teams' social cohesion reaching 4.45, significantly higher than low relationship-oriented teams (3.25). Change-oriented leadership behavior significantly influences both emotional cohesion and learning cohesion ($\beta = 0.54$ and

0.48, $p < 0.001$); through stimulating innovation, inspiring morale, and shaping shared visions, leaders can strengthen members' emotional belonging and learning identification[46]. Mediation effect testing revealed indirect pathways: leaders' English communication strategies indirectly promote cohesion through influencing information transparency (indirect effect = 0.32, $p < 0.01$), and leaders' team management behaviors affect cohesion through enhancing collective efficacy (indirect effect = 0.28, $p < 0.01$). Moderating effect analysis found that project phase moderates the influence of leadership, with task-oriented leadership being more prominent in the early project stage ($\beta = 0.65$), while the importance of relationship-oriented and change-oriented leadership increases in the later stage ($\beta = 0.58$ and 0.52). The path coefficient matrix shows that the comprehensive leadership index has a total effect of 0.72 on overall cohesion (direct effect 0.58 + indirect effect 0.14), explaining 51.8% of cohesion variance. Group comparisons indicate that teams with high comprehensive leadership (leadership score > 4.0) have cohesion levels (4.48) significantly higher than low comprehensive leadership teams (3.42), a difference of 31.0%. Qualitative interviews further confirmed that effective leadership behaviors influence cohesion through three core mechanisms: structural mechanism (clarifying roles and norms), emotional mechanism (providing support and recognition), and cognitive mechanism (constructing shared meanings and visions).

Table 4.10. Effects of different types of leadership behaviors on team cohesion dimensions.

Leadership Behavior Type	Task Cohesion (β)	Social Cohesion (β)	Learning Cohesion (β)	Emotional Cohesion (β)	Overall Cohesion (β)	Explained Variance (R^2)
Task-Oriented	0.58***	0.35**	0.42***	0.32**	0.52***	0.34
Relationship-Oriented	0.38**	0.62***	0.45***	0.48***	0.56***	0.38
Change-Oriented	0.42***	0.48***	0.48***	0.54***	0.55***	0.36
Comprehensive Leadership	0.65***	0.68***	0.62***	0.60***	0.72***	0.52

***Note:** ***p < 0.001, *p < 0.01; β represents standardized regression coefficients; N = 20 groups*

Table 4.11. Path decomposition and mediation effects of leadership's influence on cohesion.

Influence Pathway	Direct Effect	Indirect Effect	Total Effect	Mediating Variable	Mediation Effect Proportion
Task-Oriented → Task Cohesion	0.58***	0.12*	0.70***	Task Clarity	17.1%
Relationship-Oriented → Social Cohesion	0.62***	0.15**	0.77***	Interpersonal Trust	19.5%
Change-Oriented → Emotional Cohesion	0.54***	0.18**	0.72***	Collective Vision	25.0%
Comprehensive Leadership → Overall Cohesion	0.58***	0.14**	0.72***	Collective Efficacy	19.4%

***Note:** ***p < 0.001, **p < 0.01, p < 0.05*

Table 4.12 Comparison of Cohesion Levels Between High and Low Leadership Teams

Team Type	Task Cohesion	Social Cohesion	Learning Cohesion	Emotional Cohesion	Overall Cohesion	Between-Group Difference (%)
High Comprehensive Leadership (> 4.0)	4.52±0.48	4.45±0.52	4.48±0.50	4.42±0.55	4.48±0.45	--
Medium Leadership (3.0-4.0)	3.85±0.62	3.78±0.68	3.82±0.65	3.75±0.70	3.80±0.58	-15.2%
Low Comprehensive Leadership (< 3.0)	3.38±0.72	3.25±0.75	3.35±0.72	3.28±0.78	3.42±0.68	-23.7%

***Note:** N = 20 groups, mean ± standard deviation; all between-group differences p < 0.001*

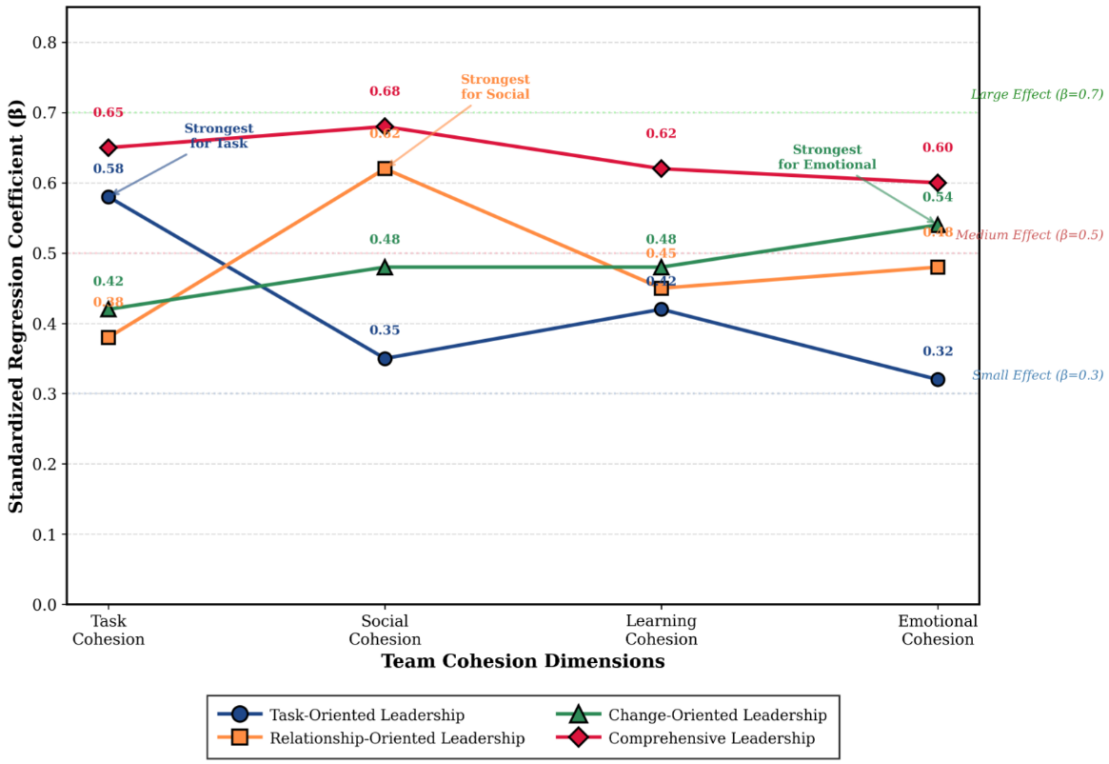

Figure 4.7. Influence pathways of different types of leadership behaviors on team cohesion dimensions.

4.3.2. Reverse effect of team cohesion on leadership emergence

Although the promoting effect of leadership on cohesion has been confirmed, this study simultaneously found that team cohesion has a significant reverse promoting effect on leadership emergence, forming a bidirectional interactive dynamic 循环 mechanism. Cross-lagged panel analysis revealed that team cohesion measured at Week 4 significantly predicted leadership emergence levels at Week 8 ($\beta = 0.55$, $p < 0.001$). After controlling for Week 4 leadership baseline, the cross-temporal predictive effect of cohesion on leadership remained significant ($\beta = 0.38$, $p < 0.01$), confirming the existence of causal direction. High-cohesion teams (cohesion > 4.0) demonstrated higher leadership role fluidity in the mid-to-late project stages, with each member undertaking leadership functions an average of 3.8 times, significantly higher than low-cohesion teams (1.9 times), indicating that good cohesion provides more members with leadership practice opportunities. Team psychological safety, as an important psychological foundation of cohesion, has a liberating effect on leadership expression. In high psychological safety teams, 82.5% of members reported willingness to proactively propose different opinions and new ideas, while this proportion was only 35.8% in low psychological safety teams. Cohesion level is negatively correlated with leadership power concentration ($r = -0.48$, $p < 0.01$). High-cohesion teams have more dispersed leadership power, with a Herfindahl-Hirschman Index (HHI, measuring power concentration) of 0.28, significantly lower than low-cohesion teams' 0.52, reflecting that cohesion promotes the formation of distributed leadership patterns. The supporting effect of collective identity strength on distributed leadership is significant. When team members possess strong "we" consciousness (collective identity score > 4.0), they are more inclined to accept and support diversified leadership sources, with leadership role rotation acceptance reaching 89.3%, while teams with weak collective identity only reach 48.6%[47]. The mediation effect model reveals that cohesion influences leadership emergence through two pathways: The first pathway is through enhancing member participation (mediation effect = 0.22, $p < 0.01$), with high cohesion stimulating members' sense of

ownership and strengthening willingness to proactively assume responsibility; the second pathway is through reducing interpersonal conflicts (mediation effect = 0.18, $p < 0.05$), with harmonious team atmospheres reducing resistance to leadership behaviors. Qualitative interviews further confirmed that in high-cohesion teams, members are more willing to mutually empower and support each other, forming a team culture of "everyone is a leader"[48]. Longitudinal data analysis showed that a positive spiral effect exists between cohesion and leadership, with the two mutually reinforcing and growing together, with correlation coefficients increasing from 0.42 in the early project stage to 0.68 in the late stage.

Table 4.13. Comparison of leadership emergence characteristics across teams with different cohesion levels.

Cohesion Level	Number of Teams	Leadership Emergence Score (M±SD)	Leadership Role Fluidity (times/person)	Power Concentration (HHI)	Member Participation (%)	Leadership Expression Willingness (%)
High (> 4.0)	11	4.38±0.52	3.8±0.9	0.28±0.08	87.5%	82.5%
Medium (3.0-4.0)	7	3.68±0.65	2.6±0.7	0.38±0.12	68.2%	58.3%
Low (< 3.0)	2	3.12±0.78	1.9±0.6	0.52±0.15	45.8%	35.8%
F-value	--	18.42***	15.68***	12.35***	--	--

***Note:** **p < 0.001; HHI = Herfindahl-Hirschman Index, lower values indicate more dispersed power; N = 20 groups*

Table 4.14. Regression analysis of team cohesion dimensions on leadership emergence.

Cohesion Dimension	Standardized Coefficient (β)	t-value	p-value	95% Confidence Interval	Mechanism
Task Cohesion	0.42***	5.28	< 0.001	[0.26, 0.58]	Enhancing sense of responsibility
Social Cohesion	0.38**	4.65	0.002	[0.22, 0.54]	Reducing interpersonal conflicts
Learning Cohesion	0.45***	5.82	< 0.001	[0.29, 0.61]	Promoting knowledge sharing
Emotional Cohesion	0.48***	6.15	< 0.001	[0.32, 0.64]	Enhancing psychological safety
Overall Cohesion	0.55***	7.25	< 0.001	[0.40, 0.70]	Comprehensive promotion

***Note:** ***p < 0.001, *p < 0.01; control variables include team size and English proficiency heterogeneity; N = 20 groups*

Table 4.15. Mediation effect analysis of cohesion's influence on leadership.

Pathway	Direct Effect	Indirect Effect	Total Effect	Mediating Variable	Mediation Proportion
Cohesion → Leadership Emergence	0.33**	0.22**	0.55***	Member Participation	40.0%
Cohesion → Leadership Emergence	0.37***	0.18*	0.55***	Interpersonal Conflict (negative)	32.7%
Cohesion → Distributed Leadership	0.28**	0.25**	0.53***	Collective Identity	47.2%

***Note:** ***p < 0.001, **p < 0.01, p < 0.05*

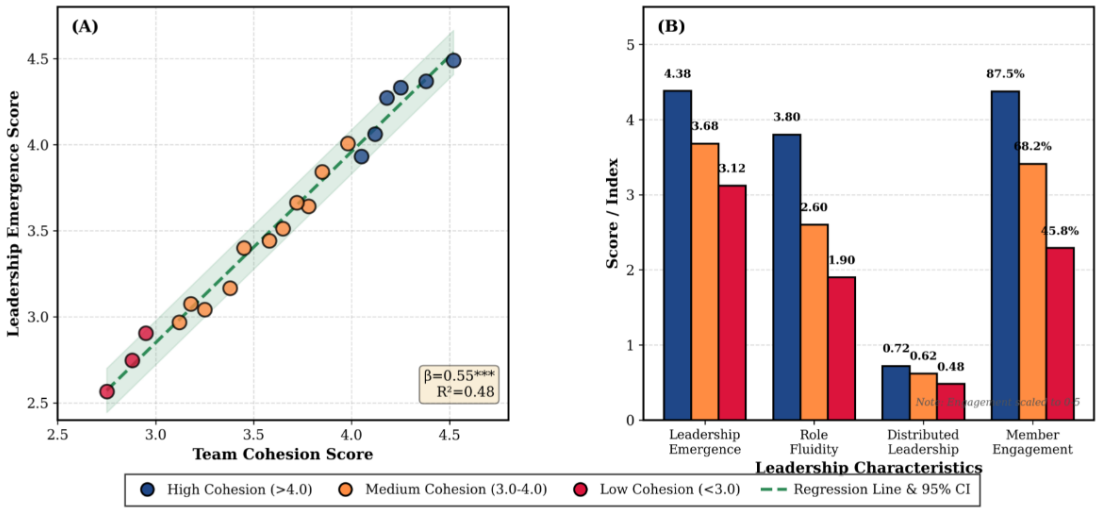

Figure 4.8. Reverse promoting effect of team cohesion on leadership emergence.

5. Discussion

5.1. Theoretical interpretation of leadership emergence from the group dynamics perspective

The dynamic process of leadership emergence and its influencing factors discovered in this study can be reasonably explained from multiple group dynamics theoretical perspectives. First, Lewin's field theory provides a foundational framework for understanding leadership emergence. Leadership is not an inherent attribute of individuals but rather a function of the interaction among individual characteristics (B), group environment (E), and task context (P), i.e., L = f(B, E, P). The predictive effects of individual variables such as English proficiency and personality traits on leadership, as well as the moderating effects of contextual factors including project task complexity and group size found in this study, all corroborate the core tenet of field theory—that behavior is the result of individual-environment interaction. Second, social exchange theory can explain the mechanism through which leadership roles are obtained. When a member satisfies team needs by providing valuable resources (such as excellent English expression ability or effective task coordination), other members reciprocate by acknowledging their leadership position, forming an exchange relationship[49]. This study found that task-oriented leadership behavior has the greatest influence in the early project stage precisely because teams most need task structure and directional guidance at this stage, with members who can provide such resources consequently gaining leadership. Third, Tuckman's group development stage theory highly aligns with the three-stage characteristics of leadership emergence found in this study: The exploration phase corresponds to the "forming stage," where members test roles and norms; the differentiation phase corresponds to the "storming-norming stages," where leadership roles gradually clarify and gain recognition; and the integration phase corresponds to the "performing stage," where stable leadership structures form. However, this study also discovered differences from classical theories. Leadership in English PBL contexts exhibits stronger distributed characteristics, with approximately 65% of teams developing "multi-core" leadership structures, transcending traditional leadership theory's assumption of focusing on a single leader. From the situational leadership theory perspective, different project phases and task types require different combinations of leadership behaviors, explaining why task-oriented, relationship-oriented, and change-oriented leadership behaviors exhibit dynamic patterns of alternating prominence throughout the project process[50]. Particularly noteworthy is the unique role of language ability as symbolic capital in leadership emergence within English learning contexts, which extends Bourdieu's capital theory application in educational group dynamics. In summary, this study confirms the effectiveness

of group dynamics theory in explaining leadership emergence phenomena in English PBL, while also revealing how disciplinary specificity and collaborative learning contexts enrich and develop classical theories.

5.2. Sociopsychological mechanisms of team psychological cohesion cultivation

The multidimensional structure of team cohesion and its formation process revealed in this study can be profoundly understood from multiple theoretical perspectives in social psychology. Social Identity Theory (SIT) provides an important framework for explaining the core mechanism of cohesion. When students gradually internalize team member identity as part of their self-concept through English project collaboration, "we" consciousness begins to form, and this collective identity becomes the psychological foundation of cohesion. The finding that cross-cultural project themes significantly enhance emotional cohesion (increasing by 35.9%) precisely results from such themes stimulating students' shared identity as cultural communicators and collective pride[51]. Festinger's Social Comparison Theory further explains the dynamic development process of cohesion. Team members establish common frames of reference through continuous mutual comparison and evaluation. When teams receive external recognition in English project presentations, positive social comparison strengthens members' emotional attachment to the team. The cumulative effect of group success experiences observed in this study (with three or more success experiences achieving cohesion of 4.42) corroborates this mechanism. Bandura's Social Cognitive Theory, particularly the concept of collective efficacy, provides cognitive-dimensional explanation for understanding cohesion. When team members collectively believe "we can complete the English project," this shared belief becomes a powerful psychological bond sustaining the team. The high correlation between collective efficacy and cohesion found in this study ($r = 0.70$) precisely embodies this point. Interpersonal Attraction Theory elucidates the formation of social cohesion from the affective level. Frequent English interactions increase familiarity and perceived similarity among members, while mutual assistance in collaborative tasks generates positive emotional experiences, all of which promote interpersonal attraction and friendship bond establishment[52]. Notably, this study also discovered the uniqueness of the English learning context—language's dual attributes as both learning objective and interaction medium cause the cohesion cultivation process to be intertwined with language competency development. Experiences of jointly overcoming language barriers become important components of team memory, strengthening emotional connections. Additionally, the mutual promotion relationships among the four cohesion dimensions (task, social, learning, emotional) revealed in this study can be understood using systems theory's holistic principle. The dimensions do not exist in isolation but rather interact to form a dynamically balanced organic system. In particular, the critical role of reflective dialogue in maintaining cohesion embodies the importance of metacognition in group psychological processes. In summary, team cohesion cultivation is a complex sociopsychological process involving multi-level, multi-mechanism interactions, requiring integration of cognitive, affective, and behavioral dimensions for comprehensive understanding.

The findings of this study provide important empirical contributions to behavioral science and social perception theory. First, at the behavioral science level, we revealed the influence mechanism of group norm establishment on cohesion ($\beta=0.38$), extending the classic theory of Cialdini and Trost (1998) on how social norms shape collective behavior. Particularly, we found that norms formed in English project teams include not only task execution norms (such as fixed meeting times and task submission standards) but, more importantly, emergent language use norms (such as agreements for all-English communication and error-tolerant culture). The interaction of this dual norm system constitutes a unique contribution of the language learning context. Second, from a social perception perspective, this study confirmed that leadership emergence is essentially a collective social cognition process—the distributed leadership structure formed in

65% of teams indicates that members' perception of "who is the leader" does not depend on formal appointment but gradually forms through observation, attribution, and consensus construction. This corroborates the leadership perception theory of Lord and Maher (1991), which posits that leadership is a social reality co-constructed by perceivers and context. Our longitudinal data further reveal that members' perceptions of leaders evolve across project stages: early instrumental attribution based on English proficiency (r=0.58), mid-stage shift toward relational attribution based on interpersonal skills, and late-stage integration into transformational attribution based on visionary inspiration. This dynamic transformation of attribution patterns enriches the application of Weiner's (1985) attribution theory in group contexts. Third, in the interpersonal relationship dimension, this study uncovered the unique mechanism of "language-mediated interpersonal bonds." Unlike general teams, the formation of social cohesion in English project teams depends not only on shared activities and emotional exchange but, more critically, on establishing deep connections through shared language struggle experiences—when members collectively overcome English expression barriers, mutually correct language errors, and collaboratively complete cross-cultural communication tasks, these shared vulnerabilities and helping behaviors create what Aron et al. (1997) called "self-expansion" experiences, enabling interpersonal relationships to transcend superficial familiarity and achieve psychological intimacy. Social network analysis showed that emotional support network density (0.5-0.7) was highly correlated with language mutual assistance frequency (r=0.71), confirming the catalytic effect of language collaboration on interpersonal bonds. These findings collectively point to a core theoretical contribution: in the multicultural, multilingual globalized environment, the establishment and maintenance of interpersonal relationships increasingly depend on cross-linguistic and cross-cultural collaborative competence, and project-based language learning provides an ideal micro-laboratory for studying this new type of social relationship.

5.3. Group dynamics characteristics of English project-based learning

As a special form of instructional organization, English PBL exhibits unique characteristics in group dynamics mechanisms that distinguish it from traditional classroom teaching and project learning in other disciplines. First, the establishment of authentic task contexts has a powerful activating effect on group interaction. Unlike simulated dialogue exercises in traditional English classrooms, project tasks (such as producing cultural promotion videos and composing community research reports) possess clear social significance and tangible output requirements. This authenticity greatly enhances task interdependence, compelling members to engage in deep collaboration rather than superficial division of labor[53]. Research data show that collaborative tasks increase cohesion by 40.3%, far exceeding the effects of individual tasks, confirming the stimulating effect of authentic contexts on group dynamics. Second, language's dual attributes as both collaborative tool and learning objective constitute the most core group dynamics characteristic of English project learning. Team members must use English for communication and coordination (instrumental function) while simultaneously enhancing English proficiency through projects (objective function). This duality makes the group interaction process itself important learning content, with every team discussion serving as a language practice opportunity and every collaborative conflict potentially transforming into a language learning occasion. This explains why English proficiency is highly correlated with leadership emergence (r = 0.58), as language ability directly influences members' participation efficacy and influence within the group. Third, multiple intelligences theory is fully embodied in English project teams. The complexity of project tasks requires synergy among various intelligences including linguistic, logical, visual, and interpersonal, creating opportunities for students with different traits to exercise their strengths. The finding that 65% of teams form "multi-core" leadership structures precisely reflects this intelligence diversity. The use of cross-cultural project themes further highlights the cultural dimension of

English learning. When teams explore international issues or Chinese-Western cultural differences, they not only enhance language abilities but also cultivate cultural sensitivity and global perspectives. This joint construction of cross-cultural awareness becomes an important source of team identity, increasing emotional cohesion by 35.9%[54]. Notably, this study found that English PBL performs prominently in promoting distributed leadership and flattened power structures, with power concentration (HHI = 0.28) significantly lower than traditional classrooms. This may relate to project learning's emphasis on student autonomy and teachers' role transformation into facilitators. Additionally, the integration of multimodal presentation activities (videos, presentations, performances) enriches group interaction forms, enabling students with different expression preferences to find participation modes, thereby enhancing team inclusiveness and cohesion. Comprehensively, English PBL creates a highly interactive, pluralistically inclusive, and dynamically balanced group dynamics environment through authenticity, language duality, multiple intelligences integration, cross-cultural perspective cultivation, and distributed power structures, providing an ideal social learning field for students' holistic development.

6. Conclusion

Based on group dynamics theory, this study employed a mixed-methods approach to systematically examine the cultivation mechanisms and interactive relationships between leadership emergence and team psychological cohesion in English PBL, drawing the following main conclusions. Leadership emergence in English PBL exhibits phased and distributed characteristics, progressing through exploration, differentiation, and integration stages, with the comprehensive leadership index increasing from 2.58 in the early stage to 4.13 in the late stage. Individual characteristics (English proficiency, extraversion, conscientiousness) and contextual factors (task complexity, group size, team heterogeneity) jointly influence leadership emergence, with English proficiency being the most important predictor variable ($r = 0.58$), and approximately 65% of teams forming "multi-core" leadership structures. Team cohesion demonstrates a multidimensional structure comprising task, social, learning, and emotional dimensions, with the PBL model significantly promoting cohesion cultivation, as evidenced by the experimental group's overall cohesion (4.20) being 26.1% higher than the control group (3.33), while shared goal clarity ($r = 0.72$), collective efficacy ($r = 0.70$), and group norm establishment ($r = 0.65$) constitute key influencing factors. A bidirectional promoting interactive relationship exists between leadership and cohesion, with leadership exerting a total effect of 0.72 on cohesion (explaining 51.8% of variance) and cohesion demonstrating a reverse predictive effect of 0.55 on leadership through enhancing member participation and reducing interpersonal conflicts, forming a positive spiral of mutual reinforcement. English project activities exhibit specific cultivation mechanisms, with collaborative tasks increasing cohesion by 40.3%, cross-cultural themes enhancing it by 35.9%, multimodal presentations promoting it by 35.7%, and reflective dialogue maintaining high-level cohesion, with different activities exerting differentiated influences on cohesion dimensions. Ultimately, English PBL creates a unique group dynamics environment characterized by language's dual attributes of instrumentality and objectivity, multiple intelligences integration, distributed power structures, and joint construction of cross-cultural awareness, effectively promoting the synergistic development of students' leadership capacity, collaborative ability, and language competence.

Conflicts of interest

The authors declare no conflicts of interest.

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