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Research on Interdisciplinary Project-Based Instructional Design Based on "Backward Design": A Case Study on the Teaching of the Theme "The Beauty of Chime" in Middle School English

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Abstract: Based on the backward teaching design concept of "Backward Design" and constructivist theory, a "Backward Design" cross-disciplinary project-based teaching design approach is proposed. This model begins by determining the expected outcomes based on the teaching objectives, then identifying the evidence for achieving those outcomes, and finally designing the corresponding courses and teaching segments. Throughout the design process, it is ensured that the goals, content, and evaluation in the interdisciplinary project-based teaching design are consistent. Subsequently, this article explored the application by taking the theme teaching of "The Beauty of Chime" in middle school English as an example. The results showed that using this set of design ideas to design interdisciplinary project-based teaching activities has a certain promoting effect on the development of students' core competencies. We hope that this set of design concepts, practical cases and reflection suggestions will stimulate discussions and exchanges in the field of education, and provide reference for interdisciplinary project-based teaching design.

Keywords: "Backward Design"; Interdisciplinary Approach; Project-Based Instruction; Instructional Design Framework.

1. Introduction

With the implementation of the new curriculum reform, research on teaching and assessment grounded in curriculum standards has continued to deepen. The "Compulsory Education English Curriculum Standard (2022 Edition)" advocates a literacy-oriented approach to teaching, emphasizing the development of students' core competencies through integrated English practical activities. Interdisciplinary project-based teaching is a student-centered, project-driven, and practice-oriented educational model[1]; which aligns closely with the principles of integrated English instruction and is widely recognized as an effective approach for cultivating students' core competencies within future-oriented learning frameworks[2]. However, in traditional designs of interdisciplinary project-based instruction, inconsistencies among the three key components—objectives, content, and assessment—often undermine instructional effectiveness and reduce overall efficiency.

Teaching objectives are often expressed in overly broad terms, and educators predominantly rely on empirically based methodologies. This tendency results in a lack of carefully designed instructional activities and systematically implemented pedagogical strategies. Moreover, formative assessments—which are essential for supporting continuous learning—are underutilized, leading to insufficient monitoring of students' competency development. Learning activities are frequently fragmented and superficial, failing to effectively cultivate core competencies. Consequently, current approaches to developing core competencies face significant challenges and yield inconsistent outcomes[3].

This study presents an innovative and highly implementable methodology for interdisciplinary project-based instructional design. Using the English thematic unit "The Beauty of Chimes" as a case study, the research aims to investigate the application of this approach in promoting the development of students' core competencies.

Two primary research questions are addressed:
Q1: How can interdisciplinary project-based teaching activities be systematically designed and implemented?
Q2: How can alignment among learning objectives, instructional content, and assessment be effectively maintained within such instructional frameworks?

2. Theoretical Foundation

2.1 Backward Instructional Design

Traditional instructional design initiates with the clarification of learning objectives, followed by the systematic development of instructional sequences and learning activities aligned with these predefined goals, and concludes with the design of assessment methods to measure achievement of the intended outcomes[4-5]. The "Backward-design" framework emphasizes beginning the design process by specifying desired learning outcomes. This approach is commonly described as "outcome-oriented", a term frequently used synonymously with "goal-oriented" in the educational design literature[6]. The fundamental distinction between "goal-oriented" and "outcome-oriented" lies in their conceptual and operational attributes: "outcome-oriented" refers to measurable achievements that are linked to specific, observable deliverables and can be attained through structured instructional strategies; whereas "goal-oriented" is typically aspirational, broader in scope, and often lacks explicit criteria for evaluation[7]. In recent years, the outcome-based approaches have gained significant recognition in educational research and have been widely adopted within institutional assessment frameworks[8].

"Backward design" is an instructional planning approach that commences with the clear articulation of desired learning outcomes aligned with established educational objectives. These outcomes serve as the foundation for the subsequent development of valid and reliable assessment methods. Only after the outcomes and assessments have been defined are curriculum content and instructional activities designed. In this model, the intended learning results act as the central reference point guiding all aspects of assessment design, curriculum organization, and instructional decision-making. As Wiggins and McTighe state, "Curriculum and instruction should be derived logically from the desired results, rather than from preferred teaching methods, materials, or activities. The most effective curricula are those designed to achieve specific learning goals in a coherent and purposeful manner. A backward design process—starting with the end goals and working backward through intentional planning—supports this alignment."[9] The distinctions between Traditional instructional design and “Backward Design” are as follows in Figure 1.

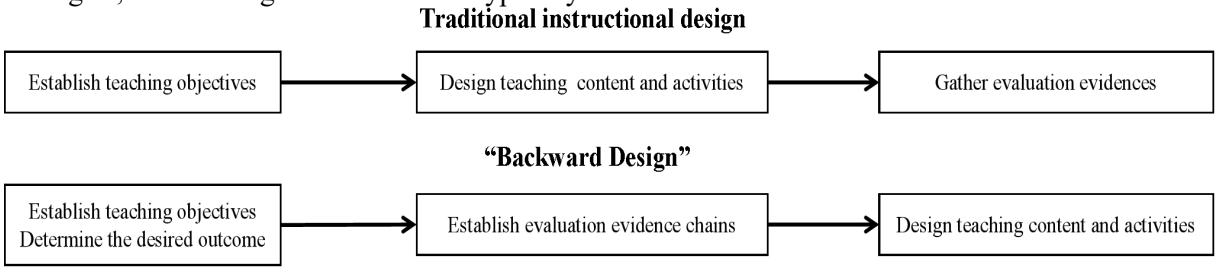

Figure 1. Backward Instructional Design

2.2 Constructivist Theory

Interdisciplinary project-based teaching is designed to enhance students' comprehensive competencies and promote independent thinking. Constructivist theory serves as a key theoretical foundation for this pedagogical approach, positing that learners achieve meaningful knowledge construction—defined as a deep understanding of the nature, underlying principles, and interrelationships of phenomena represented by knowledge—most effectively through immersion in authentic, real-world contexts. In such environments, learners can directly perceive and experience these phenomena (i.e., experiential learning), rather than relying exclusively on secondhand descriptions or explanations provided by others, such as instructors [10]. Grounded in constructivist theory, several well-established instructional strategies have emerged, including collaborative learning, inquiry-based learning, authentic contextual learning, scaffolded instruction, and reflective practice[11].

3. Interdisciplinary Project-Based Learning Design Centered on the Theme of "The Beauty of Chimes"

3.1 Establishment of Teaching Objectives

The "Compulsory Education English Curriculum Standard (2022 Edition)" explicitly proposes guiding students to integrate their human life experiences and societal needs by centering on specific themes driven by real-world issues or human-centered subjects, and comprehensively applying knowledge from related disciplines to independently engage in project-based learning, such as "Visiting Museums" (Ministry of Education of the People's Republic of China, 2022). The Zenghouyi Chimes, a national cultural relic housed in the Hubei Provincial Museum, represent a significant archaeological discovery that contributed to the revision of world music history upon their excavation. They also exemplify the advanced development of ritual-musical systems and bronze casting technology during China's pre-Qin period. To enhance students' understanding of regional historical heritage and support the international dissemination of traditional Chinese culture, this study designs an interdisciplinary inquiry centered on the theme "The Beauty of Chimes." The instructional design draws upon selected units from the "Go For It!", specifically Unit 9, "Have you ever been to a museum?" (Grade 8), and Unit 5, "What are the shirts made of?" (Grade 9). This instructional approach aims to facilitate students' participant with the artistic and historical significance of the chimes through content-integrated language learning, while promoting sustained interest in both English language acquisition and cultural heritage education.

3.2 Determination of the Expected Outcome

The research team designed an interdisciplinary project-based learning outcome centered on "an English textbook drama themed on Chinese chimes," taking into account students' foundational knowledge, available teaching resources, and instructional experience in junior high school curricula. It was estimated that approximately five class periods would be sufficient to achieve this outcome. The learning outcome is clearly defined and requires active engagement from each student, as well as the integration of knowledge across multiple disciplines for successful completion. Moreover, the process of achieving this outcome enables students to appreciate the aesthetic value of Chinese chimes, fostering national pride and cultivating profound interest in China's traditional historical culture and English learning.

3.3 Construction of an Evidence-Based Chain for Anticipated Evaluation

The evidentiary chain anticipated for evaluation comprises two components: the anticipated evaluation evidence and the corresponding formative assessment criteria.

The first aspect concerns the anticipated evaluation evidence. According to the "Compulsory Education English Curriculum Standard (2022 Edition)", students in grades 7–9 are expected to progressively apply thinking skills such as "comparison and judgment", "adaptation and communication", "perception and internalization", "induction and inference", and "criticism and innovation". They are also expected to synthesize cultural information from both Chinese and international contexts, describe cultural phenomena using acquired linguistic competencies, identify and interpret values conveyed in texts, develop an international outlook, and reinforce national identity and cultural confidence.

In the context of cross-disciplinary project-based instruction, teachers must integrate and reorganize content according to instructional goals. Based on predefined learning outcomes, the research team designed four interrelated and sequentially structured sub-projects: "AI Little Designer," "Handmade Ornament Homo sapiens," "Music Experiment Scientist," and "English Theater Little Actor." The "English Theater Little Actor" task is implemented within English classes by incorporating relevant disciplinary knowledge, while the other three—"AI Little Designer", "Handmade Ornament Homo sapiens", and "Music Experiment Scientist"—integrate content from information technology, art, physics, and music. The "Beauty of Chimes" project aims to achieve effective integration of multidisciplinary knowledge and skills and to produce tangible student outcomes. The learning objectives and outcomes of the four sub-projects are summarized in Table 1.

Table 1. Project-based Instructional Design for English Textbook Drama

Learning task	subject	Sub-project learning outcomes (evaluation evidence chain)	Learning objectives of the sub-project
AI Little Designer	Information Technology	1. Depictions of students employing artificial intelligence software to generate scripts for English textbook plays. 2. Students utilizing artificial intelligence to create preliminary script dialogues for Homo sapiens characters.	1. In-depth exploration of interrogative methodologies for generating character designs through AI tools. 2. Cultivation of learning capabilities characterized by "joyful learning and adept learning" through knowledge comprehension and internalization. 3. Development of students' capacity for continuous problem optimization to maximize AI tool utilization in designing psychologically resonant characters, thereby fostering cultural awareness of "comparison and judgment". 4. Cultivation of students' "critical and innovative" thinking competencies.
	English	In English script generation, students enhance pre-written dialogue scripts by employing AI-driven interrogation methods to refine linguistic accuracy.	To cultivate students' linguistic competencies in 'perception and accumulation' and 'acquisition and construction.'
Handmade Ornament Homo Sapiens	Art	Fabrication of Chime Bell Pendants by Student Practitioners	1. Acquire knowledge regarding the manufacturing techniques of chime bell pendants and the aesthetic principles underlying their decorative patterns, alongside their historical and cultural significance, thereby cultivating students' cultural perception and internalization. 2. Develop proficiency in utilizing tabular formats and mind maps to systematically delineate production sequences as cognitive learning strategies, enhancing students' logical reasoning abilities through induction and deduction. 3. Master the methodology for evaluating the aesthetic value of chime bell pendants, leveraging assessment mechanisms to facilitate learning progression and instructional refinement.
Music Experiment Scientist	Physics	Students can produce a simple melody by adjusting the water levels in various glass containers.	1. Comprehend the fundamental principles of sound generation and propagation. Through experimental observation, demonstrate that striking glass containers with varying water volumes produces distinct pitches and elucidate the underlying mechanisms. 2. Acquire knowledge of the structural composition and sound production mechanisms of chimes, and implement processes for knowledge perception, internalization, transfer, and innovation. 3. Develop students' practical skills and spirit of scientific inquiry via observation, experimentation, and discourse, and establish an understanding of the correlation between sound and vibration.

			4. Foster the learning capability characterized by an affinity for learning and adeptness in learning methodologies. 5. Stimulate students' interest and curiosity in physics, and cultivate teamwork competencies and innovation awareness. 6. Enhance students' critical thinking abilities in criticism and innovation.
	English	Students ask questions in English in the form of group cooperation, use AI software to generate simple English lyrics, and compose music.	1. Foster learning competencies encompassing "affection for and proficiency in learning" as well as "collaborative and exploratory skills".
English Theater Little Actor	English	1. Groups that have successfully completed their chime pendant projects will collaboratively present, in English, the background and significance of their designed chimes. 2. Students will perform the original music composed for the chimes during the physics experiment and simultaneously conduct a choral performance of an English song accompanied by the chime melodies. 3. Display the AI-generated illustrations of the English textbook drama script, followed by group-based student presentations introducing the respective English-speaking characters. 4. Group members will cooperate effectively, assume individual roles, refine the script through collaborative input, and deliver a staged English textbook drama performance depicting an international celebration.	1. Foster students' collaborative and exploratory learning abilities. 2. Promote the application, practice, transfer, and innovation of knowledge. 3. Support the acquisition, organization, generalization, and integration of knowledge. 4. Develop students' language competence in expression and communication. 5. Enhance cultural awareness through adjustment and intercultural communication.

The following section outlines the formative evaluation criteria employed in this study. In interdisciplinary project-based instruction, it is essential to maintain logical coherence within the "objectives–content–evaluation" framework. Evaluation functions primarily as a mechanism for monitoring and regulating the teaching and learning processes and outcomes, thereby supporting iterative improvements in instructional design and implementation. Concurrently, the research team has defined explicit evaluation criteria to assess student learning outcomes within each sub-project. The quality of these outcomes serves as empirical evidence for evaluating the effectiveness of instructional phases across disciplines.

The interdisciplinary project-based instructional approach centered on the theme "The Beauty of Chimes" adopts a systematic assessment framework to evaluate students' understanding of chime bell knowledge, language application abilities, interdisciplinary competencies, and proficiency in information technology. This comprehensive and multi-dimensional assessment framework is designed to evaluate students' core English literacy effectively. To support implementation, the research team developed two complementary assessment tools: a project-based textbook drama evaluation rubric (Table 2) and a structured learning reflection form (Table 3). These tables are administered at key stages throughout the instructional process, enabling assessment for learning—supporting improved learning

outcomes and fostering continuous development through guided reflection. Concurrently, the framework allows educators to collect formative assessment data, which can inform timely adjustments and refinements to instruction during the implementation phase

Table 2. Evaluation Form for the Results of the Textbook Drama "The Beauty of Chimes"

Evaluation Content	Evaluation Method	Evaluation Objective
Comprehending and Mastering Chimes Knowledge	Group Deliberation and Structured Presentations	Student Comprehension and Acquisition of Chimes Knowledge
Language application ability	Employment of English Lexical Items in Context	Students' Linguistic Performance
Interdisciplinary Learning Competency	Art and Scientific Research	Student Interdisciplinary Learning Competencies
Information Technology Application Competency	Demonstrative Analysis of Applied Technological Advancements	Information Technology Utilization Proficiency of Students

Table 3. Learning Reflection Form for the English Textbook Drama "The Beauty of Chimes"

Serial Number	Content	Description
1	What impresses you the most in the class?	Please draw it or list at least 3 words
2	What were your highlights and improvements in the class?	Share the improvements you got
3	What Challenges you and your team in the class?	Write down the difficulties you met
4	What is your goal for your future learning?	Think about the plans

3.4 Design of Teaching Content and Activities

To achieve the defined learning outcomes and objectives of the four aforementioned sub-projects and to align with relevant disciplinary frameworks, the research team adopted a backward instructional design model based on the "Backward Design" framework. This approach was used to systematically develop targeted teaching content and learning activities, leading to the creation of discipline-specific course modules. An interdisciplinary project-based learning unit centered on the theme "The Beauty of Chimes" was designed and organized into five sequenced instructional sessions. Each session addressed a distinct thematic component.

1. Student grouping and topic selection
2. Technical application
3. Art appreciation
4. Scientific inquiry
5. English learning

The specific details are outlined below:

3.4.1 Identification of the teaching topic

Prior to the implementation of the project-based instructional activity, a preparatory session was conducted to facilitate student grouping and topic selection. The primary objectives of this session were to align the instructional content with students' prior knowledge and to collect contextual information regarding their learning backgrounds through a survey administered via Questionnaire Star. The survey was designed to: (1) assess students' cognitive understanding of traditional Chinese culture and identify their areas of interest; and (2) evaluate their familiarity with the historical and folk culture of Wuhan, Hubei Province. Based on the thematic resources available at the Hubei Provincial Museum, the instructional theme was subsequently established, with initial focus centered on one of the museum's most significant artifacts—the chimes.

3.4.2 AI-generated textbook dramas

This lesson examines methodologies for formulating effective queries to generate images and scripts using artificial intelligence (AI) tools. It seeks to enhance students' ability to iteratively refine problems in order to maximize the effectiveness of AI in designing anthropomorphic characters that align with psychological expectations. Students are guided to develop an awareness of how AI tools can be strategically employed to support and enrich learning activities.

The session begins with an introduction to the historical background and cultural significance of chimes, intended to engage students and stimulate inquiry. Subsequently, the pedagogical utility of textbook-based drama is analyzed, with attention to its function in supporting the transmission of cultural heritage. Concurrently, students are guided to approach AI technology from a critical and balanced standpoint. Collaborative group discussions are then conducted, during which each group

establishes defined role allocations and specific objectives to maintain narrative consistency. Foundational aspects of character construction—including basic background information, personality attributes, and motivational drivers—are articulated to establish a solid foundation for character development. After completing the preparatory steps, students utilize AI-based tools to generate script dialogues. The educator provides focused feedback aimed at enhancing narrative quality. Subsequently, students engage in a collaborative evaluation of potential revisions to the initial draft. Concurrently, the instructor introduces methods to support deeper thematic development and further refine dialogue structure and content.

3.4.3 Art appreciation and the fabrication of chimes

The first two lessons were structured to enable students to recognize the thematic elements of chimes and establish a foundational understanding of AI software. Students exhibited basic artistic and manual competencies, along with an observable engagement with traditional cultural content; however, their knowledge regarding chime craftsmanship and structural features remained limited. The third lesson, conducted by the art teacher, was designed to enhance students' comprehension of chime production techniques and the aesthetic, historical, and cultural significance of chime patterns through the practical activity of creating pendants.

The educator presented high-resolution images of the artifacts, accompanied by supplementary video materials illustrating the historical context and cultural significance of the chimes. During the presentation, students learned the structural characteristics of ancient chimes. And then a technical demonstration followed, outlining the essential steps in the making process: (1) rolling clay into uniformly sized strips, (2) shaping the strips into flat, rectangular forms resembling bells, (3) carefully carving decorative patterns and inscriptions using fine tools such as toothpicks, and (4) creating precise perforations to enable threading with cord. Following the demonstration, student groups independently constructed their models under guided instruction, with a focus on acquiring proficiency in fundamental ceramic forming techniques.

3.4.4 Simulation of a chimes concert in a physics experiment

Each chime bell composition demonstrates distinct acoustic and structural characteristics. To effectively communicate its inherent musical properties and underlying tonal architecture, the construction and performance using a scaled replica instrument can serve as an effective pedagogical approach. How might such an experiential learning activity be systematically implemented? Educators may guide students through structured inquiry into the following questions: What physical principles underlie the sound production mechanism of chimes? Which commonly available household materials, combined with specific fabrication techniques, can most closely approximate the acoustic behavior of traditional chimes?

Students engage in collaborative inquiry into fundamental scientific concepts by integrating content from Chapter 2, Lesson 2 of the physics curriculum. Through hands-on experimentation, they examine how striking glass containers filled with varying volumes of water generates sounds of different pitches. The educator guides them in understanding of the physical principles underlying this phenomenon, including the relationship between air column resonance, vibration frequency, and sound production. Building on this conceptual framework, students adjust water levels systematically to modulate pitch and attempt to reproduce simple melodic patterns. Subsequently, they are further encouraged to apply their acquired knowledge to combine discrete pitches in structured sequences, creating original sound compositions. This approach integrates empirical investigation with creative application, supporting interdisciplinary learning through the connection of acoustic principles and musical structure.

Finally, the educators disseminate the experimental results and identify the optimal participant cohort, evaluate students' innovative thinking and collaborative abilities based on their project outputs and reflective analyses.

3.4.5 Performance of an English textbook drama accompanied by chimes music

Building upon the previous four instructional units, students have acquired the ability to apply artificial intelligence (AI) technology in designing inquiry-based learning tasks and generating dramatized content, including narrative scenarios, character profiles, and scripts derived from textbook materials. They

have attained foundational knowledge regarding the structural composition, aesthetic principles, and historical-cultural significance of chimes. This knowledge has been applied in the creation of handcrafted chime ornaments. Through experiential learning activities, students have also developed a systematic understanding of chime temperament and acoustic properties. The primary objective of the current lesson is to integrate the completed student projects—specifically AI-generated scripts, scenic designs, character portrayals, handmade chime ornaments, and chime-based musical accompaniment—into a unified performance. The resulting production constitutes an English textbook-based drama, synthesized from interdisciplinary components, and will be presented as a culminating event for an international audience.

This study implements a flipped classroom pedagogical model that integrates situational teaching with task-driven instructional strategies to facilitate student-centered and collaborative learning. The instructional design comprises two main components: pre-class preparation and in-class activities. Prior to class sessions, students view instructional videos and complete a self-assessment checklist designed to support initial comprehension of the topic.

During class, the educator introduces the central theme—the acoustical properties and cultural significance of chimes—through visual representations of chime ensembles and audio playback of representative musical excerpts. To promote active engagement and critical reflection, guided questions are posed, including "Do you appreciate this musical piece?" and "Are you familiar with its performance techniques?" To enhance contextual understanding and immersive learning, a virtual reality (VR) environment is incorporated into the instruction. This VR platform features a digitally reconstructed simulation of the Hubei Provincial Museum, allowing students to interactively explore the historical development, functional applications, performance contexts, and symbolic meanings associated with chimes within their cultural setting.

The group work presentations and experimental components are central to this project-based course. Collaborative English learning in small student groups is a key aspect of tertiary-level meta-cognitive strategies within English language learning frameworks. Educators are responsible for facilitating the development of students' independent thinking and collaborative problem-solving skills, while systematically monitoring learning processes and outcomes. Instructional design should be centered on purposeful English language activities, incorporating structured collaborative sessions to promote the internalization of organized knowledge. Additionally, systematic post-class summary and evaluation procedures should be implemented.

4. Interdisciplinary Project-Based Teaching Process and Outcomes with the Theme of "The Beauty of Chimes"

The interdisciplinary project-based instructional program, systematically designed around the theme "The Beauty of Chime Bells," was implemented in Grade 9, Class 9 at School C. Students were divided into six groups, each comprising 6 to 7 members.

The instructional implementation was aligned with the previously described instructional design framework. Over the course of a five-session interdisciplinary activity sequence, students engaged in the integration of theoretical knowledge and practical application, resulting in measurable learning outcomes. In the module titled "Art Appreciation: Crafting Chime Bells," students first examined the structural characteristics of chime bells and subsequently designed and produced chime bell pendants. Semi-finished molded products are illustrated in Figure 2, and selected student artifacts are presented in Figures 3 and 4. Student groups documented the fabrication process systematically using structured tables or mind maps, detailing key procedural stages such as material preparation, operational procedures, quality inspection, and post-activity site cleanup.

Figure 2. Semi-Finished Product Works

Figure 3. Examples of Outstanding Works

During the activity titled "Playing the Chime Bells and Performing English Textbook Plays," six participating groups presented self-designed dramatic performances based on content from their English language textbooks. The event followed a structured sequence. First, groups that had successfully constructed chime bell pendants delivered presentations in English, outlining the design principles and cultural context underlying their artifacts. Subsequently, each group performed original musical pieces generated through acoustic experiments grounded in physical principles using the chime bells, followed by group performances of English songs. Thereafter, all groups displayed AI-generated visualizations of their play scripts. Individual students, assigned specific roles within their respective groups, introduced their characters in English. Following these presentations, students participated in subgroup rehearsal sessions. Through iterative role-playing and collaborative script refinement, the groups enhanced the coherence and quality of their performances. These performances symbolically brought together international representatives in a celebratory gathering, enacted through dramatized scenarios. (Photographic documentation of Semi-finished product works is provided in Figures 2, exemplary group outputs is provided in Figures 3.

Formative evaluation tools and criteria were applied to assess group outcomes and instructional activities throughout an interdisciplinary project-based learning unit focused on "The Beauty of Chimes." Analysis of student performance indicated improvements in several cognitive and collaborative domains, including the application and transfer of knowledge, information acquisition and organization, concept summary and integration, as well as participation in collaborative and inquiry-based learning tasks. Further observations revealed developments in students' expressive and communicative abilities, particularly within adaptive communication contexts. The tangible project outputs enabled students not only to deeply appreciate the artistic and historical significance of chime bells but also to develop a genuine sense of national pride and heightened interest in traditional Chinese culture, history, and English language learning.

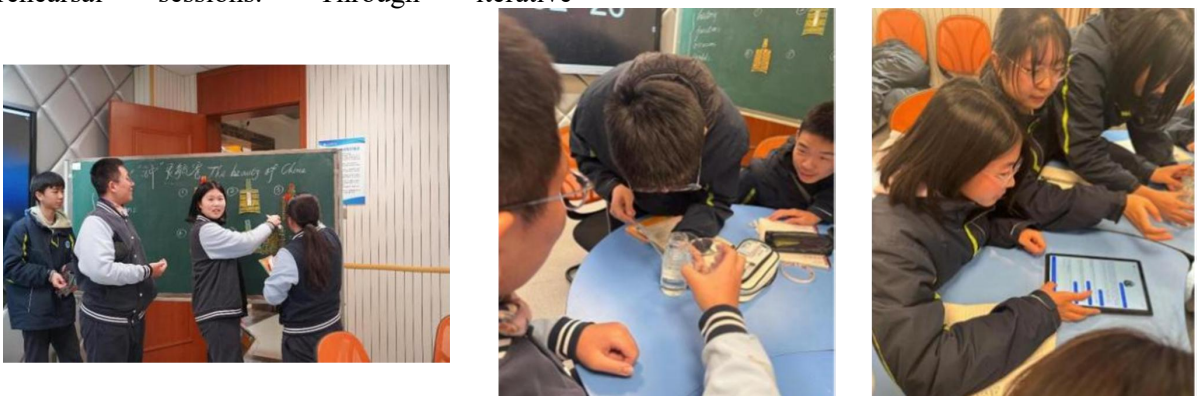

Figure 4. Photos of Outstanding Group Activity Achievements

This study proposes an interdisciplinary project-based instructional design framework grounded in Backward Design principles and constructivist learning theory. The framework systematically defines intended learning outcomes aligned with instructional objectives, identifies valid assessment evidence to measure the attainment of these outcomes, and subsequently informs the development of curriculum content and pedagogical strategies. This structured approach ensures vertical alignment among learning objectives, instructional activities, and assessment methods throughout the design and implementation of interdisciplinary projects. To demonstrate practical applicability, a case study is presented involving a junior high school English unit entitled "The Beauty of Chimes." Empirical

observations suggest that the framework facilitates the development of students' core competencies within interdisciplinary project-based learning contexts. However, the implementation remains at an initial stage and is subject to certain limitations, including the need to further enhance student agency and strengthen the integration of educational technology.

It is anticipated that the proposed framework, supported by empirical data and reflective analysis, will contribute to ongoing scholarly discourse within educational community and serve as a valuable reference for future interdisciplinary project-based instructional initiatives in similar educational settings.

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