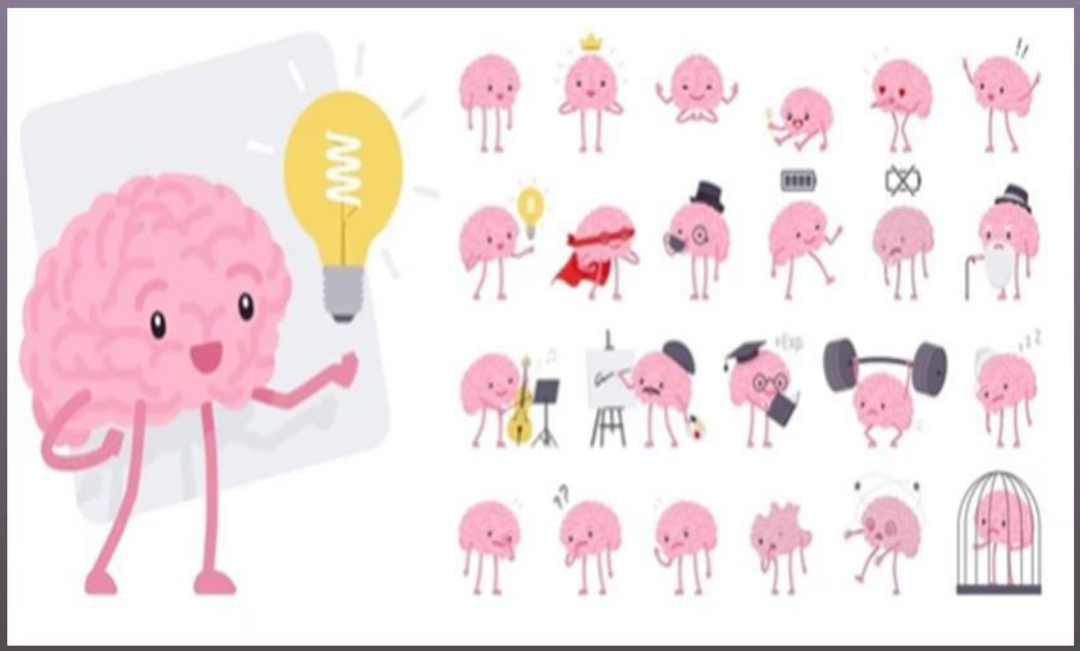
Volume 1, Issue 2, 2024

Print ISSN: 3007-6935
Online ISSN:3007-6943

Educational Research and Human Development



Educational Research and Human Development

Volume 1, Issue 2, 2024

Published by Upubscience Publisher

Educational Research and Human Development
Print ISSN: 3007-6935 Online ISSN: 3007-6943
Email: info@upubscience.com
Website: http://www.upubscience.com/

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Educational Research and Human Development
ISSN: 3007-6943
DOI: https://doi.org/10.61784/erhd3009

INTERDISCIPLINARY CURRICULUM DESIGN IN PHYSICAL EDUCATION AND ITS IMPLICATIONS FOR EDUCATIONAL MANAGEMENT INNOVATION

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Abstract: This paper explores the implementation of interdisciplinary curriculum design in physical education (PE) and its impact on enhancing student engagement, holistic development, and educational management practices. By integrating elements from sciences, arts, and humanities, interdisciplinary PE fosters intellectual, social, and physical growth. Key findings highlight the benefits of collaborative teaching models, flexible assessment frameworks, and student-centered approaches, underscoring the potential for interdisciplinary PE to drive educational innovation.
Keywords: Interdisciplinary PE; Student-centered learning

1 INTRODUCTION

The integration of interdisciplinary approaches in physical education (PE) addresses the growing emphasis on holistic student development in modern education. Traditional PE, while essential for health and fitness, often lacks connection to broader educational goals. By incorporating elements from sciences, arts, humanities, and technology, interdisciplinary PE enriches student learning, transforming PE into a platform for intellectual, social, and emotional growth alongside physical well-being[1].

2 THEORETICAL FOUNDATIONS OF INTERDISCIPLINARY CURRICULUM DESIGN

2.1 Models of Integration Between Physical Education and Other Disciplines

Interdisciplinary curriculum design in PE can integrate physical activity with other disciplines to create multifaceted learning. One model merges PE with sciences, such as biology and physics, allowing students to explore human anatomy and biomechanics. Another model links PE with social sciences, like psychology and history, where students examine mental resilience in sports or the historical development of physical activities and their societal impact.

2.2 Application of Educational Management Theory in Interdisciplinary Curricula

Implementing interdisciplinary curriculum design in PE requires adaptive educational management to support cross-departmental collaboration, resource-sharing, and teacher development. Traditional management models may limit interdisciplinary efforts, so flexible and collaborative approaches are essential. Effective management practices should provide resources and training for interdisciplinary projects, creating an environment where PE supports not only physical health but also intellectual, social, and creative growth.

3 IMPLEMENTATION PATHWAYS FOR INTERDISCIPLINARY CURRICULUM DESIGN IN PHYSICAL EDUCATION

3.1 Principles and Methods of Interdisciplinary Curriculum Design

Effective interdisciplinary curriculum design in PE requires clear principles that extend beyond physical fitness to support cognitive, social, and emotional development[2]. Objectives should include fostering critical thinking, teamwork, and problem-solving, bridging physical and intellectual learning. Integrating content from sciences, social studies, and arts with PE in a logical manner, and using diverse methods like collaborative projects and experiential learning, reinforces these interdisciplinary themes, making learning both active and meaningful.

3.2 Selection and Design of Interdisciplinary Curriculum Content

Selecting appropriate content is crucial for interdisciplinary PE programs, aligning with students' developmental stages[3]. Younger students might explore basic scientific and social concepts, like muscle function and teamwork, while older students delve into biomechanics, nutrition, sports psychology, and cultural histories of sports.

3.3 Practical Activities and Project-Based Learning

Practical, hands-on activities are vital in interdisciplinary PE, as they enable students to apply academic concepts through movement and collaborative projects. Project-based learning fosters active participation and real-world problem-solving, such as designing fitness routines based on physiological principles or creating dance routines that reflect cultural history. Another example includes integrating PE with art, where students study athletic movement and capture it in drawing or photography. Successful implementation of interdisciplinary PE requires adaptable lesson planning, cross-departmental collaboration, and professional development for teachers.

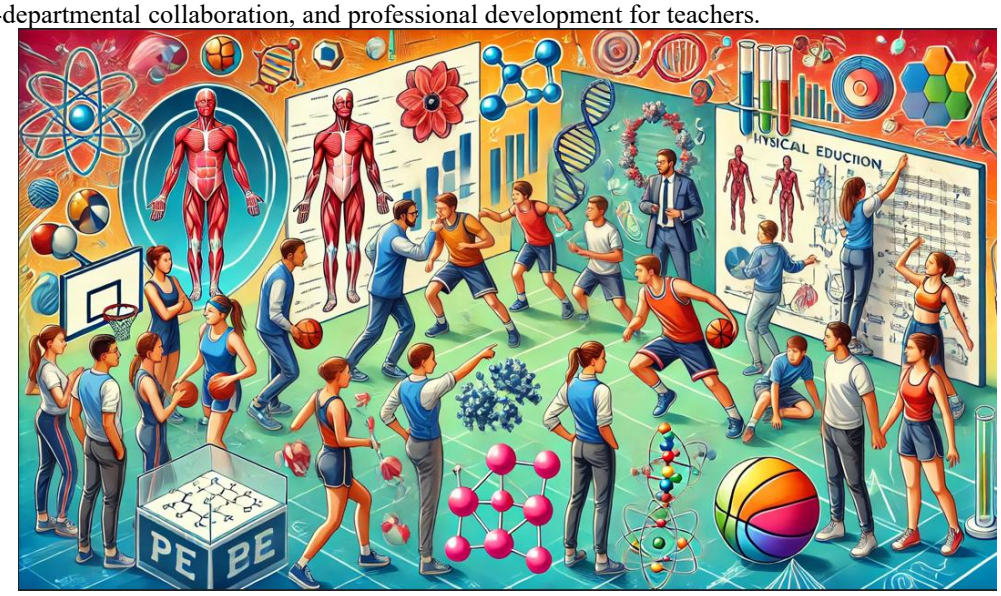

Figure 1 Integrative Physical Education: A Fusion of Science, Humanities, and Athletic Training

4 IMPLICATIONS FOR EDUCATIONAL MANAGEMENT INNOVATION IN PHYSICAL EDUCATION

4.1 Encouraging Collaborative Management Models

Interdisciplinary curriculum design requires flexible, collaborative management models that move beyond rigid departmental structures. Integrating PE with subjects like science, arts, and social studies calls for cross-departmental collaboration, with frameworks that support co-planning and cohesive lesson delivery. Management should promote teamwork by setting shared goals, forming interdisciplinary teams, and streamlining communication[4]. This collaborative approach not only strengthens interdisciplinary curricula but also fosters a culture of innovation and unity within the school.

4.2 Enhancing Teacher Professional Development and Interdisciplinary Competence

An interdisciplinary approach in PE calls for teachers to possess skills and knowledge beyond their specific subject area, making professional development a critical element in educational management innovation. Traditional PE training may not prepare teachers for integrating concepts from biology, physics, or social studies, so targeted professional development programs are essential. Educational managers can design workshops, seminars, and cross-disciplinary training sessions that equip PE teachers with a foundation in other subjects, enabling them to seamlessly incorporate interdisciplinary content into their lessons.

4.3 Strengthening Family-School-Community Partnerships

Interdisciplinary PE curriculum offers a unique opportunity for educational management to strengthen ties with families and community organizations, creating a collaborative ecosystem that supports holistic education. By involving families in interdisciplinary projects, such as community sports events or cultural activity days, schools can foster stronger family-school connections, helping parents become active partners in their children's education. Educational managers can also build partnerships with local sports organizations, cultural centers, and scientific institutions, integrating their expertise and resources into the curriculum.

4.4 Redefining Educational Assessment Systems

Traditional PE assessments, focused solely on physical performance, often miss the broader learning outcomes of interdisciplinary curricula. Innovative educational management should create multifaceted assessment frameworks that capture critical thinking, teamwork, and problem-solving skills. For instance, instead of evaluating only fitness levels, assessments can include understanding of scientific principles, collaboration skills, and creative expression. Rubrics that encompass cognitive, social, and physical competencies offer a more complete view of student development.

5 Case Studies: Successful Practices of Interdisciplinary Curriculum Design in Physical Education

Case Study 1: Integrating PE with Science and Technology in a U.S. High School

In a high school in California, the PE department collaborated with science and technology teachers to design a program that merged physical activities with scientific exploration and data analysis. Students participated in fitness activities while simultaneously learning about human anatomy, biomechanics, and data science. For example, students used wearable fitness trackers to monitor their heart rates and physical output during various exercises. They then analyzed the collected data in their science class, examining how different activities impacted cardiovascular health and energy expenditure.

The program's success was attributed to several key factors, including strong interdepartmental collaboration, the use of technology, and an emphasis on hands-on learning. Teachers from PE and science worked closely to align their curricula, ensuring a cohesive learning experience for students. The integration of wearable technology added an engaging, modern element that appealed to students' interests. Additionally, by allowing students to actively engage with scientific data about their own bodies, the program fostered a deeper, more personalized understanding of both PE and science.

Case Study 2: Physical Education and Cultural Studies in a Japanese Middle School

A middle school in Osaka, Japan, implemented a PE program that incorporated cultural studies to explore the traditional sports and physical activities of different cultures. Students learned about sports like sumo wrestling, martial arts, and traditional dances from various countries, examining the historical, social, and cultural significance of each. The curriculum included hands-on practice sessions, where students learned the basic techniques and movements, as well as classroom discussions and projects on the cultural origins and values associated with each activity.

The success of this interdisciplinary program stemmed from its integration of physical activity with cultural education, allowing students to gain global cultural insights while engaging in exercise. Teachers observed increased open-mindedness, respect for diverse practices, and heightened interest in physical activities.

The success of these interdisciplinary PE programs can be attributed to several common factors. First, strong collaboration among teachers across departments is essential for creating a cohesive and integrated learning experience. These case studies also demonstrate the importance of clear and achievable learning objectives that align with both PE and other subjects, ensuring that students gain meaningful insights across disciplines[5].

6 CONCLUSIONS

Interdisciplinary curriculum design in physical education enhances both student learning and educational management by integrating PE with fields such as science, culture, and the arts. This approach fosters critical thinking, creativity, cultural awareness, and personal health, positioning PE as a multidimensional educational experience. Key success factors include strong interdepartmental collaboration, clear objectives, student-centered learning, and support from school leadership.

COMPETING INTERESTS

The authors have no relevant financial or non-financial interests to disclose.

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Educational Research and Human Development
ISSN: 3007-6943
DOI: https://doi.org/10.61784/erhd3011

VOCABULARY LEARNING STRATEGIES FOR INTERNATIONAL STUDENTS IN SHAOXING UNDER COGNITIVE THEORY

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Abstract: Vocabulary is the foundation of language learning and an indispensable part of language learning. In teaching Chinese as a foreign language, vocabulary teaching is the focus and difficulty of language teaching. Chinese vocabulary is vast and complex, so teaching Chinese vocabulary is not an easy task. This article mainly starts from the perspective of cognitive psychology, based on the actual teaching of Chinese vocabulary in foreign language classrooms, examines the current situation of teaching Chinese vocabulary in foreign language classrooms, and based on the observation results of actual classrooms, develops a questionnaire survey. Based on this, ideas are proposed and teaching experiments are conducted to try to find a teaching principle and method suitable for implementation in specific classrooms, in order to improve the effectiveness of classroom vocabulary teaching.
Keywords: Cognitive psychology; Vocabulary teaching; Overseas student

1 INTRODUCTION

With the expansion of Belt and Road exchanges, the influence of Chinese language is also growing and spreading faster, and many foreigners come to China to learn Chinese. Statistics show that the number of people taking Chinese language examinations in various countries has also increased year by year in recent years. Chinese has also become the most popular second language with the largest number of participants, next to English. The Ministry of Education and the Chinese government have provided policy support to create more opportunities to learn Chinese. As a result, the number of international students in China has increased in recent years, and the number of international students from Southeast Asia in particular is growing year by year. The state actively introduces policies to support the education of international students, which has a positive effect on promoting the development of Chinese language teaching and the dissemination of Chinese vocabulary, not only optimising the allocation of educational resources, providing convenient conditions for diversifying Chinese language teaching modes, but also meeting the requirements of cultivating innovative talents.

2 REVIEW OF RELEVANT RESEARCH

By searching for the keyword "Cognitive Psychology and Vocabulary Teaching" on CNKI, Wu Shixiong[1] first discussed English vocabulary teaching by applying cognitive psychology theory. In his paper "Research on Cognitive Psychology Memory and Enlightenment of English Vocabulary Teaching", he believes that word memory cannot exist in isolation from the psychological domains of human perception, attention, and thinking.
Xu Ziliang [2] was one of the earliest scholars to conduct cognitive and psychological analysis on foreign students after Wu Shixiong. In his article, he recorded the cognitive and psychological processes of foreign students during their learning process, providing a wealth of teaching materials and a large amount of classroom experimental data for Chinese language teachers studying foreign students' learning strategies. Xu Ziliang conducted research using a questionnaire survey method. By organizing and analyzing survey data, he combined cognitive theory to derive language learning strategies for international students and described and analyzed the process of human brain processing language data using psychological theory. Wu Qianlong[3] analyzed the relationship between information processing and cognitive ability and analyzed the cognitive psychological processes of second language learners from two aspects: the characteristics of language itself and the connection between language and thinking. At the same time, he also sorted out and analyzed the vocabulary accumulation and language expression problems encountered by international students studying in China. Through analysis, he believes that cognitive theory has indeed played an important role in teaching Chinese as a foreign language and has provided practical and feasible suggestions for teaching Chinese as a foreign language based on theoretical foundations.
The academic community has long recognized the important role of cognitive psychology theory in vocabulary teaching. The discussion of vocabulary teaching from the perspective of cognitive psychology started relatively early in China, and the scope of research is also relatively broad. However, there are still many problems in vocabulary research from the perspective of cognitive psychology. Some scholars are only at the stage of theoretical verification. Some scholars have used questionnaire surveys and corpora to verify whether cognitive psychology is helpful for students' vocabulary learning, without verifying it from actual classroom teaching. Although some scholars combine practical vocabulary teaching, the experimental teaching process is incomplete and lacks experimental data support. So it is necessary for us

to combine specific classroom vocabulary teaching, guided by cognitive psychology theory, carefully arrange experimental steps, improve experimental data, and use experimental data as a basis to verify whether cognitive psychology theory is helpful for vocabulary teaching.

3 RESEARCH DESIGN

3.1 Analysis of Relevant Problems Faced by Teachers in Teaching

3.1.1 Neglecting students' perception and experience

In classroom teaching, teachers usually focus on the arrangement of the curriculum and teach according to the order of the textbook. It is found that few teachers pay attention to students' inner perception of the content of the lesson. Neglecting the students' feelings will result in the teachers' inadequate design of the overall classroom teaching, which is superficial vocabulary learning and ignores the content behind the vocabulary.

3.1.2 Ignoring the connotation and context of vocabulary

Chinese vocabulary is not only numerous, but also rich and colorful in its connotations. Teaching Chinese vocabulary in conjunction with the unique background of Chinese culture can not only ensure the smooth progress of teaching, but also deepen students' understanding of vocabulary. However, in the actual teaching process, teachers often neglect the unique connotation and context of Chinese vocabulary. The single explanation of vocabulary not only makes the vocabulary class lack of interest, but also leads to the students' lack of understanding of vocabulary, which has a significant impact on their learning of Chinese vocabulary.

3.1.3 Insufficient practice of Chinese vocabularies

Repeated training can constantly reproduce the vocabulary learnt and deepen students' understanding and memory of the vocabulary. However, the vocabulary practice in the classroom is basically inseparable from the textbook, and the vocabulary drill is mainly based on the teacher's leading and students' following, repeating the vocabulary from the textbook. In this case, the new knowledge learnt in the classroom is not strengthened, and the students cannot flexibly use the vocabulary they have learnt in the classroom to communicate with each other, which is a kind of confinement to the students' thinking in their learning.

3.1.4 Can't use the taught words repeatedly

Due to the limitation of curriculum arrangement, teachers are eager to arrange new contents in classroom teaching, so the classroom teaching is mostly based on new knowledge, lacking in re-recognition and reappearance of the old knowledge, neglecting the coherence of teaching and learning, which makes students' cognition of Chinese vocabulary divided, and this is extremely unfavourable to the vocabulary learning of the students.

3.2 The Analysis of The Related Problems Faced by Students' Acquisition

3.2.1 Low interest and heavy burden

According to the survey of international students in Shaoxing, students' interest in learning Chinese vocabulary is not too high in Chinese language learning and teaching, and a small number of students are not interested in the vocabulary teaching part of the classroom, and they think that grammar is more important.

3.2.2 Inadequate understanding of vocabularies

As the Chinese language programme progresses, students need to master more and more Chinese vocabulary, and the increase in the amount of memorization leads to students' poor understanding of Chinese vocabulary. On the one hand, teachers' design of vocabulary teaching is not in place in the limited classroom time; on the other hand, due to the large cultural differences between China and foreign countries, each Chinese vocabulary word contains unique cultural meanings, and students' lack of understanding of Chinese culture affects international students' understanding of Chinese vocabulary, which results in vocabulary not being stored permanently in the brain's mental lexicon as a long-term memory, and this affects the recongnition and reproduction.

3.2.3 Single way of vocabulary accumulation

At present, international students in Shaoxing learn vocabulary mainly from textbooks, teachers mainly focus on the vocabulary lists in the textbooks, and students rely on the vocabulary lists in the textbooks to remember and the way of remembering vocabulary is still based on rote memorisation. In this case, students have a single way of accumulating Chinese vocabulary, and teachers do not provide students with other ways to remember vocabulary in class. Rote memorisation can help students to remember a large amount of vocabulary in a short period of time, but since students do not have a deep understanding of the meaning of the vocabulary itself and the significance behind the vocabulary, they can easily forget it in a long time.

4 CONCLUSION

4.1 Suggestions for Teachers' Teaching

4.1.1 Build vocabulary networks and construct word-to-word links

The mental lexicon emphasises that words stored in the lexicon are interwoven with each other at certain nodes to form a huge vocabulary network. Therefore, in actual classroom vocabulary teaching, teachers should use different teaching methods to help students connect the words they have learnt as much as possible, so that students can understand and

master the words in a short time, and then enlarge the vocabulary stored in the mental lexicon, which is easy for students to retrieve and reproduce at any time. The students' mental lexicon can be enlarged so that they can extract and reproduce the words at any time.[4] However, according to our survey, the cultivation of metacognitive coding ability has not been given enough attention in both teachers‘ Chinese vocabulary teaching and students’ Chinese vocabulary learning. Metacognitive coding refers to the fact that students have a clear understanding of the process of learning vocabulary, and that they are able to comprehend the meaning of vocabulary and improve their ability to use it, so the cultivation of students' metacognitive coding ability is important in the actual teaching of vocabulary in classrooms. Therefore, the cultivation of students’ metacognitive ability is essential in the actual teaching of vocabulary in the classroom. Teachers should pay attention to students’ metacognitive coding ability, train students to apply and extract vocabulary, and increase students' interest in learning.

4.1.2 Creating Vocabulary Contexts to Improve Vocabulary Application Skills

Contextual teaching refers to the use of vivid language and imagination to recreate text scenes according to the needs of the curriculum. Students can deeply understand the meaning of vocabulary in the context, understand the specific scenes of vocabulary use, and improve their practical application ability. Therefore, when vocabulary is taught in the classroom through the context, students will concentrate on perceiving the vocabulary, so that they can grasp the meaning of vocabulary well. By projecting a suitable language environment, the teaching process changes from a static language environment to a dynamic one, in which all the senses of the students are fully mobilised, and the students are able to understand the meaning of the vocabulary and in what kind of situations the vocabulary is used. From the statistics of the previous questionnaire survey, we can see that teachers do not encode enough information about vocabulary in the classroom, which leads to the students not being able to perceive the new vocabulary they are learning, and not being able to relate to the context in which they are learning the new vocabulary. Therefore, contextualised teaching is very important. On the one hand, it can help teachers to design vocabulary sessions better, and on the other hand, it can help students to understand the scenarios of vocabulary use and improve their ability to apply it.

4.1.3 Increase the ways of practice and remember vocabulary through various channels

It is very important to master a learning strategy that suits oneself. When learning a second language, international students seldom have the chance to practice with students of the target language.[5] There are many nationalities in the world, and due to the influence of history and geography, each nationality has formed its unique way of thinking in the course of time, and there are big differences in language and culture among nationalities, so it is almost impossible to master all the vocabularies in one class, and it is necessary to listen to them more, read them more and speak them more. Therefore, rote learning is not the best way to master vocabulary. In the actual learning environment, teachers should help students to master more vocabulary learning strategies, and students should explore their own vocabulary learning methods according to their own learning habits. To deal with this situation, on the one hand, teachers can build up a vocabulary bank of vocabulary extended in the classroom, so as to make it easier to remember in the future. On the other hand, teachers should design a variety of vocabulary practice methods to extend the scope of vocabulary practice from the classroom to the classroom. By practicing vocabulary in multiple ways and through multiple channels, students' practical vocabulary application can be enhanced.

4.2 Suggestions for Students' Learning

4.2.1 Clever vocabulary memorization and increase interest in learning Chinese vocabulary

Interest is the driving force behind language learning. Language learning itself is boring and tedious, so if we cannot arouse students' interest in learning, it will easily lead to slackness in vocabulary learning and affect the learning state in the classroom. To learn a language, it is not only necessary to remember vocabulary unilaterally, but also to remember the cultural and background knowledge of the vocabulary. Each vocabulary word has a unique cultural connotation behind it. Therefore, in the process of vocabulary teaching, teachers should explain the meaning behind the vocabulary words to arouse students' interest in vocabulary learning, and the more students master the origin and meaning of the vocabulary words, the more confidence they have, the more interest they have in vocabulary learning, and the more they are inspired to explore more vocabulary words, so as to understand the vocabulary words and improve the ability to use them. The students will be more interested in vocabulary learning.

4.2.2 Cultivating metacognitive strategies and choosing appropriate learning strategies

As one of the most commonly adopted strategies, cultivating students' metacognitive awareness is crucial to their proper learning of Chinese. Students should be encouraged to develop their own learning plans based on their unique circumstances, and teachers should assist them in setting their own learning goals. In addition, it is important to monitor and guide the learning process and to help students find solutions to the problems they encounter in learning self-cognitive strategies, so that they can choose which methods are better for remembering vocabulary, which are better for improving forgetting, and which are better for expanding their vocabulary.

4.2.3 Expanding reading paths and increasing vocabulary learning methods

Since interest is the compass of students, learning and can determine the direction of students’ learning, we should not limit ourselves to remember vocabulary from textbooks, but also broaden the paths of learning, and extracurricular reading is undoubtedly one of the best ways to increase vocabulary.

According to the results of the survey, international students in Shaoxing are more influenced by their interests and hobbies when learning Chinese vocabulary, so interests and hobbies are very important when instructing students to learn Chinese vocabulary.

COMPETING INTERESTS

The authors have no relevant financial or non-financial interests to disclose.

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Educational Research and Human Development
ISSN: 3007-6943
DOI: https://doi.org/10.61784/erhd3012

THE APPLICATION OF CHINESE PAPER-CUTTING TEACHING IN TEACHING CHINESE AS A FOREIGN LANGUAGE

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Abstract: In the teaching of Chinese as a foreign language, there is often an emphasis on language teaching while cultural teaching is easily overlooked. However, from the perspective of language communication functions, language and culture are inseparable, and understanding certain Chinese cultures plays an important role in helping foreign students learn the language better. Among Chinese cultures, paper-cutting contains rich cultural connotations and is an indispensable part of Chinese cultural teaching in teaching Chinese as a foreign language. Applying paper-cutting to the teaching of Chinese as a foreign language explores how it can achieve language teaching, cultural teaching, and experiential creation.
Keywords: Teaching Chinese as a Foreign Language; Chinese Culture; Paper-cutting; Language; Culture; Experience

1 INTRODUCTION

Culture plays an important role in language teaching. In 1880, the French reformer and educator Gouin·F first pointed out the important position of cultural teaching in language teaching in his book "The Art of Teaching and Learning Languages". In the early 1980s, scholars such as Hu Wenzhong first introduced foreign cultural teaching theories into China. Starting from the perspective of language communication functions, he emphasized the inseparability of language and culture. From the 1990s to the present, most scholars have reached a consensus: "Teaching Chinese as a foreign language should focus on language teaching while closely integrating related cultural teaching."[1]
Most foreign students come to China to understand China and learn about Chinese culture. The opening of cultural courses is one of the important ways for them to come into contact with and understand Chinese culture. Chinese culture uses language as a carrier, and understanding certain Chinese cultures plays an important role in helping foreign students learn Chinese and enhance cross-cultural communication. Therefore, opening cultural courses in the teaching of Chinese as a foreign language and carrying out the study of Chinese culture can not only meet the needs of foreign students but also conform to the objective laws of language teaching.
The opening of Chinese culture courses allows foreign students to systematically experience a variety of Chinese traditional cultures.[2] Among them, Tai Chi, tea art, paper-cutting, calligraphy, and other cultural courses are very popular with foreign students. Because the materials for cultural paper-cutting courses are simple, it is possible to create a good work in a short time, which gives foreign students a sense of achievement and makes them more confident in learning Chinese language and culture. Therefore, this paper selects paper-cutting as the research object of Chinese cultural courses in teaching Chinese as a foreign language.

2 PAPER-CUTTING CULTURE IN LANGUAGE TEACHING OF CHINESE AS A FOREIGN LANGUAGE

Teaching Chinese as a foreign language includes teaching of phonetics, characters, and vocabulary. Paper-cutting is good at using homophonic meanings, such as happiness on the eyebrows (plum), year after year (lotus) surplus (fish), immediately sealed marquis (monkey), auspicious (chicken) auspicious (sheep) as you wish, etc. Teachers can explain the auspicious meanings of paper-cutting through pictures of paper-cutting, and show pictures of homophonic characters, such as plum (ei) flower, lotus (ian) flower, goldfish (u), monkey (ou), chicken (i) sheep (ang), etc., to use culture to remember phonetics, thus achieving the purpose of teaching in a fun way.
Symmetric paper-cutting is the most common method of paper-cutting. In the paper-cutting culture course, while explaining the symmetric cutting method, teachers can cut symmetrical Chinese characters such as Wang, Da, Chun, Feng, Ji, Shuang, etc., allowing foreign students to learn Chinese characters while understanding the paper-cutting techniques.
In the paper-cutting culture course, there are paper-cuts that reflect the culture of the zodiac, such as rat, ox, tiger, rabbit, etc.; there are paper-cuts that reflect the style of a gentleman, such as plum, orchid, bamboo, chrysanthemum; there are paper-cuts that reflect the culture of celebrating longevity, such as pine and cypress evergreen, crane and peach, turtle year crane longevity, five bats holding a peach, etc. By displaying paper-cut works and explaining their meanings, vocabulary teaching in paper-cutting can be completed.[3]

3 PAPER-CUTTING CULTURE IN CULTURAL TEACHING OF CHINESE AS A FOREIGN LANGUAGE

Chinese folk paper-cutting culture has a long history and has permeated into the lives of the public during its long development process. Paper-cutting culture is closely related to people's lives, and paper-cutting elements can be found

everywhere in the stage's facial makeup, shadow puppetry, clothing, tea sets, ceramics, accessories, etc.

3.1 Festival Culture

Chinese festival culture is an important part of the long history and culture of the Chinese nation, and paper-cutting is closely related to many festival cultures. On the eve of the Spring Festival, every household will paste paper-cuts on the windows, door lintels, and rooms to welcome the arrival of the New Year. During the Lantern Festival and the Mid-Autumn Festival, lanterns with paper-cut elements will be hung. During the Dragon Boat Festival, in addition to hanging wormwood, people will also paste paper-cut patterns of the five seasons and the five season flowers. On the Qixi Festival, skillful women will sing and cut out the patterns of the girl weaving and the magpies building a bridge.

3.2 Marriage Customs Culture

Double happiness paper-cutting is indispensable in marriage customs decoration. In addition, people in Yangquan, Shanxi, like to decorate the bridal chamber with a disc; some rural areas in Linqing, Shandong, use round moon patterns to decorate the windows of the marriage room; some rural areas in Northern Shaanxi use the sitting curtain flower for decoration. In the old days, before Ruichang proposed marriage, the matchmaker would find an opportunity to let the woman show the man's talent in embroidery and paper-cutting. The red daughter's carving with paper-cutting elements in Shaoxing will be used as a dowry when the daughter gets married.

3.3 Birthday Celebration Culture

Since the Han Dynasty, there has been a custom of celebrating the longevity of the elderly among the people. When celebrating longevity, the long-shaped longevity and the round-shaped longevity are essential paper-cut patterns, in addition to which patterns with the meaning of longevity, such as pine trees, cranes, peaches, etc., will also be matched. To reflect the joy of having children and grandchildren, patterns of children holding peaches will also appear in the longevity paper-cut.

3.4 Sacrificial and Religious Culture

The paper-cutting theme includes sacrificial and religious customs. Common paper-cut offerings include paper money, paper horses, paper houses, etc. Paper-cutting is also used to make various paper decorations to decorate cemeteries and sacrificial places. When the Grain Rain comes, people will paste the Grain Rain paste, which is engraved with the image of the divine chicken catching scorpions, the heavenly master removing the five poisons, or Taoist talismans, expressing people's desire to kill pests, hope for a good harvest, and peace. Paper-cutting art is also an important carrier for spreading religious culture. The creation of paper-cutting art with different styles is influenced by religious culture at different times. Paper-cutting is mainly reflected in religious culture in the form of paper-cutting of religious buildings and paper-cutting of religious activities.[4]

4 TEACHING AND ASSESSMENT METHODS OF PAPER-CUTTING CULTURE IN CHINESE AS A FOREIGN LANGUAGE

4.1 Simple and Easy-To-Understand, Popular and Straightforward Language Expression

In the process of explaining Chinese cultural paper-cutting courses, some professional terms will be involved, such as hollowing out, dropping the knife, scooping, Yin and Yang cutting, etc. Difficult-to-understand professional terms will make foreign students difficult to understand the course content, leading to dull and boring classes, and students will be tired of learning. Therefore, teachers should insist on using simple and easy-to-understand, popular and straightforward language to express themselves.

4.2 Teaching and Learning from Each Other's Student-Centered Consciousness

In the teaching process, teachers should adhere to the student-centered approach and oppose the full-class teaching model. The Chinese level of foreign students is uneven, and teachers should adopt the principle of combining unified teaching with individual tutoring. Teachers and students should maintain communication at all times during teaching, and guide students to learn to cooperate, so that teachers and students can complete the teaching tasks in interaction, and each has its own gains.

4.3 Experience-Based, Culture-Assisted Teaching Methods

Chinese cultural paper-cutting courses are divided into two parts: culture and experience. Teachers should follow the principle of culture as an auxiliary and experience as the main principle in teaching. Foreign students only need to understand the cultural part of the paper-cutting course, and mainly through experience, let students learn to think and innovate in paper-cutting. In the process of enjoying the fun of paper-cutting, they accept and identify with Chinese culture, thus playing a role in spreading Chinese culture.

4.4 Diverse Teaching Methods

In addition to the lecture method, Chinese cultural paper-cutting courses can also be completed through audio, video, pictures, and practical experience teaching methods. Diverse teaching methods can greatly mobilize the enthusiasm of foreign students to learn, thus ensuring the smooth progress of the course.

4.5 Scientific and Reasonable Assessment Methods

Chinese culture courses are different from language courses and cannot adopt a single assessment method. At present, some colleges and universities set cultural experience courses as elective courses, with fewer class hours, fewer opportunities for students to operate, and lower attention from teachers and students to cultural courses, resulting in a single assessment method.[5] Taking the Chinese cultural paper-cutting course as an example, teachers can assess the course from whether students understand the connotation of Chinese cultural paper-cutting, the growth and progress of each homework, and the innovation of the exam, to ensure the scientific rationality of the final score.

5 SUGGERTIONS AND THOUGHTS ON PAPER-CUTTING CULTURE COURSES

5.1 Setting of Cultural Courses

Due to the lack of attention from schools and teachers, the Chinese cultural paper-cutting course has fewer class hours, students attend classes casually, and the assessment mechanism is unreasonable. In view of this, the Chinese cultural paper-cutting course can be set according to language, culture, and experience for teaching, and the course content can be divided into seven parts: phonetics, characters, vocabulary, festival culture, marriage customs culture, birthday celebration culture, and sacrificial and religious culture for systematic teaching.

5.2 Compilation of Teaching Materials

Teachers who teach Chinese cultural courses mostly use textbooks for Chinese students in their teaching. Profound textbooks will not only make foreign students feel fear, thus affecting their interest and confidence in learning Chinese culture, but also cause cultural misunderstandings due to cross-cultural differences. Therefore, it is very necessary to compile applicable Chinese cultural paper-cutting textbooks to help students systematically understand Chinese culture.[6]

5.3 Teacher's Personal Quality

Teachers of Chinese as a foreign language play an important role in the dissemination of Chinese as a foreign language, so the personal quality of teachers is extremely important. Teachers of Chinese as a foreign language should not only have strong cross-cultural communication skills but also be able to use advanced teaching methods to achieve diversified teaching. For the teaching of cultural practice courses, teachers must have certain practical abilities, such as the paper-cutting culture course, which requires teachers to be proficient in paper-cutting skills.

Incorporating Chinese cultural paper-cutting courses into the teaching of Chinese as a foreign language can not only let foreign students understand the cultural connotations behind Chinese, enhance their interest in learning Chinese, but also generate a sense of identity with Chinese culture in the experiential operation, thus becoming a disseminator of Chinese culture. However, incorporating Chinese cultural paper-cutting as a systematic course in the teaching of Chinese as a foreign language requires the attention of schools and teachers, as well as a series of supporting measures. Systematically applying Chinese cultural courses to the teaching of Chinese as a foreign language will be a long process.

COMPETING INTERESTS

The authors have no relevant financial or non-financial interests to disclose.

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Educational Research and Human Development
ISSN: 3007-6943
DOI: https://doi.org/10.61784/erhd3015

RETROSPECT AND PROSPECT OF EFL CLASSROOM ENVIRONMENT RESEARCH IN CHINESE EDUCATIONAL CONTEXT

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Abstract: This review explores the development, current trends, and research prospects on English as a Foreign Language (EFL) classroom environments in China. Drawing on an analysis of 45 studies published from 1985 to 2024, it summarizes key theoretical frameworks, major research themes, and methodological choices within the field. While significant advancements have been made, the review also uncovers notable gaps to be filled in this realm. By addressing existing challenges, it offers recommendations for a deeper understanding of Classroom Environment, and also improve practices in EFL classroom settings.
Keywords: EFL classroom environment; SLA; Foreign language education; Literature review

1 INTRODUCTION

1.1 Background Information

In recent years, the classroom environment for second language acquisition (SLA) has been a key topic being discussed on a global scale. As the natural L2 environment are difficult to create, the classroom plays a crucial role in enhancing L2 learners' language learning and acquisition. Focusing on classroom environment allows for a precise understanding of individual language development paths and an examination of the overall education system's effectiveness in promoting second language acquisition. Furthermore, by analyzing pedagogical choices, teacher-student interactions, and effective use of learning resources, the factors that truly enhance language acquisition and pinpoint areas in need of optimization can truly be identified. This research is vital not only for improving current classroom teaching but also for establishing a strong theoretical foundation and practical guidance for future innovation in second language acquisition education strategies. Therefore, a classroom environment that focuses on second language acquisition is essential for advancing language education and fostering comprehensive development in learners.

The traditional teacher-centered approach, which prioritizes the role of instructors and relies predominantly on lecturing, hampers students' initiative and the development of their practical language skills. This often leads to passive knowledge absorption and a dearth of opportunities for real-world language application, resulting in a gap between language learning and effective communication. Furthermore, the traditional pedagogy tends to overlook the individual differences among students, such as variations in learning motivation, style, and habits. A standardized teaching approach is not prone to effectively meet the diverse needs of all students, thereby impacting overall teaching efficacy.

With the evolution of pedagogical evolution and the rapid development of science and technology, there have been some advancements in teaching methods and resources in SLA classrooms in recent years, including the implementation of multimedia-assisted teaching and cooperative learning. However, there are still challenges to address. Particularly in non-native language environments, in which students lack abundant exposure to natural language input and struggle to create an output environment similar to that of native language acquisition. Additionally, there is still room for improvement in the breadth and depth of technology applications. The integration and utilization of advanced educational technologies like online learning platforms and intelligent teaching systems in second language acquisition classrooms are still in the nascent stages, not fully realizing their potential in personalized teaching, learning data analysis, and feedback.

1.2 Purpose and Significance

This literature review aims to comprehensively examine and analyze the historical evolution, current status, and future development of English as a Foreign Language (EFL) classroom environment in China. Specifically, it seeks to elucidate key trends, gaps in knowledge, and emerging issues that have been shaped and continue to shape the research landscape in this field. The article will first provide a retrospective analysis of the development of EFL classroom environment research in China, tracing its evolution from early theoretical frameworks to contemporary empirical studies. Followed by this overview, it will critically evaluate the methodologies used in these studies, highlighting their strengths and limitations to inform future research designs. Next, the article will summarize the major findings and themes that have emerged across different investigations, focusing on the factors that contribute to positive or negative learning outcomes in EFL classrooms. Finally, it will identify gaps and controversies in the existing research, pointing out areas that require further explorations.

The significance of this literature review lies in its potential to contribute to both theoretical and practical advancements in EFL education in China. Theoretically speaking, it offers a comprehensive synthesis of existing research, facilitating the development of more nuanced and comprehensive frameworks for understanding the EFL classroom environment. By identifying gaps and controversies, it also points to new avenues for research that can enrich our understanding of this complex and dynamic field. Practically, for educators, especially for first-line EFL instructors, it provides insights into effective strategies for creating supportive and conducive learning environments that can enhance students' language acquisition and overall teaching effectiveness.

2 CLASSROOM ENVIRONMENT AND ITS IMPLICATIONS

2.1 Definitions of Classroom Environment

The concept of "classroom environment" has evolved over time, with scholars offering definitions from various theoretical and practical perspectives, reflecting its multidimensional nature.

Moos, in his research on environmental psychology, lays the groundwork by identifying three critical dimensions of environments: physical space, social interactions, and emotional climate. These dimensions were foundational to later educational research, particularly in studies of classroom environments, providing a framework for analyzing how environmental factors influence individual behavior and emotions. Bronfenbrenner further expands the understanding of classroom environments within his "ecological systems theory", describing them as dynamic ecosystems[1]. He emphasizes that classroom environments are not only related to students' cognitive and emotional factors, but also involve complex interactions between multiple elements, all of which contribute to students' academic success[1]. This theory provides a macro-level perspective, situating classroom environments within a broader context of human development.

With the development of information technology, Garrison and Kanuka introduce the concept of a "blended learning environment". They argue that classroom environments should not only incorporate traditional physical and social dimensions but also integrate digital elements to meet the evolving needs of modern learners. This perspective expands the definition of classroom environments, making them more adaptable to 21st-century educational practices.

Dorman et al. further refine the definition of classroom environment by describing it as the "physical, psychological, and social settings within and beyond the classroom", including teacher-student interactions, peer relationships, and the overall classroom atmosphere[2]. Their work emphasize how these factors directly impact students' learning behaviors and engagement, providing a more detailed operationalization of the concept[2].

Moving into the field of SLA, researchers begin to focus more specifically on the role of classroom environments. Peng and Woodrow approach classroom environments from an instructional perspective, defining them as comprising teacher support, student cohesiveness, and task orientation[3]. They underscore that supportive teachers, cooperative peers, and well-designed tasks are crucial conditions for creating a positive classroom environment that significantly impacts student motivation and learning outcomes. Similarly, Cao , in his study of willingness to communicate (WTC), defines classroom environment as "a set of immediate contextual factors that directly influence learners' WTC", including task types, interaction patterns, and the roles of interlocutors[4]. This definition highlights the direct impact of situational elements within the classroom environment on language learners' participation and language use.

Generally speaking, the evolution of the concept "classroom environment" encompasses perspectives from environmental psychology, ecological systems theory, blended learning environments, and the field of Second Language Acquisition (SLA). These definitions and theories offer both macro and micro perspectives for understanding classroom environments and guide educational practices and language teaching, particularly in creating positive learning environments and fostering student motivation and learning outcomes.

2.2 Previous Studies on EFL Classroom Environment

The classroom environment has consistently remained a significant topic in the field of EFL. Thereupon, this review synthesizes 45 studies involving the EFL classroom environment both domestically and internationally, spanning from 1985 to 2024. It is noteworthy that the period before 2018 goes through a relatively stagnant growth in the development of the research concerning EFL classroom environment, which witnesses a modest total of 24 studies. Nevertheless, when it comes to 2018, there exists a booming point where 6 articles related to EFL classroom environment are published, and researchers exhibit rising interest on the academic subject, leading to the emergence of 15 relevant studies from 2019 to 2024.

The studies synthesized in this paper are drawn from authoritative journals. As for the Chinese-language studies, they come from prominent publications such as Foreign Language Teaching and Research, Modern Foreign Languages, and Foreign Language Education. And the English-language studies are derived from notable scholarly journals, featuring Applied Linguistics, TESOL Quarterly and Studies in Second Language Acquisition. Therefore, reviewing these studies is of value as it offers a profile of the status quo of research on the EFL classroom environment, reflecting the depth and breadth of the scholarly discourse in this domain.

Among the 45 studies reviewed in this paper, there is a diversity in theoretical foundations, research contents, backgrounds and methodologies. In the subsequent sections, details that elaborate differences of the studies are provided.

2.2.1 Theoretical foundations

The studies encompassed in this paper are based on various theories. In the collection of articles, the most common theoretical basis is Second Language Acquisition (SLA), with 20 instances. Within the SLA framework, Stephen Krashen's Input Hypothesis is utilized in 8 articles, the affective filter hypothesis in 2 articles, and Merrill Swain's Output Hypothesis in 3 articles. Following these is the theoretical model of the Willingness to Communicate, with 9 articles. Additionally, theories like Sociocultural Theory and Ecological Systems Theory appear in 5 articles respectively, while Dynamic System Theory and Interaction Theory are discussed in 3 articles each. Other theories, such as Field Theory, Control-Value Theory, Systemic Functional Multimodal Discourse Analysis (SF-MDA) Theory, and Attribution Theory, are also employed but less frequently. Overall, the EFL classroom environment research has drawn from a variety of theories, yet it has predominantly leaned on SLA theories. Although other theories have been considered, their exploration has not been as in-depth, indicating a lack of depth in theoretical application.

2.2.2 Research contents

The selected studies are categorized into three types: empirical research, theoretical research, and literature reviews. Empirical research leads with 31 studies, representing 68.9% of the total. Following closely is theoretical research with 12 studies, constituting 26.7%, while literature reviews account for the remaining 4.4% with just 2 studies. The primary aspects of academic investigation concern the EFL classroom environment include the following. The interaction of classroom environment with academic performance is explored in six studies, and the impact of classroom environment on the willingness to communicate in a second language are investigated in seven studies. Two studies focus on the influence of classroom environment on academic emotions while four studies fix upon the effect of classroom environment on the development of language proficiency. Theoretical research draw on several issues representative of the construction and analysis of classroom environments in four studies and the impact of classroom environments on second language acquisition in another four studies. With respect to literature reviews, the main focus lies on the research methods pertaining to foreign language classroom environments.

While empirical research indeed provides valuable experiences for future studies, an imbalance in the number arises when compared to theoretical research and literature reviews. Moreover, in terms of empirical research, researchers predominantly examine classroom environment-related issues from the perspective of student perception, with fewer studies focusing on the perspective of teacher behaviors.

2.2.3 Research backgrounds and subjects

Research backgrounds are elaborated with an emphasis on empirical research, including details on research areas, categories of classroom environment, subjects' original languages, their foreign language (English) proficiency, and educational backgrounds.

As for areas where studies are taking place, a wide variety can be seen. China leads the way with 17 studies, and two studies are carried out in the United States and Iran distinctively, the United Kingdom, Cyprus, Spain, Japan, New Zealand, Germany, and Finland each producing one study. Moreover, there are two studies with no regions mentioned and one study covering a broad scope of regions including Asia, Europe, the Middle East, the Americas, and Africa, while no specific areas are indicated.

In terms of research subjects, multiple pieces of information are elaborated. First of all, the original languages that subjects speak vary a lot. In alignment with the regions where the studies are executed, all 17 studies in China feature research subjects with Chinese as their mother tongue. Also, because of the impact of minority groups, two studies carried out in the United States and one in Spain focus on Spanish as the native language. Finnish, Portuguese, and Persian are the original languages of research subjects as well, every amounting to two studies. Additionally, a few less prevalent languages like Romanian and Urdu are the original languages of subjects in certain studies. However, three studies are referring to no specific original languages. Generally, studies are characterized by a wide array of subjects' original languages, yet it is chiefly concentrated on Chinese speakers, which sets a barrier for future research in other languages. Concerning the research subjects' English proficiency, most studies lack relevant information while the English levels the rest indicate are not solid enough since there exists no standardized bar for evaluation. The educational backgrounds of the research subjects span from kindergarten to university. 17 studies mention that their subjects are university students, which take up the highest proportion, and 6 studies are featured with research subjects in high school. However, studies on those in elementary schools as well as preschoolers are significantly insufficient, totaling only three studies.

2.2.4 Research methodologies

Regarding research methodologies, this paper discusses aspects including the types of research methods, sample sizes, research instruments, and research designs. The types of research methods involved are quantitative research, qualitative research and mixed-methods research. Specifically, quantitative research is represented by 17 studies, qualitative research by 6 studies, and mixed-methods research is utilized by 8 studies. In terms of sample sizes, the smallest sample consists of only 2 individuals, while the largest sample reaches 5130 individuals, reflecting a significant numerical span. With respect to the research instruments, questionnaires are the most commonly-used tool, with 19 studies employing them. Interviews are also frequently adopted, with 8 studies taking advantages of this method. In addition, classroom observations, classroom recordings, tests, case analyses, data collection, informal conversations and reflective journals are methods selected by researchers in spite of their low frequencies. Regarding research design, 31 empirical studies encompass cross-sectional research, with 21 cross-sectional studies and 8 longitudinal studies, which range from a duration of 3 weeks to 21 months. Furthermore, there are 2 experimental studies.

Given that, the variety in research methods and wide range of sample sizes reflect a comprehensive exploration of classroom environments. The popularity of questionnaires and interviews highlights a balance between quantitative and qualitative data, while the less frequent use of methods like observations and journals indicates an area for expansion. This could provide a more detailed view of classroom dynamics. The combination of cross-sectional and longitudinal studies allows for both immediate and long-term educational insights, which is key for developing effective educational strategies. Overall, these approaches offer valuable insights into classroom environments, with implications for enhancing teaching practices and student outcomes.

3 LOOKING TO THE FUTURE

3.1 Theoretical Foundations

Current studies on EFL classroom environments often draw upon Second Language Acquisition (SLA) theories, such as Krashen's Input Hypothesis and Swain's Output Hypothesis, which are frequently cited in the literature. Although classroom environment is widely acknowledged as a vital component of language learning, it has rarely been examined as an independent research focus. Instead, it is commonly treated as a contextual factor that interacts with primary topics like willingness to communicate (WTC), motivation, and academic achievement. While this perspective has provided valuable insights into its role, the fundamental definition, structure, and autonomous mechanisms of classroom environments remain underexplored.

To bridge this gap, future research should position classroom environment as a primary area of investigation. Such studies could focus on its multifaceted nature, analyzing how various dimensions—such as physical, social, emotional, and digital factors—individually contribute to language learning. Incorporating interdisciplinary frameworks like Complexity Theory could further enhance our understanding by conceptualizing classroom environments as dynamic systems that shape learners' behaviors and outcomes across different contexts and over time. This shift in focus would promote a more comprehensive perspective on classroom environments, moving beyond simple correlations to uncover their underlying mechanisms and broader impacts.

3.2 Research Topics

Current research has primarily focused on the relationship between classroom environment and outcomes such as academic performance, WTC, emotional well-being, and language proficiency. However, much of the research has concentrated on surface-level correlations without thoroughly investigating the underlying mechanisms. For example, how do different dimensions of classroom environment (e.g., teacher support, student cohesion) interact to impact learning outcomes? This aspect remains underexplored, highlighting the need for future studies to investigate specific areas that address these gaps.

3.2.1 Mechanisms of classroom environment formation

Future studies should delve deeper into how the physical, social, and emotional dimensions of classroom environments interact to shape learning outcomes. Rather than viewing the classroom environment as a static backdrop, it should be approached as a dynamic system influenced by multiple factors. Research could examine the combined effects of teacher support, classroom atmosphere, student collaboration, and task design on student engagement and performance. These findings could offer practical guidance on optimizing teaching methods and fostering effective learning environments for language acquisition.

3.2.2 Integration of classroom environment and technology

As technology continues to transform education, the integration of digital tools into classroom environments has gained increasing attention. Future research could investigate how elements such as blended learning models, multimedia platforms, and online collaborative tools impact classroom interactions, student motivation, and language learning outcomes. By examining the role of these technologies in shaping classroom dynamics, researchers can provide strategies to enhance engagement and adapt classroom environments to meet the demands of modern learners.

3.2.3 Impact of different classroom tasks on the environment

The relationship between classroom tasks and the environment merits further exploration. Tasks such as listening exercises, speaking activities, writing assignments, and group discussions may elicit distinct emotional responses and levels of participation from students. Research could analyze how these tasks interact with classroom environments to influence student engagement and language production. By identifying these patterns, educators can design tasks and strategies tailored to optimize student outcomes in specific learning scenarios.

3.2.4 The influence of learner proficiency

Classroom environments may be perceived and experienced differently by learners with varying levels of proficiency. Future research should focus on how students at different stages of language development respond to diverse classroom settings. This work could inform the creation of personalized classroom environments that address the unique needs of learners at various proficiency levels, thereby supporting language growth across a broad spectrum of abilities.

3.2.5 Diversity in online learning environments

The growing prominence of online learning calls for a closer look at how digital classroom environments function. Research could explore diverse formats, such as MOOCs, interactive video lessons, and live-stream classes, and their impact on physical, social, and emotional aspects of learning. For instance, MOOCs often offer independent learning opportunities with minimal interaction, while live-stream lessons provide real-time engagement. Investigating how

these formats influence student motivation and learning outcomes could yield valuable insights for optimizing online education.

3.2.6 The role of native language similarity to English

The relationship between a learner's native language and English plays a crucial role in language acquisition. Languages with structural or lexical similarities to English, such as French or Spanish, may facilitate learning more easily than linguistically distant languages like Chinese or Arabic. Future research could examine how these differences affect learners' participation, motivation, and emotional engagement in the classroom. Such findings could help educators design more inclusive classroom strategies that address the needs of students from diverse linguistic backgrounds.

3.3 Research Context

Existing studies on classroom environment primarily focus on learners from China and English-language learning environments, but there is limited attention to other language and cultural contexts. Additionally, most studies concentrate on university-level students, with relatively little research involving learners from other educational stages such as primary or vocational education. Furthermore, many studies lack standardized descriptions of participants' language proficiency levels, which limits the generalizability of their findings. Future research should consider broadening the geographical and linguistic scope.

3.3.1 Expanding research regions

Future studies should move beyond a focus on learners in China and include participants from a broader range of countries, particularly those involved in the "Belt and Road" initiative. Including diverse linguistic and cultural backgrounds would enable meaningful cross-cultural comparisons and deepen our understanding of how classroom environments differ across various contexts.

3.3.2 Exploring the influence of native language similarity

The influence of learners' native language on second language acquisition deserves further exploration. Future research could investigate how similarities between native languages and English affect learning processes and outcomes. Additionally, studies could analyze the impact of using learners' native language in the classroom, particularly for students from different linguistic backgrounds to better tailor teaching strategies.

3.3.3 Addressing learner's language proficiency

The role of classroom environment in shaping language acquisition may vary depending on learners' language proficiency. Future research should focus on how different aspects of the environment influence beginners and advanced learners. This includes examining emotional responses, participation, and learning behaviors, which may differ significantly across proficiency levels.

3.3.4 Broadening Educational Levels

Most existing studies concentrate on university students, leaving gaps in our understanding of other educational settings. Future research should investigate learners in primary, secondary, and vocational education to examine how classroom environments function in different contexts and among learners of various age groups. This would provide a more comprehensive view of how classroom environments support language learning across the educational spectrum.

3.4 Research Methods

Currently, research on EFL classroom environments mostly relies on quantitative methods, particularly cross-sectional studies. Although these studies provide valuable insights, they often fail to capture the evolving nature of classroom environments and their long-term impact on students' learning processes. Future research can benefit from several improvements.

3.4.1 Increasing the use of experimental studies

Experimental studies offer a valuable approach to uncovering causal relationships between classroom environments and learning outcomes. By providing concrete evidence, such research can inform strategies for optimizing both teaching methods and classroom settings to better support student learning.

3.4.2 Strengthening longitudinal research

Longitudinal research is crucial for examining how classroom environments evolve over time and how these changes influence students' language acquisition and learning behaviors. Such studies can also shed light on the sustained impact of classroom environments on learners' academic performance and overall development.

3.4.3 Diversifying research tools

Future studies should adopt diverse and innovative research tools to capture real-time data and improve ecological validity. Methods like experience sampling, eye-tracking, and biofeedback can offer deeper insights into the interplay between classroom environments and students' emotions, behaviors, and learning experiences. These approaches would enable researchers to gain a more comprehensive understanding of how environmental factors shape learning processes.

4 CONCLUSION

This literature review has examined research on English as a Foreign Language (EFL) classroom environments, focusing on both their historical development and potential future directions. The discussion began with an overview of classroom environment research, highlighting its importance in second language acquisition (SLA). Subsequent

sections explored definitions and theoretical underpinnings of classroom environment, summarizing key studies across various methodological approaches and cultural contexts. The review also investigated how classroom environments influence student outcomes, emphasizing the dynamic and evolving nature of this research area. Lastly, attention was given to emerging themes in EFL classroom environment studies, such as the role of technology, task-based learning, and the effects of learner proficiency and native language backgrounds.

To conclude, while significant progress has been made in understanding the role of classroom environment in SLA, many areas remain underexplored. Future studies should give greater attention to classroom environment as a central research theme, delving into its interactions with individual learner factors and integrating the potential of new technologies. Moreover, there is a need to expand the scope of research beyond traditional classroom settings, incorporating online learning environments, digital platforms, and multimodal approaches. Such efforts will better reflect the evolving nature of education and provide deeper insights into how classroom environments shape learners' motivation, engagement, and language acquisition outcomes across diverse learning contexts.

COMPETING INTERESTS

The authors have no relevant financial or non-financial interests to disclose.

FUNDING

This research is supported and funded by 2023 Undergraduate research project of Xi'an International Studies University, with the theme of "The Predictive Role of Boredom, Classroom Environment, and Grit in Academic Achievements of English Majors in China".

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Educational Research and Human Development
ISSN: 3007-6943
DOI: https://doi.org/10.61784/erhd3016

AN ANALYSIS OF FACTORS AFFECTING STUDENTS' PERFORMANCE IN MATHEMATICS IN A SECONDARY SCHOOL BASED ON QUANTILE REGRESSION

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Abstract: The study of factors affecting secondary school students' performance is an important topic for educators, especially at a time when the state pays special attention to education reform. This paper uses quantile regression to explore in detail how the relevant indicators affecting secondary school students' performance affect students' performance and the degree and direction of influence at each quartile, in order to provide relevant educators as a reference for decision-making on education reform. The results of the study show that weekly study time is significantly underestimated by OLS in the lower quartiles, which means that only about 2 hours of study time per week can improve academic performance; extracurricular activities are also significantly underestimated by OLS in the higher quartiles, which means that increasing the number of extracurricular activities can improve academic performance.
Keywords: Math achievement; Influencing factors; Quantile regression

1 INTRODUCTION

Secondary school students' performance in mathematics is very important. Mathematics is not only a key subject to bridge the gap at the secondary school level, but also directly affects students' overall performance and future development. First of all, math plays a crucial role in middle school. It is not only the foundation of natural science, but also exercises students' logical thinking and problem-solving skills. With the gradual deepening of learning content, from basic algebra and geometry to complex equations and functions, math requires students to have an active mind and the ability to continue learning. Good or bad performance in mathematics often intuitively reflects the ability of students in continuous learning. Students with strong thinking ability can not only achieve excellent results in mathematics, but also transfer this ability to other subjects. Second, the gap in math scores is especially pronounced in the midterm exams. Good or bad math scores have a direct impact on whether students can enter a good high school, because math scores can easily widen the score gap. Excellent math scores can lead to high scores in the midterm, while students who do not do well may fail. Therefore, good or bad math scores are crucial for performance in the secondary school exam. This paper adopts the data related to students' mathematics course performance in a secondary school to study and understand which important indicators affect the semester grades of the students in this school, in order to provide relevant educators in China as a reference for teaching reform.

In the literature related to the study of secondary school students' performance in mathematics，Luo Qiang and Yu Feifei conducted a study on the academic quality monitoring data of junior high school students in S city, and the results of the study showed that boys had a more obvious academic advantage in difficult topics; the math scores of girls in the low subgroups were significantly higher than those of boys, and the math scores of girls in the middle and high subgroups were significantly lower than those of boys[1]. Yue Qiming studied the core journals with the theme of "education informatization" in China since 2018, using China Knowledge Network (CNKI) as the data source. The analysis shows that the reform of teaching mode, information technology and big data to promote the development of school education to personalization and intelligence is the focus of the current research on education informatization; accelerating the construction of information infrastructure projects, optimizing high-quality digital educational resources, and the in-depth fusion of information technology and education and teaching are the key directions of China's education informatization[2]. Fan Shuyuan and Xiong Yonghong conducted a study on the characteristics of the teaching mode of experimental courses, and the results of the study showed that due to the application of teaching forums, a learning group was formed in the virtual environment with the experimental project as the topic, which facilitated the communication between teachers and students, cultivated the students' interest in learning, and also brought teachers and students closer to each other and to each other[3]. Li Wan analyzed the needs and problems of mathematical modeling teaching based on the concept of "1+X" and showed that it is recommended that mathematical modeling teaching in colleges and universities should be closely linked with professional courses, introduce real cases, strengthen mathematical modeling competitions and practice sessions; adopt flipped classroom and blended teaching, strengthen group cooperation and project-based teaching; and adopt the concept of "1+X" and the concept of "1+X" in mathematical modeling teaching. The use of flipped classroom and blended teaching, strengthening group cooperation and project-based teaching; focusing on the combination of process evaluation and result evaluation, and paying attention to the evaluation of students' ability and innovation quality[4]. Deng Wenxin et al. conducted a study on the research characteristics of China's vocational education informatization in the past 10 years, which showed that under the new situation of the development of the times, digitalization and intelligence of education may become a new

research hotspot; the development of the research needs to strengthen the cooperation of researchers with each other, and to continuously innovate the design of the research and research methodology[5]. Liu Yong conducted a research on the educational teaching evaluation system based on artificial intelligence technology through the development and application of artificial intelligence technology, and the research shows that it provides relevant content references for the innovative application and practical exploration of artificial intelligence technology in higher education teaching evaluation[6]. Bie Dunrong conducted a study on the new major variables that promote the development of university education and teaching, and the study shows that in the face of the opportunities and challenges arising from the application of AI technology in university education and teaching, teachers should actively learn and master AI education technology to develop education and teaching methods that cultivate students' higher-order abilities and qualities; students should actively learn AI education technology to obtain targeted services and assistance and realize their own personalized learning. Students should actively learn AI education technology to get targeted services and help to realize their own personalized learning[7]. Kang Yueyuan, Zhang Junhong and Song Chunli studied the hotspots and future development trends of international mathematics education research in the context of the era of digital intelligence, which showed that evidence-based research in mathematics education focuses on evidence-based research in mathematics education, wisdom focuses on the development of intelligent teaching and learning ecosystems, ubiquity demonstrates the extensive use of digital intelligence in mathematics education, and ethics emphasizes the ethical principles that must be taken into account in the application of digital intelligence technologies. Ethical principles that must be emphasized[8]. Li Tieying and Wang Yunfeng conducted a study on the process of promoting the integration of Civics and Political Science courses in universities, secondary schools and elementary school, which showed that there are problems in the construction of teaching resource libraries, and efforts should be made to promote the integration of teaching resources in Civics and Political Science courses in universities, secondary schools and elementary school in the aspects of strengthening the top-level design, developing high-quality teaching resources, strengthening the efforts of joint construction and sharing, and creating a group of excellent construction teams[9]. Song Qijie for the study to tourism secondary vocational education teaching reform as a starting point, from the curriculum construction, talent supply, teacher construction, teaching resources construction four aspects of the study, the study shows that the digital transformation background of digital transformation of secondary vocational school tourism professional digital transformation path; so that secondary vocational education and the new period of social development synchronization, to help China's new era of talent supply system[10].

In summary, domestic scholars for education students domain knowledge this paper is based on a specific environmental context as a comprehensive indicator of data analysis, while the evaluation results to do input redundancy and output insufficiency analysis, for the development of theoretical and practical basis.

2 RESEARCH METHODOLOGY AND SELECTION OF INDICATORS

2.1 Quantile Regression Model

Quantile regression (English: Quantile regression) is a modeling method for estimating the linear relationship between a set of regression variables, X, and the quantiles of the explanatory variables, Y. It is one of the methods of regression analysis, which was originally proposed by Koenker Roger and Bassett Gilber5t Jr in 1978.

The survey included: basic information (gender, age, parents' education level, etc.), time from home to school, weekly study time, presence or absence of extracurricular activities, desire for higher education, quality of family relationships, free time after school, number of absences, and semester grades. The higher the value of time from home to school, weekly study time, quality of family relationships, free time after school, and semester grades, the higher the level, the presence of extracurricular activities is assigned according to the length of time, and the desire for higher education is assigned according to the student's personal wishes.

In this paper, we take three tertiles of q25, q50, and q75 to perform quantile regression analysis for independent variable X, and dependent variable Y. $P < 0.05$ was taken as significant.

2.2 Indicator System and Data on Indicators

Table 1 Indicators Related to the Mathematics Curriculum of Students in a Secondary School

variant	assign a value to something
sex - sex of the student	F=Female, M=Male
age - age of the student	15-22 years
Medu-Mother's Education	0=None, 1=Primary education (grade 4), 2=Grades 5-9, 3=Secondary education, 4=Higher education
Fedu-Father's Education	0=None, 1=Primary education (grade 4), 2=Grades 5-9, 3=Secondary education, 4=Higher education
traveltime - time from home to school	1 = <15 minutes, 2 = 15-30 minutes, 3 = 30 minutes - 1 hour, 4 = >1 hour
studytime - weekly study time	1= <2 hours, 2=2-5 hours, 3=5-10 hours, 4=>10 hours
activities - extracurricular activities	Yes or No
Higher - want to receive higher education	Yes or No

Famrel - quality of family relations	1=very poor, 2=poor, 3=fair, 4=good, 5=very good
freetime-after school free time	1=very little, 2=somewhat little, 3=no more, no less, 4=somewhat more, 5=very much
Absences -- number of absences	From 0-93
G2 - Semester grades	From 0-20

3 Empirical Research

3.1 Normal Distribution Tests for Explained Variables

In this paper, the first test of normal distribution of the explanatory variables (Y) is conducted by using two commands in stata (sktest and swilk), for the explanatory variables. The hypothesis of the test is that H0 is that the explanatory variables conform to normal distribution; H1 is that the explanatory variables do not conform to normal distribution. A test result of less than 0.05 means that H0 is rejected, which means that the explanatory variables do not conform to normal distribution. From the analysis results, it is found that the swilk test result is 0.00001, which is significantly less than 0.05, so the explanatory variables do not conform to normal distribution. Then from the test results of sktest observed p-value of 0.0003, also significantly less than 0.05, the explanatory variables also do not conform to the normal distribution, so this paper performs quantile regression analysis to estimate this non-normally distributed sample data.

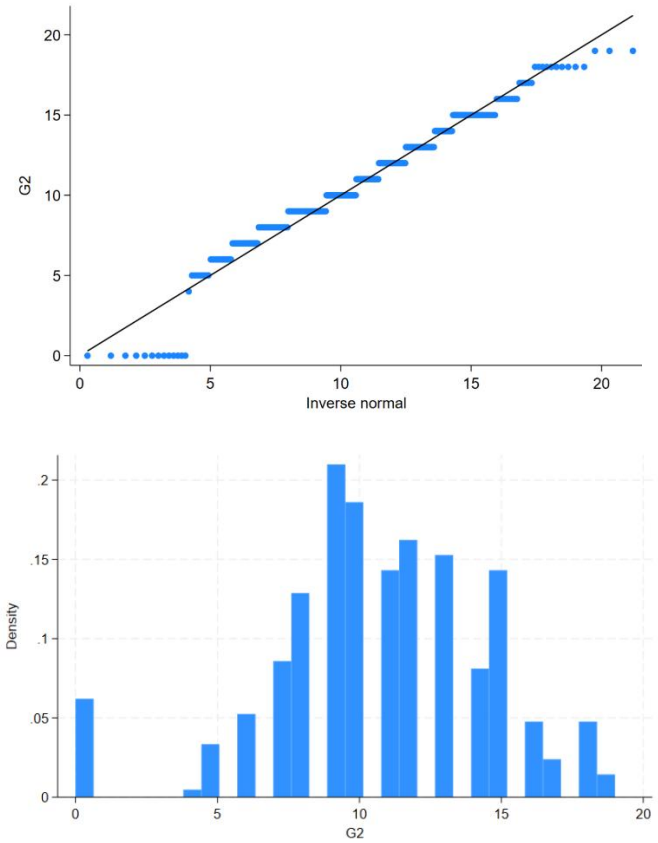

Figure 1 Graphical Test of Normal Distribution of Explanatory Variables

And then by the normal distribution of the explanatory variables graphical observation, Figure 1 in the upper graph of the blue points closer to the diagonal represents the sample closer to the normal distribution, as seen by the blue points in the figure in the left and right sides of the points are not on the diagonal, so it is clear that the variable final grades are clearly not normally distributed. In addition, the histogram data in the lower panel of Figure 1 is also clearly skewed to the right, and there are many samples that are skewed to the far left, which is clearly not a normal distribution pattern, so once again, it can be demonstrated that the final grades of the variable clearly do not follow a normal distribution, so we must perform quantile regression analysis to explore the characteristics of these outliers.

3.2 Quantile Regression Analysis

Table 2 Interquartile Coefficient Test for Final Grades

mould	OLS			0.25 quartile			0.50 quartile			0.75 quartile		
variant	ratio	T-value	statistically	ratio	T-value	statistically	ratio	T-value	statistically	ratio	T-value	statistically

			significant			significant			significant			significant
sex	-1.02	-2.31	**	-0.96	-1.6	-	-1.20	-2.07	**	-0.72	-1.27	-
age	-0.16	-0.90	-	-0.00	-0.01	-	-0.18	-0.96	-	-0.23	-0.80	-
medu	0.39	1.57	-	0.12	0.38	-	0.17	0.47	-	0.68	2.00	**
fedu	0.04	0.16	-	0.30	1.02	-	0.09	0.23	-	-0.00	-0.01	-
traveltime	-0.69	-2.21	**	-0.16	-0.33	-	-0.64	-1.92	*	-0.64	-1.34	-
studytime	0.46	1.79	*	0.59	1.65	**	0.22	0.72	-	0.46	1.24	-
activities	-0.01	-0.02	-	-0.31	-0.59	-	0.17	0.33	-	0.09	0.18	-
higher	2.84	-2.86	***	1.82	-1.01	-	2.43	-2.02	**	2.72	-2.2	**
internet	-0.24	-0.40	-	0.04	0.04	-	-0.25	-0.37	-	-0.30	-0.39	-
famrel	-0.08	-0.35	-	0.28	0.94	-	-0.15	-0.49	-	0.02	0.09	-
freetime	-0.10	-0.47	-	-0.25	-0.87	-	-0.06	-0.21	-	-0.06	-0.21	-
absences	0.01	0.19	-	0.00	0.07	-	0.00	0.02	-	-0.03	-0.96	-
Pseudo R^2	0.0711			0.0854			0.0664			0.0710		

Note: One * indicates a p-value of less than 0.1; two * indicates a p-value of less than 0.05; and three * indicates a p-value of less than 0.01.

Gender (sex) was found to be significant with a p-value of less than 0.05 when analyzed by os, but it was not clear at which quartile it was significant, but from the quantile results we know that it was significant at the 0.5 quartile. From Figure 2 and Table 2, it is found that the more skewed females are, the higher the scores are, probably because females generally mature earlier and are more able to be still to accomplish their goals, whereas males may be more active and are more likely to divert their time to other activities such as sports.

Mother's education (medu) is found to be insignificant when analyzed by os, with a p-value greater than 0.1, but under quantile regression we find it to be significant at 0.75, and thus it would be implausible to estimate it using general os. In our study we found no significant direct effect of mother's education on scores, and indirect effects are not explored in depth in this paper.

The traveltime from home to school is found to be significant when analyzed by los with a p-value of less than 0.05, but it is not clear at which quartile it is significant, from the quantile results we know that it is significant at the 0.5 quartile. The time from home to school is clearly negatively significant, the longer the time to school the higher the grades, it could be that the parents expect the students to go to a better school and therefore it will show in the grades.

Weekly study time (STUDYTIME) is found to be significant if analyzed by ols with a p-value of less than 0.05, but it is not clear at which quartile it is significant, but by the quartile results we know that it is significant at the 0.25 quartile. The reason for this is that the students want to learn more so they will spend more time exploring the study.

The factor of wanting higher education (higher) is found to be significant when analyzed by os, but the significance varies at different quartiles, as can be seen in Table 2, the factor of enjoyment of higher education is not significant at the 0.25 quartile in affecting final grades, but it is indeed significant at the 0.5 and 0.75 quartiles. The coefficients of 2.43 at 0.5 and 2.72 at 0.75 are higher than the other variables, so the effect on the grades is very significant. The probable reason for this is that the students want to pursue higher education in the future and therefore will work harder in their studies.

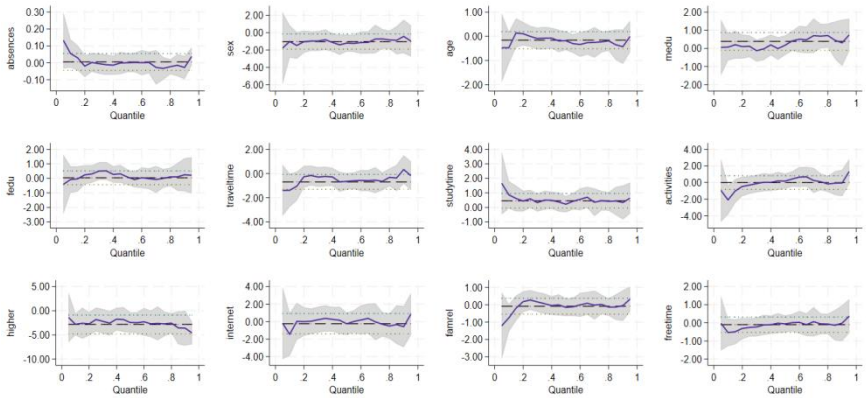

Figure 2 Regression analysis of student course quartiles in a secondary school

As can be seen in Figure 2，The amount of change in the number of absences is scored based on the number of absences, a low number of absences results in a high score, and a high number of absences results in a low score; a high number of absences directly affects a student's overall performance and future development. From the figure, it can be seen that in the case of low scores if the least square regression model is used to estimate the phenomenon of underestimation, the number of absences in the case of low scores significantly affects the overall performance of the students. Therefore students need to be aware of the number of absences so that it does not affect the overall performance of the students. The amount of variation in the distance from home to school data is based on the length of time scoring, the shorter the time, the lower the score, the longer the time, the higher the score; the longer the time the higher the score is because the school's quality of teaching and educational resources are better, the longer the distance students travel to school scores, the more the score is added to be considered a kind of incentive. The variable of extracurricular activities is based on the length of time of extracurricular activities, the longer the time of extracurricular activities, the more points, and the shorter the time, the less points. Extracurricular activities can contribute to the overall development of students. The variable of weekly study time is based on the data of weekly study time over a period of time (e.g., one month), as well as various factors that may affect study time. The study environment was found to have a significant effect on study time, and could be improved to enhance study efficiency. The variable of free time after school needs to be analyzed based on our need to clarify the nature of this variable and the question we want to explore. Free time after school is usually a continuous variable that indicates the period of time after school when students do not have scheduled activities or tasks, such as the amount of homework, participation in extracurricular activities, and the home environment. The greater the amount of homework, the less free time students have after school or the less free time students involved in extracurricular activities have after school.

4 CONCLUSION OF THE STUDY AND RECOMMENDATIONS FOR COUNTERMEASURES

In this paper, we use a combination of OLS and quantile regression to comparatively analyze the extent to which the factors affecting final grades of students receiving secondary education affect final grades and whether they are significant or not at different quartiles. The results of the analysis lead to the following conclusions: First, the variable of wanting to receive higher education significantly affects final grades, so students can be encouraged to aim for higher education in the future, which can improve their academic performance. Secondly, commuting time is also an important factor that affects the final grade, which depends on the parents' expectations of the students, so it is important for the teacher to communicate with the parents. Thirdly, the number of absences is also an obvious factor that affects students' academic performance, so teachers should strictly manage attendance in the classroom in order to improve students' academic performance. Fourthly, the gender factor shows that more female students have higher scores, which is due to the fact that male students have more activities that cause them to miss their homework. Therefore, the classroom teacher should plan the number of extracurricular activities or the time of the activities reasonably.

COMPETING INTERESTS

The authors have no relevant financial or non-financial interests to disclose.

FUNDING

This study was supported by the Guangzhou Huashang College "Elderly Care Service Supply chain Service Quality and improvement path Research of Guangzhou" (2021HSQX11).

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Educational Research and Human Development
ISSN: 3007-6943
DOI: https://doi.org/10.61784/erhd3010

ASSESSMENT OF RESPECTFUL CONDUCT IN SCHOOL CULTURE MANAGEMENT PRACTICES FOR IMPROVED ACADEMIC PERFORMANCE IN RURAL PUBLIC SECONDARY SCHOOLS IN RIVERS SOUTH-EAST SENATORIAL DISTRICT

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Abstract: This study assessed the role of respectful conduct in school culture management practices aimed at enhancing academic performance in rural public secondary schools in Rivers South-East Senatorial District. The research focused on the effects of collaborative dialogue, conflict resolution, and student community involvement on academic outcomes. Employing a descriptive survey design, the study sampled 400 participants from a total of 986 staff members using Taro Yamane sample size determination. Data was collected using the validated Respectful Conduct in School Culture Management Practices Questionnaire (RCSCMPQ), achieving a return rate of 70.75%. Analysis of the data was conducted using descriptive statistics of mean and standard deviation. The findings indicated notable deficiencies in teacher engagement and feedback mechanisms related to collaborative dialogue, while participants expressed favourable opinions on conflict resolution strategies. Furthermore, although community service initiatives elicited varied responses among participants, the overall consensus acknowledged their positive impact. It was concluded that implementing targeted respectful conduct strategies aimed at improving collaboration, resolving conflicts, and encouraging community engagement is central to school culture management practices for improved academic performance in the rural public secondary schools. Recommendations include developing structured communication initiatives, providing conflict resolution training, and fostering community partnerships.
Keywords: Respectful conduct; School culture, Management practices; Rural public secondary schools

1 BACKGROUND TO THE STUDY

Enhancing performance in rural public secondary schools is intricately connected to the concept of school culture management, which serves as a critical administrative task. School culture serves as a critical administrative task because it encompasses the beliefs, values, and practices shared within educational institutions that shape student behaviour and learning outcomes [1]. Key indices of effective school culture management include communication dynamics, behavioural norms, and a sense of belonging among students and staff [2].

Public secondary schools operate as the backbone for education in many communities of developing countries, providing essential opportunities for young people to acquire knowledge and middle level manpower skills crucial for personal and societal advancement. These schools reflect the diverse cultural, social, and economic fabric of their communities and play a vital role in preparing students for higher education, vocational training, and informed citizenship. In the context of the Rivers South-East Senatorial District, characterized by diverse rural settlements, effective management of school culture becomes imperative for fostering a conducive learning environment. The rural setting of this district requires a unique approach to managing school culture, emphasizing respectful conduct that impacts the academic environment. Respect fosters positive relationships and is essential for an inclusive educational culture. Promoting respect enhances interactions between students and teachers, contributing to a conducive learning climate [3]. However, rural teachers often struggle with disrespectful behaviours that disrupt learning and hinder effective teaching [4,5]. Such challenges can damage teacher-student relationships, leading to disengagement, poor academic performance, and high staff turnover. Overall, a disrespectful culture undermines educational success.

2 STATEMENT OF THE PROBLEM

The educational system in developing countries, particularly in rural public secondary schools, faces immense challenges that are critical for national growth. Promoting respectful behaviour is vital for enhancing student conduct and learning outcomes. However, many teachers and administrators encounter ongoing issues with disrespectful behaviour that disrupts the school environment. This lack of respect damages relationships among students and further deteriorates the school culture, negatively affecting communication, engagement, and academic performance, while also contributing to high

teacher turnover. Hence, this study underscores the significance of respectful behaviour in improving academic success and student-teacher relationships, addressing the gap in empirical research on respectful conduct in school culture management practices in rural public secondary schools in developing countries like Nigeria.

3 AIM AND OBJECTIVES OF THE STUDY

This study was aimed on assessment of respectful conduct in school culture management practices for improved academic performance in rural public secondary schools in Rivers South-East Senatorial District. Specifically, the study sought to:
1. Ascertain the impact of collaborative dialogue in school culture management practices on academic performance in rural public secondary schools in Rivers South-East Senatorial District.
2. Determine the effect of conflict resolution in school culture management practices on academic performance in rural public secondary schools in Rivers South-East Senatorial District.
3. Analyze the contribution of students' community involvement in school culture management practices to academic performance in rural public secondary schools in Rivers South-East Senatorial District.

4 RESEARCH QUESTIONS

1. What is the impact of collaborative dialogue in school culture management practices on academic performance in rural public secondary schools in Rivers South-East Senatorial District?
2. What is the effect of conflict resolution in school culture management practices on academic performance in rural public secondary schools in the Rivers South-East Senatorial District?
3. What is the contribution of students' community involvement in school culture management practices to academic performance in rural public secondary schools in the Rivers South-East Senatorial District?

4.1 Hypotheses

The following three (3) null hypotheses were tested at 0.05 alpha level.
1. There is no significant difference in mean scores between the teachers and school administrators' opinion regarding the impact of collaborative dialogue in school culture management practices on academic performance in rural public secondary schools in Rivers South-East Senatorial District.
2. There is no significant difference in mean scores between the teachers and school administrators' opinion regarding the effect of conflict resolution in school culture management practices on academic performance in rural public secondary schools in the Rivers South-East Senatorial District.
3. There is no significant difference in mean scores between the teachers and school administrators' opinion regarding the contribution of students' community involvement in school culture management practices to academic performance in rural public secondary schools in the Rivers South-East Senatorial District.

4.2 Conceptual Framework

The study's framework focuses on respectful conduct in school culture management practices for improved academic performance in rural public secondary schools in Rivers South-East Senatorial District as illustrated in Figure 1 below.

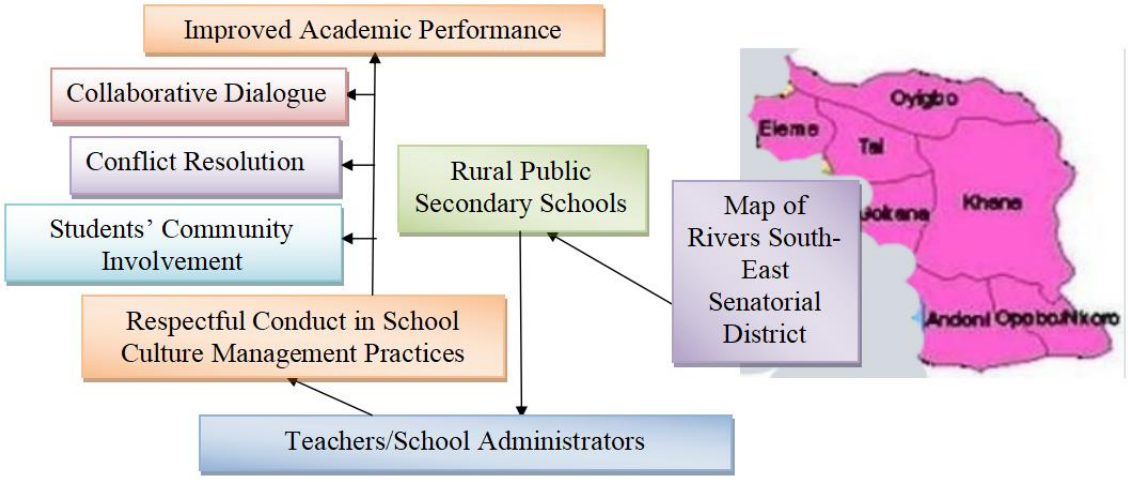

Figure 1 Conceptual Framework Showing the Relationship between Variables
Source: Researchers' conceptualization (2024).

4.3 Literature Review

Respectful conduct within the school culture is essential for boosting academic performance in the rural public secondary schools of Rivers South-East Senatorial District, which includes Tai, Oyigbo, Gokana, Eleme, Khana, Andoni, and Opobo-Nkoro. Saryanto et al. and Cardona et al. affirm that respectful behaviour is a cornerstone of positive school culture and is closely linked to academic success[6,7]. Ukoima et al. and Edet et al. emphasize that a positive school climate is crucial for academic achievement[8,9], echoing Griffiths et al.[10]. Hennessy et al. note the importance of effective teacher-student dialogue in nurturing this climate[11], a perspective that resonates with Idenyenmhin and Chandrasekaram [3,12]. Idenyenmhin highlights that managing school culture in rural areas is pivotal for educational outcomes through respectful interactions[12]. Mette and Chandrasekaram [3,13] align respect promotion with academic success. Cleveland et al. argue that fostering a positive school culture is vital for student performance[2], especially in resource-constrained environments, focusing on equity and respect to tackle academic disparities. Enwereuzor et al. advocate that respectful engagement boosts tacit knowledge sharing, essential for conflict resolution[14]. Agi outlines that teachers and principals play a crucial role in establishing a respectful culture that enhances student involvement[15]. Olatunji stresses that respectful conduct among educators and students are foundational for a collaborative learning environment[1]. Effiom et al. address the importance of managing aggressive behaviours[16], with Sewell and Brown and Danaher promoting respectful classroom dialogue[17,18]. Calling upon Adeyeye's recommendations for addressing indiscipline[4], Asanebi and Okafor highlight that peace education is vital for respectful communication[19]. This goes in line with Cress et al. who illustrate how community service relates to respect for diverse cultures[20], while Dewantara et al. connect community engagement to academic improvement[21]. The wisdom of this proverb resonates here: "If you want to go fast, go alone. If you want to go far, go together." Amesi and Egop demonstrate that community service enhances social awareness[22], positively impacting academic performance, corroborated by Ntaah and Adolphus [23] and Villa and Knutas [24], who advocate for valuing local culture. Effective communication underpins managing school culture [25], contributing to conflict resolution [26,27]. Nouah et al. highlight community service's role in nurturing empathy[5], while Amie-Ogan and Epelle connect human resource management to educational success[28]. Hendry advocates restorative practices for fostering respectful relationships[29], a notion echoed by Nwisane [30], who warns of the negative effects of political interference on educational leadership. Iksal et al. stress the importance of character education in promoting respectful behaviour[31], with Eden et al. arguing that cultural competence enhances respect for diverse viewpoints[32].

4.4 Theoretical Framework

Durlak's Social-Emotional Learning (SEL) Theory, developed by Joseph Durlak in the 2010s, posits that enhancing students' social and emotional skills significantly improves their academic performance and overall well-being. This theory emphasizes the importance of collaborative dialogue, conflict resolution, and community involvement in fostering a positive school culture. By integrating these elements into school management practices, rural public secondary schools in Rivers South-East can create an environment that promotes respectful conduct.

5 METHODOLOGY

This research adopted a descriptive survey design, focusing on a population of 68 school administrators and 918 teachers, which totals 986 staff members. The sample size was determined using the Taro Yamane formula, resulting in a total of 400 participants. A two-stage sampling technique was employed, incorporating both stratified and disproportionate sampling methods. Thus, the sample consisted of 68 secondary school administrators and 332 teachers from rural areas across the six Local Government Areas (LGAs) of the Rivers South-East Senatorial District. Data collection was conducted using a self-structured instrument known as the Respectful Conduct in School Culture Management Practices Questionnaire (RCSCMPQ). This questionnaire underwent rigorous face and content validation by three experts. It comprised fifteen items divided into three sections, with responses measured on a four-point Likert scale: Strongly Agree (SA), Agree (A), Disagree (D), and Strongly Disagree (SD), assigned weighted values of 4, 3, 2, and 1, respectively. The reliability of the RCSCMPQ was confirmed with a Cronbach Alpha coefficient of 0.78. Out of the distributed copies of questionnaire, 283 copies were completed and returned—61 from school administrators (61/68 x 100 = 89.71% return rate) and 122 from teachers (122/332 x 100 = 36.75% return rate), resulting in an overall return rate of 70.75% (283/400 x 100). The study addressed the research questions using mean and standard deviation, while hypotheses were tested through z-tests.

6 RESULTS

6.1 Answer to Research Questions

Research Question 1: What is the impact of collaborative dialogue in school culture management practices on academic performance in rural public secondary schools in Rivers South-East Senatorial District?

Table 1 Mean and Standard Deviation Scores on the Impact of Collaborative Dialogue in School Culture Management Practices on Academic Performance in Rural Public Secondary Schools in Rivers South-East Senatorial District

S/N	Test Items- Collaborative Dialogue.	Principals (N = 61)		Teachers (N = 122)		Mean Set (xx)	Remarks
		$\bar{x}$	sd	$\bar{x}$	sd		
1.	Opportunities for joint teacher-student discussions on academic improvement are adequate in my school.	2.43	0.56	2.48	0.58	2.46	Disagreed
2.	The school culture promotes open dialogue, but not everyone feels comfortable participating.	2.61	0.62	2.57	0.60	2.59	Agreed
3.	My school administration actively seeks feedback from students during school meetings.	2.55	0.60	2.38	0.54	2.47	Disagreed
4.	There is a noticeable lack of engagement among teachers when it comes to sharing ideas with students.	2.54	0.59	2.69	0.64	2.62	Agreed
5	In my experience, concerns raised during discussions are regularly considered and acted upon by the school administration.	2.80	0.67	2.52	0.59	2.66	Agreed
	Cluster Mean/SD	**2.59**	**0.62**	**2.53**	**0.59**	**2.56**	**Agreed**

Criterion mean score = 2.5

Results in Table 1 present the mean and standard deviation scores on the impact of collaborative dialogue in school culture management practices on academic performance in rural public secondary schools in Rivers South-East Senatorial District. The cluster mean score for principals is 2.59 with a standard deviation of 0.62, while the cluster mean score for teachers is 2.53 with a standard deviation of 0.59, indicating a general agreement regarding the perceived impact of collaborative dialogue on school culture. The overall cluster mean score of 2.56 exceeds the criterion mean score of 2.5, suggesting a significant extent of agreement between the groups regarding the impact of collaborative dialogue in enhancing school culture and academic performance. While the majority of specific items evaluated fall under the "agreed" category, they also highlight areas of concern. Specific items such as the adequacy of opportunities for joint teacher-student discussions and the active engagement of school administration in seeking student feedback received disagreement, indicating a perceived insufficiency in these aspects of collaborative dialogue practices. However, there is a general acknowledgment that concerns raised during discussions are regularly considered by the school administration, suggesting a level of responsiveness to student input.

Research Question 2: What is the effect of conflict resolution in school culture management practices on academic performance in rural public secondary schools in Rivers South-East Senatorial District?

Table 2 Mean and Standard Deviation Scores on the Effect of Conflict Resolution in School Culture Management Practices on Academic Performance in Rural Public Secondary Schools in Rivers South-East Senatorial District

S/N	Test Items- Conflict Resolution.	Principals (N = 61)		Teachers (N = 122)		Mean Set (xx)	Remarks
		$\bar{x}$	sd	$\bar{x}$	sd		
6.	The conflict resolution strategies used by teachers in my school help in maintaining a positive school culture.	2.65	0.63	2.70	0.64	2.68	Agreed
7.	Conflicts among staff members often disrupt the learning environment in my school.	2.46	0.57	2.51	0.58	2.49	Disagreed
8.	When conflicts are resolved effectively, I notice an improvement in overall student engagement and academic motivation.	3.03	0.74	2.88	0.70	3.00	Agreed
9.	The current conflict resolution practices in my school promote a culture of respect and understanding.	2.71	0.65	2.70	0.64	2.71	Agreed
10	Students feel comfortable bringing their concerns and conflicts to the attention of school authorities.	2.48	0.58	2.45	0.57	2.47	Disagreed
	Cluster Mean/SD	**2.67**	**0.63**	**2.65**	**0.63**	**2.67**	**Agreed**

Criterion mean score = 2.5

Results in Table 2 present the mean and standard deviation scores on the effect of conflict resolution in school culture management practices on academic performance in rural public secondary schools in Rivers South-East Senatorial District. The cluster mean score for principals is 2.67 with a standard deviation of 0.63, while the cluster mean score for teachers is 2.65 with a standard deviation of 0.63, indicating a general agreement regarding the perceived impact of conflict resolution practices on school culture. The overall cluster mean score of 2.67 exceeds the criterion mean score of 2.5, suggesting a significant extent of agreement between the groups concerning the effectiveness of conflict resolution strategies in enhancing school culture and, consequently, academic performance. Specific items such as the effectiveness of conflict resolution strategies in maintaining a positive school culture, the improvement in student engagement and academic motivation when conflicts are resolved effectively, and the promotion of respect and understanding through current practices all received "agreed" ratings. However, areas of concern were identified, such as the perception that conflicts among staff disrupt the learning environment and that students do not feel comfortable bringing their concerns to school authorities, both of which received "disagreed" ratings.

Research Question 3: What is the contribution of students' community involvement in school culture management practices to academic performance in rural public secondary schools in Rivers South-East Senatorial District?

Table 3 Mean and Standard Deviation Scores on the Contribution of Students' Community Involvement in School Culture Management Practices to Academic Performance in Rural Public Secondary Schools in Rivers South-East Senatorial District

S/N	Test Items- Students' Community Involvement.	Principals (N = 61)		Teachers (N = 122)		Mean Set (xx)	Remarks
		$\bar{x}$	sd	$\bar{x}$	sd		
11.	Community service projects are often organized by the school in line with the school's academic programme	2.55	0.60	2.36	0.54	2.46	Disagreed
12.	Community service projects are not a thing we find interesting as such it is rarely organized in our school.	2.33	0.53	2.46	0.57	2.40	Disagreed
13.	Students are often cajoled to actively participate in community service projects organized by the school.	2.55	0.60	2.51	0.58	2.53	Agreed
14.	Students see it as the school culture to actively participate in community service projects organized by the school.	2.57	0.60	2.50	0.58	2.54	Agreed
15	Parents are more engaged in the school's academic programmes when students are involved in community activities, positively influencing student performance.	2.82	0.68	2.64	0.63	2.73	Agreed
	Cluster Mean/SD	**2.56**	**0.60**	**2.49**	**0.58**	**2.53**	**Agreed**

Criterion mean score = 2.5

Results in Table 3 present the mean and standard deviation scores on the contribution of students' community involvement in school culture management practices to academic performance in rural public secondary schools in Rivers South-East Senatorial District. The cluster mean score for principals is 2.56 with a standard deviation of 0.60, while the cluster mean score for teachers is 2.49 with a standard deviation of 0.58, indicating a general agreement regarding the perceived contribution of community involvement to school culture. The overall cluster mean score of 2.53 exceeds the criterion mean score of 2.5, suggesting a significant extent of agreement between the groups on the positive contribution of community involvement to school culture management practices and academic performance. However, specific test items reveal mixed feelings about community involvement initiatives. Both principals and teachers expressed disagreement regarding the adequacy and interest in community service projects organized by the school, as reflected in the low ratings for items on the organization and appeal of such projects. Conversely, there is agreement on the perception that students are often encouraged to participate in these projects and that participation is viewed as part of the school culture. Additionally, respondents agreed that when students engage in community activities, parents become more involved in academic programmes, which positively influences student performance.

6.2 Test of Hypotheses

Hypothesis 1: There is no significant difference in mean scores between the teachers and school administrators' opinion regarding the impact of collaborative dialogue in school culture management practices on academic performance in rural public secondary schools in Rivers South-East Senatorial District.

Table 4 Z-test Analysis on the Mean Differences in Teachers and School Administrators' Opinion Regarding the Impact of Collaborative Dialogue in School Culture Management Practices on Academic Performance in Rural Public Secondary Schools in Rivers South-East Senatorial District

Status	n	$\bar{x}$	Sd	df	z-cal	z-crit value	Sig.	Level of significance	Decision
Principals	61	2.59	0.62						
				181	4.07	1. 96	0.00	0.05	Significant
Teachers	122	2.53	0.59						

Results in Table 4 indicate that a z-test analysis was conducted to assess the mean differences in teachers and school administrators' opinions regarding the impact of collaborative dialogue in school culture management practices on academic performance in rural public secondary schools in Rivers South-East Senatorial District. The mean score for principals is 2.59 with a standard deviation of 0.62, while the mean score for teachers is 2.53 with a standard deviation of 0.59. The calculated z-value is 4.07, which significantly exceeds the critical z-value of 1.96 at a significance level of 0.05. With a significance value of 0.00, this indicates a statistically significant difference in the opinions of teachers and school administrators regarding the impact of collaborative dialogue on school culture and academic performance. Therefore, the decision is to reject the null hypothesis, suggesting that there is a significant difference in perceptions between teachers and school administrators on the effectiveness of collaborative dialogue in enhancing academic performance.

Hypothesis 2: There is no significant difference in mean scores between the teachers and school administrators' opinion regarding the effect of conflict resolution in school culture management practices on academic performance in rural public secondary schools in the Rivers South-East Senatorial District.

Table 5 Z-test Analysis on the Mean Differences in Teachers and School Administrators' Opinion Regarding the Effect of Conflict Resolution in School Culture Management Practices on Academic Performance in Rural Public Secondary Schools in the Rivers South-East Senatorial District

Status	n	$\bar{x}$	Sd	df	z-cal	z-crit value	Sig.	Level of significance	Decision
Principals	61	2.67	0.63						
				181	1.90	1. 96	0.10	0.05	Not Significant
Teachers	122	2.65	0.63						

Results in Table 5 indicate that a z-test analysis was conducted to assess the mean differences in teachers and school administrators' opinions regarding the effect of conflict resolution in school culture management practices on academic performance in rural public secondary schools in the Rivers South-East Senatorial District. The mean score for principals is 2.67 with a standard deviation of 0.63, while the mean score for teachers is 2.65 with a standard deviation of 0.63. The calculated z-value is 1.90, which does not exceed the critical z-value of 1.96 at a significance level of 0.05. The significance value of 0.10 indicates that there is no statistically significant difference in the opinions of teachers and school administrators regarding the effect of conflict resolution on school culture and academic performance. Therefore, the decision is to retain the null hypothesis, suggesting that there is no significant difference in perceptions between teachers and school administrators concerning the effectiveness of conflict resolution in enhancing academic performance.

Hypothesis 3: There is no significant difference in mean scores between the teachers and school administrators' opinion regarding the contribution of students' community involvement in school culture management practices to academic performance in rural public secondary schools in the Rivers South-East Senatorial District.

Table 6 Z-test Analysis on the Mean Differences in Teachers and School Administrators' Opinion Regarding the Contribution of Students' Community Involvement in School Culture Management Practices to Academic Performance in Rural Public Secondary Schools in the Rivers South-East Senatorial District

Status	n	$\bar{x}$	Sd	df	z-cal	z-crit value	Sig.	Level of significance	Decision
Principals	61	2.56	0.60						
				181	2.03	1. 96	0.01	0.05	Significant

Teachers	122	2.49	0.58

Results in Table 6 indicate that a z-test analysis was conducted to assess the mean differences in teachers and school administrators' opinions regarding the contribution of students' community involvement in school culture management practices to academic performance in rural public secondary schools in the Rivers South-East Senatorial District. The mean score for principals is 2.56 with a standard deviation of 0.60, while the mean score for teachers is 2.49 with a standard deviation of 0.58. The calculated z-value is 2.03, which exceeds the critical z-value of 1.96 at a significance level of 0.05. The significance value of 0.01 indicates that there is a statistically significant difference in the opinions of teachers and school administrators regarding the contribution of students' community involvement to school culture and academic performance. Therefore, the decision is to reject the null hypothesis, suggesting that there is a significant difference in perceptions between teachers and school administrators on the effectiveness of students' community involvement in enhancing academic performance.

7 DISCUSSION OF FINDINGS

Skepticism surrounds the adequacy of opportunities for joint teacher-student discussions on academic improvement in rural public secondary schools in the Rivers South-East Senatorial District. This skepticism arises from the divergent opinions between principals and teachers regarding the impact of collaborative dialogue on school culture management practices aligning with Loh et al. [33], who highlight its potential to enhance educational environments. This goes in line with the findings of Nouah et al. that rural educational settings face significant challenges[5], particularly with communication, which hinders academic performance and undermines a supportive atmosphere. Despite an encouraging culture of dialogue, discomfort among participants indicates an urgent need for strategies to enhance inclusive participation [14]. Moreover, claims that the administration actively seeks student feedback contradict teachers' viewpoints, which undermine the efficacy of feedback in management practices [34]. The dissent among teachers concerning feedback processes emphasizes their vital role in management and student success [28]. A notable lack of teacher engagement in sharing ideas complicates the creation of a collaborative environment necessary for academic achievement and a thriving school culture [23]. While administration acknowledges concerns, mere recognition does not suffice in cultivating a positive school culture [35]. Additionally, political interference in school leadership complicates these dynamics [30].

Consequently, despite the commendable aspects of dialogue and responsiveness, major challenges related to teacher engagement, discomfort, and feedback discrepancies necessitate strategic interventions to foster a genuinely well-managed collaborative environment that enhances academic outcomes and strengthens school culture management practices [22,31,32]. Additionally, effective conflict resolution strategies foster a positive school culture, as noted by Edet et al. [9], which improves teachers' job effectiveness in Nigerian public schools. However, divergent perspectives among principals about disruptions caused by staff conflicts illustrates a disconnect with teachers' experiences, a notion acknowledged by Griffiths et al. [10]. While there is consensus on the benefits of effective conflict resolution for student engagement [25]and its role in promoting a respectful culture [3,18], this study in line with other authors' findings show that disagreement about student comfort in voicing concerns reveals communication barriers [11].

The significance of conflict resolution in maintaining a positive culture resonates with Ukoima et al. [8], further emphasizing its importance in shaping student behavior. Moreover, this study unveils a significant divide between principals and teachers regarding the impact of community involvement on school culture and academic performance. Cleveland et al. assert that a robust school culture enhances academic outcomes[2], echoing this study's findings on community engagement. However, Agi points to administrative challenges hindering such initiatives[15]. Furthermore, Olatunji reinforces that school culture shapes student behaviour, aligning with the finding that students perceive community service as cultural norm[1]. Yet, skepticism among teachers regarding their interest in community service projects reflects a disconnect identified by Amtu et al. as detrimental[36]. In contrast, Onaolapo and Makhasane emphasize cultural factors shaping discipline[37], suggesting community involvement as a vital engagement tool, which resonates with the study's recommendations for enhanced community activities. Villa and Knutas assert that valuing local culture can significantly benefit rural schools[24], aligning with the findings on community service. Idenyenmhin insists on effective school culture management to enhance educational outcomes[12], while Dewantara et al. underscore character education through community participation as crucial[21]. More so, in line with this study's findings, Radio Desk highlights the challenges rural schools face, reinforcing the urgent need for robust community involvement to improve conditions and outcomes[38], echoing the study's call for action.

8 CONCLUSION

This assessment on respectful conduct in school culture management offers valuable insights into factors influencing academic performance in rural public secondary schools in the Rivers South-East Senatorial District. Collaborative dialogue shows that it can significantly boost academic outcomes; however, notable gaps persist in teacher engagement and feedback

mechanisms. Moreover, the effectiveness of conflict resolution strategies in fostering a respectful school environment is apparent, indicating a need for enhanced practices that adequately address the concerns of both teachers and students. Additionally, the role of community involvement in managing school culture is crucial for academic achievement. Thus, implementing targeted interventions that promote collaboration, conflict resolution, and greater community participation is vital for improving academic performance within the context of school culture management practices in these institutions.

9 RECOMMENDATIONS

Based on the findings, the following recommendations were made:

1. To leverage the positive impact of collaborative dialogue on academic performance, school administrators should implement structured programs that facilitate regular communication between teachers, students, and parents. This could include workshops, forums, and feedback sessions aimed at fostering a culture of openness and mutual respect. By actively engaging all stakeholders in discussions about academic expectations and school culture, schools can create a more supportive environment that enhances student learning outcomes.
2. Given the effectiveness of conflict resolution strategies in promoting a respectful school environment, it is crucial for schools to provide comprehensive training for both teachers and students. This training should focus on effective communication, negotiation skills, and mediation techniques. By equipping educators and students with the tools to resolve conflicts amicably, schools can reduce disruptions and create a more conducive atmosphere for learning.
3. To capitalize on the role of community involvement in enhancing academic achievement, schools should develop partnerships with local organizations and community leaders. Initiatives could include mentorship programs, community service projects, and collaborative events that encourage parental and community participation in school activities. By integrating community resources and support into the educational framework, schools can create a more enriching environment that positively influences student engagement and academic success.

COMPETING INTERESTS

The authors have no relevant financial or non-financial interests to disclose.

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Educational Research and Human Development
ISSN: 3007-6943
DOI: https://doi.org/10.61784/erhd3017

THE PATH OF SERVING LOCAL TECHNOLOGY ENTERPRISES IN THE CONTEXT OF INDUSTRY-EDUCATION INTEGRATION

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Abstract: This study employs a comprehensive approach combining empirical research and case analysis to delve into the essence of industry-education integration and the needs of local technology companies. Based on these insights, it proposes several strategies: establishing a joint research and development platform between universities and enterprises, optimizing professional training programs, strengthening mechanisms for the conversion of scientific research achievements, building a multi-level communication and cooperation network, and establishing a long-term mechanism for sustainable industry-education integration. These strategies aim to achieve resource sharing and complementary benefits, jointly driving local economic innovation and development. By implementing these strategies, universities can more effectively fulfill their roles in talent development, scientific research, and social services, providing robust intellectual and talent support to local technology companies. The study aims to build a strong communication bridge between universities and local technology enterprises, fostering deep cooperation between the two parties to jointly contribute to local economic prosperity and technological innovation, and injecting new vitality and momentum into local technology enterprises. These research findings hold significant theoretical and practical implications for deepening industry-education integration and promoting local economic development.
Keywords: Industry-education integration; Local technology enterprises; University-enterprise platform; Achievement transformation

1 INTRODUCTION

In the current era of economic globalization and the knowledge economy, industry-education integration has emerged as a paradigmatic model for deep cooperation between higher education and the industrial sector. As institutions of higher learning, universities not only bear the important tasks of talent cultivation and scientific research innovation but also shoulder the mission of serving technology enterprises and boosting local economic prosperity [1]. Especially with China's vigorous implementation of the innovation-driven development strategy, universities are even more tasked with providing excellent talents to local technology enterprises and facilitating efficient conversion of their scientific and technological achievements, which holds immeasurable value for the sustained prosperity of regional economies. The core of industry-education integration lies in closely integrating the actual needs of the industrial sector with the abundant resources of universities, and jointly cultivating high-quality technological talents that meet the demands of modern industrial development through diversified models such as university-enterprise joint research and development, project cooperation, etc. [2-3]. At the same time, universities, leveraging their profound scientific research accumulation and innovation capabilities, can provide solid intellectual support and talent guarantees for local technology enterprises through technology transfer, scientific and technological consultation, and other means. However, it cannot be ignored that universities and local technology enterprises still face numerous challenges in the process of industry-education integration, such as inefficient conversion of scientific research achievements, obstacles in information exchange, and imperfect cooperation mechanisms. These issues not only restrict universities' ability to serve local technology enterprises but also pose obstacles to the growth and expansion of these enterprises. Based on the spiral model theory of industry-university-research cooperation, universities and enterprises should establish a closely interactive and mutually promoting cooperative relationship to jointly drive the innovation of knowledge and technology and their conversion into actual productive forces [4-5]. Therefore, this study is dedicated to exploring how universities should construct and optimize paths to serve local technology enterprises in the context of industry-education integration. Through in-depth analysis of advanced experiences and typical cases of industry-education integration both domestically and internationally, combined with the actual needs and development characteristics of local technology enterprises, this study aims to construct a service model that aligns with local characteristics and effectively promotes university-enterprise cooperation. This will not only significantly enhance universities' ability to serve society and enterprises but also inject new vitality into the innovative development of regional technology enterprises, thereby promoting higher-quality development of the regional economy.

2 DIFFICULTIES FACED BY UNIVERSITIES IN SERVING LOCAL TECHNOLOGY ENTERPRISES UNDER THE BACKGROUND OF INDUSTRY-EDUCATION INTEGRATION

2.1 Insufficient Consideration of Regional Industrial Characteristics

When universities serve local technology enterprises, they may face the problem of inadequate understanding of regional industrial characteristics. This deficiency includes a lack of deep knowledge about pillar industries, special industries, and emerging industries, as well as an insufficient grasp of the upstream and downstream connections within the industrial chain. This lack of understanding makes it difficult for universities to precisely grasp the development needs of enterprises and industry trends when supporting local technological development. The alignment between university majors and the demands of key regional industries needs to be improved. The updating of course content lags behind the pace of industrial development, resulting in a significant disconnect. This disconnect not only affects the employment competitiveness of university graduates but also makes it difficult for research achievements to be directly applied to local industries, thereby reducing their practicality and relevance [6]. Furthermore, universities do not adequately consider regional industrial characteristics in practical teaching, further exacerbating the mismatch between university research achievements and the development needs of local industries. At the same time, the application and conversion of research achievements also fail to fully consider the characteristics of regional enterprises, which to some extent limits the contribution of university technological achievements to local technology enterprises [7].

2.2 Insufficient Consideration of Regional Industrial Characteristics

The demand for different goals between universities and technology enterprises is an important factor affecting their cooperation. In summary, the main task of universities is to cultivate talents and impart knowledge, with a focus on basic theoretical disciplines and academic research, but limited by funding and equipment. In contrast, technology companies prioritize economic benefits and place greater emphasis on product efficiency and technological advancement, investing more in product applications and market development. From the perspective of the interests of local technology enterprises, there is a certain degree of skepticism towards the market prospects and service capabilities of universities in terms of scientific research achievements [8-9]. Enterprises believe that the scientific research achievements of universities do not fully match the market demand for products, or that the research and development progress of university products cannot meet their requirements for research and development time in the face of fierce competition. The administrative approval process within universities is relatively complex, and there are also certain difficulties in initiating cooperative projects, which further weakens the willingness of enterprises to cooperate. The cumbersome procedures of fund disbursement and equipment procurement can hinder the progress of project cooperation, thereby increasing the difficulty and uncertainty of cooperation between both parties.

2.3 The Disconnect between Talent Cultivation and Enterprise Needs

The problem of universities being disconnected from the needs of enterprises in talent cultivation lies in the fact that their professional settings and course content focus too much on the theoretical system of disciplines, and fail to closely follow the development pace of actual work content in enterprises. The slow pace of updating course content results in graduates' knowledge and skills not being able to reflect the latest developments in the industry in a timely manner. Due to students' lack of hands-on ability and problem-solving skills, companies need to invest additional costs in secondary training after accepting new employees. In addition, universities have insufficient investment in practical teaching, and the construction of off campus internship practice bases lags behind, which limits students' internship opportunities and lacks necessary work experience. The disconnect between practical teaching content and actual work further exacerbates this problem, leading companies to prefer job seekers with relevant work experience when recruiting, which puts many fresh graduates at a disadvantage in the job market. Insufficient communication between universities and enterprises is also one of the important reasons for the disconnect between talent cultivation and enterprise needs. The willingness of enterprises to participate in curriculum construction and talent development plans is not strong, and universities often lack effective information exchange mechanisms and awareness of actively seeking teaching resources, making it difficult to accurately grasp changes in enterprise talent demand and adjust subject talent development plans in a timely manner. This information asymmetry and lack of effective communication further exacerbate the disconnect between talent cultivation in universities and the needs of enterprises.

3 THE PATH OF UNIVERSITIES SERVING LOCAL TECHNOLOGY ENTERPRISES UNDER THE BACKGROUND OF INDUSTRY EDUCATION INTEGRATION

3.1 Collaboration between Schools and Enterprises for Scientific Research and Technological Innovation

In order to deepen cooperation between schools and enterprises, promote scientific research cooperation and technological innovation, joint research and development centers or laboratories between schools and enterprises can be established. The center or laboratory will be responsible for integrating the advantageous resources of universities and enterprises, developing research and development cooperation plans and goals for cutting-edge technologies and key common technologies, and clarifying the responsibilities and obligations of both parties. By building a joint research and development platform that integrates industry, academia, and research, and establishing mechanisms such as regular cooperation meetings and contact windows, we ensure that both parties can exchange information in a timely manner and jointly solve problems. According to the actual needs of enterprises, universities can be commissioned to carry out technological research and development to solve technical problems in production and operation. Both parties can jointly apply for national, local, and industry technology projects, covering areas such as new technology development,

research and development of new products and processes, and tackling technical difficulties. When formulating a detailed research plan, it should be guided by the needs of the enterprise and focus on conducting applied and developmental research.Universities can actively build innovation carriers such as technology centers and engineering technology research centers for enterprises, while leveraging the innovation support role of science and technology parks, innovation and entrepreneurship parks, etc. in incubating enterprises to assist them in solving technical problems. Both parties can also jointly establish a research instrument and equipment sharing platform and R&D team, with the participation of university researchers and enterprise technicians, to promote the construction of a technology innovation platform for school enterprise sharing. In order to strengthen scientific research cooperation, attention should be paid to the construction and management of platforms such as university laboratories and enterprise R&D centers, and necessary funding, venue, and equipment support should be provided for cooperative projects. At the same time, universities and enterprises are encouraged to guide researchers to participate in the transformation of achievements in various ways, in order to maximize the value of knowledge for both parties. By strengthening the transfer and transformation of scientific and technological achievements from universities in enterprises, transforming research results into products or services with independent intellectual property rights, and promoting the industrialization of key technological equipment that meets industry development needs. In addition, in order to safeguard the interests of both parties, a reasonable mechanism for distributing benefits should be established. Both parties can also jointly establish a training base for enterprise employees to cultivate and enhance their professional and technical skills. Supporting two-way learning and exchange between university teachers and enterprise technical personnel, providing opportunities for enterprises to select teachers and students to carry out product research and development, thereby helping teachers and students accumulate practical product research and development experience and enhance work experience. Universities and enterprises can form cross industry and interdisciplinary collaborative R&D alliances to strengthen technology sharing, knowledge sharing, and R&D inheritance, laying a solid foundation for further development of school enterprise cooperation.

3.2 Construction of School Enterprise Cooperation Innovation and Entrepreneurship Platform

The construction of a school enterprise cooperation innovation and entrepreneurship platform is to jointly build an ecosystem that promotes technological innovation and commercialization. Establish a management organization composed of representatives from universities and enterprises to operate and supervise the daily activities of the platform,Responsible for the execution and management of specific projects. Establish a dedicated daily operation organization, responsible for inviting industry experts, investors, and other consultants to form a team to provide service support for the platform, formulate project management methods, fund utilization regulations, and intellectual property protection management systems. Universities provide resources such as office space, conference facilities, and experimental equipment to support product innovation and technology research and development for enterprises. Enterprises provide project funding, internship bases, and other resources to assist universities in transforming promising scientific research achievements and providing market promotion support. Through school enterprise cooperation projects, we jointly provide entrepreneurship training, technical seminars, business plan guidance and other services to promote industrial upgrading and transformation. Establish an online information service platform that provides functions such as seminars, research forums, and project docking to facilitate cooperation between universities and enterprises. Establish a special fund or guide venture capital to provide entrepreneurial training, physical space, technical seminars, business plan guidance and other service support for cooperative projects. Offering educational courses in universities to cultivate students' innovative consciousness, entrepreneurial spirit, and practical abilities, combining entrepreneurial theory, case analysis, and practical activities. Covering knowledge from multiple disciplines such as engineering technology, finance, law, economics, and marketing. Adopting diverse teaching methods such as project-based teaching, group discussions, entrepreneurial role-playing, and lecture presentations to stimulate students' enthusiasm and interest in learning. Invite industry experts and investment advisory teams to campus to hold innovation and entrepreneurship lectures and other activities, sharing entrepreneurial experiences and business plans. Regularly organize innovation and entrepreneurship competitions, roadshows, and other activities that involve both schools and enterprises, implement a two-way guidance mechanism between university and enterprise mentors, cultivate excellent entrepreneurial projects, and provide opportunities for career development and lifelong learning for students and enterprise employees. Establish a feedback mechanism to regularly provide feedback and evaluation on school enterprise innovation and entrepreneurship projects, service platform operations, etc. Based on the feedback results, provide incentives such as equity and stock options for teachers and students participating in the project, reward and support outstanding projects and teams, and motivate more universities and enterprises to actively participate in collaboration. Make full use of various channels to promote successful cases and achievements on the platform, organize universities and enterprises to participate in various industry demand releases and technology roadshows, and promote the integration of university research achievements with enterprise needs. Actively communicate and collaborate with innovation and entrepreneurship platforms of other universities and enterprises, sharing experiences and resources.

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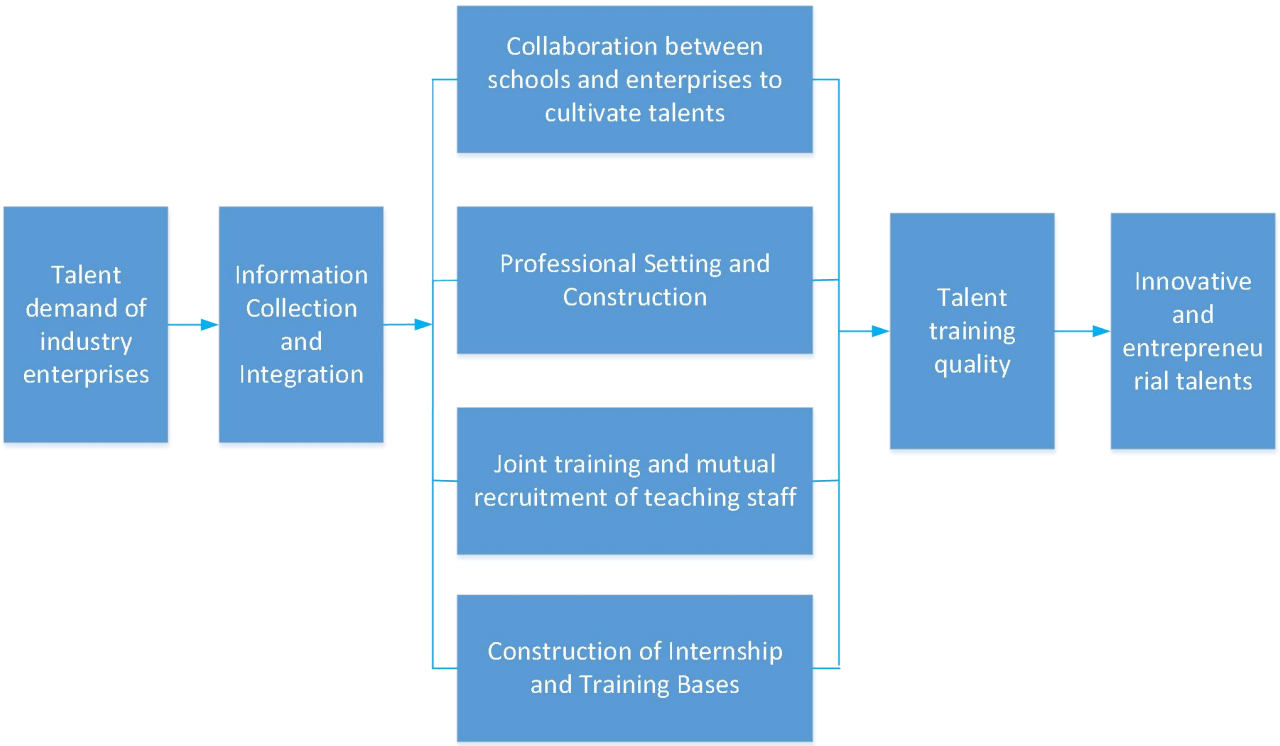

Figure 1 School Enterprise Cooperation Training Model

COMPETING INTERESTS

The authors have no relevant financial or non-financial interests to disclose.

FUNDING

This article is supported by the Education Science Planning Project of Jiangxi Province (Project No. 22YB222)

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Educational Research and Human Development
ISSN: 3007-6943
DOI: https://doi.org/10.61784/erhd3019

EXPLORATION OF INTEGRATION SCHEMES FOR INFORMATION SECURITY AND PROGRAMMING COURSES

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Abstract: Despite the fact that universities have paid sufficient attention in accordance with national information security policies, information security education during the college period is still constrained by issues such as limited coverage and insufficient training hours. Considering that programming courses are offered in the majority of engineering and science majors, this paper proposes a scheme to integrate the cultivation of information security awareness into the teaching of various programming courses. Through studying the integrated cases, students can develop their information security awareness while mastering theoretical knowledge points. Results indicate that students' information security awareness has been significantly enhanced after studying the integrated cases. Leveraging the high proportion of programming courses in the teaching system, this scheme is expected to greatly expand the coverage of information security education in universities.
Keywords: Information security; Programming course; Integration schemes

1 INTRODUCTION

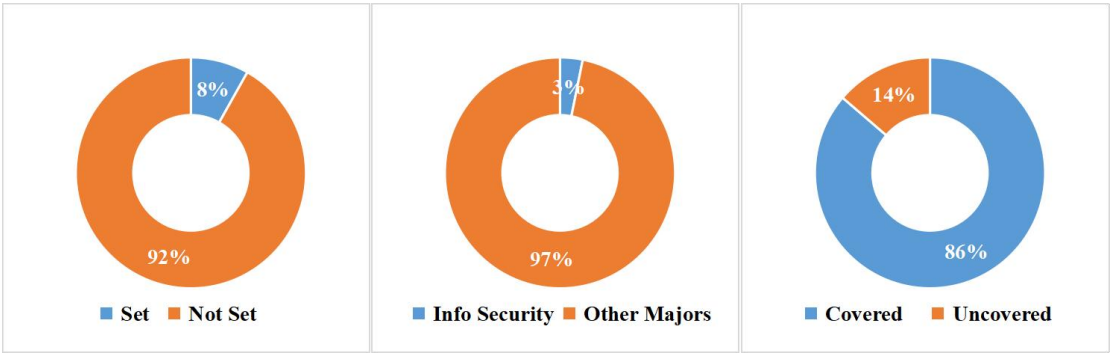
In recent years, with the intensification of international competition, information security incidents such as cyberattacks and breaches that jeopardize national and social security have occurred repeatedly. China has passed laws including the Data Security Law of the People's Republic of China and the Network Security Law of the People's Republic of China to enhance information security capabilities and prevent information from being tampered with, damaged, leaked, or illegally obtained or utilized during economic and social development. The primary causes of information security incidents are technical vulnerabilities and a lack of security awareness. Technical defects or vulnerabilities in systems or networks can be exploited by attackers. Therefore, some institutions have established relevant mechanisms to eliminate the possibility of information leaks from both technical and institutional perspectives. For example, Sinopec has constructed a relatively comprehensive information security management system such as the "Five-in-One" network security risk management and control mechanism to ensure the safe operation of critical infrastructure [1]. However, many breaches are caused by a lack of information protection awareness and disregard for confidentiality regulations or policies. Thus, merely establishing regulations cannot completely eliminate such incidents.

Cultivating students' awareness of information protection early in their college education helps safeguard confidential information they may encounter in their future careers. The cultivation of information security concepts in higher education primarily stems from the establishment of information security disciplines and the implementation of general education courses on information security. The curriculum of information security disciplines generally includes cryptography, network security, application security, and other related content, which enables students to effectively cultivate their information security awareness while learning relevant technologies [2]. However, in 2024, only 69 universities in China offered information security majors, accounting for only 8% of the 845 public universities nationwide, indicating a low coverage rate. Additionally, the number of students majoring in information security does not constitute a high proportion of the total student population. Taking Xi'an University of Posts and Telecommunications as an example, in 2024, there were 603 undergraduate students majoring in information security, which is only 3% of the total undergraduate population of 19,000. Therefore, the strategy of cultivating students with good information security awareness through information security disciplines cannot achieve widespread coverage.

Another approach currently employed by universities to cultivate knowledge of information security is to offer general education courses on information security to all students on campus. In recent years, many universities have explored methods to popularize information security education among their students, by inviting experts in the field of information security to conduct lectures, organizing students to take online open courses on information security, and other means, in order to cultivate the concept of information security among non-major students [3]. The main issue faced by such methods is the insufficient duration of training, which is usually only around 2 academic hours, making it impossible to deeply instill the concept in students. Additionally, non-major students often adopt a perfunctory attitude when taking online open courses [4], so cultivating the concept of information security through this method tends to become a mere formality, failing to achieve the expected results.

The offering of programming courses is very common in China, covering almost all universities nationwide, including comprehensive key universities, ordinary institutions, and vocational colleges. Furthermore, various programming courses have also achieved wide coverage among non-computer majors in universities [5]. Taking Xi'an University of Posts and Telecommunications as an example again, the university has a total of 51 undergraduate majors, among which 44 majors offer programming courses, mainly including C++, Java, Python, etc., accounting for 86.3% of all majors.

Compared to majors related to information security, programming courses have an absolute advantage in terms of coverage within the university. On the other hand, programming courses explain some of the mechanisms for the transmission of computer information, and object-oriented computer languages possess mechanisms such as encapsulation and inheritance for achieving information protection and separation [6]. These concepts are highly complementary to the concept of information security. Therefore, a teaching mode that integrates the knowledge points of programming courses with the cultivation of information security awareness can be designed. With the understanding of relevant knowledge points in computer languages, students are more likely to accept the integrated concept of information security. At the same time, the wide coverage of language courses can ensure synchronous coverage of the cultivation of security awareness, potentially addressing the shortcomings of the two current main training modes (Figure 1).



(a) (b) (c)

Figure 1 Comparison of Coverage Rates Among Several Strategies for Cultivating Information Security Awareness. (a) The Proportion of Universities in China that Offer Information Security Majors. (b) The Proportion of Students Majoring in Information Security at XUPT to the Total Student Population. (c) The Coverage Rate of Computer Language Courses at XUPT.

2 OVERALL STRATEGY FOR INTEGRATING PROGRAMMING COURSES WITH THE INFORMATION SECURITY

The strategy explored in this paper for integrating and cultivating programming courses with the concept of information security generally consists of four main steps, as illustrated in Figure 2 below. Firstly, based on the characteristics of the selected programming courses, the knowledge points are dissected and correlated with the main concepts of information security. Secondly, through the analysis of actual cases from actual cases completed by scientific research teams, and publicly sourced cases, a collection of cases suitable for matching with the course knowledge points is screened and summarized. After completing the dissection of knowledge points and case research, the third step involves matching the dissected knowledge points with the cases in the collection according to the corresponding information security concepts, and designing specific training plans. Finally, the training plan is implemented in actual course, and the training effect of the plan is evaluated based on relevant evaluation mechanisms to optimize it. At the same time, this process achieves the cultivation of students' information security protection awareness.

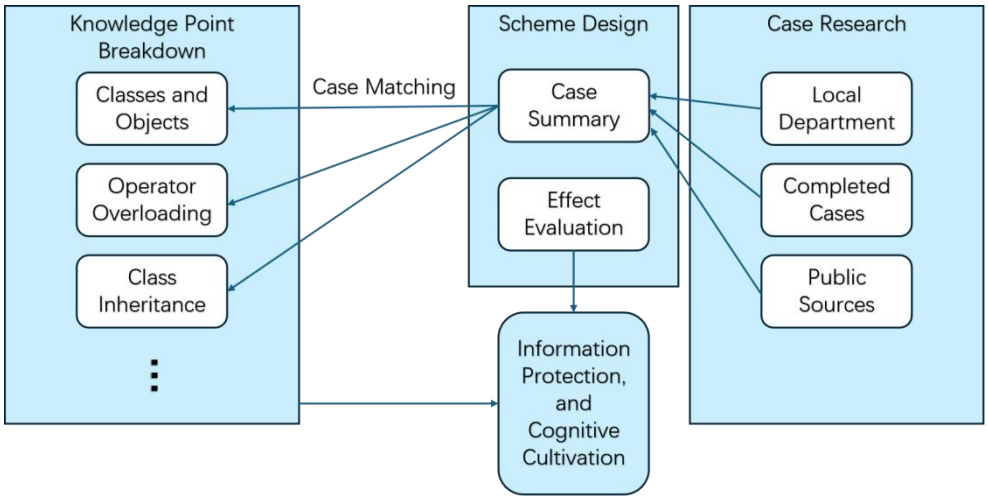


Figure 2 Framework for Integration Strategy of Computer Language Courses and Information Security Concepts

3 PATTERNS OF KNOWLEDGE POINTS IN PROGRAMMING COURSES

Currently, the language courses offered in universities mainly include five mainstream advanced programming languages: C++, Java, Python, C#, and Matlab, among which C# and Matlab account for a relatively low proportion, while the other three languages dominate. Mainstream advanced languages typically share characteristics of object-oriented programming, which are also key focus areas during the course of study. These include classes and objects, encapsulation, inheritance, polymorphism, abstraction, message passing, etc. By conducting an in-depth analysis of these characteristics, matching information security cases are identified for integration, ultimately generating an upgraded set of teaching plans for each characteristic. This plan enables students to cultivate relevant security awareness through integrated information security cases while deeply studying the technical characteristics. The concept of information security can be mainly divided into three categories: (1) Physical security achieved through physical isolation; (2) Communication security during information transmission; and (3) System security, including operating systems, databases, vulnerability and virus detection, etc. Each knowledge point within the characteristics of computer languages can be matched with the most suitable category from the above three, in order to explore suitable cases for integration. The specific analysis results are as follows.

(1) Classes and objects, as fundamental concepts introduced in object-oriented programming languages, reversed the process-oriented programming paradigm, significantly enhancing efficiency in developing large-scale software. By introducing the concepts of object attributes and methods within classes and objects, and implementing access control through access specifiers to isolate visitors, system security can be achieved by setting different levels of object states and behaviors. (2) The encapsulation characteristic combines an object's attributes and methods into an independent unit, hiding the internal details of the object as much as possible to ensure that its internal state cannot be arbitrarily changed by external programs. External programs can only interact with the encapsulated data through interfaces, thereby improving code security and maintainability. This characteristic controls the physical isolation and openness of member information by setting interfaces. (3) The inheritance characteristic enhances code reusability, maintainability, and extensibility by allowing subclasses to inherit attributes and methods from their parent classes. By selecting inheritance methods, invisible hiding of related members of the parent class can be achieved, thereby realizing physical isolation. (4) Polymorphism refers to the ability of different objects to respond differently when calling the same member function. This characteristic enables program architects to focus on top-level design and programmers to focus on specific programming during large-scale software development, facilitating efficient collaboration. The concept of overloading in polymorphism ensures that the program can handle multiple different situations using the same method, which requires considering multiple possibilities during program design to ensure smooth operation and safeguard the security of the program or system. (5) Similarly, abstract classes and virtual functions are commonly used abstraction means in inheritance behavior to meet the needs of software division development and polymorphism, aligning with the concept of system security. (6) The message-passing mechanism is the primary information exchange mechanism between objects, achieving decoupling and loose coupling between objects, making the program more flexible. Friend functions or classes are often used during the exchange process to break access restrictions between classes. Therefore, attention should be paid to the use of the friend mechanism to ensure the security of the information transmission process. The detailed correspondence between advanced language characteristics and information security classifications is shown in Table 1 below.

Table 1 The Correspondence Between Programming Characteristics and Information Security Classifications

Characteristics of Programming Languages	Knowledge Points	Classification of Information Security
Classes and Objects	Member Functions and Attributes	System Security
Encapsulation of Classes	Access Specifiers and Interfaces	Physical Security
Inheritance of Classes	Inheritance and Code Reuse	Physical Security
Polymorphism	Overriding and Overloading	System Security
Abstraction of Classes	Abstract Classes and Virtual Functions	System Security
Message Passing	Friend Functions and Friend Classes	Communication Security

4 ACQUISITION OF INFORMATION SECURITY CASES

Based on the analysis of knowledge points in the Advanced Programming Language course and the corresponding information security classifications obtained, it is necessary to disassemble actual information security cases and match them with the types of information security. So teaching cases for programming languages that integrate the concept of information security can be devised. To achieve the above objectives, a large number of information security cases need to be acquired and screened. To ensure that the cases align with national development strategies, the overall direction should first be established according to relevant laws and regulations formulated by the country, and then relevant cases that conform to this direction should be obtained from various sources. From the perspective of national security, China's laws such as the State Secrets Law and Data Security Law establish relevant obligations related to national security in information activities. In terms of information system security, regulations such as the Network Security Law and Regulations on the Security Protection of Computer Information Systems provide behavioral norms for computer and internet security. Finally, amendments to the criminal law provide practical grounds for punishing

computer-related crimes. Therefore, the acquisition of relevant integrated cases needs to comply with the overall direction of the above laws and regulations, so that students can understand the background knowledge of these laws and regulations during the learning process.

The main sources for acquiring cases are public information on the internet and relevant professional departments. With the increase in information security incidents in recent years, the relative department has expanded the promotion of such cases, leading to their widespread dissemination on the internet. By searching for keywords such as "leak" on domestic search engines, it is easy to obtain information security cases on various topics. This type of data is abundant and diverse, serving as an excellent source of cases. However, due to privacy concerns, many details are often removed from these cases. Although such omissions have no practical impact on the cultivation of security awareness, they can create a sense of distance for students during the learning process, reducing students' interest in learning. When relevant cases occur close to students and may have an impact on them, it will stimulate their interest and effectively improve learning efficiency. Local public security departments and public security laboratories usually have a large amount of historical case data, including cases of information security incidents. This study relies on the research team's laboratory resources and long-term cooperation with local public security departments to compile a series of real information security cases after removing confidential and sensitive information. These cases are rich in non-confidential details, serving as a good supplement to publicly available internet cases in the process of designing teaching cases.

Based on the overall design strategy and combining the sources of the aforementioned cases, this research compiles 12 practical cases concerning information security protection, including incidents such as the leakage of user data from medical equipment monitoring systems and the theft of communication content from encrypted communication software. These cases are matched with the knowledge points of encapsulation, inheritance, and code reuse in computer language courses. Using the matched case collection, a teaching scheme integrating information security and knowledge points is designed.

5 DESIGN APPROACH OF THE INTEGRATED CASE

The teaching scheme integrating information security consists of five components: Case Background, Overview of Information Security Incident, Technical Solution Approach, Sample Code, and Insights on Information Security Concepts. The derivation relationships among these five components are illustrated in Figure 3 below. (1) The Case Background provides an overview of the current case, introducing the context in which the incident occurred and the relevant computer language knowledge points. (2) Based on the Case Background, the Overview of Information Security Incident section details the vulnerabilities of the information security incident, the conditions and processes leading to information leakage, the consequences and severity of the leakage incident, and other relevant content. (3) In response to the actual situation of the incident, the Technical Solution Approach presents solutions and remedies for the aforementioned vulnerabilities through technical means, combining the teaching knowledge points. (4) The Sample Code resolves the issue in the form of code using the programming language taught, based on the Technical Solution Approach. (5) The Insights on Information Security Concepts summarizes the key technical issues of the case and the corresponding key points for cultivating information security awareness. Among these, Parts 3 and 4 aim to train students on the knowledge points of related courses, while Parts 1, 2, and 5 aim to cultivate students' information security awareness. Below is an intuitive presentation of one of these cases.

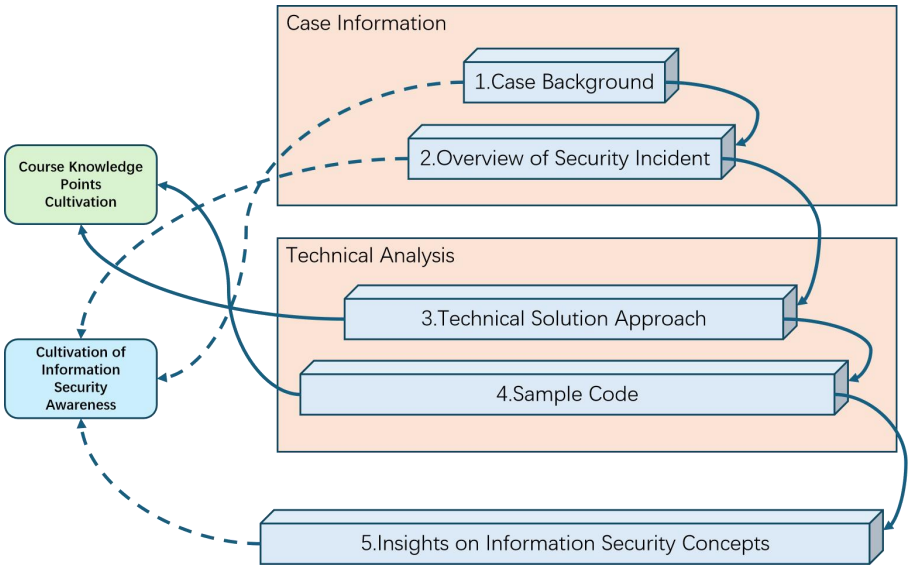


Figure 3 Framework for Integrated Information Security Case Studies

Case Name: Classes and Objects - Common Encryption Methods

Case Background: A small library, aiming to enhance its management efficiency, developed a C/S architecture library management system implemented in C++. This system encompasses functionalities such as user management, book

borrowing, and returning, utilizing C++ classes to encapsulate user information and book details. However, due to inadequate consideration of information security during system design, a user data breach occurred at the library.

Overview of the Security Incident: The library management system harbored certain design flaws. Specifically, the password attribute within the user class was stored in plaintext and could be directly accessed through member functions. Additionally, the system lacked rigorous validation of user inputs, posing risks such as SQL injection. During the attack, hackers attempted an SQL injection attack on the system by maliciously constructing query parameters. Upon successful exploitation, the hackers gained access to the user table structure within the database and downloaded all user data, including usernames and plaintext passwords. Ultimately, users' private information, including borrowing records and contact details, was leaked.

Solution Approach: During the system design process, implement encrypted password storage by modifying the user class to store password attributes as encrypted strings. Utilize secure encryption algorithms (such as AES, SHA-256, etc.) to encrypt passwords. Secondly, input validation is necessary, adding input validation logic to all functions that accept user input to prevent attacks like SQL injection. Use prepared statements or ORM frameworks to securely execute database queries. Additionally, implement access control, including role-based access control (RBAC), to ensure that only authorized users can access sensitive data. Log access to user data for tracking and auditing purposes. Finally, introduce security audits, including periodic security audits of the system to check for potential vulnerabilities. Utilize automated tools for code scanning to identify insecure programming practices.

Lessons Learned on Information Security Awareness: In this case, it is crucial to prioritize password security by educating students and users about the importance of password safety, such as using strong passwords and regularly changing them. Emphasize that passwords should not be stored or transmitted in plaintext. Secondly, enhance data protection awareness by understanding the basic principles and importance of data encryption, including encryption for transmission and storage. Recognize that sensitive data (such as user information, financial information, etc.) should be specially protected. Thirdly, stress the importance of validating all user inputs to prevent attacks like SQL injection and XSS. Learn how to write secure code to avoid common security vulnerabilities. Finally, guide students in understanding the concept of access control to ensure that only authorized users can access sensitive data. Learn how to implement strategies such as RBAC.

6 ANALYSIS OF THE CULTIVATION EFFECT OF THE INTEGRATED SCHEME

To validate the cultivation effect of the information security awareness integration case proposed in this paper, the author implemented it in the C++ Programming course for the 2023 intake of Information Engineering students at their university. To ensure the comprehensiveness and representativeness of the evaluation results, multiple methods were adopted during the course to collect data on the cultivation effect, including random testing, student interviews, analysis of homework completion, and questionnaire surveys. Firstly, the random testing method required students to answer questions related to information security knowledge covered in the previous class at the beginning of the course. The evaluation scheme recorded the students' test scores as the test evaluation value S_Q for this round of evaluation. Next, students are selected for interviews based on the median score of each round of testing to assess their understanding of relevant knowledge points and information security concepts. Subjective scoring is conducted during these interviews, and the results are recorded as the interview evaluation value S_D for this round of assessment. Subsequently, the completion status of information security-related knowledge points in students' after-school assignments and experiment reports is analyzed, with the accuracy rate of answers serving as the assignment evaluation value S_W for this round of evaluation. Finally, two information security knowledge surveys are conducted at the beginning and end of the course, with the results recorded as S_1 and S_2, respectively. Let $S_P = (S_2 - S_1) * e/E$ represent the survey evaluation value for a given round e, where e is the current evaluation round and E is the total number of evaluation rounds, and $\mathrm{e} \in \mathrm{E}$. Then, the evaluation value S_e for the cultivation effect in the $\mathrm{e}-\mathrm{th}$ round of teaching can be derived from S_Q, S_D, S_W and S_P, as shown in Formula 1.

$$S_e = W^T \cdot S \tag{1}$$

Where $\mathrm{W} = [\mathrm{w}_1, \mathrm{w}_2, \mathrm{w}_3, \mathrm{w}_4]$ is the vector of weight coefficients for the evaluation values, set as $w_1 = 0.4, w_2 = 0.15, w_3 = 0.3, w_4 = 0.15$ in the verification process of this paper. $\mathrm{S} = [S_Q, S_D, S_W, S_P]$ represents the evaluation vector for the cultivation effect. A total of 5 rounds of evaluation were conducted in the verification process of this paper, noted as $\mathrm{E} = 5$, and the average evaluation value $\overline{S_e}$ for the cultivation effect of the 2023-grade students in Information Engineering was calculated for each round. The changes in the $\overline{S_e}$ values over the 5 rounds of evaluation are shown in Figure 4 below. The verification results indicate that $\overline{S_e}$ generally maintained an upward trend throughout the 5 rounds of evaluation. The final evaluation value $\overline{S_5}$ was 80.1, representing a significant improvement compared to the initial evaluation value $\overline{S_1}$ of 65.3. This confirms the effectiveness of the proposed scheme in cultivating the concept of information security in teaching process.

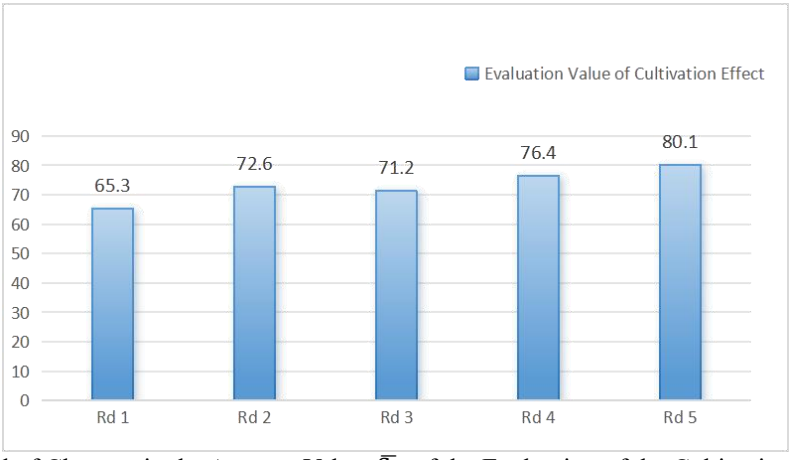


Figure 4 The Trend of Changes in the Average Value $\overline{S_e}$ of the Evaluation of the Cultivation Effect Across Five Rounds for Students Majoring in Information Engineering at XUPT.

7 CONCLUSION

Cultivating students' information security awareness at the university level holds significant strategic importance, as a lack of such awareness may lead to severe national security and economic security incidents in their subsequent professional careers. However, due to the relatively low coverage of specialized information security courses in current universities in China and inadequate cultivation effects of general information security courses, it is challenging to effectively promote the cultivation of information security awareness. To address these issues, considering the widespread offering of programming courses in science and engineering universities and the similarity in the knowledge structures of advanced programming teaching, this paper proposes a fusion scheme that integrates programming courses with the concept of information security. This scheme analyzes the knowledge points of mainstream advanced programming courses in universities and the corresponding directions for cultivating information security awareness that are compatible with these courses. Meanwhile, guided by national policy documents, the scheme screens out multiple real-life information security cases from public internet information and local public security departments and matches them with the cultivation directions. Finally, based on the fusion method proposed in the scheme, information security cases are integrated into the teaching of computer language courses. Practical verification results from computer courses for students at a university indicate that the proposed scheme effectively enhances students' information security awareness. Given the similarity in the knowledge structures of advanced programming teaching, this scheme can be applied to most coding courses, achieving wide coverage among students on campus.

COMPETING INTERESTS

The authors have no relevant financial or non-financial interests to disclose.

FUNDING

This work is funded by Educational Reform Projects of Xi'an University of Posts and Telecommunications (JGSZB202402) and (JGZYB202402).

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