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Original Articles

Music, Technology and Education

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Abstract: This article explores the profound impact of technological development on music education. It points out that since the 1980s, driven by government initiatives, computer and telecommunications-based technologies have been gradually integrated into the education system. This integration has prompted a shift in teaching methodology from teacher-centred knowledge transmission to a student-led framework for exploration primarily facilitated by technological tools. This study defines "music technology" as a broad conceptual domain, whose scope is not limited to digital software (e.g., Soundplant, Audacity) but also encompasses long-standing auxiliary tools such as pitch forks and pianos. Research indicates that the application of music technology has significantly influenced music education. For instance, it makes learning more intuitive through recording and analysis technologies (from phonographs to simulation systems); it stimulates student creativity and fosters unexpected inspiration through exploratory activities; and it promotes interdisciplinary collaboration and a transformation of teacher and student roles through projects like 'live coding'. In the process of utilizing these new technologies, the role of the teacher also shifts, increasingly becoming that of a supervisor and co-learner in the learning process. Furthermore, technological advancements create pathways for more individuals to learn music more effectively, as exemplified by the "Plug IT" project, which assists individuals with disabilities in participating in music creation, thereby broadening the inclusivity of music. In summary, technology serves as an empowering tool that not only optimizes teaching effectiveness and extends the horizons of possibility and creativity within music education but also enables both educators and learners to discover their individualized insights amid exploratory pursuits.

Keywords: Music Technology; Music Education; Pedagogy; Creativity; Teacher Role Transformation; Interdisciplinary Collaboration; Integration

1 Introduction: Core Questions About Technology and Music Education

This essay focuses on the impact of technology on music education. We are in an era of rapid technological development. Internet devices are not only growing every year, but they are growing at an ever-increasing rate. New technology is being updated more and more rapidly as time goes by. We can search the internet for almost anything we need. But at the same time, as technology continues to improve, more and more simple tasks can be replaced by technology. What impact has technology had on education?' What exactly does the term 'music technology' stand for? And what aspects of music education does technology affect? These are the three main points of this piece of essay.

2 The Influence of Technological Development on Education

First of all, how does the constant development of technology affect education? Somekh (2000) points out that since 1980, the government has been committed to introducing new technologies into education. And he quotes Tony Blair's speech in 1997, arguing that technology, in addition to already changing the way we live and work, will also continue to contribute to the development and change of education. So, children and teachers alike should be constantly learning about new technology and techniques in order to work more effectively in the future (p. 20). The term 'new technology' needs to be noted here, as the author refers to all computer and telecommunications-based technologies collectively as new technology. As technology continues to develop, there is no doubt that our work and life are becoming easier and easier. With the government pushing forward, education is embracing technology step by step. New things mean change, so teachers and students must learn new technologies to adapt to different times before change comes. When learning and using new technology, we need to be clear about the status of the technology. Its use should not just be a mandatory requirement, but rather a process of continuous breakthrough. Learning technology is a process of receiving new knowledge, and selecting the right technology to use in teaching is a test of the teacher's familiarity with this knowledge. Somekh and Davies (1991) also suggest that 'the development of a pedagogy for IT' is the process of interconnecting people with computers in educational learning. These technologies do not exist only as tools, they are also guides and witnesses to

our growth (p. 154). Thus, it is important to focus not just on the technology itself, but on the ways in which we want students to learn whatever we want them to learn.(Mishra & Henriksen, 2017, p. 11). And in order to choose the most appropriate technology, to teach effectively and quickly, teachers must understand the different ways in which multiple technologies can be presented and think about their relevance to pedagogy. The variety and multi-faceted nature of technology require teachers and students to carefully select the right one for them in order to get the best results.

3 The Transformation of Teaching and Learning Roles Driven by New Technologies

Somekh and Davies (1991) state that:

The computer, by providing an additional source of knowledge and information, reduces the dependency of students upon the teacher. They can use software to control and pace their own learning, taking the active role of constructing knowledge rather than the more passive role of receiving it (pp. 159-160).

To some extent, new technologies have expanded the options available to teachers and students, allowing them to choose more and more appropriate technologies to complete their learning. Somekh (2000) has done a number of studies on the use of new technology in teaching, such as students using the alternative keyboarding device Quinkeys to write long stories, which allows four students to sit around the computer and write their parts at the same time. There is also the author's research into the Apple Classroom of Tomorrow (ACOT) programme in Scotland (P. 24). From the results of the study, it seems that new technologies can be useful for classroom education if they are used in a way that helps teachers to observe each student's learning process better and faster and to identify and discuss problems that students do not understand immediately. They also allow students to be more aware of their progress, to have a better grasp of their strengths and weaknesses, and to be the first to practice. With the use of new technology, you will find that teachers are becoming less preoccupied with lectures in the classroom and students are becoming directly involved in the learning process. It reminded me of a lesson I had where the teacher asked us to learn and use a programme called Soundplant to create. The whole lesson was a little different from the previous ones in that the teacher's explanations were inserted. After a brief introduction to the software, the students' practise began. After a period of fumbling around, which coincided with finding some problems that could not be solved, the teacher again explained in more depth how to use the software better. This instantly solved the questions in our minds and deepened our impressions of what we had learned. We then used this knowledge to create a new piece of work, and so on. And so on and so forth until the final product was created. In this lesson, I felt that my own initiative and the teacher's real-time solutions not only made me more interested in what I was learning but also helped me remember it better. The teacher, on the other hand, was more of a guide and supervisor during the course of the lesson. Somekh & Davies (1991) also argue that the use of new technologies in the classroom can reduce the teacher's over-involvement and that the teacher's role becomes more of a supervisor and coordinator. The authors emphasise that the use of these technologies also transforms the teacher into a 'co-learner' who works with students to discuss and solve problems as they arise (p. 161). In summary, the constant advancement of technology has brought to education not only the need for constant learning, but also a shift in identity, which has made teaching and learning somewhat more straightforward and clearer and has allowed both teachers and students to improve.

4 The Definition and Scope of Music Technology

So, what does music technology look like? Before we do that, we need to define music technology. The term 'music technology' is widely used nowadays - the Soundplant mentioned above, or the well-known Audacity, are all music technology. However, these computer and software technologies do not represent the whole spectrum of music technology. In other words, music technology has never been just digital technology. It is not the same concept as the 'new technology' mentioned above. Himonides (2012) also agrees and points out from a historical perspective that not only computer technology, but also music scores, pitch forks, pianos, metronomes, etc., created long ago, are all part of music technology. From a macro perspective, 'music technology' is everything that helps us learn music better. Himonrides and Purves (2010) point out that technology is already present in almost everyone's lives. However, the term 'music technology' is not well defined. So, the authors consider 'music technology' as a broad concept, while it can help us to continuously understand music and the impact it has on our lives; to continuously capture music; to create better teaching and learning experiences; to facilitate communication between

music and music; to make us better musicians; and to be able to monitor and evaluate teaching practises (P. 123-124).

5 The Multidimensional Impact of Music Technology on Music Education

With this understanding of what music technology really is, let's look at the impact of music technology on music education. Firstly, music technology is constantly evolving to include more than just expensive large-scale technology. More and more powerful and practical music technology is being released on the internet, being downloaded and used for free, and the expansion of resources is allowing teachers to use technology in the classroom more often (Savage, 2005, p. 167). The most intuitive aspect of the use of technology for me is that it makes it easier for me to capture my own voice. The recording technology that Himonides (2019) points out is one of the technologies that I use most for music, the phonograph, invented by Thomas Edison in 1877 when sound could be preserved for the first time. Then came the 'analog domain', where sound vibrations could be converted into different electrical signals and stored on tapes etc. The quality and duration of sound preservation have greatly increased. Later, different types of microphones were developed for different people, with a completely different focus (pp. 1-9). These techniques constantly facilitate a better understanding of how to use the voice. Just like I used to record every vocal lesson I had so that I could listen to it over and over again during practise for better results. It has also been shown through research data that new technologies enable students to have more direct access to sound and to analyse research based on this more closely (Savage, 2005, p. 171). As well as allowing us to record and analyse sounds in a better and more direct way, the constant use of music technology allows students to be more creative. Torrance (1972) notes that children tend to think and learn more creatively when they are engaged in manipulative or exploratory activities (p. 115). Therefore, as they continue to explore new techniques, students may inadvertently become inspired. The process of creativity is the sudden discovery of unexpected elements in the process of working and their use at the right time (Stravinsky, 1974, P. 50). Savage (2005) also points out that in exploring various musical techniques, there are always many 'surprises' that arise. And these accidents are the spark of creativity (p. 172). In other words, active and continuous exploration of music technology allows students to move away from 'standard answers' and explore and create more answers of their own. Paynter (1997) also points out that information technology is a means rather than an end, and that technology offers many opportunities for us to learn to enjoy music, 'it offers the opportunity to explore different timbres' or 'the opportunity to create a unique interpretation of music for each individual' (P. 108). Being imaginative in the use of music technology not only makes teaching easier and simpler, but also allows you to find your own unique sound in learning. While music technology can help us learn music better, it can also contribute to a certain extent to the interdisciplinary development of students and the meaningful collaboration between teachers and external teachers. For example, in Learning From Live Coding, the author combines live code and music education in an experiment using Sonic Pi as a learning object. The results of the experiment confirm that the learning and use of this software has led to an improvement in students' abilities in music, coding and live coding performances. And to a certain extent, it has allowed teachers and experts to become music artists. Computer teachers and others have established partnerships that better facilitate teaching and learning (Burnard et al., 2016, pp. 5-11). It is also worth noting that music technology has been very helpful in the education of people with disabilities. 'Plug IT', a project run by the Drake Music Project in London, aims to provide disabled people with the opportunity to create music, using music technology to break through their limitations and enjoy creating their music (Himonides, 2012, pp. 10). I think this project proves that technology is not just an aid but also has the potential to create new lives. It breaks things that would otherwise not be possible and allows people to better communicate with each other. Also, as the project ultimately required a full performance, the students themselves had to use a large number of extremely complex musical techniques, each with a different purpose, some to help the students, some to make music, etc. And learning to coordinate these musical techniques also made the students better themselves.

6 Conclusion: Technology as an Enabler in Music Education

It can be seen that music technology can push the limits of the human body, turning the uncontrollable into the controllable and making people understand the importance of music.

In an era of data explosion, we need to understand that technology is our enabler. It guides and helps teachers and students learn better. And music technology is one of these many categories of technology. It is important to understand that music technology is something that enables teachers and students to learn music better, it makes teachers more accessible, it makes students more creative, it allows both to find

their own answers in explorers, and it empowers people with disabilities to participate in music learning.

References

[1] Burnard, P., Florack, F., Blackwell, A. F., Aaron, S., & Philbin, C. A. (2016). Learning From Live Coding. Routledge Handbooks Online. https://doi.org/10.4324/9781315686431.ch4

[2] Hallam, S., McQueen, H., Creech, A., Adams, P., Conlon, J., Durrant, C., Ellison, J., Gaunt, H., Himonides, E., & Laurence, K. (2010). Music Education in the 21st Century in the United Kingdom: Achievements, Analysis and Aspirations. Institute of Education Press (IOE Press). http://ebookcentral.proquest.com/lib/ucl/detail.action?docID=1047876

[3] Himonides, E. (2012, September 6). The Misunderstanding of Music-Technology-Education: A Meta Perspective. The Oxford Handbook of Music Education, Volume 2. https://doi.org/10.1093/oxfordhb/9780199928019.013.0029_update_001

[4] Himonides, E. (2019, April 11). Ave Verum Pentium. The Oxford Handbook of Singing. https://doi.org/10.1093/oxford-hb/9780199660773.013.55

[5] Mishra, P., & Henriksen, D. (2017). Creativity, Technology and Education: Exploring Their Convergence. Springer International Publishing AG. http://ebookcentral.proquest.com/lib/ucl/detail.action?docID=5183823

[6] Paynter, J. (1997). Editorial. British Journal of Music Education, 14(2), 107–108. https://doi.org/10.1017/S0265051700003533

[7] Savage, J. (2005). Working towards a theory for music technologies in the classroom: How pupils engage with and organise sounds with new technologies. British Journal of Music Education, 22(2), 167–180.

[8] Somekh, B. (2000). New Technology and Learning: Policy and Practice in the UK, 1980–2010. Education and Information Technologies, 5(1), 19–37. https://doi.org/10.1023/A:1009636417727

[9] Somekh, B. (2007). Pedagogy and learning with ICT. London: Routledge.

[10] Somekh, B., & Davies*, R. (1991). Towards a pedagogy for information technology. The Curriculum Journal, 2(2), 153–170. https://doi.org/10.1080/0958517910020205

[11] STRAVINSKY, I. (1974) The Poetics of Music. Cambridge, MA: Harvard University Press.

[12] Torrance, E. P. (1972). Can We Teach Children To Think Creatively?*. The Journal of Creative Behavior, 6(2), 114–143. https://doi.org/10.1002/j.2162-6057.1972.tb00923.x

The Impact of Teacher-student Relationship on Students' Academic Satisfaction in Calligraphy Aesthetic Education: With Academic Self-efficacy, Coping Styles, and Grit as Mediators

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Abstract: This study aims to explore the impact of teacher-student relationship on students' academic satisfaction level in calligraphy aesthetic education, as well as the mediating effects of coping styles and self-efficacy in this process. Taking 500 college students from 5 universities offering calligraphy aesthetic education courses as the research subjects, this study collected data through questionnaires. An empirical model was constructed with "teacher-student relationship" as the explanatory variable, self-efficacy, coping styles and grit as mediating variables, and academic satisfaction as the explained variable, and relevant hypotheses were tested. The results show that the teacher-student relationship in calligraphy aesthetic education has a positive impact on academic satisfaction, and self-efficacy, coping styles and grit also play positive mediating roles between the two. This study holds that in calligraphy aesthetic education, teachers should focus on guiding college students to improve teacher-student relationship, cultivate self-efficacy, optimize coping styles and develop grit, so as to enhance students' academic satisfaction.

Keywords: Calligraphy Aesthetic Education; College Students; Teacher-Student Relationship; Academic Satisfaction; Self-efficacy; Coping Styles; Grit

1 Introduction

Academic satisfaction of college students is a key indicator for measuring educational quality, student development, and college life experience. It is directly related to students' learning motivation, mental health, academic achievement, as well as their career development and social adaptation after graduation (Wei & Fang, 2005; Wen & Shi, 2013; Wen, 2019).

Therefore, paying attention to and improving college students'academic satisfaction is of great significance to individuals, educational institutions, and the whole society (Wu, 2011). When students can fully concentrate on learning, actively participate in class discussions, and take the initiative to explore and think about problems, they are more likely to achieve good academic performance and academic recognition, thereby improving their satisfaction with their studies (Cui, 2020). College students'self-efficacy also plays an important role in their academic satisfaction. Self-efficacy refers to an individual's confidence and belief in their ability to successfully complete a specific task (Bandura, 1986). When college students possess positive coping styles, they are more likely to invest actively in learning and make sustained efforts, thus improving their academic satisfaction (Woolfolk, 2008).

Based on the aforementioned existing studies, this research deems it necessary to explore the correlation between teacher-student relationship and factors affecting coping styles, self-efficacy, grit, and college students'academic satisfaction. Niu (2017) pointed out that the group difference trends of the two dependent variables—teacher-student relationship and academic satisfaction—are surprisingly consistent, which further confirms a strong correlation between teacher-student relationship and students'academic satisfaction. Therefore, this study takes 500 college students from 5 universities offering calligraphy aesthetic education courses as research subjects, and analyzes how teacher-student relationship, self-efficacy, coping styles, and grit—factors influencing academic satisfaction—relate to the level of academic satisfaction.

The purpose of this study is to examine the impact of teacher-student relationship on academic satisfaction in calligraphy aesthetic education, as well as the mediating roles of coping styles and self-efficacy in this process. Specifically, it first analyzes the overall characteristics of teacher-student relationship, coping styles, self-efficacy, grit and academic satisfaction of college students in calligraphy aesthetic education programs at the sample universities, and explores whether there are significant differences in terms of demographic variables. Then,

it focuses on investigating the impact of teacher-student relationship on academic satisfaction in calligraphy aesthetic education, and the mediating effects of coping styles, self-efficacy, and grit between the two. Based on the results, this study provides suggestions for enhancing college students'coping styles, self-efficacy, and grit, improving teacher-student relationship, and boosting academic satisfaction. This study draws on research methods in the field of educational psychology to investigate the impact of teacher-student relationship on college students'academic satisfaction—specifically, the state of academic satisfaction after the implementation of calligraphy courses—and the mediating roles of variables such as self-efficacy and coping styles.

The following research questions are proposed:

Q1: Under the influence of teacher-student relationship, are there differences in the level of academic satisfaction among different groups of students?

Q2: Does the quality of teacher-student relationship of college students in calligraphy aesthetic education have a direct impact on their academic satisfaction?

Q3: In calligraphy aesthetic education, do college students'self-efficacy, coping styles, and grit have a direct impact on their academic satisfaction?

Q4: In calligraphy aesthetic education, when teacher-student relationship affects college students' academic satisfaction, do self-efficacy, coping styles, and grit exert an influence on college students' academic satisfaction?

Q5: In calligraphy aesthetic education, can college students'academic satisfaction be mediated by self-efficacy, and what effect does this mediation have in the process of teacher-student relationship influencing academic satisfaction?

Q6: In calligraphy aesthetic education, can college students' academic satisfaction be mediated by coping styles, and what effect does this mediation have in the process of teacher-student relationship influencing academic satisfaction?

Q7: In calligraphy aesthetic education, can college students' academic satisfaction be mediated by grit, and what effect does this mediation have in the process of teacher-student relationship influencing academic satisfaction?

2 Theoretical Background

2.1 Teacher-Student Relationship

This study mainly refers to Walker & Baepler (2017) for its definition of teacher-student relationship, which defines it as a relationship of interaction and cooperation, in which teachers act as mentors and guides, providing support and guidance to help students achieve success in academic and personal development. The summary of the elements of teacher-student relationship also draws on Walker & Baepler (2017), who summarized the elements of this relationship in their research, including formal student-teacher relationship, informal student-teacher relationship, and the role of students as teachers.

(1)Self-efficacy

Bandura defined self-efficacy as an individual's judgment of their ability to organize and execute the courses of action required to achieve predetermined behavioral goals (Zhang, 2023). The widely used version of the GSES was developed in 1981 by Professor R. Schwarzer, a renowned clinical and health psychologist from Freie Universität Berlin, and his colleagues (Schwarzer, 2009).

(2)Coping Styles

The concept of coping is translated from the English word cope, which means to deal with or face, usually in the context of abnormal situations, anxiety, or stress. According to Webb (1999), there are four research perspectives on coping. Internationally, the most widely used scale for measuring coping styles is the Ways of Coping Questionnaire developed by Lazarus & Folkman (1984). Additionally, there is the COPE Inventory compiled by Carver et al. (1989).

(3)Grit

Duckworth et al. (2007) argued that grit, a character strength mentioned in positive psychology, refers to the perseverance and determination to accomplish grand and long-term goals, despite inevitable failures, adversities, and stagnations in the process. Regarding the connotation of grit, Duckworth (2007) was the first to discuss it and proposed the two-factor concept of grit.

(4)Academic Satisfaction

Appleton-Knapp & Krentler (2006) believed that the essence of academic satisfaction lies in college students' subjective evaluation of their university's educational quality based on their own subjective feelings, which also reflects students' attitudes and tendencies towards learning and campus life. Du et al. (2003) argued that students evaluate aspects such as teachers' teaching and campus environment according to their own evaluation criteria, and they are considered satisfied if the actual situation meets or exceeds these criteria. Jaeger (1974) divided academic satisfaction into dimensions such as satisfaction with teachers and satisfaction with courses.

3 Research Methods

3.1 Research Model and Hypotheses

3.1.1 Research Model

The purpose of this study is to examine the relationships between college students' self-efficacy, coping styles, and academic satisfaction level in calligraphy aesthetic education based on teacher-student relationship, and to verify the contribution of teacher-student relationship to college students' academic satisfaction level in calligraphy aesthetic education. On the basis of theories and previous studies on various variables, a model is constructed, with teacher-student relationship as the independent variable, self-efficacy and coping styles as mediating variables, and academic satisfaction level as the dependent variable, as shown in [Figure 1].
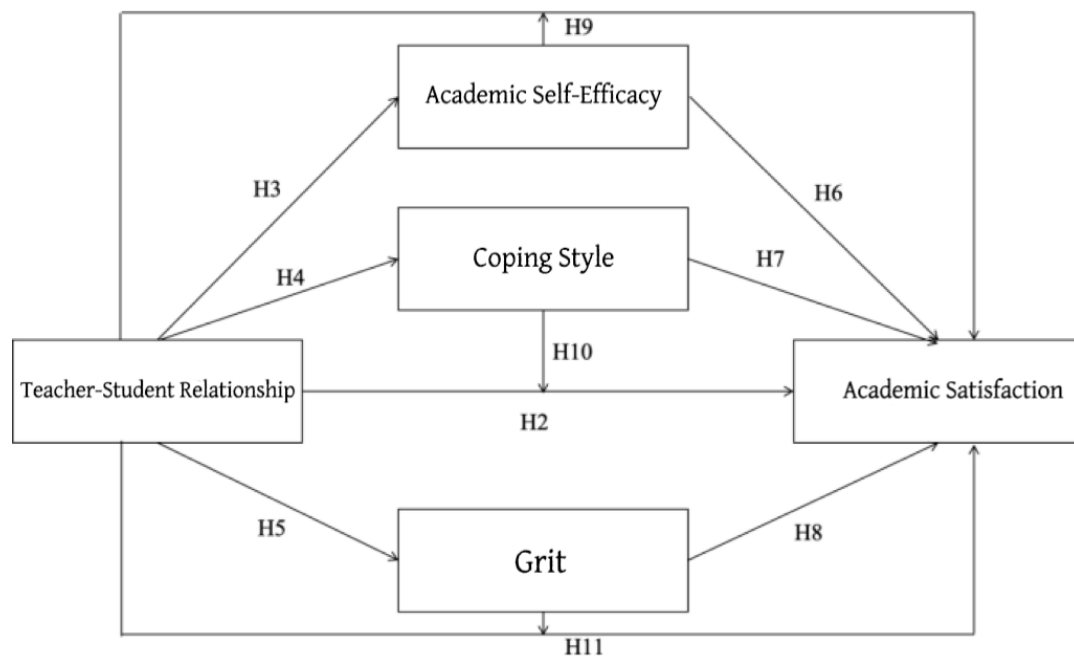
[Figure 1] Research Model

3.1.2 Research

Hypotheses Based on the theoretical background and previous studies, this study formulates the following research hypotheses in accordance with its research objectives:

<H1> Do demographic variables of different student groups lead to differences in the impact of teacher-student relationship on self-efficacy, coping styles, grit, and academic satisfaction level?

<H2> Does the teacher-student relationship have a direct impact on students' academic satisfaction level in calligraphy aesthetic education?

<H3> Does the teacher-student relationship have a direct impact on students' self-efficacy in calligraphy aesthetic education?

<H4> Does the teacher-student relationship have a direct impact on students' coping styles in calligraphy aesthetic education?

<H5> Does the teacher-student relationship have a direct impact on students' grit in calligraphy aesthetic education?

<H6> Does college students' self-efficacy have a direct impact on their academic satisfaction level in calligraphy aesthetic education?

<H7> Does coping style have a direct impact on academic satisfaction level in calligraphy aesthetic education?

<H8> Does grit have a direct impact on academic satisfaction level in calligraphy aesthetic education?

<H9> Does the teacher-student relationship in calligraphy aesthetic education affect academic satisfaction level through the mediating role of self-efficacy?

<H10> Does the teacher-student relationship in calligraphy aesthetic education affect academic satisfaction level through the mediating role of coping styles?

<H11> Does the teacher-student relationship in calligraphy aesthetic education affect academic satisfaction level through the mediating role of grit?

3.2 Research Subjects

The samples of this study consist of 500 college students from 5 universities offering calligraphy aesthetic education courses, including the Central Academy of Fine Arts, China Academy of Art, Luxun Academy of Fine Arts, Xi'an Academy of Fine Arts, Guangzhou Academy of Fine Arts, and Hubei Academy of Fine Arts. This survey was conducted from June 1, 2025, to September 30, 2025, spanning a total of 18 weeks. Additionally, a questionnaire survey was distributed from September 1 to September 30, 2023, with 510 questionnaires issued in total. After excluding erroneous and invalid questionnaires, the actual number of valid samples was 500, resulting in an effective questionnaire rate of 98.04%. The demographic variables included in the questionnaire cover gender, grade, and others. Statistical data on the number of participants show that among the college students surveyed, there are 325 females (65.00%) and 175 males (35.00%). In terms of grade distribution, there are 124 freshmen (24.80%), 135 sophomores (27.00%), 121 juniors (24.20%), and 120 seniors (24.00%).

3.3 Research Instruments

3.3.1 College Students' Academic Satisfaction

The main instrument used in this study to measure college students' academic satisfaction is the 12-item General Health Questionnaire (GHQ-12; Zhang et al., 2008), which has been revised according to the specific characteristics of the respondents' satisfaction. The original questionnaire has no dimensional division; in the revised version, items 1–5 are positively worded (5 items), and items 6–10 are negatively worded (5 items), totaling 10 items.

3.3.2 Teacher-Student Relationship

The measurement of teacher-student relationship in this study mainly refers to the Teacher-Student Relationship Measurement Scale developed by Walker & Baepler (2017). This scale consists of 3 dimensions, namely formal student-teacher relationship (5 items), informal student-teacher relationship (5 items), and the role of students as teachers (6 items), with a total of 16 items.

3.3.3 Coping Styles

In this study, coping styles are categorized into positive coping styles and negative coping styles. Lazarus & Folkman (1984) developed a Coping Styles Scale, which divides coping styles into two dimensions: positive coping styles and negative coping styles. Additionally, the Simplified Coping Style Scale developed by Xie (1998) also includes two aspects: positive coping styles and negative coping styles. Based on these two scholars' scales, this study adjusted the Coping Styles Scale according to the characteristics of college graduates in central China. The adjusted scale used in this study has 10 items and 2 dimensions, namely positive coping styles (5 items) and negative coping styles (5 items).

3.3.4 Self-efficacy

The measurement of self-efficacy in this study is based on the Self-efficacy Scale (SES) developed by Bandura in 1977, which has been revised according to the specific self-efficacy characteristics of the respondents. The revised scale includes 2 dimensions: Academic Ability Self-efficacy: Including 2 items on judgment of failure avoidance and 3 items on confidence in failure avoidance (5 items in total); Academic Behavior Self-efficacy: Including 3 items on learning methods and 2 items on goal-directed behavior (5 items in total). The scale has 10 items

in total. 5) Grit The measurement of grit in this study mainly adopts the Grit Questionnaire designed by Duckworth (2007). This question-naire has a structured format and contains 12 items, covering two dimensions: consistency of interests (6 items) and perseverance of effort (6 items).

3.4 Research Procedures

This study will be conducted in the following steps:

First, a survey will be conducted to collect data on respondents' basic information, as well as college students' self-efficacy, coping styles, and academic satisfaction level in calligraphy aesthetic education. Descriptive statistics will then be performed to determine whether there are differences among different groups.

Second, a correlation analysis of the variables will be carried out to identify the correlations between them.

Third, a regression model will be constructed to test the impact of teacher-student relationship on academic satisfaction, and to verify the mediating effects of self-efficacy and coping styles.

4 Research Results

4.1 Descriptive Statistics

The results of descriptive statistics show that: the mean value of the teacher-student relationship variable is (M = 3.548); the mean value of the self-efficacy variable is (M = 4.038); the mean value of the coping styles variable is (M = 3.577); the mean value of the grit variable is (M = 2.626); and the mean value of the academic satisfaction variable is (M = 3.058).

4.2 Correlation Analysis

<Table 1> Correlations Between Teacher-Student Relationship and Scales of Self-efficacy, Coping Styles, Grit, and Academic Satisfaction

Variable	1	2	3	4	5
1.Teacher–Student Relationship	1				
2.Academic Satisfaction	.61**	1			
3.Self-efficacy	.53**	.54**	1		
4.Coping Style	.62**	.69**	.68**	1	
5.Grit	.60**	.65**	.73**	.55**	1

As shown in <Table 1>, in the multi-factor correlation analysis of teacher-student relationship with self-efficacy, coping styles, and academic satisfaction, the teacher-student relationship exhibits a significant positive correlation with self-efficacy (r = .530, p < .01), with coping styles (r = .620, p < .01), and with academic satisfaction (r = .610, p < .01).

5 Conclusions

The results of this study indicate that the teacher-student relationship in calligraphy aesthetic education exerts a positive impact on academic satisfaction, and self-efficacy, coping styles, and grit also play positive mediating roles between the two. Therefore, this study suggests that in calligraphy aesthetic education, teachers should focus on guiding college students to improve the teacher-student relationship, cultivate self-efficacy, and optimize coping styles, so as to enhance students' academic satisfaction.

References

[1]Appleton-Knapp, S. L., & Krentler, K. A. (2006). Measuring student expectations and their effects on satisfaction: The importance of managing student expectations. Journal of Marketing Education, 28(3), 254–264.

[2]Duckworth, A. L., Peterson, C., Matthews, M. D., & Kelly, D. R. (2007). Grit: Perseverance and passion for long-term goals. Journal of Personality and Social Psychology, 92(6), 1087–1101.

[3]Du, H. M., Wang, K. W., Shao, X. P., et al. (2003). A survey on graduate students' satisfaction with the present situation of graduate education in higher education. Journal of Chongqing University, (6), 161–163. (In Chinese)

[4]Jaeger, R. M. (1978). Chapter 7: About educational indicators: Statistics on the conditions and trends in education. In Review of Research in Education (Vol. 6, No. 1, pp. 276–315).

[5]Lazarus, R. S., & Folkman, S. (1984). Stress, appraisal, and coping. Springer Publishing Company.

[6]Niu, K. H. (2017). Current situation, problems and countermeasures of college students' learning process evaluation: A survey based on 16 undergraduate universities nationwide. University Education Science, (6), 42–49+121. (In Chinese)

[7]Printz, B. L., Shermis, M. D., & Webb, P. M. (1999). Stress-buffering factors related to adolescent coping: A path analysis. Adolescence, 34(136), 761–778.

[8]Schwarzer, R., & Renner, B. (2009). Health-specific self-efficacy scales (14th ed.). Freie Universität Berlin.

[9]Walker, J. D., & Baepler, P. (2017). Measuring social relations in new classroom spaces: Development and validation of the Social Context and Learning Environments (SCALE) Survey. Journal of Learning Spaces, 6(3), 34–41.

[10]Zhang, D. C. (2023). A classification analysis of "45-degree youth" and the cultivation of the spirit of striving. Journal of Yunnan University (Social Sciences Edition), (6), 94–101. (In Chinese)

The Impact of Working Memory on Cognitive Load via Viewing Bilingual Subtitles

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Abstract: This study explores the relationship between working memory and cognitive load during bilingual subtitle viewing. 42 Chinese university students completed a working memory test and watched an English documentary with bilingual subtitles. After viewing, they reported their perceived intrinsic, extraneous, and germane cognitive load using a validated questionnaire. Regression analyses showed that working memory significantly predicted germane load but not intrinsic or extraneous load. These findings suggest that learners with greater working memory are more likely to invest in meaningful learning processes. The study offers insights into the cognitive mechanisms underlying multimedia language learning and calls for more individualised approaches in instructional design.

Keywords: Working Memory; Cognitive Load; Bilingual Subtitles; Multimedia Learning

1 Introduction

In multimedia second language (L2) learning, learners often face simultaneous auditory, visual, and textual information. Bilingual subtitles display both the first language (L1) and the L2 text during audiovisual input (Wang & Pellicer-Sánchez, 2022), supporting comprehension and vocabulary development (Montero Perez et al., 2020), but increasing cognitive processing demands due to multi-modal information coordination (Gottlieb, 1998). These demands may exceed working memory capacity if instructional design fails to optimise cognitive resource allocation (Kalyuga et al., 1999).

Working memory, which is responsible for temporarily storing and processing information (Baddeley, 2000), affects performance in complex L2 tasks (Linck et al., 2014; In'nami et al., 2022). However, its link to learners' subjective cognitive effort in multimedia settings, especially with bilingual subtitles' unique demands, remains understudied. Cognitive Load Theory (Sweller et al., 2011) distinguishes intrinsic (content complexity), extraneous (instructional design), and germane (meaningful learning) load. Empirical studies on how working memory relate to each load type in bilingual subtitle are limited.

To address this gap, the present study investigates whether working memory predicts the three cognitive load types in bilingual subtitle viewing. It enhances understanding of L2 multimedia cognitive processing and highlights learner characteristics' role.

2 Literature review

2.1 Subtitles in different linguistic formats and cognitive load

Subtitle linguistic format has common types including full, keyword, glossed, and bilingual subtitles, each varying in linguistic and visual complexity. Glossed and keyword captions reduce extraneous load by offering targeted lexical support without redundant information (Teng, 2023; Montero Perez, 2012). In contrast, bilingual subtitles are more cognitively demanding, requiring simultaneous processing of two languages, images, and sounds. Though they may boost comprehension via redundancy, poor design risks overload (Winke et al., 2010). Eye-tracking studies show bilingual and full captions lead to longer fixations and stronger split-attention effects than simplified formats (Montero Perez et al., 2014; Winke, Gass, & Sydorenko, 2013), linking to higher extraneous load when coordinating visual, audio, and subtitle input.

Cognitive Load Theory (CLT) explains these effects: intrinsic load depends on audiovisual content's linguistic complexity, while extraneous load relates to subtitle presentation. Overly dense or asynchronously bilingual subtitles increase extraneous load, reducing resources for germane processing (Sweller et al., 2011; Leppink et al., 2014). Thus, instructional designers must optimise subtitle format and alignment.

2.2 Working memory and cognitive load

Working memory, a key individual difference variable, shapes cognitive load experience and regulation in multimedia learning. According to Baddeley's (2000) multicomponent model, it consists of a central executive and two storage systems: the phonological loop for verbal information and visuospatial sketchpad for visual information, which is relevant in subtitle-video tasks.

Several studies have found positive relationships between working memory and L2 listening, reading, and vocabulary performance in multimedia settings (Linck et al., 2014; In'nami et al., 2022; Miyake & Friedman, 1998). Learners with higher working memory better process concurrent audiovisual input, integrate it with prior knowledge, and experience lower extraneous load and higher germane engagement. Winke et al. (2010) noted higher working memory learners benefit more from full and bilingual captions, while lower-capacity learners face greater overload risk. Recent findings also emphasise the component-specific working memory effects. Teng (2023) found phonological working memory best predicts incidental vocabulary learning from captioned videos in younger learners, suggesting input modality and age moderate its role in load regulation.

Moreover, working memory interacts differently with each load type. It does not reduce content's intrinsic complexity but filters extraneous elements and promotes germane load. Low working memory learners struggle with subtitles, especially bilingual ones, lowering content attention and learning outcomes (Sydorenko et al., 2017).

2.3 Cognitive load theory

Developed by Sweller (1988), Cognitive Load Theory (CLT) frames learning's mental demands, emphasising working memory limits and effective cognitive resource management. CLT categorises load into intrinsic, extraneous, and germane load (Sweller, Ayres, & Kalyuga, 2011). Leppink et al. (2014) created a multidimensional questionnaire to measure perceived intrinsic, extraneous, and germane load, which is widely used in experiments and education for reliable load assessment in complex tasks. Mayer's (2001) CLT extension to multimedia learning stresses coherence, signalling, and dual-channel processing, which is critical for subtitled videos where learners process simultaneous audio and text. Studies by Montero Perez et al. (2014) and Sydorenko et al. (2017) have shown that subtitle design impacts learning by altering load distribution: poor synchronisation or excessive text increases extraneous load, while well-aligned, concise subtitles boost germane load and deeper engagement.

While subtitle format and working memory both affect cognitive load, few studies explore how working memory shapes processing during bilingual subtitle viewing. Guided by CLT, this study investigates if working memory predicts different load types in this context.

3 Methodology

3.1 Participants

42 Chinese English-major students (37 females, 5 males; Mage=20, SDage=1.47) from a university in southwest China participated in this study voluntarily. The sample size matches similar studies (Zhang & Zhang, 2022; Teng, 2024) and suffices for mixed-effects modelling. All participants completed English proficiency and working memory tests, and signed consent forms at first.

3.2 Materials

3.2.1 Measurements of participants' working memory

The Reading Span Task (RST) (Daneman and Carpenter ,1980) measured working memory. It used 70 unrelated English sentences (11-13 words each, half grammatical, half ungrammatical), with participants judging grammaticality and recalling final words to ensure active syntactic processing. Administered via E-prime 3.0, the task had a maximum total score of 140 (70 each for working memory's processing and storage). RST is reliable in L2 research (Juffs & Harrington, 2011) with Cronbach's alpha=0.83 (Teng, 2024).

3.2.2 Experiment materials

The video clip: An 856-word excerpt from the BBC documentary Animal Odd Couples (2013) was edited with Clipchamp (Microsoft Corporation, 2023). Focused on a bear-tiger-lion friendship, the clip content matched participants' vocabulary. Post-viewing interviews with

another similar 7 learners indicated that 1.0x speed was too fast. Therefore, the playback speed was adjusted to 0.8x with 6 minutes and 55 seconds totally. Python (v3.9.6) analysed the top 3,000 frequent words covered 97% of the material, with the Corpus of Contemporary of American English (COCA) (Davies, 2008) as the reference corpus.

Vocabulary test: the Vocabulary Size Test (VST) (Nation, 2007) includes 140 items (10 items per level), covering the 1,000 to 14,000 word-family levels, with a maximum score of 14,000. The Cronbach's alpha of the test was 0.80(Peters, 2019). On average, participants had a vocabulary size of approximately 4,986 words, which was sufficient to understand the English subtitles of the video.

Subtitles: The original English video script was translated into Chinese, cross-checked with an amateur translation (Bilibili, n.d.) and reviewed by 3 English-fluent native Chinese speakers. CapCut Professional software (v7.5.0) ensured L1 and L2 subtitle synchronisation with audio and images.

Comprehension test: A 5 multiple-choice questions test (2 points each, max=10) was designed to evaluate participants' understanding of the video. No target words were included, and "I don't know" was an option. All the participants had achieved a score over 8 (M=9.78, SD=0.63).

3.2.3 Measurements for participants' cognitive load

Leppink et al.'s (2014) post-task self-report cognitive load questionnaire was used to validate and distinguish load types, which adjusted the contextual information for film comprehension. It had 14 items (10-point Likert scale: 1= "not at all", 10= "completely"):

Intrinsic Cognitive Load (IL) included 4 items that evaluated the complexity of the video content itself. Participants rated the visual, auditory, subtitle-related language complexity, and the mental effort for the overall complexity of the video.

Extraneous Cognitive Load (EL) consisted of 7 items that measured the clarity and effectiveness of the information presentation, assessing the clarity of visual and auditory information, the subtitle comprehensibility, the inefficiency of English and Chinese subtitles in supporting vocabulary learning, and the mental effort for unclear presentation.

Germane Cognitive Load (GL) included 3 items that evaluated the perceived contribution of the video to knowledge construction, assessing the video's role in learner's understanding, their vocabulary knowledge, and the mental effort for knowledge enhancement.

Cronbach's alpha confirmed reliability: IL=0.927, EL=0.856, GL=0.842, supporting construct validity and contextual suitability.

3.3 Procedures

The study comprised three stages: English vocabulary size and working memory test; consent form signing and video viewing that focused on comprehension; comprehension test and a cognitive load questionnaire. The complete processes are shown in Figure 1.
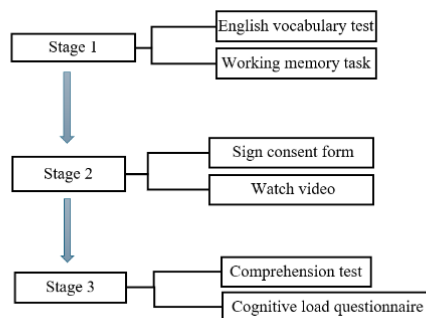

Figure 1 The experiment process

4 Results and Discussion

4.1 Working memory results and cognitive load results

Working memory scores ranged from 50 to 115 (M=90.02, SD=15.21), with slight negative skewness (Skewness=-0.69) and moderate kurtosis (Kurtosis=0.65). As shown in Table 1, IL's scores ranged from 4 to 25, the mean was 13.71 (SD = 5.07), with near-normal distribu-

tion (Skewness=-0.03, Kurtosis=-0.68), suggesting a relatively symmetrical distribution with slight platykurtic tendencies. For EL's scores ranged from 7 to 32, the mean was 18.29 (SD = 8.03). The skewness (0.17) and kurtosis (-0.89) indicated a moderately right-skewed distribution. GL's scores ranged from 12 to 30, the highest mean was 20.05 (SD=4.70) among the three dimensions, which suggested a positively skewed and near-normal distribution (Skewness=0.37, Kurtosis=0.09).

Table 1 Descriptive statistics of cognitive load

Cognitive load	Mean	SD	Max.	Min.	Skewness	Kurtosis
IL	13.71	5.07	25	4	-0.03	-0.68
EL	18.29	8.03	32	7	0.17	-0.89
GL	20.05	4.70	30	12	0.37	0.09

4.2 The Impact of Working Memory on Cognitive Load

To examine the effect of working memory capacity on cognitive load, three linear regressions (working memory as independent variable, each load type as dependent variable) were conducted.

Table 2 The impact of working memory on cognitive load

Cognitive load	F	p	R^2	Adjusted R^2
IL	0.014	0.908	0.000	-0.025
EL	2.661	0.111	0.064	0.040
GL	6.588	0.014*	0.144	0.123

The regression analysis for IL indicated that working memory was not a significant predictor, $F(1, 39) = 0.014$, $p = .908$. This result suggests that the perceived complexity of the audiovisual material remained consistent across learners. This aligns with CLT's claim that IL depends on material inherent complexity and prior knowledge (Sweller et al., 2011), and working memory does not alter perceived material complexity (Leppink et al., 2014; Montero Perez et al., 2014).

Similarly, no significant relationship was found between working memory and EL, $F(1, 39) = 2.661$, $p = .111$. This indicates that participants' evaluations of instructional clarity or the quality of subtitle presentation was largely independent of their working memory capacity. This outcome partially aligns with Winke et al. (2010), who reported that subtitle format can influence EL, and Teng (2023), who noted that well-synchronised captioning reduces EL variance across cognitive profiles.

In contrast, a significant effect was observed for GL, $F(1, 39) = 6.588$, $p = .014$. This finding suggests that higher working memory correlated with more effort for meaning construction and knowledge integration. This finding is consistent with In'nami et al. (2022) and Linck et al. (2014), who emphasised that working memory is positively associated with deeper L2 processing, and Teng (2023) who indicated that stronger phonological working memory enhances captioned input benefits. It also supports CLT's view that germane load reflects motivation and meaningful processing ability (Sweller et al., 2011). The regression results are visualised in Figures 2, 3, and 4.

Figure 2 Scatter plots with regression line showing the relationship between working memory and IL

Figure 3 Scatter plots with regression line showing the relationship between working memory and EL

Figure 4 Scatter plots with regression line showing the relationship between working memory and GL

5 Conclusion

This study examined how working memory capacity affects cognitive load during bilingual subtitle viewing. The results showed that working memory did not significantly predict intrinsic or extraneous cognitive load. However, it did significantly predict germane cognitive load, indicating that learners with higher working memory were more likely to invest effort in meaningful learning processes. These findings support the distinction among the three types of cognitive load and highlight the role of individual cognitive capacity in multimedia learning. They suggest that while working memory may not affect how learners perceive complexity or presentation, it contributes to their ability to engage in deeper processing. This study is limited by its small sample size and single-subtitle condition. Future research should consider using more diverse participants, varying subtitle formats, and incorporating objective measures of cognitive load. Overall, the study adds to our understanding of how working memory interacts with bilingual subtitle processing and provides useful implications for the design of language learning materials.

References

[1] Baddeley, A. (2000). The episodic buffer: A new component of working memory? Trends in Cognitive Sciences, 4(11), 417–423.

[2] BBC. (2013). Animal odd couples. https://www.bbc.co.uk/programmes/b03jp46s

[3] Bilibili. (n.d.). 奇特的动物伙伴 1 [odd animal couples 1]. https://www.bilibili.com/video/av21620515/

[4] Daneman, M., & Carpenter, P. A. (1980). Individual differences in working memory and reading. Journal of Verbal Learning and Verbal Behavior, 19(4), 450–466.

[5] Davies, M. (2008). The corpus of contemporary American English (COCA): 450 million words, 1990-present.

[6] Gottlieb, H. (1998). Subtitling. In M. Baker (Ed.), Routledge Encyclopedia of Translation Studies (pp. 244–248). Routledge.

[7] In'nami, Y., Koizumi, R., & McLean, S. (2022). Working memory and L2 reading: A meta-analysis. Language Learning, 72(3), 742–785.

[8] Juffs, A., & Harrington, M. (2011). Aspects of working memory in L2 learning. Language Teaching, 44(2), 137–166.

[9] Kalyuga, S., Chandler, P., & Sweller, J. (1999). Managing split-attention and redundancy in multimedia instruction. Applied Cognitive Psychology, 13(4), 351–371.

[10] Leppink, J., Paas, F., Van der Vleuten, C. P. M., Van Gog, T., & Van Merriënboer, J. J. G. (2014). Development of an instrument for measuring different types of cognitive load. Behavior Research Methods, 45(4), 1058–1072.

[11] Leppink, J., Paas, F., Van Gog, T., Van Der Vleuten, C. P. M., & Van Merriënboer, J. J. G. (2014). Effects of pairs of problems and examples on task performance and different types of cognitive load. Learning and Instruction, 30, 32–42.

[12] Linck, J. A., Osthus, P., Koeth, J. T., & Bunting, M. F. (2014). Working memory and second language comprehension and production: A meta-analysis. Psychonomic Bulletin & Review, 21(4), 861–883.

[13] Mayer, R. E. (2001). Multimedia learning. Cambridge University Press.

[14] Microsoft Corporation. (2023). Clipchamp (version x.x) [software]. Microsoft Corporation. https://www.clipchamp.com

[15] Miyake, A., & Friedman, N. P. (1998). Individual differences in second language proficiency: Working memory as language aptitude. In A. F. Healy & L. E. Bourne (Eds.), Foreign language learning: Psycholinguistic studies on training and retention (pp. 339–364). Lawrence Erlbaum.

[16] Montero Perez, M. (2012). Learning L2 vocabulary through subtitled video: An eye-tracking study [Doctoral dissertation, Ghent University].

[17] Montero Perez, M. (2020). Second or foreign language learning through watching audio-visual input and the role of learner differences. Applied Linguistics Review, 11(2), 301–328.

[18] Montero Perez, M., Peters, E., Clarebout, G., & Desmet, P. (2014). Effects of captioning on video comprehension and incidental vocabulary learning. Language Learning & Technology, 18(1), 118–141.

[19] Nation, P. (2007). A vocabulary size test. The Language Teacher, 7, 9–13.

[20] Peters, E. (2019). The effect of imagery and on-screen text on foreign language vocabulary learning from audiovisual input. TESOL Quarterly, 53(4), 1008–1032.

[21] Sweller, J. (1988). Cognitive load during problem solving: Effects on learning. Cognitive Science, 12(2), 257–285.

[22] Sweller, J., Ayres, P., & Kalyuga, S. (2011). Cognitive load theory. Springer.

[23] Sydorenko, T., Hellmich, A., Colpaert, J., & Desmet, P. (2017). Subtitles in the second language classroom: Balancing benefits and cognitive load. ReCALL, 29(2), 178–199.

[24] Teng, L. S. (2023). Understanding the effects of caption types on vocabulary learning: Working memory and cognitive load perspectives. System, 117, 102886.

[25] Teng, M. F. (2024). Working memory and prior vocabulary knowledge in incidental vocabulary learning from listening, reading, reading-while-listening, and viewing captioned videos. System, 124, 103381.

[26] Wang, A., & Pellicer-Sánchez, A. (2022). Incidental vocabulary learning from bilingual subtitled viewing: An eye-tracking study. Language Learning, 72(3), 765-805.

[27] Winke, P. M., Godfroid, A., & Gass, S. M. (2013). Introduction to the special issue: Eye-movement recordings in second language research. Studies in second language acquisition, 35(2), 205-212.

[28] Winke, P., Gass, S., & Sydorenko, T. (2010). The effects of captioning videos used for foreign language listening activities. Language Learning & Technology, 14(1), 65–86.

[29] Zhang, S., & Zhang, X. (2022). The relationship between vocabulary knowledge and L2 reading/listening comprehension: A me-

ta-analysis. Language Teaching Research, 26(4), 696-725.

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Narrative Painting in the East and West: Structural Divergence and Contemporary Relevance

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Abstract: This paper examines the similarities and differences between Chinese and Western narrative painting within the contemporary image-saturated cultural context, focusing on their visual language, structural logic, and cultural functions. It traces the distinct developmental trajectories of both traditions: Western painting evolved from religious narratives to individual expression, ultimately ceding dominance to abstraction, while Chinese narrative painting, influenced by philosophical and societal shifts, developed its own characteristics, particularly a strong secular and collective focus from the Song and Yuan dynasties onwards. The comparative analysis highlights key structural differences: Western painting often employs a fixed, dramatic moment and focal perspective, emphasizing individual heroes, whereas Chinese painting utilizes a flowing, multi-perspective "scenic stroll" approach and often depicts collective scenes. The paper also explores brief historical convergences, such as artistic exchanges during the Qing dynasty, and concludes by reflecting on the potential relevance of narrative painting in countering historical nihilism in the contemporary era, where abstraction prevails. The main critique points to a need for greater academic rigor, clearer research questions, and formal citations.

Keywords: Arrative Painting; Isual Language; Ross-Cultural Context; Rtistic Exchang

1 Introduction

We live in an era of images today, where images have become the primary medium of communication. This mode of communication is fast and efficient, but it is also fragmented and superficial. Various images on the Internet isolate people's observation of reality. Traditional painting art has gradually become more Abstract with the development of the times, and it is also increasingly close to philosophical expression. In his evaluation of traditional painting, Greenberg believed: "Representation, or, illustration, as such does not attain the uniqueness of pictorial art; what does do so are the association of the things represented."Narrative painting, as a way of representing stories, has been marginalized.

There are narrative paintings of hunting and sacrifice ceremonies in prehistoric cave murals. As a painting that appeared much earlier than characters, it carries the mission of narration from the very beginning. Hieroglyphs such as Chinese characters and Mayan characters are pictures themselves, and the record of hieroglyphs is another form of visual storytelling. Egyptian murals, decorations on Chinese bronzes, and Greek sculptures are also narrated with images. In the process of thousands of years of development, many ethnic groups have developed their own unique narrative painting. Narrative painting not only has its irreplaceable artistic value, but also is the carrier of human culture. However, throughout history, the narrative paintings of China and the West present different development characteristics. This study intends to explore the similarities and differences between Chinese and western narrative paintings in visual language, structural logic and cultural functions and their enlightenment on contemporary art creation in the context of image dominated contemporary culture.

2 The Development of Narrative Painting in the East and West

2.1 The Development of Western Narrative Painting

2.1.1 Classical period to the Middle Ages

Most surviving artworks from before the Middle Ages are sculptures and reliefs. Early artists recorded heroic tales on pottery, such as the works from the Hellenistic period, including the Laocoön, which exhibit more dramatic effects. In the Christian-dominated Middle Ages, painting no longer focused on individual images but on the stories themselves, and began to serve as a evangelism tool. Judging by the standards of Western scientific realism, painting at that time was clearly in its early stages, with inaccurate perspective and form. There were also few independent paintings, most of which were based on architecture and manuscripts. The frescoes of artists like Giotto already showed

glimpses of the embryonic Renaissance. From another perspective, the paintings of this era emphasized spiritual expression over material reality.

2.1.2 Renaissance and Baroque Periods

During the Renaissance, religious painting occupied a central position, but human consciousness had already begun to awaken. With the beginning of the Renaissance, the West entered a period of typical painting history. This is why we see many classic works centered around biblical stories. During the Baroque period, the Old Church used art to inspire believers, but it did not exclude heretical sensory stimulation. The paintings of the time exhibited a strong sense of movement and possessed a strong dramatic tension.

2.1.3 From the Age of Enlightenment to Modern Times

During the age of Enlightenment, religion, which had dominated art history for centuries, was replaced by science and rationality, and human stories replaced divine stories. In the masterpiece of neoclassicism, The Death of Marat, David portrayed ordinary people as if they were epic heroes. The representative work of Romanticism, Liberty Leading the People, which reflected on the French Revolution, also depicted the struggle of human beings. The evolution unfolded across eras: the Middle Ages avoided depicting humans, the Renaissance infused human spirit into religious themes, and the Enlightenment placed humans at the center of artistic expression. In modern times, along with Impressionism, various modernism emerged. Art became an expression of the artist's individual will—the human subject asserting autonomy. At the same time, art inevitably shifted from narrative toward abstraction.

2.2 The Development of Narrative Painting in China

2.2.1 From Pre Qin to Sui and Tang Dynasties

The influence of Confucianism can be clearly seen in narrative paintings from the pre-Qin to Sui and Tang Dynasties. Early bronze vessels were used as ritual vessels and were decorated with Abstract patterns. As ritual traditions declined during the Spring and Autumn period, secular labor scenes began to appear on bronzeware, such as the "Cai Sang Yan Yue Gong Zhan Tong Hu" marking the embryonic form of narrative painting. By the Han Dynasty, narrative painting was influenced by the Taoist thought of Huang Lao in the early Han Dynasty and the Confucian thought that was exclusively revered by the royal family in the later period. Stylistically, these paintings pursued a sense of elegance and fluidity, often depicting stories of filial sons and loyal ministers to convey moral education. Similarly, Confucian moral education was also reflected in works from the Wei and Jin Dynasties. Gu Kaizhi's " Wise and Benevolent Women " is a typical example. In the Tang Dynasty, the economy was unprecedentedly prosperous and ethnic and cultural exchanges were close. The representative works of this time, " Portraits of Periodical Offering " and " Emperor Taizong Receiving the Tibetan Envoy ", expressed the majesty of the Tang Dynasty.

2.2.2 The Turning Point of the Song Dynasty and the Diversification of the Ming and Qing Dynasties

The Song Dynasty marked both the peak and a turning point in the development of Chinese narrative painting. Compared to earlier narrative works that often incorporated portraiture, narrative paintings from Song Dynasty and later placed stronger emphasis on storytelling. The fundamental reason for the peak of narrative painting was the Song Dynasty's economic development. The booming commerce led to an increased demand for secular art, and painting began to cater to the aesthetic tastes of the common people. This trend continued into the Ming and Qing dynasties. However, influenced by foreign cultures in the Ming and Qing periods, traditional genre painting underwent stylistic transformations and incorporated Western techniques. The development of opera and novels in the Ming and Qing dynasties led to the emergence of narrative illustrations. Coupled with the popularity of woodblock New Year pictures, narrative painting gradually diversified and became more popular.

2.2.3 Modern and Contemporary Periods

In the modern and contemporary periods, China introduced Western realist oil painting and adopted Western scientific standards to "reform Chinese painting. In the 1950s and 1960s, painters created many thematic paintings that met the needs of the times. By this period, narrative painting in the West had already begun to decline. However, in China, Western-style realistic narrative painting experienced a brief period of prosperity (strictly speaking, it no longer falls within the scope of Chinese narrative painting). After the 1980s, Chinese art followed the footsteps of Western contemporary art and, although not completely, gradually integrated into the global art system.

2.3 A Phased Comparison of Chinese and Western Narrative Paintings

In the West, narrative painting evolved from a focus on theology in the Middle Ages to the awakening of human consciousness during the Renaissance, followed by a greater emphasis on human stories in the Enlightenment, and eventually diversified into various modern schools after Impressionism. In this process, art shifts from grand historical narratives to the artist's personal expression. Ultimately, narrative painting was forced to recede from history, replaced by Abstract art. A crucial factor in this process was the changing role of humans as the narrative subject, reflecting the rise and fall of divine power and human rights. Similarly, in China, for a long time, art practiced the Confucian missionary role of "promoting education and promoting human relations." In the Song Dynasty, the development of the economy brought about the aesthetic needs of the urban class, giving rise to genre paintings that met the tastes of the common people. However, in China, Confucianism and the people were not positioned as opposites. Painting has always fulfilled its social function. Classic genre paintings such as "Children Playing" embody Confucian ethical values. This understanding of painting's role persisted into the modern era. Therefore, while the West has abandoned narrative painting, narrative painting in China continues its social function.

3 A Structural Comparison of Chinese and Western Narratives

3.1 Form

Western painting is a dramatic art form. The artist freezes the moment before the drama reaches its climax, which is referred to as "the most fruitful moment" in Lessing's "Laocon". (evidently,the most fruitful moment and the most fruitful aspect of that moment must be chosen,now that only is fruitful which allows free play to the imagination. The more we see the more we must be able to imagine;and the more we imagine,the more we must think we see.[Germany] Lessing:<Laocoon>,translated by Ellan Frothingham,Dover ed,2005,p16) This frozen image is then projected onto the canvas, freezing time in space. Western perspective is focal perspective, where the artist stands outside the painting from a fixed perspective, forming a binary relationship with the work. For instance, Jacques-Louis David's "The Intervention of the Sabine Women" depicts a fierce battle scene, divided into close-up, mid shot, and distant shots, pushing the space further away. The artist calmly depicts the scene from a fixed point. In Western narrative painting, time is frozen and the viewpoint is fixed, and this stillness and fixation often carry a noble and solemn temperament.

Chinese painting is the art of dance. As Zong Baihua noted,"The Chinese sense of space is musical. It is not measured by geometry or trigonometry, but experienced through music and dance." (Zong Baihua, Selected Works on Aesthetics and Art, Henan Literature and Art Publishing House, 2009, p.62) The lines in a painting resemble the flowing traces of a dancer's movement, and the viewer feel the charm of the painting as the lines flow. The perspective of wandering creates the scattered perspective of Chinese painting, combining objects seen from different angles within a single image. The "Famous Paintings Record" records that in his later years, when Zong Bing was physically unable to travel, he painted landscapes on his walls so that he could "purify his mind and contemplate the Dao, journeying while lying down." Furthermore, the unique Chinese scroll painting allows the story to unfold slowly as the scroll unfolds. The unrolling embodies the passage of time, making space temporal. The painting "Along the River During the Qingming Festival" employs an omniscient perspective, also known as scattered perspective, to place diverse scenes from different perspectives within a single image, leading the viewer from the farmland southeast of the city to the bustling Along the River During the Qingming Festival . Therefore, it can be seen that the perspective of Chinese narrative painters is that of "wandering observation." Space is space within time.

In summary, the structural difference in form between Chinese and Western narrative painting lies in their treatment of time and space. Western narrative painting follows a theatrical model, where space solidifies time, while Chinese narrative painting presents temporalized space.

3.2 Content

Both the East and the West were once in the feudal society period, and at some point capitalism emerged, with similar social structures. According to different audiences, narrative paintings can be divided into three categories: religious paintings, customized palace/aristocratic paintings, and folk custom paintings. Influenced by ancient Greek heroic epics and Christian culture, the Western narrative of hero worship,

which has been passed down from classical times, is a collective cultural nourishment. And,, Western painting is an art of drama, highlighting the protagonist like a drama, and the story revolves around the protagonist. Painting often focuses on individual actors and constructs dramatic conflicts. After the Renaissance, painting emphasized the depiction of character images. Jacques Louis In David's' The Oath of the Horace Brothers', three brothers raise their arms to form a visual focal point with their father holding a weapon. The woman in the middle scene is below the line of sight, highlighting the protagonist's heroic image.

Chinese painting, on the other hand, tends to depict collective scenes and events. Influenced by Confucian culture, China emphasizes the concept of "ruler, subject, father, son". As a qualified person, the standard is to play a good role in society, which does not encourage the expression of individuality and leads to the disappearance of individualism in collectivism. This is also the reason for the standardization of character images in Chinese painting. As the most typical narrative painting, the Qingming Riverside Scene only depicts the climax of the story without highlighting the protagonist.

The content classification of storytelling in Chinese and Western painting is roughly the same, but there are significant differences in the selection and shaping of the protagonist. Western painting tends to choose one or more protagonists, while Chinese painting, even with works such as "Qianlong's Southern Tour" featuring emperors, does not highlight the protagonists. Religious painting only uses a larger proportion of characters with high social status, and the protagonist is still in a balanced position on the plane. Western painting adopts a hero centered and typified narrative, while Chinese painting adopts a de protagonist and group image narrative, reflecting the difference between individualism and collective structure in terms of concepts.

3.3 Interaction with the audience

Wu Hong divided narrative painting into two categories: "idol style" and "plot style" based on the way the story interacts with the viewer. Idol type "is an open structure, where the theme of the image often summons viewers to participate. In addition to being the protagonist of the story, the subject of the image is also a revered idol with weak narrative and portrait like qualities. Plot based, the visual display is a closed or semi closed structure that completes the narrative independently, belonging to strong narrative. The time selection of the screen is the most fertile moment, leaving the viewer with the space they have already thought about. According to this standard, both Chinese and Western narrative painting use these two interactive mechanisms to interact with the viewer. The difference is that, as mentioned earlier, the Western hero centered system and typified narrative make Western narratives more inclined towards idol style, while Chinese narratives tend to be more plot oriented.

It is easy to understand why the most religious paintings are directed towards idols, on the one hand to showcase the solemn authority of idols, and on the other hand to arouse viewers' longing. For example, in "The Last Supper," the protagonist is in the center, with a balanced composition on both sides, facing the audience and summoning viewers. Chinese religion does not have the strong missionary intention of Christianity, and religious paintings are more used to communicate with gods rather than believers, so the size of religious paintings is relatively small.

In addition to being used as decoration, Chinese painting is often appreciated and played with by literati during their gatherings. "The Eighteen Scholars" is a commonly used theme in literati narrative paintings, with descriptions of literati appreciating paintings, making scroll paintings easier to carry. With the opening of scroll paintings , the author to slowly lead the viewer into the story, making it easier for the viewer to participate. It can be seen that Western large-scale paintings arouse viewers' longing, while Chinese small-scale works summon viewers to participate.

Narrative painting in both the East and the West focuses on different ways of communication between viewers, but actually, both have idol and plot based approaches, and the two interactive methods often appear simultaneously and cannot be completely separated.

4 Narrative transformation in cross-cultural contexts

4.1 Integration of Chinese and Western in Palace Painting

Both Eastern and Western art developed along their own veins, and the economic exchange between China and the West during the

Ming and Qing dynasties also brought about cultural exchange. Qianlong once asked the court painter Lang Shining to paint the mural "Victory of the Pacification and Restoration of the Central and Southern Regions" and create prints based on the mural. The French printmaker Charles Nicolas Cochin II was responsible for it. From these versions, we can see the fusion of Chinese story painting with Western narrative techniques and perspectives. Firstly, the fusion of Eastern scattered perspective and Western focal perspective.

The emperor requested the painter to make some slight adjustments, but overall follow the original painting, so we can roughly see the style of the original painting. Italian painter Lang Shining, who served the court, integrated different perspectives into the same painting. Comparing with the "Qianlong Southern Tour" of the same period, we will find that the marching troops depicted in the picture have already appeared in a perspective of near large and far small, but the distant mountains still appear larger than they should, which does not conform to the principle of focal perspective. This is the combination of Western realistic techniques and Chinese true stories.

Secondly, in terms of character portrayal, compared with the "Qianlong Southern Tour", in the "Southern Tour", the characters are integrated into the scenery and do not highlight the main subject. In the printmaking of the "Pacification of the Central Plains and the Victory of the Central Plains", the characterization of the characters is in-depth and the facial features are westernized, which is the result of the fusion of Western narrative painting styles in character portrayal. Finally, in terms of narrative style, the work selects the climax of drama like Western narrative paintings, freezes time, while retaining the Chinese style long scroll narrative. It combines 16 independent paintings and 16 dramatic scenes to complete a complete narrative, compressing stories from different times into a cohesive narrative.

During the reign of Emperor Yongzheng and Emperor Qianlong, the painter Zou Yigui commented on Western perspective, saying, "... but there is no brushwork at all, even though it is tidy but mechanical, it is not included in the catalog of classical painting." (trans. by author). It is difficult to say that the emperor and Chinese artists at that time accepted Western scientific realism aesthetically. The six sets of war prints independently completed by Chinese painters afterwards can prove that Chinese painters and emperors did not accept Westernized painting aesthetically. These six sets of prints have made adjustments in composition, character portrayal, and narrative perspective that are in line with Chinese aesthetic taste.

The painting 'Pacifying Taiwan War' showcases the decorative image of water with Chinese characteristics. The proportion of water and mountains far exceeds that of the characters , reflecting China's emphasis on landscape scenery and the story itself, rather than depicting the characteristics of the protagonist. In another painting titled 'Conquering the Thermobridge', there are similar features, which use scattered perspective and integrate events that occurred at different time points into the same image. The technology used is Western, but the formal processing still follows Eastern methods. This exchange was a complete and systematic communication, becoming a model of integration between Chinese and Western cultures in terms of technical language and narrative style.At the same time, this exchange has its limitations, mainly because it is a one-way exchange and more about China's learning of Western technology. The purpose of Qianlong's order to make prints was to record his achievements and political propaganda, but there is no accepted evidence for narrative style and aesthetics.

4.2 The Re creation of Chinese Images by Western Art

In the early 18th century, French printmaker Bernard Picart created "Convoi funebre d'un grand de la Chine" (Funeral of Chinese Nobles). The painter adjusted Chinese objects to suit Western aesthetics, and the scenery was different from European painting style, incorporating clouds that often appear in Western landscape paintings. The characters are completely Western in appearance, and there is no prominent protagonist in the picture, perhaps influenced by the Chinese narrative style. Hermann's "Illustrated Library of Emperors" and "Biography of Confucius" published in 1788 can also see this kind of misreading. The character images and costumes are basically westernized, adopting a Western style theatrical composition in form, freezing a certain moment of time and leaving only some Chinese style architecture.

The acceptance of Chinese art by the West has a long history, and in the 17th and 18th centuries, it sparked a craze for Chinese style art. During this period, the West not only purchased Chinese export products, but also produced artworks with Chinese style. The production of these two prints happened against this backdrop. Western artists have misinterpreted and adapted the narrative style of China, indicating that what Western audiences need is not a true Chinese narrative, but symbols that satisfy their Eastern fantasies, reflecting the author's self projection as a Western artist and the embodiment of cultural rights. Like Chinese painter Zou Yigui's criticism of Western painting. In the

18th century, Swiss painter Jean Etienne Liotard contemptuously evaluate Chinese painting at that time:"what gives to Chinese painting its appeal is that it is smooth,clean,and neat,even though it is made by a people having only a smattering of knowledge on art"

4.3 Narrative Fracture and Reproduction

After a brief accidental exchange in the 18th century, the art world of both the East and the West underwent earth shattering changes in narrative painting. After the end of the 19th century Impressionism, various modern art schools emerged, and painting shifted from representation to ontological exploration. "Modernism demonstrated the values of Western individualism, and individualization became the most fundamental artistic concept hidden behind the exploration of modernist art"(trans.by author) .Postmodernism attempts to repair modernism， and bring back grand narratives, leading to the emergence of new media art. These changes wre rapid and disruptive ,narrative paintings with rigorous logic have exited history. Western artists were beginning to recognize the value of Eastern art at a time when they are negating Western traditions. Artist David Hockney has conducted in-depth research on the scroll style and scattered perspective of China, using multiple viewpoints and collages to realize the continuity of space and the sense of time passing. In his painting "The Bigger Water Splash", no one appears in the painting, but the water splashes in the picture indicate that people have come and time has passed, implying that the story continues. This is a unique case. Western artists' attention to Chinese culture actually injects more Abstract spirit into their artistic works.

In China, it is a different scene. At the beginning of the 20th century, although narrative painting still existed in large numbers, the development of Chinese art was also fragmented. After complete Westernization, strictly speaking, narrative painting no longer belongs to the category of Chinese painting, but is an" improved "Chinese painting based on Western scientism (at that time, some Chinese artists and scholars such as Xu Beihong and Cai Yuanpei advocated improving Chinese painting based on Western scientific realism). It is precisely because of this so-called improvement that narrative painting in China has truly integrated Eastern and Western styles. For example, oil paintings include Xu Beihong's "Five Hundred Scholars of Tian Heng" and ink paintings include Zhou Sicong's "The Premier of the People". After the 1980s, Chinese art closely followed the footsteps of Western contemporary art and gradually integrated into the global art system, although not completely. Today, Chinese art exists in two forms: officially supported thematic painting and market-oriented abstract painting, with narrative painting existing in the former. Market driven art, like the West, often appears in the form of images that are detached from narrative.

5 summary

Previously, we have outlined the development paths, characteristics, and communication between narrative painting in both the East and the West. When Western art abandoned narrative, in 20th century China, narrative painting between the East and the West achieved true integration. Nowadays, the theme creation supported by the national system in China still maintains narrative nature and plays a social function of "educating and helping people's relationships" in some form. And more Chinese artists prefer to express themselves in contemporary forms. Contemporary art in China did not go through the process of "modernism establishing the independence of media through structural image narration" to "postmodernism creating images to negate the technicality of media".Instead, it directly accepted contemporary art in the 1980s and gradually merged into the global art system.

In today's globalized art world, narrative painting has been marginalized. On the one hand, this is because new media has taken over the narrative function of painting as a new narrative tool. On the other hand, abstract images completely negate concrete narrative painting. Compared with new media produced by technological processes, painting is closer to the audience due to the lack of technical barriers. As an art form with language quality, narrative painting carries strong logical attributes, and in this era of imagery, this strong logic is more likely to trigger viewers' deep thinking. In this era of the" end of art", narrative painting,which is closer to reality ,may be able to bring art back to art." Epic not only exists in words, but also in painting. When painting creates meaningful shapes, the humanistic images carried by the shapes will form a truly solidified and timeless visual epic"

References

[1]<modernist painting> Clement Greenberg page3 https;//www.yorku.ca

[2][Germany] Lessing:<Laocoon>,translated by Ellan Frothingham,Dover ed,2005,p16

[3]Zong Baihua: Selected Works of Zong Baihua's Aesthetics and Art, Henan Literature and Art Publishing House, 2009, p. 62

[4]groups of Baihua; Where to Find Beauty "Chongqing University Press, 2014, p. 83

[5]Frank Vigneron<China Pluperfect>,The Chinese University of Hong kong Press, 2022,P16

[6]Shang Hui, "The Frozen Epic," Guangxi Normal University Press, 2023, p. 10

[7]Shang Hui, "The Frozen Epic," Guangxi Normal University Press, 2023, p. 11

Digital Transformation and Application of Blended Teaching of Probability Theory and Mathematical Statistics

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Abstract: As the digital transformation of education continues to advance, the traditional teaching model of "Probability Theory and Mathematical Statistics" —a core course in higher education that combines profound theoretical foundations with practical application—has increasingly revealed pressing challenges such as low teaching efficiency, weak practical components, and difficulties in providing personalized learning guidance. Grounded in the advanced principles of blended learning, this paper explores how to organically integrate digital and intelligent technologies, including but not limited to artificial intelligence, big data analytics, and virtual simulations, into every aspect of the course. It proposes a systematic closed-loop teaching model: "Intelligent Pre-class Preparation—Interactive In-class Exploration—Personalized Post-class Extension." Specifically, this involves building a resource repository rich in digital teaching materials, developing an intelligent assessment system with real-time learning feedback, and designing multiple practical virtual experiment scenarios. These efforts aim to dynamically optimize course content, accurately profile students 'learning processes, and deeply cultivate their practical skills. Practical applications demonstrate that this transformation not only significantly enhances students' learning initiative and enthusiasm but also effectively improves their ability to apply knowledge and solve real-world problems, providing a feasible reference framework and valuable experience for the digital and intelligent reform of mathematics courses in higher education.

Keywords: Probability Theory and Mathematical Statistics; Blended Teaching; Digital Transformation; Teaching Model; Virtual Simulation

Introduction

As a mathematical discipline dedicated to exploring the inherent patterns of random phenomena, Probability Theory and Mathematical Statistics has extensive applications across engineering, economics, medicine, and other fields. The quality of this subject's teaching directly determines students' ability to master quantitative analysis methods and problem-solving skills. In traditional teaching models, instructors typically use a "blackboard + PPT" approach, which often makes theoretical knowledge seem overly Abstract and difficult to grasp. Moreover, there's a significant disconnect between case studies and real-world applications, leading to relatively low student engagement and learning interest. To address these issues, blended learning has emerged as a solution, combining online and offline instruction to provide new approaches for curriculum reform. However, blended learning still has considerable room for improvement in areas like data-driven precision teaching and intelligent resource provision. With the continuous development of digital and intelligent technologies, we now possess the technical support to overcome these challenges, which has also driven the transition from traditional "experience-driven" teaching models to more efficient "data-driven" approaches.

1 The Necessity and Core Objectives of Digital and Intelligent Transformation

(1)The Imperative for Educational Transformation: Traditional teaching models exhibit three critical shortcomings. First, abstract concepts like axiomatic probability definitions and the Law of Large Numbers prove challenging to grasp through conventional lectures. Second, complex computational processes—particularly in multidimensional stochastic variable distributions—require tedious mathematical derivations that overload students. Third, the disconnect between theoretical knowledge and practical application prevents students from reinforcing learning through real-world practice. Furthermore, blended learning faces systemic challenges: online resources lack diversity and innovation, while fragmented learning data makes systematic analysis impractical. Outdated personalized feedback mechanisms hinder timely adjustments to individual needs, undermining the "teaching according to students' aptitude" philosophy. Most crucially, industry demands necessitate educational transformation. The big data era requires enhanced data analysis skills, necessitating curriculum reforms that emphasize statistical software proficiency (e.g., Python, SPSS) and real-world modeling capabilities to cultivate high-caliber professionals meeting

contemporary demands.

(2)Core Objective: To achieve comprehensive intelligent management of teaching resources, we aim to establish a dynamically updated and continuously optimized repository of micro-lecture materials, teaching case studies, and algorithmic frameworks. This system will precisely match learning progress and individualized needs across students. Building on this foundation, we strive to refine the teaching process by conducting in-depth analysis of learning behavior data. Through this approach, we can accurately identify each student's learning weaknesses and knowledge gaps, then provide customized learning pathways to enhance educational outcomes. Additionally, we emphasize visual presentation of practical components, leveraging advanced virtual simulation technology to vividly demonstrate the formation of random phenomena. Examples include step-by-step generation of normal distribution curves and simulated demonstrations of statistical significance in hypothesis testing. These intuitive visualizations effectively strengthen students' understanding and cognitive abilities, transforming abstract theoretical knowledge into more accessible and engaging content.

2 Construction of Digital and Intelligent Hybrid Teaching Mode

(1)Instructional Framework Design: Grounded in the blended learning philosophy of "online self-directed learning + offline in-depth discussions," this framework integrates digital tools to create a three-phase closed-loop teaching model. First, during the pre-class smart preview phase, teachers utilize the WPS Docs platform to distribute detailed preview tasks embedded with AI voice-guided micro-lectures (e.g., animated demonstrations of "relationships and operations in random events") to help students grasp abstract concepts visually. Simultaneously, an intelligent question bank system (e.g., WPS Sheets with formula editors) delivers foundational practice questions. After students complete answers, the system provides real-time feedback and automatically generates error rate reports. Teachers leverage this data to precisely adjust classroom focus and difficulty levels, ensuring targeted instruction. Second, in the in-class interactive exploration phase, the "problem-driven" teaching model stimulates students 'investigative interest. Using WPS Sheets' real-time data visualization feature, teachers demonstrate "frequency stability in dice experiments" on-site. Students submit experimental data via QR code scanning, and the system dynamically generates frequency distribution histograms to visually present results. Additionally, an AI teaching assistant system provides real-time answers to classroom questions (e.g., "approximation conditions for binomial and Poisson distributions") while recording high-frequency queries to create teaching improvement lists for future reference. Finally, in the post-class personalized extension phase, the system delivers tiered tasks based on students' learning profiles to meet diverse educational needs. At the foundational level, students complete textbook exercises and use WPS Premium's exclusive formula recognition and grading features for self-assessment to ensure mastery of core concepts. Advanced students engage in real-world case studies (e.g., "Constructing a Probability Model for E-commerce Platform Purchasing Behavior") to enhance practical application skills. Additionally, students conduct comprehensive experiments using virtual simulation platforms (e.g., MATLAB/Simulink) to simulate "Hypothesis Testing Processes in Production Line Quality Control." After completing these experiments, students submit reports to WPS Drive, where instructors provide online feedback, forming a complete teaching cycle to comprehensively improve instructional effectiveness.

(2)Application of Digital and Intelligent Tools in Education and Learning: This domain application is crucial as it can significantly enhance teaching efficiency and learning experiences. A key application involves building intelligent resource libraries that integrate WPS's mind mapping features to organize and construct knowledge systems. For instance, mind maps can be used to compare different probability distributions like normal and binomial distributions, visually demonstrating their differences and connections through tree diagrams. Additionally, these libraries can embed Python code snippets, such as generating random numbers using the NumPy library or simulating Monte Carlo methods. Such functionality allows students to edit and run code online, deepening their understanding of programming and mathematical concepts. Another critical application is developing case libraries linked to real-world data in fields like financial risk control and medical statistics. For example, in financial risk control, Bayesian probability models for credit card fraud detection can be introduced; in medical statistics, hypothesis testing for vaccine efficacy can be incorporated. Through WPS's data visualization plugins, these cases can generate dynamic charts to help students intuitively understand and analyze data. Furthermore, digital and intelligent tools can be used to develop learning analytics systems. Leveraging WPS Education Edition's learning behavior tracking feature, the system can collect data such as students'

online video viewing duration, exercise accuracy rates, and forum question keywords. Through clustering algorithms, these datasets can be categorized into distinct learning groups—such as "theory-deficient" and "practice-deficient" —to provide teachers with tailored group instruction strategies. Virtual simulation experiments represent another key application of digital intelligence tools. A "Stochastic Process Visualization Lab" can be established to demonstrate abstract concepts like Brownian motion and Markov chain transitions, enabling students to grasp complex theories through intuitive visual demonstrations. Additionally, a "Statistical Modeling Practice Platform" can be developed, integrating real-world datasets such as the Iris dataset and stock price data. Through drag-and-drop operations, students can perform data cleaning, model selection (e.g., linear regression or logistic regression), and result interpretation, thereby enhancing their practical skills and data analysis capabilities.

3 Practice Effect and Reflection

(1)Case Study Details: At a prestigious university's STEM program, the innovative teaching model was fully implemented for the 2023 freshman cohort (120 students). After one semester of application, systematic data comparison between this group and traditional classes revealed remarkable improvements in educational outcomes. Specifically, students' task completion rates on online learning platforms surged by 42 percentage points, demonstrating significant progress in self-directed learning and task execution capabilities. Final exam scores improved by 15.3 points, reflecting both deeper knowledge mastery and the optimized teaching model. Notably, practical questions involving statistical software operations saw a qualitative leap in student performance, with the pass rate rising from 58% to 82%. This marked substantial enhancement in hands-on skills and practical application abilities. Even more encouragingly, participation in high-level mathematical modeling competitions saw a 30% increase in awards compared to previous years. These achievements not only validate the effectiveness of the teaching reform but also highlight students' comprehensive improvement in innovative thinking and problem-solving capabilities, showcasing their enhanced overall competence and competitiveness. This series of data and results undoubtedly provide a strong support and valuable experience for the further optimization and innovation of the teaching mode in the future.

(2)Reflection and Optimization Directions: In the current process of educational informatization, we must not only focus on the introduction and application of technology but also deeply reflect on and optimize our educational practices. First, the compatibility of technology is a critical issue. We need to simplify the operation processes of certain tools. For example, when developing interfaces between WPS Forms and Python, we should consider students 'technical proficiency thresholds, striving to make operations more intuitive and accessible so they can better utilize these tools for learning and research. Second, data security remains a vital concern. We must strictly adhere to educational data privacy regulations and adopt WPS Private Cloud storage for learning behavior data, effectively safeguarding information security and preventing personal data leaks. Finally, the transformation of teachers' roles is an urgent issue. We need to enhance teachers' digital and intelligent skills training, such as equipping them with AI tool applications and data analysis methods, enabling them to transition from "knowledge transmitters" to "learning designers" who can better guide students in their studies and research. In summary, we need to conduct in-depth reflection and optimization in areas like technological compatibility, data security, and teacher role transformation to advance educational informatization and improve the quality and efficiency of education.

4 Conclusion and Prospect

The course "Probability Theory and Mathematical Statistics" is undergoing profound transformation amid the digital and intelligent transformation. This evolution transcends mere updates to teaching methods—it represents an advanced hybrid learning model. By integrating cutting-edge information technology, it achieves comprehensive optimization across teaching resources, instructional processes, and evaluation systems. This digital transformation presents unprecedented opportunities and challenges for the course. First, generative AI technology enables the GPT model to automatically generate personalized exercises and case analyses, significantly enhancing resource efficiency. Such tailored materials better meet students 'learning needs and improve educational outcomes. Second, interdisciplinary collaboration with engineering and business disciplines allows developing digital teaching modules that integrate probability statistics with professional scenarios. These modules strengthen practical application, helping students master real-world implementations of probability theory. Third, establishing a lifelong learning platform provides alumni with a professional community. By sharing industry-leading case studies like proba-

bility models in AI algorithms, we create sustainable connections between academic learning and career development. Ultimately, this digital transformation isn't just about upgrading tools—it's about reinventing educational philosophies. It is student-centered and data-driven, transforming abstract mathematical knowledge into perceptible, applicable and innovative practical abilities, ultimately serving the cultivation of high-quality interdisciplinary talents. This transformation will undoubtedly open up broader development prospects for the course "Probability Theory and Mathematical Statistics".

References

[1] Long Weifang, Ye Xuguo. Exploring the Ideological and Political Education in the Course of Probability Theory and Mathematical Statistics [J]. Industry and Science Forum, 2025,24(21):184-186.

[2] Lee Young-gyu. Exploring and Practicing Ideological and Political Education in the Teaching of Probability Theory and Mathematical Statistics [J]. Talent Intelligence, 2025, (32):37-40.

[3] Liang Zhenying, Sun Juntao, Liu Xuanjiang, et al. Research on the Deep Integration of Innovative Thinking and Mathematical Modeling in Classroom Teaching Mode: A Case Study of Probability Theory and Mathematical Statistics [J]. Higher Education Journal, 2025,11(30):71-74.

[4] Zhi Nan, Zeng Cheng, and Liu Jing. Teaching Exploration of "Probability Theory and Mathematical Statistics" Based on Case Studies and Ideological and Political Education in Courses [J]. Journal of Zunyi Normal University, 2025,27(05):154-157+161.

[5] Yang Wenli, Shao Hu, Zhang Huixing. "Research on the Diverse and Mixed Teaching Methods of Probability Theory and Mathematical Statistics" [J]. Education and Teaching Forum, 2025,(43):137-140.

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Fund Project:

Research on the Dynamic Adjustment Mechanism of Undergraduate Programs from the Perspective of Complex Adaptive Systems

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Abstract: The theory of complex adaptive systems emphasizes the interactions between adaptive agents and their external environment, offering new approaches for establishing dynamic adjustment mechanisms in undergraduate programs. The behavioral choices and interactions among adaptive entities—including governments, universities, markets, teachers, and students—create characteristics of aggregation, diversity, nonlinearity, and "flow" in these adjustment mechanisms, influenced by modular mechanisms, labeling mechanisms, and internal modeling mechanisms. Through nonlinear interactions, these entities spontaneously evolve into organizational systems with information processing and proactive response capabilities. Therefore, building a dynamic adjustment mechanism for undergraduate programs requires respecting diverse needs of multiple stakeholders, shifting from administrative dominance to agent collaboration, creating digital communication platforms, transitioning from "precise prediction" to "agile adaptation," and establishing feedback and continuous improvement systems.

Keywords: Complex Adaptive System; Undergraduate Major; Multi-Agent; Dynamic Adjustment

The dynamic adjustment of academic disciplines is an essential requirement for higher education's comprehensive supply-side structural reform during its universalization phase, aiming to build a high-quality higher education system that supports China's modernization drive. In February 2023, the Ministry of Education and four other departments jointly issued the "Reform Plan for Adjusting and Optimizing Academic Disciplines in Regular Higher Education," which explicitly requires "establishing new disciplines aligned with emerging technologies, industries, business models, and operational modes while phasing out outdated programs that fail to meet socio-economic development needs" [1]. Under this policy guidance, from 2014 to 2024, China's undergraduate programs underwent annual adjustments averaging 5%, resulting in nearly 28,000 program restructurings. During this period, 19,966 new undergraduate programs were established, while 5,290 programs were either revoked or discontinued.According to the data released by the Ministry of Education in March 2024, the adjustment of undergraduate majors involved 3,389 major distribution points, which was the largest in history [2].

China's current dynamic adjustment of academic programs reveals several issues: universities either blindly proliferate similar majors or abruptly phase out specific disciplines. There persists a "new bottles for old wine" phenomenon, where newly restructured programs still rely on outdated faculty teams, training methods, and curriculum resources. University program adjustments consistently lag behind economic development and industrial restructuring. Institutions must proactively establish adaptive adjustment mechanisms to align with economic changes [3].

In recent years, research on dynamic adjustment mechanisms for undergraduate programs in higher education has primarily focused on three categories: First, studies examining program adjustments through the lens of policy evolution [4]; Second, analyses of talent cultivation dynamics within specific disciplines such as Education [5]; Third, investigations into program modifications from perspectives of human capital development and social benefits [6].Existing research has predominantly focused on a single perspective, neglecting dynamic adjustments in complex scenarios. Building upon the application of Complex Adaptive Systems Theory (CAS) across various fields, this study adopts a CAS-based systems thinking approach to examine dynamic adjustments in university undergraduate programs. By exploring the underlying mechanisms of such adjustments, it breaks away from traditional single-perspective approaches and establishes a new methodology that comprehensively reveals the intrinsic connections of program adjustments from micro to macro levels. This research provides scientific theoretical foundations and practical guidance for optimizing academic disciplines in higher education institutions.

1 Dynamic adjustment of undergraduate majors as complex adaptive systems

1.1 Overview of CAS

The concept of CAS was formally proposed in 1994 by Professor John Holland at the Santa Fe Institute in the United States. This theory encompasses seven key concepts: aggregation, nonlinearity, flow, diversity and identification, internal models, and three mechanisms (building blocks). Adaptive agents within complex systems follow a "stimulus —— response" model, exchanging information and energy with other adaptive entities under environmental stimuli. Through adaptive behaviors such as information processing, experiential learning, and rule adjustment, these agents continuously optimize their behavioral strategies. Such micro-level nonlinear interactions, through multi-layered and multidimensional coupling effects, ultimately give rise to macro-system characteristics including self-organization evolution, dynamic equilibrium, and creative mutations [7].

CAS emphasizes examining the behavioral patterns of micro-level adaptive agents to reveal the formation pathways and structural mechanisms of macroscopic systems. This approach transforms human understanding of complex phenomena from static "structural analysis" to dynamic "evolutionary generation," not only bridging microscopic behaviors with macroscopic complexity but also deepening our comprehension of the inherent logic within complex systems. The framework provides a systematic analytical approach that illuminates these intricate interactions.

1.2 Interpret the appropriateness of undergraduate major adjustment from the perspective of CAS

The core concept of CAS (Complex Adaptive System) is that adaptability generates complexity, emphasizing the interactions between adaptive agents and their external environment, thereby creating evolutionary dynamics [7]. CAS is applicable to multidisciplinary explorations of complex systems, initially widely used to analyze complex mechanisms in political and social systems. As scholars increasingly recognize the complexity of interactions between micro-level individual behaviors and macro-level policies in educational systems, this theory has now been applied to analyze various phenomena in education.For example, CAS perspective focuses on regional higher education integration, which provides a new perspective and analytical framework for understanding its practical difficulties and solutions [8]; CAS is used to build a dynamic governance mechanism to solve the governance difficulties of higher education [9].To be specific, first of all, the adjustment of undergraduate majors involves multiple adaptive subjects. The adjustment of undergraduate majors is an organic system including government, universities, market, teachers, students and other diverse subjects as well as institutional rules.The government acts as the policymaker and macro-regulator for academic program adjustments, influencing universities 'restructuring decisions through policy guidance, program approval processes, and professional evaluations. Higher education institutions serve as the primary implementers of these changes, yet their implementation remains profoundly shaped by faculty-student interactions. Academic disciplines constitute both scholars' professional identities and career anchors – some actively embrace reforms while others resist or dilute them. Students make major selection decisions based on limited information including personal interests, employment prospects, and social prestige [10].Adaptive entities dynamically coordinate and adapt to each other, fulfilling the foundational requirements of CAS components. These adaptive entities—individuals or units with perception, decision-making, and learning capabilities—align perfectly with CAS systems where multiple stakeholders autonomously organize into behavioral response patterns and information processing mechanisms. Secondly, professional adjustments exhibit emergent properties. Emergence refers to how micro-level entities interacting under relatively simple rules spontaneously generate new, complex patterns or attributes at macro levels. Such novel patterns cannot be predicted through simplistic aggregation of micro-level behaviors. University program adjustments are not precise government or institutional blueprints; they emerge from the interactions between millions of students, parents, universities, and government policies. This process gives rise to both popular majors and unpopular "pit" programs, as well as universities rushing to add new majors or revoke existing ones.

2 Complex adaptation characteristics of dynamic adjustment of undergraduate majors

2.1Agglomeration characteristics

Agglomeration characteristics stem from interactions between entities and their outcomes. The embryonic form of specialized education and higher education institutions originated from medieval chamber of commerce organizers who formed communities based on shared objectives. As society evolved, these groups gradually developed into academic institutions with distinctive professional education features [11]. Building upon this agglomeration within universities, stakeholders including governments, educational institutions, and market entities that align with professional adjustments have collectively created an agglomeration effect.

Higher education institutions conduct comprehensive evaluations of their academic program design and talent development practices, then provide statistical findings to government agencies, market entities, and other stakeholders. After gaining insights into the evolving needs and challenges within academic programs, these external parties offer resource support while simultaneously sending feedback to universities to drive further improvements. This collaborative process ultimately establishes an organic ecosystem characterized by dynamic communication and continuous self-renewal.

2.2 Flow characteristics

Flow refers to the channels of interaction and communication among entities, where the concept vividly illustrates the dynamic process of resource movement between subjects. In CAS (China's Academic and Scientific Community), a flow structure integrating nodes, connectors, and resources exists, with resources encompassing material flow, energy flow, and information flow. Government agencies, universities, markets, and faculty/students each represent nodes within this system. The continuous circulation of materials, information, and energy across these nodes forms a dynamic equilibrium, enabling efficient adjustments in university programs. Within the dynamic adjustment mechanism for undergraduate majors, information technology plays a crucial bridging role. For instance, policy updates, teaching materials, and employment information circulate continuously among the four major nodes [12].

In the process of academic program restructuring, material flow forms the foundation. This includes laboratory equipment, internship facilities, textbooks, and teaching materials for target disciplines. Information flow refers to the transmission of data between entities. The government guides universities in dynamically adjusting undergraduate programs through policy directives and official notices, while media serves as an information conduit by publishing rankings, career trends, and market demands. Notably, Zhang Xuefeng's online posts caused the average minimum admission scores for journalism and communication majors to drop by 15% [13]. Energy flow acts as an invisible driving force for program optimization, facilitated by institutional reforms such as government funding and flexible enrollment policies that enhance educational efficiency [12].

2.3 Diversity features

Diversity refers to the internal transformation and proactive adaptability within a system. Driven by market-oriented policies and digital technologies, the higher education system is undergoing unprecedented changes. Universities must proactively evolve by adjusting academic programs through measures like program additions, reductions, and interdisciplinary integration, ensuring their alignment with contemporary societal needs and technological advancements.

The continuous adjustments in undergraduate programs at universities are achieved through constant adaptation between existing disciplinary foundations and emerging demands. Diversity manifests in three aspects: changes in form, content, and structure. Content-related transformations involve updates and modifications to theoretical frameworks and practical systems. Structural changes include interdisciplinary integration, cross-disciplinary convergence, micro-specializations, and the development of comprehensive discipline-integrated programs. Form-oriented adaptations encompass shifts between experimental and theoretical courses, innovations in educational models, and transitions between academic and professional orientations. By strategically implementing differentiated adjustment strategies based on institutional positioning, external policies, and market needs, universities effectively promote diversified program development.

2.4 Nonlinear characteristics

During the process of academic discipline restructuring, the involvement of multiple stakeholders (government, universities, faculty, and students) and massive information exchange result in evolving role definitions, functional contributions, and deep environmental interactions. As these entities act, they accumulate experience that enables strategic adjustments to their behavioral paradigms and knowledge frameworks, enabling flexible adaptation to changing external challenges. The interactions among stakeholders are not simple cause-effect relationships but nonlinear processes, making the final outcomes of disciplinary restructuring difficult to predict. New policies interact with existing institutional rules, diverse stakeholders, and informal norms in complex, nonlinear ways, generating unpredictable "side effects" and "resistance". For instance, after the Ministry of Education proposed the goal to "optimize and adjust approximately 20% of university academic disciplines by 2025", some program adjustments and cancellations faced resistance from faculty members. In the power struggle between academic autonomy and administrative authority, certain programs continued enrollment and teaching through experimental class formats.

3 The complex adaptation mechanism of dynamic adjustment of undergraduate majors

3.1 Identification mechanism

The essence of institutional branding lies in its distinctive identity and unique attributes that set it apart from other academic entities. Like a strategic banner, this brand carries forward-looking vision and serves as a guiding force. As universities optimize their undergraduate programs, they must proactively adapt to evolving trends and market demands. By establishing innovative and forward-looking "branding" disciplines, institutions can drive comprehensive quality enhancement and ensure sustainable development in education.

The dynamic adjustment mechanism for undergraduate programs should emphasize distinctive characteristics in discipline development, avoiding blind trend-following or homogenization tendencies. This approach highlights unique institutional identities and promotes differentiated development strategies, thereby supporting the establishment of universities with distinct features. In the 1980s, Beijing Union University's College of Applied Arts and Sciences pioneered the "Applied Historiography" program reform concept, transforming traditional history disciplines into specialized programs in cultural heritage and museology. The "Applied Historiography" program has been recognized as a hallmark of Beijing Union University's distinctive development in liberal arts education.

3.2 Building block mechanism

The "building block" mechanism organizes university undergraduate programs into modular structures, akin to interlocking components. These flexible building blocks enable institutions to adapt their academic frameworks and operational behaviors in response to policy shifts and market demands. Within the CAS (Chinese Academy of Sciences) system, individual disciplines—including curriculum resources, educational systems, and faculty teams—function as modular units [14]. At the institutional level, synergistic interactions emerge among government funding, academic governance, market dynamics, and faculty-student relationships. Through strategic combinations and dynamic interactions, these building blocks collectively shape each university's distinctive educational architecture and academic identity.

The modular components within academic disciplines require adaptive adjustments based on market demands, disciplinary trends, and student interests. These components do not simply stack together during program restructuring, as this process involves high complexity and uncertainty, necessitating flexible adjustment strategies [15]. Through mutual interactions and adaptive adjustments among these components, new professional trends emerge. Such evolutionary phenomena may manifest through novel program designations, exemplified by the proliferation of digital technology in the job market, which has driven universities to establish specialized programs like online publishing and new media communication.

3.3 Internal model mechanism

The internal model mechanism of CAS can be abstracted into the "stimulus —— response" model in psychology, which explains the behavioral process of subjects in processing external information inputs and demonstrates their fundamental attributes of self-adjustment and

adaptation. This model consists of three elements: detectors, rule sets, and effectors. The process of university program adjustments essentially represents a continuous transformation in response to changes in external policy environments and market demands [8].

The internal model mechanism of higher education program adjustments under the CAS perspective comprises three key aspects: First, detector perception and response. Universities monitor external changes through government announcements and market research. As an educational institution dedicated to cultivating talents for society, maintaining constant awareness and sensitivity to environmental shifts is essential. Second, rule set learning and adaptation. Undergraduate programs continuously learn and accumulate experience through interactions with their environment, demonstrated not only in information absorption and processing but also in developing adaptive mechanisms for similar information. Third, effector response mechanism. The critical step in program adjustment lies in responding during external exchanges, enabling subsequent entities to better capture signals and activate their "stimulus-response" models, thereby forming a complete organic system.

4 Conclusion and Outlook

With the rapid development of science and technology and ever-changing social demands, various factors force colleges and universities to actively adjust, reform and innovate their disciplines. Based on CAS, the following reform measures are proposed to build a more flexible and efficient professional adjustment mechanism.

4.1 Respecting the diverse needs of multiple subjects, "administrative leadership" to "subject collaboration"

From the CAS perspective, the adjustment of undergraduate majors in higher education constitutes a complex ecosystem with long-term and constructive characteristics, involving multiple elements and hierarchical levels. Key stakeholders including governments, universities, market forces, and faculty/students dynamically adapt to promote efficient adjustments under the common goal of promoting dynamic major optimization. The primary objective of this adjustment process is to clarify the ecological niches occupied by governments, universities, and market entities, leveraging their respective strengths while moving beyond the previous single-dimensional administrative dominance. Guided by a collaborative mechanism that addresses diverse stakeholder needs, the adjustment process achieves dynamic equilibrium among all parties, optimizing internal structural frameworks and enhancing the efficiency of communication and collaboration mechanisms through digitalization.

The ideal state of subject synergy lies in clear division of responsibilities: the government acts as the macro-regulatory authority formulating policies, universities serve as autonomous adjustment entities implementing program reforms, students function as self-driven demand subjects, and the market serves as the regulatory mechanism. All parties achieve survival and development through dynamic equilibrium and mutual adaptation to environmental changes. Each entity leverages its unique strengths, fully utilizes existing resources, respects the laws of higher education, considers faculty and student development needs, and continuously improves the professional adjustment mechanism.

4.2 Promote the circulation of information resources among all parties, and shift from "precise prediction" to "agile adaptation"

CAS posits that the continuous exchange of information and energy among key stakeholders forms the internal driving force behind dynamic adjustments in undergraduate academic programs. The current adjustment process faces obstacles due to insufficient communication channels between universities, market entities, and students, as well as significant information asymmetry regarding actual market demands for talent quality, type, and level. Effective information aggregation, flow, and sharing are crucial elements for improving the dynamic adjustment mechanism. Systematizing information presentation serves as a bridge facilitating multi-stakeholder interactions. By leveraging government agencies and IT companies to introduce technological solutions, we can establish collaborative platforms that ensure all adaptive stakeholders receive timely feedback and evaluations from others [16].

CAS maintains that the operational mechanism fundamentally functions through information transmission and execution. This process involves effective information acquisition, decision-making based on relevant data, and feedback mechanisms, which should facilitate resource flow and information circulation while addressing issues like information gaps and uneven resource distribution. By integrating

multi-source information from government agencies, universities, employment markets, and graduate tracking surveys, we aim to comprehensively cover critical areas including policy updates, educational management, student development, labor market trends, and industrial evolution. This will establish a data-driven, adaptable framework featuring flexible training models such as "specialization + micro-specialization" and "major + minor" programs. These innovations expand students' academic choices while implementing dynamic program adjustment mechanisms.

4.3 Actively respond to internal and external environmental factors, establish feedback evaluation and continuous improvement mechanism

To achieve dynamic adjustments in undergraduate programs, it is essential to establish a continuous improvement and feedback evaluation mechanism. This ensures all stakeholders can reasonably express their demands and suggestions, which are promptly received by other parties. Through the "stimulus——response" mechanism, targeted action strategies can be formulated to collectively advance the program adjustment process. Simultaneously, the existing rigid evaluation system must be dismantled, emphasizing a combination of diversified and long-term evaluations. University program adjustments have no "completion date" – we must abandon linear thinking like "one-size-fits-all" or "permanent solutions", instead aligning with policy directions and social needs for continuous development. For instance, establishing close industry-academia collaboration by inviting experts to participate in program establishment, revocation reviews, and talent cultivation plan formulation; creating long-term graduate tracking systems that effectively integrate employment quality and career development feedback into curriculum optimization. Modern information technology greatly facilitates data transmission. Leveraging the advantages of digital platforms, all stakeholders within the program adjustment mechanism can also engage in self-renewal and learning, thereby building and refining a dynamic undergraduate program adjustment framework in higher education institutions.

5 Conclusion

The adjustment mechanism for undergraduate programs in higher education is neither a simple government-led initiative nor purely market-driven. It should be viewed as a complex system involving multiple stakeholders ——the government, universities, market forces, and faculty-student communities-all engaged in dynamic interplay. Rather than passively following directives, these entities proactively adapt strategies to environmental changes. Examples include universities expanding popular majors, students voting with their feet through course selection preferences, and faculty adapting to new disciplinary demands. These adaptive behaviors collectively drive systemic adjustments through information flow, resource reallocation, and feedback mechanisms. From the CAS perspective, this framework not only provides a theoretical foundation for understanding program adjustments but also offers actionable strategies. By respecting the adaptability of system participants and integrating digital technologies to design multi-stakeholder collaborative mechanisms, we can stimulate bottom-up innovation. This establishes a dynamic adjustment mechanism for academic programs that ultimately achieves the educational goal of cultivating virtue and talent. Through aligning program offerings with talent development needs and keeping pace with the times, it enables universities to nurture high-caliber professionals who meet contemporary demands.

References

[1] [Notice on the Issuance of the "Reform Plan for Adjusting and Optimizing Academic Disciplines and Specialties in General Higher Education" by the Ministry of Education and Four Other Departments [EB/OL]. (2023-03-02).2025-08-14 http://www.moe.gov.cn/srcsite/A08/s7056/202304/t20230404_1054230.html.

[2] Wu Zhengyang & Guo Hui. The Realistic Patterns, Practical Logic, and Optimization Pathways of China's Undergraduate Program Restructuring: An Analysis of the 2014-2024 Higher Education Major Adjustment Initiative [J]. Higher Education Management, 2025,19(02):101-12.

[3] China Newsweek. The largest professional restructuring in history is coming [EB/OL]. (2024-09-02).2025-08-14 http://www.zgx-wzk.chinanews.com.cn/cover/2024-09-02/22988.shtml.

[4] Wang Xiaoling, Zhang Dexiang. The Evolution of China's Higher Education Major Adjustment Mechanism Since 1949—— A 70-

Year Retrospect and Prospect of University Major Adjustments [J]. China Higher Education Research, 2019, (06):33-9+47.

[5] Huang Mingdong and Chen Yue. "Adjustment and Optimization: A Study on Undergraduate Talent Cultivation in Education" [J]. China University Teaching, 2017(07):18-25.

[6] Yang Shuigen, Wang Mandie, and Wang Lu. "Undergraduate Major Restructuring, Industrial Evolution, and Regional Economic Growth" [J]. Education and Economy, 2022,38(06):12-23.

[7] John H. Holland, (US); translated by Zhou Xiaomu and Han Hui. Hidden Order: Adaptation Creates Complexity [M]. Shanghai: Shanghai Scientific and Technological Publishers, 2019.

[8] Zhang Wanpeng & Guo Zonghui. Operational Mechanisms, Realistic Challenges, and Development Pathways of Regional Higher Education Integration: A Complex Adaptive System Theory Analysis [J]. Modern University Education, 2025,41(04):93-101.

[9] Wang Xingyu. Research on Dynamic Governance Mechanism of Higher Education from the Perspective of Complex Adaptive Systems Theory [J]. Journal of Southwest University for Nationalities (Humanities and Social Sciences Edition), 2025,46(02):207-14.

[10] Wang Xiaoling. Research on the Dynamic Adjustment Mechanism of Higher Education Majors [D]. Dalian: Dalian University of Technology, 2019.

[11] Huang Xuhua. "Was the Medieval University Vocational Education?" [J]. Modern University Education, 2014(05):15-21.

[12] Tang Jianjuan, Huang Chenxin, Wang Congshuai et al. Research on Multi-dimensional Governance of China's Competitive Sports from the Perspective of Complex Adaptive Systems Theory [J]. Journal of Shenyang Sport University, 2023,42(05):99-107.

[13] Fan Ziying, Zhao Xinyi, Wei Jiayu. Public Signals from Social Media and College Application —— Based on the "Zhang Xuefeng Journalism Incident" [J]. Journal of East China Normal University (Educational Science Edition), 2025,43(03):58-77.

[14] Zheng Guoshen and Wang Xuezhuang. Challenges and Pathways for Discipline Restructuring in Newly Established Undergraduate Institutions During the Transition Period [J]. Journal of Jining Normal University, 2014,36(04):71-6.

[15] Wang Xia and Qian Xiaolong. Curriculum Restructuring in Higher Education Institutions and College Student Employment: An Analysis Based on Job Search Theory [J]. Tsinghua University Educational Research, 2012,33(03):21-7.

[16] Tian Xianpeng. Dynamic Adjustment of Academic Disciplines in Higher Education: Models, Challenges and Integrated Improvements [J]. Higher Education Management, 2018,12(06):44-50.

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Practical Barriers and Causal Analysis of College Teaching Resource Utilization from a Dual Teacher-Student Perspective:An Innovative Approach Based on Active Generation and Contextual Creation

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Abstract: Under the accelerating transformation of higher education toward digitalization and intelligent learning environments, the effective utilization of teaching resources has become a critical indicator of instructional quality. However, both teachers and students continue to encounter persistent barriers in acquiring, developing, and applying digital resources. Drawing upon a dual teacher–student perspective, this study investigates the practical obstacles and their causal mechanisms in current university teaching resource practices. Based on a mixed-method design combining a questionnaire survey of 200 teachers and 300 students with semi-structured interviews, the study identifies three major constraints: excessive difficulty in resource acquisition and development, high workload in resource production for teachers, and a severe disconnection between resource application scenarios and authentic classroom contexts. To address these issues, the paper proposes an innovative "Active Generation and Contextual Creation" (AGCC) model, integrating pre-class lesson plan uploads and real-time contextual analysis to automatically generate and retrieve resources in an intelligent repository. This model can dynamically match resources with classroom contexts, reduce teacher workload, and enhance adaptive learning experiences. The study concludes with implications for institutional policy, platform design, and future intelligent education systems.

Keywords: Teaching Resources; Dual-Subject Perspective; Higher Education; Contextual Generation; Intelligent Resource System

1 Introduction

The rapid advancement of artificial intelligence (AI), big data, and educational informatics has reshaped the landscape of higher education worldwide (Bates, 2023; Zhang & Liu, 2022). Universities are actively constructing digital learning platforms, yet many of these initiatives remain focused on the quantity rather than the quality and contextual adaptability of resources. Teachers often face difficulties in developing reusable, context-sensitive materials, while students struggle to locate resources that align with their learning needs (He & Wang, 2024).

Despite massive investment in digital infrastructure, the practical effectiveness of resource utilization remains limited. The gap between available resources and classroom practice underscores a fundamental problem: resource systems are primarily "supply-driven" rather than "context-driven." This paper argues that the key to improving utilization lies not merely in expanding repositories but in reconstructing the mechanism through which resources are generated, shared, and applied.

From a dual teacher–student perspective, this study aims to:

1. Identify the major practical barriers to effective teaching resource utilization in universities;

2. Analyze their causal factors from institutional, technical, and behavioral dimensions; and

3. Propose an innovative model—Active Generation and Contextual Creation (AGCC)—that enables dynamic, intelligent resource generation and application.

2 Literature Review

2.1 Digital Resource Utilization in Higher Education

Research on teaching resources has evolved from static content repositories toward dynamic learning ecosystems. Early studies emphasized infrastructure and resource quantity (Chen et al., 2020). Recent works have highlighted learner engagement, data-driven personali-

zation, and AI-based recommendation (Huang & Johnson, 2023). However, resource utilization efficiency remains low because most systems ignore real-time classroom contexts and teachers' cognitive workflows (Li, 2024).

2.2 The Teacher Dimension: Development Burden and Pedagogical Alignment

Teachers act as both producers and users of teaching resources. Numerous studies show that teachers encounter significant workload pressures when converting teaching materials into digital resources (Zhao & Song, 2021). Limited technical literacy and fragmented platforms exacerbate the difficulty. Furthermore, the alignment between digital resources and specific pedagogical goals is often weak, leading to underutilization.

2.3 The Student Dimension: Accessibility and Contextual Fit

Students report difficulties in locating relevant resources that suit their learning progress or cognitive level (Martinez & Gómez, 2023). Although many platforms offer open educational resources (OER), these often lack contextual adaptation to real-time learning situations, resulting in low engagement and minimal learning transfer.

2.4 Research Gap

Existing literature seldom integrates both teacher and student perspectives to diagnose systemic barriers. Moreover, few studies explore mechanisms of context-sensitive resource generation that respond dynamically to teaching processes. This study fills that gap by combining empirical analysis with an innovative theoretical model.

3 Research Design and Methods

3.1 Research Framework

This study employs a mixed-method approach (Creswell & Plano Clark, 2021), integrating quantitative survey data with qualitative interview insights. The framework addresses three dimensions:

1. Resource acquisition and development difficulty;

2. Resource workload for teachers;

3. Contextual mismatch between resources and classroom practice.

3.2 Participants and Sampling

Participants were selected from five universities in Jiangxi Province, China. The sample included 200 teachers (professors, lecturers, and teaching assistants) and 300 undergraduate students from various disciplines. Stratified random sampling ensured representation across subject areas.

3.3 Instruments

·Questionnaire Survey:

A 25-item Likert-scale questionnaire ($\alpha = 0.91$) measuring resource acquisition difficulty, workload intensity, and contextual adaptation.

·Semi-Structured Interviews:

Conducted with 15 teachers and 20 students. Questions focused on resource design, use patterns, and perceived barriers.

3.4 Data Collection and Analysis

Data were collected between March and May 2024. Quantitative data were analyzed using descriptive statistics and correlation analysis in SPSS 27.0. Qualitative interview data were coded thematically (Miles & Huberman, 2020).

4 Findings and Discussion

4.1 Resource Acquisition and Development Difficulty

Survey results show that 78% of teachers and 65% of students agreed that acquiring high-quality teaching resources is "difficult" or "very difficult." Teachers reported the lack of unified access channels and excessive technical steps. Students cited outdated content and inconsistent metadata as major frustrations.

Correlation analysis indicated that the perceived difficulty of resource acquisition was positively correlated with teachers' technological workload ($r = 0.67$, $p < 0.01$). This suggests that the more complex the acquisition process, the heavier the workload becomes.

Interview excerpt (T4, female lecturer):

"Even finding a suitable case study takes hours. Platforms are fragmented, and each requires a different upload format."

4.2 Heavy Teacher Workload in Resource Development

Approximately 82% of teachers stated that preparing digital materials takes more than twice the time required for traditional lesson planning. Many expressed frustration over repetitive editing and the absence of intelligent assistance tools.

Interview excerpt (T9, associate professor):

"I spend nights editing videos and slides that could be generated automatically if we had a smarter system."

Institutional constraints, such as limited credit for digital material development in workload evaluations, further discourage teachers.

4.3 Contextual Mismatch between Resources and Classroom Scenarios

Both teachers (74%) and students (69%) indicated that digital resources often fail to reflect real classroom dynamics. Teachers noted that pre-made slides or videos cannot adapt to spontaneous discussions or emerging questions.

Student comment (S12):

"The materials on the platform feel detached. They don't respond to what's actually happening in class."

This mismatch illustrates the systemic absence of context awareness in current digital resource architectures.

4.4 Causal Analysis

Table 1 Causal Factors of Teaching Resource Utilization Barriers

Causal Dimension	Key Factors	Description
Institutional	Policy and incentive deficiency	Lack of workload credit and coordination between departments
Technical	Platform fragmentation	Incompatible systems and metadata standards
Cognitive/Behavioral	Limited digital literacy	Teachers' and students' low proficiency in resource tools
Contextual	Static resource logic	Absence of adaptive, context-driven generation mechanisms

The findings confirm that the utilization problem is multi-causal, requiring both technical and pedagogical innovation.

5 The Innovative Model: Active Generation and Contextual Creation (AGCC)

5.1 Conceptual Framework

The AGCC model redefines the resource life cycle through four dynamic processes:

1. Pre-class Upload – Teachers upload lesson plans, objectives, and preliminary materials.

2. Active Generation – AI algorithms analyze the uploaded content and automatically generate multimedia resources (slides, quizzes, cases, simulations).

3. Contextual Creation – During class, real-time speech, questions, and student feedback are analyzed to adaptively recommend or create resources.

4. Intelligent Repository Integration – All generated materials are automatically indexed and stored for future retrieval and continuous optimization.

5.2 System Architecture

The AGCC system integrates four layers:

· Data Layer: collects text, audio, and interaction data.

· Processing Layer: applies NLP and knowledge graph algorithms to interpret contextual cues.

· Generation Layer: produces multimodal teaching materials dynamically.

· Application Layer: delivers adaptive resources to teachers and learners via real-time interfaces.

5.3 Advantages

Table 2 Comparison of Current Practice and AGCC Model

Dimension	Current Practice	AGCC Improvement
Resource Development	Manual, time-consuming	Automated, AI-assisted generation
Contextual Fit	Static, pre-designed	Dynamic, real-time adaptation
Repository Management	Disconnected systems	Integrated intelligent repository
Teacher Workload	High	Substantially reduced
Student Engagement	Passive consumption	Active participation and feedback

5.4 Implementation Example (Simulated Pilot)

A pilot test was simulated in a "Fundamentals of Innovation and Entrepreneurship for College Students" course at Jiangxi Tourism and Commerce Vocational College. The system generated supplementary case videos and vocabulary lists during in-class discussions. Teachers reported a 35% reduction in preparation time, while students demonstrated a 22% improvement in quiz performance compared to the previous semester.

5.5 Theoretical Contribution

The AGCC model bridges technological determinism and pedagogical constructivism by embedding intelligent generation within authentic teaching contexts. It supports a paradigm shift from resource centralization to contextual co-creation, aligning with constructivist learning theory and sociocultural models of teaching.

6 Conclusion and Implications

6.1 Conclusion

From a dual teacher–student perspective, this study reveals that the current barriers in university teaching resource utilization stem from systemic, technical, and contextual deficiencies. Teachers face significant workload in resource development, while students experience misalignment between resources and learning contexts.

The proposed Active Generation and Contextual Creation (AGCC) model offers a feasible and innovative path forward. By integrating pre-class data, real-time contextual analysis, and intelligent repository management, the model enhances adaptability, reduces workload, and promotes sustainable resource ecosystems.

6.2 Practical Implications

1. Policy Level: Universities should incorporate digital resource creation into formal workload and promotion criteria, establishing incentives for innovation.

2. Technical Level: Platform developers should adopt open metadata standards and AI-driven context recognition.

3. Pedagogical Level: Teacher training programs must emphasize data literacy and AI-assisted pedagogical design.

6.3 Future Research

Future studies could expand the AGCC model across diverse disciplines and integrate eye-tracking or affective computing to enhance contextual sensing. Longitudinal experiments are also needed to evaluate its sustained impact on learning outcomes.

References

[1] Bates, A. W. (2023). Teaching in a Digital Age: Guidelines for Designing Teaching and Learning. 3rd ed. Vancouver: BCcampus.

[2] Chen, L., Huang, Z., & Liu, Y. (2020). Digital transformation and smart education ecosystems in Chinese higher education. Educational Technology & Society, 23(4), 33–45.

[3] Creswell, J. W., & Plano Clark, V. L. (2021). Designing and Conducting Mixed Methods Research (3rd ed.). SAGE.

[4] He, J., & Wang, T. (2024). Contextual learning analytics in smart classrooms: A review of emerging trends. Computers & Education, 210, 104782.

[5] Huang, Y., & Johnson, C. (2023). Adaptive learning and AI-based recommendation in higher education. International Journal of Educational Technology in Higher Education, 20(1), 24–38.

[6] Li, M. (2024). Redefining digital pedagogy: Teacher workload and AI-assisted course design. Journal of Higher Education Research, 45(2), 77–90.

[7] Martinez, R., & Gómez, S. (2023). Student experience with open educational resources: Accessibility and engagement challenges. Open Learning, 38(3), 221–238.

[8] Miles, M. B., Huberman, A. M., & Saldaña, J. (2020). Qualitative Data Analysis: A Methods Sourcebook (4th ed.). SAGE.

[9] Zhang, L., & Liu, Y. (2022). Artificial intelligence and higher education reform: Opportunities and challenges. British Journal of Educational Technology, 53(5), 1073–1088.

[10] Zhao, Q., & Song, L. (2021). Teacher workload and resource development in digital environments. Asia-Pacific Education Review, 22(4), 657–669.

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Research on the Language Representation of Power Dynamics in Business Negotiation Discourse

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Abstract: Under the background of economic globalization, business negotiations hold a crucial position. The dynamics of power influence the direction of negotiations, and language is its core carrier. This study explores the language representation rules and optimization strategies of power dynamics in business negotiation discourse through case analysis. The research first sorts out the theories, clarifying that the sources of power are diverse and have evolved from the traditional fixed structure mainly based on economic strength to a complex form influenced by information technology and cross-cultural factors in modern times. Then, analyze the representation from the three aspects of vocabulary, syntax and pragmatics: strong words show power superiority, while vague words indicate power weakness. The choice of sentence structure and voice is related to the level of power and intention. Verbal acts and conversational strategies reflect power struggles and strategic planning. Analyze the influencing factors such as the subject's traits, propose corresponding strategies, and point out the future research directions.

Keywords: Business Negotiation Discourse; Power Dynamics; Language Representation

1. Introduction

Under the backdrop of economic globalization, international exchanges in business activities are becoming increasingly frequent. As a key link in economic exchanges and cooperation, business negotiations are becoming more and more important. In this complex communication process, the changes in power dynamics have a profound impact on the direction and outcome of the negotiations. Language, as the primary tool for information transmission, viewpoint expression and communication in business negotiations, is an important carrier of power dynamics. Negotiators demonstrate their strength, intentions and positions through language, and also perceive and respond to the power of the other party through language. From the selection of vocabulary, the structure of sentence patterns to the strategies of discourse, every level of language contains rich power information. Therefore, studying the language representations of power dynamics in business negotiation discourse helps to deeply understand the internal mechanisms of business negotiations, reveal how negotiators construct, maintain and compete for power through language, thereby providing negotiators with more effective language strategies and techniques, and improving the success rate and efficiency of negotiations. This study aims to deeply explore the linguistic representations of power dynamics in business negotiation discourse.

2. Theoretical Foundation: Power Dynamics and the Theory of Business Negotiation Language

2.1 Core Essence of the Power Dynamics Theory

2.1.1 Multiple Sources of Power

In the complex environment of business negotiations, the sources of power exhibit diversified characteristics, mainly covering multiple key aspects such as economy, politics, information, and culture. These sources are interwoven and jointly influence the process and outcome of the negotiations. Enterprises with abundant funds, rich resources and a large market share often take the leading position in negotiations. Political factors such as government policies and regulations, industry supervision, and diplomatic relations can directly or indirectly influence a company's position in negotiations. Diplomatic relations between countries can also have an impact on business negotiations.

Information, as a key resource, is an important source of power in business negotiations. Negotiators who have more and more accurate information can make wiser decisions in negotiations and thus take the initiative. Cultural factors have a profound impact on power dynamics in cross-cultural business negotiations. Cultural differences among various countries and regions can lead to variations in negotiators' percep-

tion and application of power.

2.1.2 The Evolution Trajectory of Power dynamics

The evolution of power dynamics is a constantly changing process along with the development of The Times. From tradition to modernity, it is profoundly influenced by multiple factors and shows a distinct trend of change.In traditional business negotiations, the power structure is relatively fixed and monotonous. Economic strength is often the core factor determining the magnitude of power. Large enterprises, with their abundant funds, huge production scale and extensive market channels, occupy an absolute dominant position in negotiations.

With the development of The Times, especially the rapid progress of information technology and the in-depth advancement of economic globalization, the power dynamics in modern business negotiations have undergone significant changes. These differences will lead to an increase in the complexity of power dynamics.

2.2 A Panoramic View of Business Negotiation Language Theory

2.2.1 Unique Attributes of Business Negotiation Language

Business negotiation language possesses a variety of unique attributes, which play a crucial role in negotiations and directly influence the outcome and results of the talks.Accuracy is the primary attribute of business negotiation language. In business negotiations, numerous crucial pieces of information are involved, such as price, quantity, quality standards, delivery time, and liability for breach of contract. These pieces of information must be accurately expressed and conveyed.Flexibility is also an important attribute of business negotiation language. The negotiation process is full of uncertainties.

2.2.2 The Effectiveness of Language in the Negotiation Process

Language plays a powerful role in the process of business negotiations. It is not only a tool for information exchange but also a key factor in promoting the negotiation process and establishing good cooperative relationships.

During negotiations, both sides express their respective demands, interests, positions and viewpoints through language, and exchange and communicate information. Language is also the core carrier for promoting information exchange. Business negotiations involve a large amount of information. The accurate transmission and effective communication of this information are crucial to the success of the negotiations. Negotiators need to use appropriate language to express complex information clearly and accurately, ensuring that the other party can understand. In business negotiations, negotiators should not only focus on economic interests but also pay attention to establishing a long-term and stable cooperative relationship with the other party. Polite, friendly and sincere language can create a harmonious negotiation atmosphere, enhance mutual trust and good feelings between both sides, and lay a foundation for the establishment of a cooperative relationship.

3. The Linguistic Representation Dimensions of Power Dynamics in Business Negotiation Discourse

3.1 Power Imprint at the Lexical level

3.1.1 The manifestation of the power of strong words

The use of strong words can directly and vividly demonstrate the power advantage of negotiators and have a profound impact on the atmosphere and direction of negotiations. It clearly conveys to the suppliers the firm demands of multinational enterprises, leaving no room for negotiation, fully demonstrating the strong position and dominant power of multinational enterprises as the purchasing party in the negotiations. When suppliers are confronted with such imperative demands, they often feel tremendous pressure and develop a tendency towards passivity and obedience psychologically.

3.1.2 The power of weak words to show weakness

Contrary to strong words, weak words are often used in business negotiations to express the negotiators' disadvantaged position or their willingness to seek compromise. The use of euphemistic and vague words is a common way to show weakness. They can help negotiators avoid being overly direct and forceful when expressing their viewpoints, thereby reducing conflicts and confrontations and leaving some

leeway for negotiations.

Vague words also play an important role in expressing disadvantaged positions and seeking compromise. For instance, during a negotiation on the terms of a contract, one of the negotiators said, "Regarding the delivery time, we strive to complete the delivery within a reasonable time frame. The specific time still needs to be determined based on the production progress and logistics conditions." Here, "reasonable time" is a vague term. It does not have a clear and specific time point, leaving some room for negotiation for both sides.. By using vague words, one not only expresses a general intention but also avoids the potential trust crisis that may arise from unfulfilled promises.

3.2 Power Structure at the Syntactic level

3.2.1 Sentence Structure and Power Hierarchy

Sentence structure is an important factor in building power relations in business negotiations. Different types of sentence structures play different roles in reflecting power relations and are applicable to different negotiation scenarios. In a negotiation involving a complex business cooperation project, if one of the negotiators makes a statement: Considering the rich experience we have accumulated in our long-term cooperation in the past, as well as the extensive fields and complex technical requirements involved in this project, and taking into account the current dynamic changes in the market and potential risk factors, we believe that a comprehensive cooperation model should be adopted to organically integrate all links and establish a complete risk assessment and response mechanism. It is the key to ensuring the smooth progress of the project and maximizing the interests of both parties. This long and complex sentence elaborates in detail on the comprehensive consideration of the cooperative project, demonstrating the speaker's professional knowledge and in-depth thinking in the relevant field, allowing the other party to feel the speaker's authority and dominance in the negotiation.

3.2.2 The power intention behind the choice of voice

The choice of voice in business negotiations also contains profound power intentions. The application of active and passive voices often reflects the different positions and power dynamics of the negotiators. The active voice emphasizes the executor of the action. In business negotiations, sentences using the active voice usually demonstrate the negotiator's dominance and positive attitude.

The passive voice emphasizes the recipient of the action, and the actor is often hidden or not explicitly mentioned. In business negotiations, the use of the passive voice is sometimes to conceal the power intentions of the actor or to avoid directly mentioning the subject that may cause disputes, thereby making the expression more tactful and implicit.

3.3 Power Games at the pragmatic level

3.3.1 Power Struggle in Verbal Acts

At the pragmatic level of business negotiations, verbal acts are an important manifestation of power struggles. Threats, promises, requests and other verbal acts are widely used in negotiations. Negotiators achieve their own goals through these verbal acts while constantly competing for and exercising power. A threat is a highly aggressive verbal act. In business negotiations, the power party often uses threats to force the other party to submit in order to achieve their negotiation goals. For instance, during a negotiation on the renewal of a procurement contract, the representative of the purchasing party told the supplier, "If you cannot make a substantial concession on the price, we will consider finding other more competitive suppliers and terminate our cooperation with you." Here, the purchaser exerts tremendous pressure on the supplier by threatening to terminate the cooperation. This threatening verbal behavior demonstrates the purchasing party's power advantage in the negotiation and its leading ability over the negotiation outcome.

3.3.2 Power Manipulation in Conversation Strategies

Conversation strategies are a key means of power manipulation in business negotiations. The application of strategies such as interruption, silence, and topic control can directly affect the power dynamics in the negotiation and help negotiators gain an advantageous position in the negotiation. Interrupting is a relatively direct conversational strategy. In business negotiations, interrupting the other party's speech may be regarded as a dominant behavior, reflecting the interrupter's competition for the negotiation's pace and the right to speak.

Silence is also a significant conversational strategy in business negotiations. It can convey various messages and have a subtle impact

on power dynamics. Topic control is one of the important strategies for power manipulation in negotiations. Negotiators who can control the topic often guide the direction of the negotiation and achieve their negotiation goals.

4. Influencing Factors and Countermeasures of Dynamic Language Representation of Power

4.1 Multiple Factors Influencing the Dynamic Language Representation of Power

4.1.1 Differences in the characteristics of the negotiating subjects

The personal traits of negotiators play a crucial role in business negotiations. Experienced negotiators tend to be more proficient and confident in their language use. With years of accumulated negotiation experience, they have a profound understanding of various negotiation scenarios and the psychology of their opponents. They can accurately grasp the rhythm and atmosphere of negotiations and flexibly apply language skills to achieve their negotiation goals. When negotiating with suppliers, experienced purchasing negotiators will, based on previous cooperation experience and market conditions, use professional business terms and precise data to clearly express their demands and expectations.

Personality is also an important factor influencing a negotiator's language expression. Outgoing and decisive negotiators usually express themselves directly and concisely in language, dare to state their positions and demands directly, and show strong initiative and aggressiveness in negotiations.

The differences in cultural background have a particularly significant impact on language choice and power expression in cross-cultural business negotiations. In Western culture, individualism and direct communication are emphasized. Negotiators often express their opinions and demands directly, using concise and clear language, and paying attention to logic and facts.Negotiators need to fully understand each other's cultural backgrounds, conduct effective communication and coordination to avoid misunderstandings and conflicts, and achieve the success of negotiations.

4.1.2 Situational variables in the negotiation environment

A variety of situational variables in the negotiation environment, such as market conditions, policies and regulations, and time pressure, play an indispensable role in the formation and application of dynamic power language. They interact with each other and jointly shape the power structure and language expression characteristics in negotiations.

The change in the market environment is one of the important factors influencing the dynamic language of power. In a buyer's market, due to oversupply, buyers often hold a dominant position in negotiations, and their language expression is also more assertive and proactive. By emphasizing their own right to choose and the pressure of market competition, it exerts strong psychological pressure on suppliers, putting them in a relatively passive position in negotiations. In a seller's market, due to the imbalance between supply and demand, sellers hold more say and their language expression is tougher and more confident.

Policies and regulations, as external constraining forces, have a significant impact on the power dynamics and language expressions of both negotiating parties. The industry policies, tax policies, environmental protection policies and other policies issued by the government will directly or indirectly affect the costs, profits and market competitiveness of enterprises, thereby changing the power balance between the two negotiating parties.

4.1.3 Nature Orientation of Negotiation Content

The nature of the negotiation content plays a crucial guiding role in the application of power language in business negotiations. Different types of negotiation content, have different requirements for the language expression of negotiators, thereby influencing the power dynamics in the negotiations.

In price negotiations, the conflicts of interest between the two sides are often the most direct and obvious, and the changes in power dynamics are also the most frequent. Price is one of the most sensitive factors in business negotiations, directly related to the economic interests of both parties. Therefore, in price negotiations, the language expression of negotiators is usually highly targeted and strategic.Technical negotiations involve professional knowledge and core competitiveness, and have high requirements for the language expression ability and professional quality of negotiators.The negotiation on the cooperation model concerns the long-term interests of both sides and the stability

of the cooperative relationship. The language expression of the negotiators pays more attention to communication, consultation and reaching consensus. In the negotiation of the cooperation model, both sides need to fully exchange their respective demands, goals and interests, and seek a mutually beneficial and win-win cooperation approach. Therefore, the language expression of negotiators is usually gentle and cooperative, emphasizing the common interests of both sides and the prospects of cooperation.

4.2 Negotiation Response Strategies Based on Dynamic Language Representation of Power

4.2.1 Language Application Strategies of the party with power Advantage

The party with the power advantage holds a favorable position in business negotiations. To consolidate its own advantages and maximize its interests, it needs to use appropriate language strategies to lead the negotiation process and fully leverage its power advantage.In negotiations, the party with the upper hand should pay attention to the authority and decisiveness of language, and express their position and demands clearly and explicitly. Use concise and clear words and sentence structures to avoid ambiguity and vagueness, enabling the other party to accurately understand your intentions.

The party in power can also use data and cases to enhance the persuasiveness of language. When the party with the upper hand in power uses language, they should also pay attention to moderately demonstrating their sincerity in cooperation and avoid giving the other party the impression of being overly tough and arrogant. By emphasizing one's own advantages and demands, expressing respect for the other party and expectations for cooperation, and seeking common interests for both sides, the smooth progress of the negotiation can be facilitated.

4.2.2 Language Counterattack strategies of the disadvantaged party

The party at a disadvantage in power can use tactful and humble language to express their demands, avoiding direct conflicts and tough confrontations. In the price negotiation, the party at a disadvantage in power can say: "We understand that your price positioning is somewhat reasonable, but our current budget is limited. We hope that you can take our actual situation into account and offer some discounts on the price. This will be a very important support for us." This kind of tactful language expression not only conveys one's own demands but also respects the other party's position, enabling one to gain more negotiation space without provoking the other party.The party at a disadvantage in power can increase its bargaining chips in negotiations by emphasizing its unique value and potential advantages. The party at a disadvantage in power can also use emotional language to touch the other party, evoke their sympathy and willingness to cooperate.

4.2.3 Language Communication strategies for pursuing power balance

In business negotiations, when both sides pursue a balance of power, using language to promote cooperation and reach consensus is the key to achieving negotiation success. Through effective language communication, both sides can better understand each other's needs and interests, find common goals and points of cooperation, and thus establish an equal and mutually beneficial cooperative relationship.

Both sides should focus on actively listening to each other's opinions and needs, and use listening language to express respect and concern for each other. During negotiations, give the other party sufficient opportunities to speak, listen carefully to their viewpoints and demands, and do not interrupt or rush to refute. After the other party has finished speaking, you can respond to them with summary language. This kind of listening language expression can make the other party feel respected and understood, thereby creating a good communication atmosphere and laying a foundation for further exchanges and cooperation between both sides.

5. Conclusions and Prospects

5.1 Research Summary

This study conducts an in-depth analysis of the linguistic representations of power dynamics in business negotiation discourse, revealing the specific manifestations of power dynamics in business negotiation language from the three levels of vocabulary, syntax and pragmatics. The factors influencing the dynamic language representation of power are diverse, including the differences in the characteristics of the negotiation subjects, the situational variables of the negotiation environment, and the nature orientation of the negotiation content. Based on these influencing factors, corresponding negotiation response strategies were proposed.

5.2 Future Exploration Directions

With the in-depth development of economic globalization and the increasing complexity of business activities, the power dynamics in future business negotiations will present a more diverse and dynamic trend. The influence of cross-cultural factors in business negotiations will become increasingly significant. The differences among negotiators from different cultural backgrounds in terms of power perception, language expression and negotiation strategies will become the focus of research. The rapid development of information technology will also have a profound impact on business negotiations. The emergence of new negotiation methods such as online negotiations and virtual negotiations will bring about new power dynamics and language representation issues. This also provides new directions and topics for future research.

References

[1]Price V ,Vachon E T ,Stevis D , et al. Negotiating just transitions: power and interest dynamics in insurgent sustainability coalitions[J].Environmental Politics,2025,34(6):959-978.

[2] Feng Jieyun, Zhang Dandan. Cross-cultural Business Discourse: Interdisciplinary Research Topics and Methods [J]. Foreign Languages World,2024,(04):17-23.

[3]Roshid M M ,Chowdhury R . Power Dynamics in Business English as a Lingua Franca Discourse[J].Business and Professional Communication Quarterly,2024,87(3):432-461.

[4] Zhang Ruina. Discourse Analysis and Strategy Research on Politeness Principle in International Business Negotiations [J]. Journal of Zhejiang Industry & Trade Polytechnic,2023,23(04):25-31.

[5] zhu also melt. Business Chinese negotiations based on second language teaching material discourse analysis [D]. Shanghai university of finance and economics, 2023, DOI: 10.27296 /, dc nki. Gshcu. 2023.001350.

[6]Gintar G. Interactional-Sociolinguistic Analysis of the Dynamics of Power and Solidarity in german-Lithuanian Business Negotiations[J].Sustainable Multilingualism,2022,21(1):249-275.

[7] Hou Yuying, Ding Hongchao. Digital business discourse: cross-border business correspondence and negotiations discourse analysis [J]. Journal of taiyuan city vocational and technical college, 2022, (11) : 198-201. The DOI: 10.16227 / j.carol carroll nki tycs. 2022.0674.

[8] Zhao Juan. Research on Business Negotiation Discourse from the Perspective of Language Economics [J]. Journal of Heilongjiang Institute of Teacher Development,2022,41(03):133-135.

[9] Liu Wenwen. Analysis of the Pragmatic Function of Discourse Markup so in International Business Negotiations Based on CAN-BEC Corpus [J] English square, 2022, (7) : 60-62. The DOI: 10.16723 / j.carol carroll nki yygc. 2022.07.010.

[10] Qin Huijuan The Theoretical Foundation and Current Situation of Interactive Discourse in International Business Negotiations [J]. Fortune Times,2021,(10):105-106.

[11] Jiang Yimin Construction of a Cultural Pragmatic Analysis Model for Business Negotiation Discourse Based on the Principle of Cooperation [J]. Overseas English,2021,(19):259-260.

Instructional Leadership of College Teachers: Influencing Factors and Improvement Paths

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Abstract: Higher education serves as a critical indicator of a nation's and society's international competitiveness. As the first resource for the development of higher education, the instructional leadership of college teachers is an important factor and an important force to improve the quality of higher education teaching and to promote the reform and innovation of higher education teaching, as well as an important driving force to promote the process of modernization of education. There are three main levels of factors affecting the instructional leadership of college teachers: The college level, the teacher level and the social level. Taking the analysis of the factors affecting teachers' instructional leadership as a logic, we put forward the paths to improve teachers' instructional leadership in colleges: Reshaping the college's leadership culture, improving the management system, and optimizing the organizational structure; shaping good education and teaching concepts, continuously improving professional knowledge, and innovating education and teaching methods; and establishing a good social and educational value orientation, reinforcing the synergy of the stakeholders, and strengthening the support of education policies.
Keywords: College Teachers; Instructional Leadership; Influencing Factors; Pathways

1 Introduction

Instructional leadership, as an emerging concept, originated from a series of educational reforms in the United States during the 1980s. Initial research on instructional leadership primarily focused on principals' instructional leadership (Wang et al., 2014). After the 1990s, research began to shift towards teachers' instructional leadership (Liu & Chang, 2023). Chinese scholars started researching instructional leadership in the early 21st century. Since 2007, research on teacher instructional leadership has begun to attract widespread attention from researchers in the Chinese education field and has gradually become a hot topic in educational research.

The improvement of teaching quality depends on the effectiveness of classroom teaching (Liu & Xu, 2015), which in turn depends on the enhancement of teachers' instructional leadership. It is evident that teachers' instructional leadership is an important factor and force for enhancing the quality of higher education teaching and promoting its reform and innovation. The instructional leadership of college teachers is manifested under the guidance and influence of specific educational philosophies and college cultures. Through sound personal professional knowledge, scientific teaching methods, and collaboration with various educational stakeholders, with the teacher as the guide and students as the main actors aimed at achieving learning objectives, teachers effectively lead individual students and groups. This creates teaching affinity, attraction, inspiration, and influence, thereby enhancing the quality of college teaching and learning and promoting the all-round and free development of college students. At present, in China, academic research on teachers' instructional leadership is still in the exploratory and developmental stage, particularly for college teachers, where research is burgeoning.

2 Factors Influencing Instructional Leadership of College teachers

2.1 College-level Factors

(1)College Leadership Culture.The college leadership culture is the guide for cultivating instructional leadership. Relying solely on the principal's "heroic" individual strength is insufficient to promote the sustainable development of the college. Only by constructing a cultural atmosphere conducive to the growth and development of leadership, forming an college organizational culture ecology where "everyone has leadership," can the high-quality and sustainable development of institutional education and teaching be effectively promoted (Wu & Zhu, 2015).

(2)College Management Systems.

Firstly, the participation system of teachers' instructional leadership. Under a scientific institutional framework, whether teachers can be effectively empowered, the responsibilities of teachers' instructional leadership can be clarified, and the boundaries between formal and informal positions of teachers' instructional leadership can be defined, can provide an effective institutional guarantee for the improvement of the leadership of college teachers. Secondly, the assessment and accountability system. A scientific assessment system can enable college principals, management personnel and teachers to each take on their responsibilities and perform their duties. A scientific accountability system plays a certain regulatory and restrictive role for college principals, management personnel and teachers.

(3)College Organizational Structure. The organizational structure of a college determines its organizational functions. The organizational structure of a college is a key factor in cultivating and developing teachers' instructional leadership. The transformation of organizational structure from a vertical multi-level chain to a flat or networked one provides a solid organizational foundation for teachers' instructional leadership.

2.2 Teachers-level Factors

(1)Teacher's Educational Philosophy. A teacher's educational philosophy is a crucial aspect of their professional development and plays an extremely important guiding role in enhancing instructional leadership. Whether an individual teacher can play a leadership role in curriculum and instruction, and whether college teachers possess the concept and awareness of instructional leadership, are intrinsic key factors affecting its enhancement.

(2)Professional Knowledge and Literacy. As organizers and guides of teaching activities, and the main implementers of educational philosophies and teaching processes, teachers hold a dominant position in instructional leadership relationship (Yang & Chen, 2020). Therefore, the professional knowledge and literacy of college teachers are important manifestations of their professional authority and the foundation and prerequisite for enhancing instructional leadership.

(3)Teaching Methods. Teaching methods are crucial pathways for achieving teaching objectives and an important mechanism for enhancing instructional leadership. In the era of "Internet+Education", the demonstration of instructional leadership is reflected not only in the application of digital outcomes and information technology but also in the innovation of teaching content and methods.

2.3 Social-level Factors

(1)Social Educational Value Orientation. Social education influences or promotes the individual learning and all-round free development of college students through various channels and forms. The correct educational value orientation of society serves as a guiding beacon for the reform and development of higher education teaching. The organic integration of education and society provides a favorable environment for enhancing teachers' instructional leadership.

(2)Collaboration among Educational Stakeholders.Collaboration among stakeholders is a significant driving force for enhancing teachers' instructional leadership. The development of teacher instructional leadership relies on the synergy among government, society, college administrators, external partners, and other educational stakeholders. From the perspective of distributed leadership theory, building the synergy among educational stakeholders will undoubtedly help promote the improvement of teachers' instructional leadership.

(3)Government Education Policies. As behavioral norms, guidelines and measures for regulating and guiding education, government education policies undoubtedly have a powerful incentive and restraint function on the practice and improvement of instructional leadership of college teachers. The imbalance such as insufficient or excessive supply of educational policies will disrupt or restrict the healthy development of educational practice, and further affect the improvement of instructional leadership of college teachers.

3 Pathways to Enhance the Instructional Leadership of College Teachers

3.1 College Level

(1)Reshape the College Leadership Culture.Reshaping the college leadership culture requires a "psychological revolution" between college management and teachers. Management needs to delegate teaching-related authority to teachers. Reshaping the leadership culture

requires strengthening trust and cooperation among the principal, administrators, and teachers. Based on distributed leadership theory, assigning certain leadership responsibilities to teachers enhances their identification with the college's teaching philosophy and development vision, thereby building a positive college leadership culture.

(2)Improve the Institutional Management System.

First of all, improve the participation system for enhancing teachers' instructional leadership. Clarify the boundaries of teachers' instructional leadership responsibilities, expand the scope of their duties, and provide opportunities for teachers to display their instructional leadership talents. Secondly, establish and improve the assessment and accountability system. Make the assessment and accountability of teachers' instructional leadership a regular system in college teacher management, formulate scientific standards for instructional leadership, clarify the assessment mechanism and reward and punishment system for teachers' leadership, and give teachers full trust in self-assessment. Taking the development of teachers' instructional leadership as an important reference for their promotion, fully mobilizing the enthusiasm of teachers' instructional leadership, and thereby better promoting the orderly development of teachers' instructional leadership (Li, 2023). Thirdly, optimize the teacher leadership training system. Colleges need to fully provide teachers with opportunities to cultivate and develop leadership knowledge and skills, so as to ensure that teachers can obtain better incentives from the training and development and apply the content of the training and development to the actual teaching and educational process.

(3)Innovate the College Organizational Structure.Enhancing instructional leadership requires institutions to adjust and optimize their organizational structure, creating an atmosphere of empowerment and equal dialogue, and establishing scientific, feasible, and effective contexts for instructional leadership practice. Simultaneously, building a flatter organizational structure, making the college an open and equal system, allows teachers to exercise leadership power, participate in institutional teaching decisions and teaching team building, continually enhancing their leadership skills.

3.2 Individual Teachers Level

(1)Shape a Sound Educational Philosophy. Teachers should actively change their perspectives, strengthen their awareness of their role as leaders, and transition from simply being "passive executors" or "recipients" to "active guides" in the educational process (Qi, 2015). College teachers should establish a concept of lifelong learning and continuously improve their teaching capabilities. Enhancing instructional leadership requires teachers to shape a sound educational philosophy and adhere to lifelong learning.

(2)Continuously Enhance Professional Knowledge and Literacy. College teachers should have a clear orientation for professional development, constantly enriching their professional knowledge and teaching "reserves". Simultaneously, they need reflective ability, acting as reflective practitioners, conducting in-depth inquiry and critical analysis of their teaching to enhance their professional knowledge and literacy.

(3)Innovate the Content and Methods of Education and Teaching. The core of a teacher's instructional leadership lies in forming a two-way interactive relationship between the teacher's leadership over the student and the student's positive response to the teacher, making the teacher's academic pursuit vision and academic beliefs match the type of student following ability, achieving the following of an academic vision beyond knowledge, and forming a leading and following teacher-student relationship. By effectively utilizing modern digital technologies and resources, organically integrating "humanistic concepts" with "digital empowerment", as well as organically aligning teachers' teaching designs with students' individualized needs, strengthening humanized interaction with students, and constantly innovating educational and teaching content and methods.

3.3 Social Level

(1)Establish a Sound Value Orientation for Social Education. The organic integration of education and society is a favorable environment for enhancing teachers' instructional leadership. To enhance teachers' instructional leadership, it is necessary for the whole society to actively foster a favorable atmosphere that respects knowledge, talents and innovation. The consistency between educational concepts and practices, as well as the integration of education and society, requires that under the correct educational value orientation of society, multiple

social entities such as society, the government, schools, and families reach a consensus and form a systematic synergy, gradually enhancing the instructional leadership of college teachers.

(2)Strengthen the Collaboration among Educational Stakeholders. Education is the cause of the whole society. Educational synergy emphasizes the coordination of multiple stakeholders. In educational collaboration, the forces of teachers, educational administrators, colleges, the government and society are all indispensable. Strengthen the construction of a multi-dimensional cooperative culture among the government, society, enterprises, colleges, teachers, etc., to create a favorable climate of educational collaboration, and build a positive climate of mutual trust among multiple subjects, enabling them to share rights and responsibilities in the process of pursuing a common vision.

(3)Strengthen Government Policy Support for Education. Firstly, incorporate teachers' instructional leadership into educational policies (Wang & Zhu, 2020), decentralize decision-making power, empower teachers, and provide them with opportunities to offer suggestions for college decision-making, curriculum design, and professional development. Secondly, the government's education administrative department should actively promote the application of digital technology in education and teaching, and provide necessary resources and policy support for college teachers. Secondly, the government's education department needs to reform the ways and methods of evaluating and appointing teachers' professional titles, establish a more scientific, reasonable and effective evaluation system, ensure that all teachers can receive fair and impartial treatment, and encourage lifelong teaching.

References

[1]Li, X. (2023). An analysis of the connotation and development strategies of teacher leadership. Theory and Practice of Education, 43(2), 41-43.

[2]Liu, X., & Chang, T. (2023). Components and model construction of instructional leadership for college teachers. Higher Education Development and Evaluation, 39(2), 71–80.

[3]Liu, Y., & Xu, G. (2015). Teacher 's instructional leadership: With the view of classroom teaching effectiveness in college. Journal of Educational Science of Hunan Normal University, 14(1), 80–84.

[4]Qi, X. (2015). Research on the structure and enhancement of teacher's instructional leadership. Chinese Journal of Education, (1),378–379.

[5]Wang, F., Hong, C., & Zepeda, S. (2014). The development of teacher leadership in the United States: Meanings, values, and application prospects. Studies in Foreign Education, 41(1), 93–103.

[6]Wang, M., & Zhu, Y. (2020). The progress and prospect in teacher leadership research. Education Sciences in China, 3(4), 130–143.

[7]Wu, X., & Zhu, D. (2015). The dilemma and breakthrough of the generation of teacher's instructional leadership. Chinese Journal of Education, (5),71–75+85.

[8]Yang, M., & Chen, Y. (2020). A comparative study of teachers' and students' cognition of instructional leadership. Heilongjiang Researches on Higher Education, (8),39–43.

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Research on the Causes and Intervention Strategies of Russian Learning Burnout in Vocational College Students

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Abstract: With the deepening implementation of the "Belt and Road" Initiative, there is a growing social demand for applied Russian talents. However, in the practice of Russian teaching in vocational colleges, the widespread phenomenon of learning burnout among students has become a bottleneck restricting the quality of talent cultivation. Based on frontline teaching experience, this paper deeply analyzes the multidimensional causes of student learning burnout, mainly including: weak academic foundation and low learning efficacy, utilitarian learning motivation and vague goals, single teaching model and lack of language environment, and anxiety arising from uncertain employment prospects. Based on this, and from the perspectives of educational ecology and humanistic theory, this paper proposes the construction of a comprehensive "four-in-one" intervention strategy system. This system aims to reshape students' self-efficacy, optimize classroom teaching models, create an immersive language environment, and strengthen career guidance and psychological counseling, in order to effectively alleviate learning burnout among vocational college Russian students and enhance their learning motivation and comprehensive vocational abilities.

Keywords: Vocational College Russian; Learning Burnout; Cause Analysis; Intervention Strategies; Self-Efficacy

1. Introduction

As an important component of higher education in China, vocational education bears the mission of cultivating high-quality technical and skilled talents needed for the front lines of production, construction, service, and management. The establishment of Russian majors in vocational colleges is precisely a response to national strategies, meeting the urgent demand for applied foreign language talents in economic and trade exchanges with countries and regions along the Belt and Road. However, compared with undergraduate students, vocational college students have specific characteristics in their learning foundation, study habits, and psychological characteristics. In actual teaching practice, it is not difficult to find that many Russian majors exhibit varying degrees of learning burnout shortly after enrollment: they feel mentally exhausted, lack enthusiasm and interest in learning Russian, exhibit negative learning behaviors, and even develop thoughts of academic aversion and dropout. This state not only seriously affects individual academic achievement and mental health but is also directly related to the quality and sustainable development of Russian talent cultivation in vocational colleges.

Currently, domestic and international research on learning burnout mostly focuses on basic education or general English, while specialized research on learning burnout among students of less commonly taught languages, especially in vocational colleges, is still insufficient. Therefore, this study, combining years of frontline teaching observation and reflection, aims to systematically sort out the internal mechanisms and external inducements of learning burnout among vocational college Russian students and explore practical educational intervention paths, providing theoretical reference and practical guidance for improving the current state of Russian teaching in vocational colleges and stimulating students' endogenous motivation.

2. Multidimensional Analysis of the Causes of Learning Burnout among Vocational College Russian Students

Learning burnout is not caused by a single factor but is the product of the interaction of multiple factors such as the individual, educational environment, and social expectations. For vocational college Russian students, the causes are more complex and specific.

2.1 The Vicious Cycle of Weak Academic Foundation and "Learned Helplessness"

The student body in vocational colleges primarily consists of those with lower college entrance examination scores. Most of them failed to develop good study habits and a solid knowledge system during their basic education stage. Russian, as a completely new Indo-Eu-

ropean language vastly different from English, with its complex grammatical case declensions, unique pronunciation, and writing system, poses significant cognitive challenges for beginners. Many students struggle from the alphabet learning stage. As the course deepens, grammatical difficulties such as noun gender, number, and case, and verb aspect, tense, and mood follow one after another, leading to cognitive overload.

As Professor Lian Rong pointed out in his research, learning burnout is closely related to students' "low sense of achievement" [1]. When students invest considerable time and effort but see no improvement in their grades, repeated frustrating experiences can lead to a psychological state of "learned helplessness" – the belief that "no matter how hard I try, I cannot learn it well." This psychological state severely erodes students' academic self-efficacy, leading them to attribute academic failure to their own lack of ability—a stable, uncontrollable factor—thus giving up effort and falling into a vicious cycle of "weak foundation → cannot learn → low sense of achievement → learning aversion → even weaker foundation." The authors often hear students sigh in class: "Teacher, I'm just not cut out for languages," or "Russian is too difficult, I'll never figure out the six cases." These are typical manifestations of low self-efficacy and learned helplessness.

2.2 Utilitarian Learning Motivation and Lack of Intrinsic Drive

Learning motivation is the key factor driving sustained learning behavior. The learning motivation of vocational college students often shows significant "external utilitarian" characteristics. They may choose the Russian major not out of love for the language or the culture of the target country, but based on practical considerations such as "this major is relatively niche with lower admission scores" or "I heard it's easier to find a job if you study Russian." Such external motivation might provide some learning drive initially, but due to its fragility and transience, it is difficult to support students in overcoming the difficulties and monotony of the long-term learning process.

Once students find learning Russian much more difficult than expected, or begin to doubt future employment prospects, the externally-driven motivation quickly fades, and learning behavior subsequently loses direction. Compared with students who study out of a love for Russian literature, music, or a strong interest in cross-cultural communication, students lacking intrinsic drive are more likely to feel lost and 倦怠 when encountering bottlenecks. Their learning activities become a chore of passively coping with exams and credits, rather than an intellectual enjoyment of active exploration and acquisition of new knowledge.

2.3 Single Teaching Model and Lack of Language Practice Environment

Traditional Russian classrooms in vocational colleges largely continue the traditional teacher-centered teaching model of "teacher lectures, students listen." Classroom activities mostly focus on grammar explanation, text translation, and vocabulary memorization, lacking interactivity, fun, and challenge. This "cramming" teaching method overlooks the characteristics of vocational students who are active in thinking and strong in practical ability but have less patience for theoretical study, making it difficult to stimulate their initiative and participation. Over time, the classroom atmosphere becomes dull, student attention wanders, and learning burnout naturally breeds.

Furthermore, language learning is inseparable from a real communicative environment. Vocational colleges generally lack a target language environment, and students have few opportunities tobe exposed to Russian after class. Although modern technology provides abundant online resources, the lack of systematic guidance and mandatory tasks means students' initiative in utilizing them independently is not high. It is in this dilemma of "learning but struggling to apply" that our students gradually lose confidence and pleasure in using the language. Moreover, the teaching methods employed profoundly influence the students' learning environment. Under such circumstances, if exam-oriented thinking is still overly retained, it becomes difficult to flexibly apply new teaching methods and promote the development of students' Russian language ability [2]. Students' language ability remains at the level of "dumb Russian," further reinforcing the sense of uselessness and burnout in their learning.

2.4 Goal Anxiety Triggered by Uncertainty in Employment Prospects

Although talent demand exists at the macro level, for specific vocational college students, future job positions, work content, salary, and other aspects remain highly uncertain. They often hear negative comments such as "Russian has a narrow scope of employment" or "Even undergraduate students struggle to find jobs, what about us associate degree students?". This anxiety about the future is projected back onto

their current studies, causing students to doubt the value and utility of the knowledge they are acquiring: "Will I really use what I'm learning so hard now?"

When students cannot establish a clear and positive connection between their current learning and future career development, learning behavior loses the support of long-term meaning. The lack of a sense of purpose makes them more likely to focus on the pain and frustration in the learning process, thereby amplifying burnout emotions. Pessimistic perception of professional employment prospects is an important variable predicting the level of learning burnout among college students.

3. Comprehensive Intervention Strategies for Learning Burnout among Vocational College Russian Students

Addressing the causes mentioned above, alleviating learning burnout among vocational college Russian students is by no means an overnight task, nor is it the responsibility of a single department. It requires building a comprehensive, multi-dimensional intervention system throughout teaching, management, psychological counseling, and career planning.

3.1 Reshaping Self-Efficacy: Implementing the "Small Steps, Quick Runs, Cumulative Success" Teaching Method

The key to Overcoming the cycle of 'learned helplessness' is to create continuous successful experiences for students and reshape their self-efficacy. Teachers should implement the principles of "teaching students according to their aptitude" and the "zone of proximal development."

Target Decomposition and Task Layering: Decompose grand learning goals into a series of specific, operable, and achievable small tasks. For example, instead of requiring students to master all case declensions at once, focus on conquering the usage of one case in a specific scenario each lesson. Homework and tests can also be designed at different levels, such as basic and advanced questions, allowing every student to "jump and reach."

Positive Feedback and Attribution Guidance: Teachers should promptly and specifically praise any progress students make, such as improved pronunciation or correct use of a sentence pattern. More importantly, they should guide students to attribute success to their own efforts and effective learning methods ("Look, because you persisted in reading aloud after class, your language sense has improved greatly!"), while attributing temporary difficulties to unstable, controllable factors such as insufficient effort or methods needing improvement.

Establishing Growth Portfolios: Encourage students to establish personal Russian learning growth portfolios, recording every word mastered from scratch, every sentence pattern, every successful classroom presentation, or test score. This visualized "history of progress" is a powerful weapon against frustration and low self-confidence.

3.2 Optimizing the Classroom Teaching Model: Promoting a "Student-Centered, Task-Driven" Classroom Revolution

Changing the one-way knowledge transmission model and transforming the classroom into a more dynamic learning environment is a direct means to stimulate intrinsic motivation.

Introducing Task-Based Language Teaching (TBLT): Design "tasks" close to students' future professional scenarios, such as simulating business receptions, product presentations, and order negotiations. Students work in groups, actively looking up vocabulary, learning sentence patterns, and practicing dialogues to complete real tasks. In this process, language becomes a tool for task completion, and learning becomes an exploratory process of problem-solving, greatly enhancing initiative and interest.

Integrating Modern Educational Technology: Make full use of multimedia, language learning apps, clips of Russian films and TV shows, Russian songs, and other resources to create vivid and interesting teaching situations. For example, using platforms like "Kahoot!" to organize vocabulary competitions, or using dubbing software for film clip dubbing exercises, can effectively engage students' multiple senses and reduce learning monotony.

Infusing Cultural Teaching and Ideological and Political Education into the Curriculum: Language is the carrier of culture. Integrating Russian history, geography, customs, art, and other cultural knowledge according to the teaching content, and holding events like Russian

Culture Festivals or Food Festivals, can satisfy students' curiosity, cultivate their empathy and understanding of the target culture, and emotionally bring them closer to Russian. Meanwhile, exploring the ideological and political elements within the curriculum, such as telling stories of cooperation between China, Russia, and Central Asian countries under the Belt and Road framework, and introducing the achievements of outstanding alumni in the foreign trade field, can guide students to link personal learning with national development, sublimating the meaning of learning.

3.3 Creating an Immersive Language Environment: Building an "Integrated In-and-Out-of-Class, Online-and-Offline" Practice Platform

Strive to break through the time and space limitations of the classroom and create more opportunities for students to "use Russian."

Establishing a "Campus Russian Corner": Regularly hold Russian Corner activities, inviting foreign teachers, international students, industry mentors, and outstanding senior students to participate, engaging in free communication around specific themes. Create a relaxed, inclusive, and error-encouraging communicative atmosphere, allowing students to dare to speak and enjoy speaking.

Building Virtual Language Communities: Utilize WeChat groups, QQ groups, or professional learning platforms to establish class Russian learning communities. Teachers can daily assign "Russian check-in" tasks (e.g., reading a passage aloud, sharing a news vocabulary), encouraging students to post updates and exchange insights in Russian, making use of fragmented time.

Expanding Second Classrooms and Practice Bases: Actively establish connections with local Russian trade enterprises, travel agencies, etc., to organize student visits, internships, and even undertake simple translation tasks (e.g., translating product manuals). Authentic workplace experience is the most powerful proof of the value of student learning and can 极大地 stimulate their learning enthusiasm. Real language use experience is one of the most effective ways to stimulate and maintain learner motivation.

3.4 Strengthening Career Orientation and Psychological Counseling: Building a Dual Support System of "Career Planning and Psychological Support"

Helping students see the way forward and reducing their anxiety about the future is the fundamental strategy for stabilizing learning emotions.

Front-loading Career Planning Education: From the first year of enrollment, systematic career education should be carried out. Invite industry experts and outstanding alumni to give lectures, introducing the work content, development paths, and market demand for Russian talents in various industries, allowing students to have a clear and positive 认知 of their future career landscape.

Offering Professionally-Oriented Courses with Vocational Characteristics: In the senior years, based on regional economic characteristics and employment market demand, offer highly applied directional courses such as "Spoken Business Russian," "Tourism Russian," and "Practical Russian for Cross-Border E-commerce," directly linking student learning with employment, ensuring they learn what is applicable.

Establishing a Sound Psychological Support System: The psychological counseling centers of vocational colleges should proactively pay attention to the learning pressure issues of foreign language students. Counselors and professional teachers need the ability to identify early signs of learning burnout. For students showing obvious symptoms of burnout, timely heart-to-heart conversations and professional psychological counseling should be provided to help them adjust their mindset and manage stress. The focus is on strengthening ideological guidance for students across all grades in vocational colleges, popularizing professional identity education within the scope of vocational colleges, advocating for students to apply professional knowledge to solve problems in social practice, and mobilizing the subjective initiative of vocational college students to serve society and share in social development [3].

4 Conclusion

Learning burnout among vocational college Russian students is a complex educational phenomenon with multiple causes. It reflects the universal challenges currently faced by foreign language education in vocational colleges regarding student quality, teaching models, motivation stimulation, and career guidance. To cure this "stubborn illness," we educators need to jump out of the narrow perspective of "teaching language for language's sake" and examine and understand our students from a broader educational ecology perspective and with deeper hu-

manistic care.

We must recognize that they are not just "students learning Russian," but also young individuals full of personality, eager for recognition, and facing growth confusions. The core of intervention strategies lies in "empowerment" and "connection": empowering students through teaching innovation and psychological support to reshape their confidence and ability; and closely "connecting" student learning with future career development and personal growth through career guidance and environmental creation, endowing their learning with a profound sense of meaning and value. This is a systematic project that requires multi-party collaboration and long-term efforts from schools, teachers, enterprises, and the students themselves. Only in this way can we effectively ignite the learning enthusiasm of vocational college Russian students and cultivate applied Russian talents who truly meet the needs of the times, are mentally and physically healthy, and have solid skills.

References:

[1]Lian R, Yang L X, Wu L H. The Relationship between College Students' Professional Commitment and Learning Burnout and the Development of a Scale [J]. Acta Psychologica Sinica, 2005, 37(5): 632-636.

[2]Luo X J. Research on the Reform Path of Higher Vocational Russian Teaching under the Background of the New Era [J]. Scientific Consult, 2024, (10): 73-76.

[3]Yin Y N. Discussion on the Correlation between Professional Identity and Learning Burnout of Higher Vocational Students [C]// Henan Private Education Association. Proceedings of the 2025 Higher Education Development Forum (Volume 1). Maanshan Technical College;, 2025: 69-70.

Scenario Description, Barrier Model and Human Factor Classification to Analysis Freight Train Derailments, Part II: Case study

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Abstract: The background part of this work was firstly to learn the history of incident data at the SMIS and AEAT Rail derailment database, attributed to the causal factors analysis and the preliminary statistics process.

The review of the vehicle acceptance test included the Y/Q derailment criterion and the bogie rotation inspection demonstrated the major technical reason; The track geometry deterioration model was calculated in the Markov Chain transition probabilistic model.

The work explained the case analysis in the Porthkerry derailment: the track Vertical Longitudinal Split (VLS) failure mechanism study; the Heworth derailment: the track geometry degradation and Human Reliability Analysis (HRA); the Camden derailment: the freight train unevenly loading derailment compliant to the standard intervention.

Keywords: System Theory; Track Geometry Deterioration; Barrier Model; Performance Shaping Factor; HEART

1 Introduction

In the RAIB reports, there were at least 10 incidents due to the defective switch and crossing; and 12 derailment incidents at the S&C due to the vehicle exposed to the poor track geometry, if the RAMS standards and practical data analysis be the consequence? (according to the RAIB original investigation).

From 1992 to 2001, the RSSB T357 (2006) reported that in the derailment risk analysis in statistics, poor loading was the most common principal factor, but the rapid deterioration of track quality was a causal feature. If the author could learn from the incident, for:

1) Perform the operational integration and human response audit.

2) Large-scale experimental focus on the track geometry deterioration model.

2 Aim and Key objectives

The research aim of the work was: to analyse the causes of freight train derailments using the scenario method, barrier description and performance shaping factors evaluation.

1.To quantify the failure probability of individual barriers and understand each barriers' system reliability through the generic task unreliability and error-producing condition (EPC).

2.To use a traditional probabilistic model (Markov Chain) to predict the railway geometry system deterioration and the impact on safety.

3 Case study

1) Porthkerry derailment

A loaded coal train derailed at Porthkerry on 2 October 2014, in South Wales on the Vale of Glamorgan line. Train loaded with coal at Avonmouth Docks, and then the train passed over a wheel load monitoring installation at Marshfield; data showed the wagon has unevenly loaded. However, the front train passed the site at 16.5 mph, the first 19 wagons passed over the defective rail; therefore, the 20th wagon ran onto the defective left rail when the field side of the rail head broke.

• The cause of the derailment was the failure of a section of the left-hand side rail due to a metallurgical defect within that rail. The defect arose due to impurities within the steel which had been present since manufacture;

• The track repair actions could improve the track quality;

• The RCF site investigation play key role in the Porthkerry derailment;

• The UTU and verification as the latent failure in the functional barrier system.

The precursor indicator model broken track subsection demonstrated that the annual FWI due to the broken fishplates, broken rails, buckled rails, gauge faults, switches and crossing faults, and track twist & geometry faults. The broken rails (in the Porthkerry derailment), the S&C faults and track twists are the most severe factors from April 2010 to April 2016 listed below (RSSB).

To learn the failure mechanism: the critical defects could lead to the rail being broken: Banverket (1998) established that the transverse fracture occupied 44.1%, vertical split 19.4%, welded joint 19.4% and horizontal defect 17.2% (Kumar, 2006).
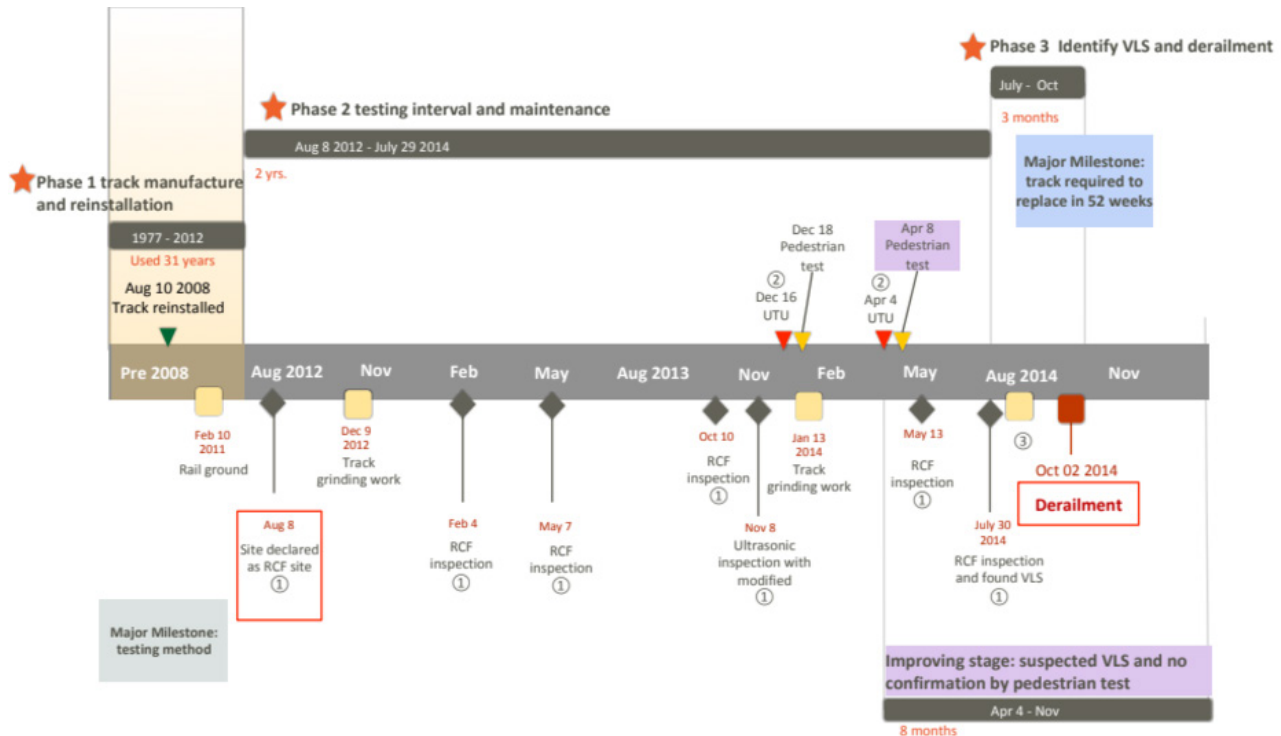

FIGURE 1 Porthkerry Derailment Timeline

2) Heworth Derailment

23 October 2014, the accident happened when a train travelling at 51 mph passed through Heworth station. The derailment was caused by wagon worn suspension component, the track geometry deterioration and human unreliability to prevent the incident consequence. There are barrier model and timeline descriptions including the Plain time Pattern Recognition (PLPR), the basic visual inspection, track geometry recording train, track maintenance engineering (TME), Vehicle inspection and Brake Test (VIBT), speed restriction, and track drainage improvement.

In the study of the track degradation analysis, following 50-55 mph of train speed, the measurements of the SD value and track geometry quality are:

i. Top = 3.5 (mm) good

ii. 3.5 to 5.0 satisfactory

iii. 5.0 to 5.9 poor

iv. 5.9 to 6.3 very poor

v. 6.3 maximum = super-red level TSM inspection in 14 days, immediate 30 mph emergency speed restriction and correct within 36 hours.
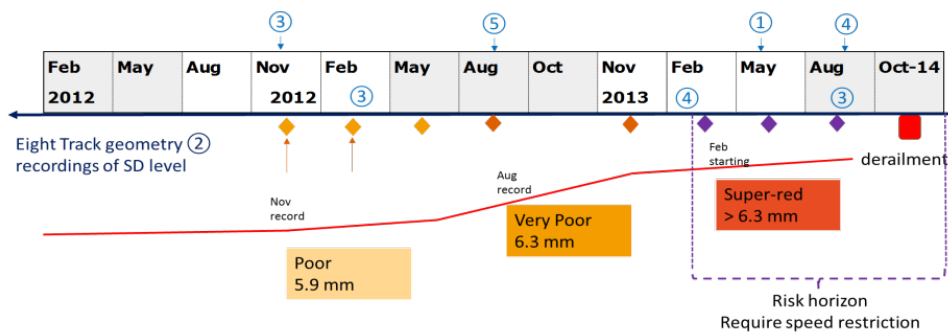
FIGURE 2 Track geometry deterioration in the Heworth derailment

The standard deviation stated in the GC/RT 5021: The Standard Deviation (SD) is the universally used scientific measurement of the variation of random processing. The vertical and horizontal track profile data have been found similar to the statistical calculation of the magnitude of track irregularities by obtaining the SD measurement level.

$$Standard\ Deviation\ \sigma = \sqrt{1/n \sum_{j-1}^{n} x_{ij}^2 - \bar{x}_i^2}$$

$$TQI = \sum_{i=1}^{7} \sigma_i$$

The track quality index (TQI) combined seven the deviation levels for the track alignment (1), the twist measurement (2), the gauge (3), the left/right longitudinal (4-5), the left/right alignment (6-7), and the cross-level.

According to the accident report 16/2015, the track geometry recording train on the Down Sunderland line recorded the standard deviation (SD) for the vertical value in each eight-mile section. In the historical record, from the 99 miles 220 yards to 99 miles 440 yards, the track had fallen into 'very poor' from August 2013. In 2014 Feb, the record shown the track geometry was 'super-red' level (Figure 3).

From the year of 2011/12 to the 2014/15 financial year, the track geometry recording train identified track geometry faults on the LNE route, the number of defects requiring correction: Newcastle route (about 500 defects), Doncaster route (about 300) and Sheffield route area (about 200) respectively. Three percentages of eighths in the one-mile section of track fall in the 'super-red' level in the Newcastle area.

3) Camden Derailment

The derailment accident happened on 15 October 2013; the train 4L77 was travelling from Birmingham Lawley Street to Felixstowe freight port derailed at Camden road west junction. The accident reasons were the vehicle's lateral and longitudinal imbalance leading to asymmetric loading negotiated with track twist conditions. The combination of the vehicle and track conditions caused reducing the vehicle's resistance to flange climb.

According to the accident report, for the load condition of the derailed wagon, 'the 20ft container was loaded with scrap electrical machines and had a gross weight of 28.83 tonnes; the empty 40ft container on the rear of the wagon weighed 3.88 tonnes.' The information was shown that 'the offset in the centre of gravity of the 20ft container towards the front of the wagon, with the longitudinal eccentricity 3-4\%'. Concerning the analysis report, there was a longitudinal weight ratio of 2.7:1.

4 Discussion

The large scale experimental: example of the SD level calculation based on the track geometry recording data (2013-2014, 70 mileages, at LEC1 2100). The Markov Chain transition matrix could be established the track deterioration probability from the slightly, medium to the severe deterioration state.

In order to understand the track geometry monitoring, the first step is trying to calculate the track standard deviation, and based on the transition matrix to assess the feasibility of the model through the comparison between prediction value and accurate track geometry recording:

$$\begin{bmatrix} S_1 \\ \vdots \\ S_n \end{bmatrix}^k = \begin{bmatrix} P_{11} & \cdots & P_{1N} \\ \vdots & \ddots & \vdots \\ P_{n1} & \cdots & P_{nn} \end{bmatrix} \begin{bmatrix} S_1 \\ \vdots \\ S_n \end{bmatrix}^{k-1}$$

and

$$P_{ij} = P(S^k = i | S^{k-1} = j)$$

$$\sum_{i=1}^{n} P_{ij} = P_{1j} + P_{2j} + \cdots + P_{nj} = 1, (j = 1, 2 \dots n)$$

The track irregularities (track twist) were derived from the characterization, the track recording vehicle, the specification for the measuring device, and the geometric quality assessment (EN 13848-1). The twist measurement was taken simultaneously at the fixed distance; it showed the different gradients between the two points. The algebraic difference between the defined distance of the two cross-levels, which specify equivalent to the wheel-base distance, and the consecutive measurement of the cross-level were calculated. The probabilistic transitions model based on the matrix is illustrated.
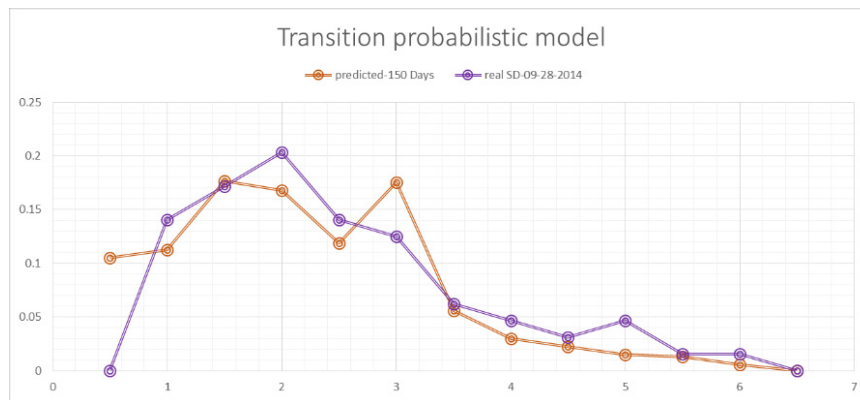

FIGURE 3 Track geometry deterioration model

The iterations shown above for the transition for the standard deviation depicted the comparison between predicted degradation and real-time recorded Standard Deviate (SD) value.

With respect to the Low Carbon Freight Modelling strategy from 2023 to 2050, the author basically surveys the technical reasons, firstly through the understanding of physical experiments, such as, compilation of the track geometry degradation model, the fatigue reliability prediction methods and the survival analysis. The main failure modes of the system are identified and the system failure probabilities could be calculated.

5 Conclusion

Firstly, there are investigations of the derailment mechanism, for instance, the track geometry deterioration, the track twist, the degradation at switches and crossing, the track void, the vehicle frame twist, the suspension characteristics, the friction liner performance and case studies to learn the technical reasons.

Secondly, the work concluded the quantitative analysis based on the state transition model (track geometry recording data), and the qualitative analysis to demonstrate HEART and cognitive reliability understanding of the performance shaping factors in the normal vehicle/track maintenance regime.

References:

[1]Le Coze, J. C. (2015). Reflecting on Jens Rasmussen's legacy. A strong program for a hard problem. Safety Science, 71, 123-141.

[2]Sklet, S. (2006). Safety barriers: Definition, classification, and performance. Journal of Loss Prevention in the Process Industries, 19(5), 494-506.

[3]Duijm, N. J. (2009). Safety-barrier diagrams as a safety management tool. Reliability Engineering & System Safety, 94(2), 332-341.

[4]Duijm, N. J., &Goossens, L. (2006). Quantifying the influence of safety management on the reliability of safety barriers. J Hazard Mater, 130(3), 284-292.

[5]Underwood, P., & Waterson, P. (2013). Systemic accident analysis: examining the gap between research and practice. Accident And Prevention, 55, 154-164.

[6]Akyuz, E., Celik, M., Cebi, S., (2016), A phase of comprehensive research to determine marine-specific EPC values in human error assessment and reduction technique, Safety Science, 87, 63–75

[7]Williams, J. C.. (1988). A Data-Based Method for Assessing And Reducing Human Error To Improve Operational Performance. Human Factors and Power Plants, 1988. Conference Record for 1988 IEEE Fourth Conference on. IEEE.

[8] Hollnagel, E.. (1998). Cognitive Reliability and Error Analysis Method (CREAM).

[9] HAZARD AND BARRIER ANALYSIS GUIDANCE DOCUMENT (1996), OFFICE OF OPERATING EXPERIENCE ANALYSIS AND FEEDBACK.

The "Technology + Aesthetics" dual-dimensional cultivation path of visual communication education from an international perspective

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Abstract: This study takes an international perspective as the macro background and comprehensively and deeply explores the cultivation approaches of integrating "technology" and "aesthetics" in visual communication education. In the dual environment of the rapid development of digital technology and the accelerated process of globalization, the traditional visual communication education model encounters challenges such as single cultivation ability, disconnection from international frontiers and industrial demands This article first sorts out the evolution of the concept of visual communication education and its international development trend, and establishes a theoretical framework for cultivating both technical and aesthetic aspects. Then, by analyzing the teaching practices and curriculum Settings of domestic and foreign universities, the separation status and integration difficulties of the two dimensions in teaching were pointed out. Moreover, through case analysis and hypothetical data, the effectiveness of the integration of the two aspects in improving students' innovation ability was proved.

Keywords: Technology; Aesthetics; Dual-Dimensional Cultivation Path; Visual Communication Education; International Perspective

Introduction

In today's era of information overload and extremely scarce consumer attention, brands worldwide are truly confronted with the challenge of gradually declining visual communication effectiveness. The traditional one-way and passive advertising model is now increasingly unable to meet users' demands for personalization, interactivity, and depth of experience. Augmented reality (AR) technology and virtual reality (VR) technology are gradually moving from their original professional fields into the mass consumer domain. Their core value lies in blurring the boundary between digital information and the physical world by creating immersive environments, providing users with unprecedented dimensions of perception and interaction. This undoubtedly creates a historic opportunity for the innovation of brand visual communication.

1 The Development and Theoretical Foundation of Visual Communication Education from an International Perspective

1.1 The Concept and Development of Visual Communication Education

Visual communication design, as a discipline, uses visual elements such as graphics, text, and color to convey information, emotions, and concepts. In China's higher education system, it belongs to the undergraduate major of design studies. Its purpose is to cultivate specialized talents with leading aesthetic judgment and systematic professional knowledge, capable of engaging in design research and development and communication application work. Its disciplinary boundaries have greatly expanded compared to traditional graphic design, deeply integrating into multiple fields such as digital media, brand planning, and information visualization. In terms of its development history, this major in China has gone through different stages, from the craft education influenced by Japan in the late Qing Dynasty, to the pattern education integrating Europe and America during the Republic of China period, and then to the arts and crafts education influenced by the former Soviet Union after the founding of the People's Republic of China. Since being officially included in the undergraduate major catalog in 2012, it has experienced rapid development. As of 2016, 569 universities nationwide offered this major. The current core trend is to actively respond to the changes brought about by digital technology. Curricula are continuously incorporating cutting-edge content such as intelligent design, dynamic visuals, and cross-media interaction. The training objective is also shifting from "specialists" to "generalists" and "interdisciplinary talents" who meet industry needs.

1.2 The Dual-Dimensional Training Theory of Technology and Aesthetics

In the context of globalization and digitalization, the core competitiveness of visual communication education lies in the deep integration and balanced training of the two dimensions of "technology" and "aesthetics." The technology dimension is the cornerstone of design realization, and its connotation far exceeds the scope of traditional software operation. It requires students to master digital design, such as AIGC workflows, 3D modeling, immersive interactive technologies such as AR/VR, and the skills necessary for multimedia communication. Aesthetic dimension is the soul and value orientation of design, encompassing keen visual creativity, problem-solving-oriented design thinking, and profound humanistic and cross-cultural literacy. The integration of these two dimensions is not merely a simple addition, but rather a qualitative transformation of innovation through a "dual-drive of art and science." Technology provides new tools and fields for realizing and iterating imaginative aesthetic creativity, such as the construction of metaverse spaces. Meanwhile, advanced aesthetic judgment and cultural insight ensure that technological applications possess emotional warmth and social value, preventing them from becoming empty displays of technical prowess. The Lu Xun Academy of Fine Arts' path of "technology as the foundation, culture as the empowerment" proves that only through the joint development of both can we cultivate well-rounded talents who understand cutting-edge digital tools and possess rich cultural background and creativity.

1.3 Implications of International Educational Philosophy and Practice

An international perspective provides crucial conceptual references and practical pathways for the dual-dimensional cultivation of "technology + aesthetics." The educational philosophies of top overseas institutions emphasize that design should aim to solve practical problems at the forefront of society, culture, and technology. Their curricula are flexible and meticulously divided, placing great emphasis on design thinking, critical thinking, and interdisciplinary collaboration. This makes it clear to local teaching that it is necessary to break away from the one-way lecture model and make greater use of project-based, studio-based, and international workshop formats. Faculty with overseas study experience or Sino-foreign cooperative education programs can directly introduce this student-centered teaching design that emphasizes process and practice. Analyzing the curriculum of relevant institutions in Hong Kong, Macau, and Malaysia reveals their emphasis on the integration of technology and aesthetics. As shown in the table below, their curriculum systems generally exhibit a characteristic of giving equal importance to technological application and aesthetic cultural literacy.

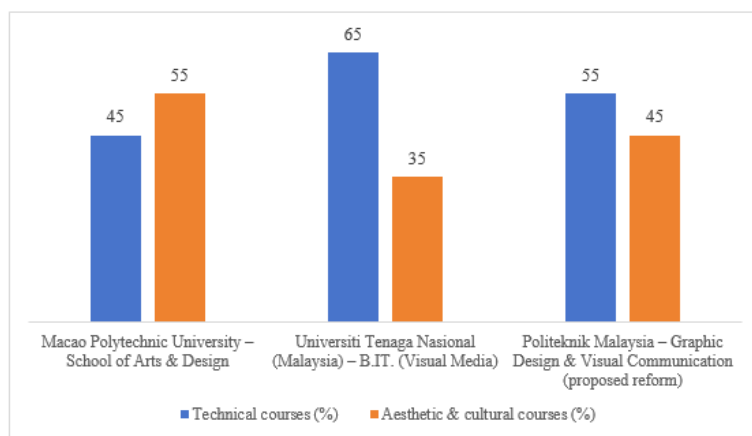Figure 1.Estimated weight of technical vs. aesthetic-cultural courses in selected visual-communication programmes (Hong Kong, Macao & Malaysia)

2 Teaching Practice and Case Analysis of Dual-Dimensional Cultivation of Technology and Aesthetics

2.1 Teaching Practice in the Technology Dimension

In terms of teaching in the technology dimension, contemporary curriculum systems employ a layered and progressive strategy to build

a solid digital skills stack for students. The foundational level focuses on mastering industry-standard software, such as training students' efficient execution capabilities in Adobe Creative Suite through systematic imitation and original projects. The advanced and cutting-edge levels introduce interactive and immersive technologies, encompassing interface and user experience prototyping using Figma, learning the basics of the Unity 3D engine to create interactive content, and exploring the possibilities of enhancing realistic visual storytelling using tools such as Adobe Aero. Teaching is generally centered on project-based practical courses, such as setting up projects like "Brand Dynamic Visual Identity System" or "Interactive Posters on Social Issues," allowing students to integrate multiple skills in the process of solving real-world problems. The assessment system goes beyond simple software operation assessments, employing a combination of process-oriented and outcome-oriented evaluations, emphasizing the evaluation of students' comprehensive ability to use technology to realize creative ideas and solve complex design problems.

2.2 Strategies for Cultivating the Aesthetic Dimension

Cultivating the aesthetic dimension is significant for shaping students' critical vision, cultural awareness, and original thinking. Strategies for this cultivation present a multi-pronged approach: First, systematic creative thinking training, utilizing methodologies such as brainstorming, mind mapping, and design sprints to break down fixed mindsets; second, in-depth analysis of design works, analyzing formal aesthetics and deconstructing the historical context, cultural symbols, and conceptual expressions behind them; and third, broad cultural and artistic appreciation, with courses covering Chinese and Western art history, design history, film, philosophy, and even the history of science and technology, building a broad knowledge base. In an international context, a cross-cultural perspective is crucial. For example, courses at Universiti Sains Malaysia might guide students to compare and analyze the compositional principles of traditional Malaysian batik patterns with the grid system of Swiss International Style, exploring how to transform local visual vocabulary into contemporary design language. This training allows students to understand the relativity of aesthetic standards and cultural diversity, establishing a unique cultural identity and design stance in global dialogue.

Table 2.Student vs. faculty ratings of technical and aesthetic competencies (5-point scale; hypothetical data)

Competency item	Student self-rating	Faculty rating	Gap analysis
Software-tool proficiency	4.2	3.8	Students over-rate operational skill; faculty stress efficient, problem-solving use.
New-tech learning & application	4.0	4.1	Close match; students show strong motivation and adaptability.
Visual-form aesthetics	3.8	3.5	Students confident; faculty apply stricter professional/cultural criteria.
Conceptual & narrative depth	3.5	3.0	Largest gap; students focus on idea, faculty on logical development, cultural insight and clear communication.
Cross-cultural integration	3.0	2.8	Both scores low; teaching priority area, students need support to embed cultural knowledge in creative work.

2.3 Teaching Integration Strategies and Effects

Truly meaningful dual-dimensional education is not simply about juxtaposing technical and aesthetic courses, but rather about achieving "artistic and academic fusion" through carefully designed teaching integration strategies. Its main practical models include the following: Thematically integrated projects, such as those on the theme of "Sustainable Cities," where students simultaneously utilize data visualization (technology) and public symbol design (aesthetics) to complete an integrated communication plan; dual-mentor collaborative teaching, where a technical mentor and an art theory mentor jointly guide a studio, integrating technical and aesthetic considerations at each stage of the project; and reverse integration, embedding aesthetic principles and critical workshops into advanced technical courses such as interaction

design, and vice versa. Teaching effectiveness evaluations show that this integration strategy improves students' learning experience and the quality of their overall output. Course satisfaction surveys reveal that while purely technical or aesthetic courses may initially provide a sense of skill acquisition, satisfaction may fluctuate over time or with increasing difficulty. In contrast, integrated courses, although more challenging, exhibit a more positive and stable satisfaction trend due to the stronger sense of "creative" accomplishment they provide.
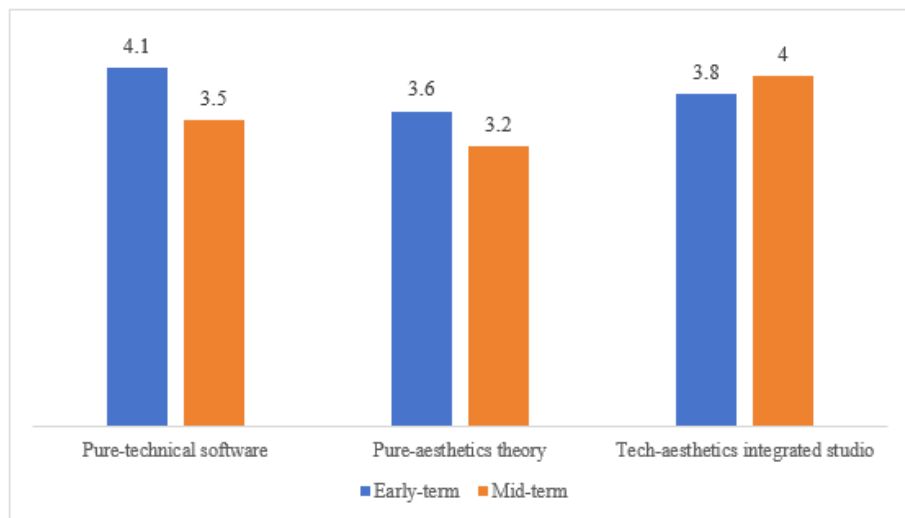

Figure 2.Student-satisfaction trajectories: integrated "tech-aesthetics" vs. single-dimension courses (5-point scale; hypothetical panel survey)

3 Innovative Paths for Visual Communication Education from an International Perspective

3.1 Design of a Dual-Dimensional Integrated Teaching Model

The key to constructing a dual-dimensional integrated teaching model is to break down traditional curriculum barriers and design a curriculum system where technology and aesthetics permeate each other and spiral upwards. The curriculum design adopts a "layered and progressive, horizontally related" structure. In lower grades, parallel courses of "basic technology + aesthetic general knowledge" are offered, such as *Digital Design Fundamentals* and *Introduction to Visual Culture*, instilling aesthetic judgment from the initial technology introduction stage. In higher grades, the focus shifts to integrated courses centered on "project-based learning," such as the "Brand Experience Design" project. This requires students to comprehensively utilize AR interactive technology, motion graphics, and brand narrative theory to complete the entire process from concept to prototype. Interdisciplinary practice is actively promoted, with joint projects with computer science, psychology, sociology, and other majors to solve complex problems such as "community information accessibility design." This cultivates students' core "design thinking" abilities—defining problems, integrating multidisciplinary knowledge, and proposing innovative solutions—ensuring that technological application and aesthetic expression always serve a specific and in-depth socio-cultural context.

3.2 Internationalization Practice Strategies

Internationalization practice plays a crucial role in achieving the dual-dimensional training objectives. It requires building a diverse system of international exchange channels, including long-term exchange programs with mutual credit recognition, allowing students to fully immerse themselves in overseas learning environments; short-term thematic workshops and summer academies focusing on cutting-edge topics such as "sustainable design" and "social innovation," fostering intensive collaboration; and regular international joint online courses, enabling remote collaboration with overseas faculty and students on the same projects. Learning from universities in Hong Kong, Macau, and Malaysia should not be limited to formalities but should delve into their core essence. For example, we can learn from the "design for society" concept emphasized by the School of Design at Hong Kong Polytechnic University, strengthening social responsibility in projects; or learn from Malaysian universities' curriculum modules that transform local visual resources such as "Peranakan culture" into design vocabulary, thereby reflecting on and constructing our own teaching content that is rooted in local contexts and engages in global dialogue. Most

importantly, we must localize international experiences to form teaching practices with our own cultural identity.

4 Conclusion

At the juncture where deep globalization and the digital technology revolution converge, visual communication design has gradually evolved from the traditional field of graphic aesthetics into a key strategic practice that can promote information dissemination, shape brand stories, and even build cultural experiences. This evolution has provided unprecedented compound demands for the cultivation of visual communication professionals They need to be proficient in the constantly updated digital design tools and media technologies, and also possess profound cultural literacy, critical aesthetic judgment ability and cross-cultural communication skills.

References

[1]Zihong Wu,Youmei Wang & Xiangping Long.(2025).Reform path and empirical exploration of visual communication design education based on graph neural network.Systems and Soft Computing,7,200413-200413. https://doi.org/10.1016/J.SASC.2025.200413.

[2]He Li,Liang Sun & Seongnyeon Kim.(2025).Effects of Customized Generative AI on Student Engagement and Emotions in Visual Communication Design Education: Implications for Sustainable Integration.Sustainability,17(22),9963-9963. https://doi.org/10.3390/SU17229963.

[3]Yajing Yao.(2025).Research on the Current Situation and Optimization of the Integration of Industry and Education in the Visual Communication Design Major.Lecture Notes in Education, Arts, Management and Social Science,3(5),110-114. https://doi.org/10.18063/LNE.V3I5.1085.

[4]Yingqi Wu & Junhua Mo.(2025).Visual branding of higher education institutions in web-mediated communication: a hypermodal analysis of an elite Chinese university.Language and Semiotic Studies,11(3),466-491. https://doi.org/10.1515/LASS-2025-0004.

[5]Rong Dong,Izzuddinazwan Bin Misri,Zhichao Zou & Liying Zhao.(2025).Educational Innovation Driven by Artificial Intelligence—Research on the Penetration of AI Technology and Development Strategy in Visual Communication Design Education in Regional Universities in China.Journal of Humanities, Arts and Social Science,9(5), https://doi.org/10.26855/JHASS.2025.05.021.

[6]Xiaoyi Wu & Seungjin Lee.(2025).Critical Thinking Education in Visual Communication Design in China: Current Status and Key Challenges.Journal of Educational Research and Policies,7(5),98-103. https://doi.org/10.53469/JERP.2025.07(05).23.

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The integrated teaching path of art design and science and technology in the Greater Bay Area under the STEAM education concept

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Abstract: This research builds a framework around the STEAM education concept, comprehensively and deeply analyzing the innovative approaches of integrating art design with science and technology in the Guangdong-Hong Kong-Macao Greater Bay Area. The paper begins by sorting out the theoretical foundation of STEAM interdisciplinary education and its guiding value for the transformation of traditional art design education towards modernization. Then, by analyzing the teaching practices of representative universities in the Greater Bay Area, this paper truly dissected the implementation methods and effects of strategies such as digital tools, AR/VR, and project-based learning in specific teaching from three aspects: technology application, aesthetic cultivation, and curriculum integration. The research presents an optimization plan with the key being the reconstruction of an interdisciplinary curriculum system and the simultaneous advancement of internationalization and regionalization in teaching strategies. It also offers suggestions on policy support and future research directions, providing systematic theoretical references and practical guidance for building an "art and science integration" talent cultivation model with the characteristics of the Greater Bay Area and in line with future demands.

Keywords: STEAM Education Philosophy; Greater Bay Area; Fine Arts and Design; Science and Technology; Teaching Methods

Introduction

Against the backdrop of the global trend of technological innovation and the continuous upgrading of industries, the traditional art design education that divides fields based on skills is facing an increasing number of challenges. The rapid development of technologies such as artificial intelligence and immersive media has revolutionized creative tools and profoundly changed the essence of aesthetic expression, narrative logic, and even design issues The STEAM education concept, which emphasizes the interdisciplinary integration of science, technology, engineering, art and mathematics, provides a key theoretical framework for responding to this transformation. The Guangdong-Hong Kong-Macao Greater Bay Area enjoys a unique geographical advantage that combines an international perspective, a technological highland and rich cultural resources, making it an ideal experimental site for exploring the integrated education model of "art and technology".

1 STEAM Education Philosophy and Art & Design Teaching Theoretical Foundation

1.1 Overview of STEAM Education Philosophy

The STEAM education philosophy embodies a paradigm shift from STEM towards integration with the arts. Its key element is breaking down the boundaries between traditional disciplines, employing interdisciplinary integration to cultivate students' comprehensive qualities and innovative abilities. Originating in the United States in the 1980s to address the demand for multi-skilled talent in global competition, its essence is not a simple addition of five subjects, but a "practice-oriented transdisciplinary education concept." It emphasizes the organic integration and creative application of knowledge in real-world contexts through project-based and problem-solving analysis. The inclusion of art is crucial, adding humanistic care, aesthetic judgment, and emotional thinking to the STEM field, which originally focused on logic and technology. This allows the learning process to stimulate learners' emotional experiences and meaningful reflection, enabling them to cope with the complexities of the real world. The theoretical foundation of STEAM education is built upon constructivism, the learning-by-doing approach, and the theory of multiple intelligences. Ultimately, it aims to cultivate future innovators who can use interdisciplinary knowledge to solve practical problems, possessing both scientific rationality and artistic sensibility.

1.2 Development and Trends of Art and Design Education

Contemporary art and design education is undergoing a profound transformation from simply "imparting professional skills" to "inter-disciplinary integration and innovation." This modernization trend aligns perfectly with the STEAM concept. The key to this transformation is addressing the disruptive changes brought about by new technologies such as artificial intelligence, and society's demand for new talents capable of solving complex problems. Educational trends clearly show a two-way integration of "art as engineering" and "engineering as art," advocating for "the combination of art and engineering, and the permeation of arts and sciences," enabling students to master technical implementation and engineering thinking skills while possessing excellent artistic expression. Numerous interdisciplinary teaching cases have emerged both domestically and internationally. For example, in STEM courses, experts skillfully integrate artistic elements, guiding students to think about social and cultural contexts and creative intentions through their works, rather than simply imitating. Universities such as Tongji University and Tianjin University are actively exploring ways to deeply integrate artificial intelligence with design creation in design education. These practices demonstrate that successful art and design education is no longer limited to art studios and workshops, but needs to be closely linked to science laboratories, engineering workshops, and the digital technology field to build a new "new arts" or "art-engineering" training system.

1.3 The Application Value of STEAM Concepts in Art and Design

Applying STEAM concepts to art and design education has the core value of creating an educational model that integrates creative cultivation, technical training, and scientific thinking. This directly addresses the common problem in current design education where "art and technology are simply added together" rather than deeply integrated. Firstly, it restructures the creative cultivation process through "design thinking" and "project-driven learning," ensuring that creativity is not just groundless ideas but a complete cycle from identifying real problems to proposing innovative solutions. Secondly, technical training, such as programming, 3D printing, and digital media, is placed within specific design tasks, becoming essential tools for realizing creativity rather than standalone skills. Thirdly, scientific thinking, such as rational analysis, system modeling, and experimental iteration, is integrated, allowing students to study user needs like scientists and test design prototypes like engineers, improving the logic, feasibility, and innovation of their work. In the Greater Bay Area, this integration trend has already achieved policy consensus and widespread practice at the higher education level.

2 Teaching Practices Integrating Art, Design, and Science & Technology in the Greater Bay Area

2.1 Teaching Practices from a Technological Perspective

At the technological level, teaching practices in universities in the Greater Bay Area have evolved from basic software instruction to a deeply integrated stage driven by cutting-edge digital technologies and oriented towards solving complex problems. The focus of teaching is no longer limited to the operation of tools like Photoshop and Illustrator, but has broadly introduced immersive and intelligent technologies such as AR/VR/MR, 3D printing, digital twins, and AI-generated content. For example, Shenzhen Technology University, in collaboration with Shenzhen Media Group, developed a campus digital twin model based on 3D Gaussian splash technology. Students can use VR devices for immersive roaming and interaction. This project itself forms a comprehensive technical training topic. Shenzhen University, in its design achievement exhibition, guided students to use MR technology to create urban and campus landscape experiences that transcend the boundaries between virtual and real, and also explored the application of 3D printing technology in virtual IP creation. These practices place technical training within specific real-world project scenarios such as "smart campuses," "future cities," and "cultural heritage," allowing students to deeply understand the core logic of technology serving creativity and humanistic connotations while mastering advanced tools.

2.2 Cultivating the Aesthetic Dimension of Art

In terms of aesthetic appreciation, the training strategies of universities in the Greater Bay Area focus on reshaping students' visual creativity, design thinking, and cultural cognition within a cross-cultural context and against the backdrop of cutting-edge technology. The key

is to integrate visual creative training with profound cultural and artistic literacy and critical design thinking. A typical approach is to guide students in contemporary translation of local traditional culture. For example, a team from the Hong Kong University of Education led students in the "Greater Bay Area Intangible Cultural Heritage Virtual Museum" project. Students conducted field research, video recording, and content design on Hakka walled villages and folk customs, balancing "cultural authenticity" and "technological innovation" in a 720-degree panoramic virtual space. This requires students to master visual storytelling skills and deeply understand the historical and social significance behind cultural symbols. Shenzhen University's design discipline, through the "Dialogue of Civilizations" section, explores the modern design translation of Dunhuang art and Silk Road patterns. The Faculty of Humanities and Arts at Macau University of Science and Technology, through its collaboration with the Shenzhen Guan Shanyue Art Museum's "Greater Bay Area Seed Project," transforms the museum's academic resources and digital collections into a "living classroom," enabling students to improve their aesthetic judgment and academic level through cross-disciplinary research in art and technology.
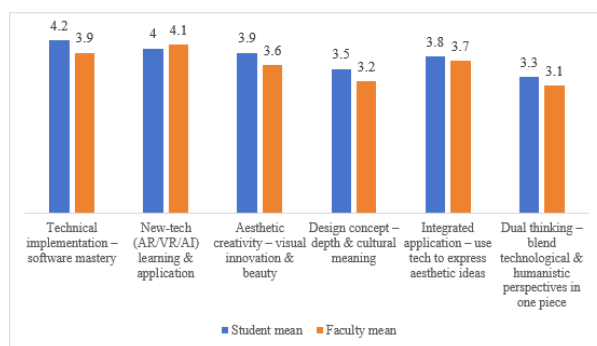

Figure 1.Student self-ratings vs. faculty ratings after project-based learning (1–5 scale)

2.3 Teaching Integration Strategies and Practical Results

A key strategy for promoting the integration of "fine arts and design + technology" in the Greater Bay Area is to systematically build an interdisciplinary, inter-institutional, and project-based teaching ecosystem. In terms of curriculum, this manifests as the development of deeply integrated "dual-narrative" courses. For example, courses on "digital art" and "intelligent interaction" technology are designed together with humanities topics such as "contemporary translation of traditional cultural context." In implementation, "museum-school cooperation" and "university-enterprise collaboration" models are widely used. For instance, the "Greater Bay Area Seed Project" collaborates with the Guan Shanyue Art Museum and numerous universities such as Macau University of Science and Technology and Southern University of Science and Technology to jointly build laboratories and research and teaching bases, introducing real cultural projects and industry needs into the classroom. Teaching evaluations show that this integrated teaching based on complex projects can effectively promote the simultaneous and coordinated development of students' technical and aesthetic abilities. Compared with traditional subject-based teaching, students can better feel the indispensability of both abilities in the process of solving practical problems, stimulating intrinsic learning motivation and achieving a higher overall sense of accomplishment and learning satisfaction.
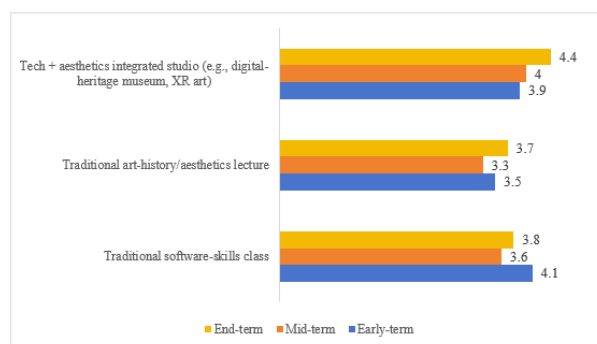

Figure 2.Student-satisfaction trajectories by course type (hypothetical data, 1–5 scale)

3 Optimization and Development Strategies of STEAM Integrated Teaching Paths

3.1 Interdisciplinary Curriculum System Design

The key to optimizing the curriculum system is to break away from the traditional mechanical parallelism of "technology" and "aesthetics" courses, and instead construct a double-helix progressive organic structure. In the lower grades, a "basic integrated module" can be offered, such as teaching courses like *Digital Media Fundamentals* and *Introduction to Visual Culture* simultaneously. This ensures that students develop the cognitive concept that "technology serves beauty" from the very beginning of their exposure to tools. In the higher grades, the focus shifts entirely to "project-based learning" and "research-based learning." Project-based learning, such as the "Digital Revitalization of Cultural Heritage in the Greater Bay Area" project, requires students to form teams to complete the entire process from field research and conceptual design to technology development. Research-based learning encourages students to conduct in-depth academic analysis on cutting-edge topics such as "artificial intelligence aesthetics" and "sensory engineering," writing research papers or creating experimental works. This design elevates learning from skills acquisition to knowledge creation, cultivating students' meta-ability to define problems, integrate resources, and innovate solutions in complex situations.

3.2 Internationalization and Regionalization Teaching Strategies

Teaching strategies need to simultaneously deepen "local practice" and broaden "international perspectives." At the regionalization level, teaching should closely revolve around the dual characteristics of the Greater Bay Area—"technology + culture"—developing a teaching case library centered on real local issues. For example, using topics such as the "Shenzhen-Hong Kong Biennale," "Revitalization of Guangzhou's Traditional Cultural Blocks," or "Brand Upgrading of Greater Bay Area Enterprises" as prompts, students can be guided to use STEAM thinking to propose innovative solutions. At the internationalization level, a systematic, multi-level exchange network should be built: encouraging students to participate in international short-term workshops and competitions, promoting joint degree or credit recognition programs with top overseas institutions, and regularly conducting international scholar residency programs and online collaborative courses. Crucially, international experience should be critically absorbed and localized, rather than simply transplanted, to cultivate designers who can solve local problems and participate in global dialogue.

Table 1. Comparative models of art-design & technology integration in selected Greater Bay Area universities

University	Core integration model & positioning	Flagship courses / projects
The Hong Kong Polytechnic University	Design-thinking-led, tech-enabled: user-centred research merged with advanced engineering.	MDes in Intelligent Products & Services, Interaction Design
The Education University of Hong Kong	Culture & education-oriented tech fusion: digital humanities, heritage preservation, innovative education.	GBA Intangible-Cultural-Heritage Digital-Museum Project
Macau University of Science & Technology	Cross-institutional collaboration & art-tech frontier: joint work with museums & industry.	"Bay Area Seed Project" (with Guan Shanyue Art Museum, etc.)
Shenzhen University	Comprehensive innovation under "new liberal arts": leverages full university ecosystem for theory + practice.	Digital-media arts, 3-D printing & virtual-IP design, MR urban-landscape studio
Guangzhou Academy of Fine Arts	"Art-science fusion" serving local industry: fine-arts foundation driving tech innovation for cultural & creative industries.	

4 Conclusion

This study, through theoretical construction and practical analysis, comprehensively demonstrates the necessity and feasibility of promoting the deep integration of art design and science and technology in the Greater Bay Area under the STEAM education concept. The core conclusion shows that the successful integration path relies on a set of systematic reforms, involving the design of the "double helix" curricu-

lum system and the teaching process driven by real projects. Until a strategy that combines internationalization with localization. This system reform can effectively enhance students' compound abilities such as technological application and aesthetic innovation, and it is also a strategic measure to respond to the fundamental requirements of the digital age for design talents. The limitation of this study mainly focuses on the construction of macro paths at the higher education level. Future research can delve into areas such as the connection mechanisms among different educational stages, the quantitative evaluation of the effects of specific courses, and cross-cultural comparisons.

References

[1]Zhiheng Cheng.(2025).Exploration of Primary and Secondary School Music Teaching Models under the STEAM Education Philosophy.Region - Educational Research and Reviews,7(6), https://doi.org/10.32629/RERR.V7I6.4184.

[2]Shuzhen Zhan & Fengtong Wen.(2025).Research on Instructional Design for High School Mathematics Based on the STEAM Education Philosophy—A Case Study of "Ellipses and Their Standard Equations" with Reduced Complexity.Academic Journal of Mathematical Sciences,6(1), https://doi.org/10.25236/AJMS.2025.060101.

[3]Yiting Jiang & Yubei Jin.(2024).Exploration of Interdisciplinary Project- based Learning in Junior High School English under the STEAM Philosophy.Region - Educational Research and Reviews,6(2), https://doi.org/10.32629/RERR.V6I2.1666.

[4]Deguo Yang & Haoran Ma.(2023).Teaching Application of Middle Level "C language programming" Based on STEAM Education Concepts——Taking "5E" Model as an Example.(eds.)Proceedings of 2023 3rd International Conference on Internet Technology and Educational Informatization(pp.56-65).School of Computer Science and Engineering, Northwest Normal University;

[5]Department of Educational Studies, The University of Alabama , Tuscaloosa , AL , USA.(2020).Toward a Philosophy of STEAM in the Anthropocene.Educational Philosophy and Theory,52(7),769-779. https://doi.org/10.1080/00131857.2019.1690989.

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A Study on the Development Trends of Table Tennis Receive Techniques Based on Video Analysis

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Abstract: This paper systematically examines the development and emerging trends of table tennis receiving techniques in international elite competitions over the past decade through the use of video analysis. By analyzing match footage from significant events such as the Olympic Games and the World Table Tennis Championships, and combining motion recognition with statistical methods, the study identifies changes in crucial aspects of receiving, including reaction time, stroke types, placement distribution, and tactical combinations. The results suggest that contemporary receiving techniques are characterized by increased speed, precision, variability, and consistency. Techniques like the backhand flick, short pushes, and long chops have become more prominent and are now integral to offensive strategies. The findings provide valuable data for athlete training and tactical improvement.

Keywords: Video Analysis; Table Tennis; Receiving Technique; Technical Development; Motion Recognition

Introduction

The receiving phase, where players respond to an opponent's serve, is a pivotal point in table tennis that significantly impacts the game's rhythm and match outcomes. As equipment and rules continue to change, receiving techniques have seen ongoing evolution. In this study, leveraging video data from international elite competitions over the past decade, we utilize computer vision and sports biomechanics to quantitatively analyze the frequency, spatiotemporal characteristics, and tactical efficacy of various receiving techniques. The objective is to discern underlying developmental trends and performance-influencing patterns, providing a theoretical basis for training and tactical innovation.

1 Overview of Table Tennis Receive Techniques

1.1 Fundamental Concepts of Receive Techniques

Receive techniques in table tennis are the technical actions a player performs in response to an opponent's serve, considering the ball's spin, speed, placement, and trajectory. As one of the five fundamental skills in the sport—alongside serving, pushing, attacking, and looping—the receive involves various methods such as short pushes, long chops, flicks, backhand or forehand \banana flips\ (wrist flicks with heavy topspin), quick blocks, and fast drives. Effective receiving requires not only acute perceptual judgment and rapid reaction but also precise control over racket angle, timing, and the direction of force application to counteract different types of spin (e.g., topspin, backspin, sidespin). In modern table tennis, the importance of the first three strokes is heightened, with the receive—being the second stroke—often determining whether a player gains the initiative or is forced into a defensive position. Thus, it has become a critical phase that combines defensive stability with offensive potential.

1.2 Strategic Importance of Receive Techniques in Competition

The receive is strategically vital in table tennis matches, acting as a bridge between defense and offense. It can determine the success of the server's pre-planned tactics and can also create immediate scoring opportunities or initiate attacks. With the introduction of the 40+ plastic ball, which has reduced speed and spin, receivers now have more time to assess and prepare counterattacks, increasing the tactical significance of this phase. At the elite level, serve-and-receive exchanges are often a \micro-cycle\ of strategic interplay, where the match outcome can depend on the quality of the receive. For example, a well-executed backhand flick to the opponent's backhand corner can limit their offensive options, while a precisely placed short push can neutralize an anticipated aggressive third-ball attack. The receive is a comprehensive test of technical skill, psychological composure, experience, and adaptability, making it a cornerstone of competitive success in modern table tennis.

1.3 Historical Evolution of Receive Techniques

In table tennis, the technique of receiving serves has evolved from the past passive and simple response to the opponent's serve to the current stage where one can actively utilize receiving serves to control the pace of the game, create offensive opportunities, and even score directly. Before the 1980s, due to the limitations of rubber technology and competition rules, players mainly used pushing and blocking, emphasizing safety and consistency rather than aggressiveness. By the 1990s, the popularity of the loop shot technique led to a greater use of topspin shots in receiving serves. Entering the 21st century, changes in rules, such as the ban on the use of organic glue and the introduction of 40-millimeter balls, have reduced the spin intensity and ball speed, making the competition for the first three strokes even more intense. Such an environment prompts wrist shake techniques, especially the backhand banana shot, to become the main receiving and serving method in high-level competitions. In recent years, receiving and serving strategies have become more refined, personalized and intelligent. Players can predict their opponents' serving habits and adjust their return strategies accordingly. Nowadays, table tennis receiving and serving have developed into a system integrating perception, reaction, precise control and tactical intention, promoting the progress of competitive table tennis techniques.

2 Application of Video Analysis Methods in the Study of Table Tennis Receive Techniques

2.1 The basic principles of video analysis methods

Video analysis methods involve collecting, processing and interpreting sports video data to extract the movement features, spatio-temporal parameters and tactical behaviors of athletes. The core principles include image acquisition, target recognition, pose estimation and motion trajectory reconstruction. By using high-speed cameras to obtain competition or training videos and then applying computer vision algorithms (such as OpenPose, DeepLabCut, etc.) to identify key points of the human body, indicators such as hitting time, body Angle, racket speed and center of gravity shift can be quantified. By integrating timestamps with tabular coordinate systems, researchers can analyze elements such as ball rotation recognition, distribution of return ball landing points, and reaction time. This method transforms subjective experience into objective data, providing a scientific basis for technical diagnosis and tactical optimization, and has been widely applied in the field of contemporary sports research.

2.2 Current Application of video Analysis methods in the research of table tennis receiving and serving techniques

In recent years, video analysis has gradually been applied to the empirical research of table tennis receiving and serving techniques. Scholars at home and abroad have collected videos from top competitions such as the World Table Tennis Championships and the Olympic Games, and have encoded and statistically analyzed the receiving and serving movements of outstanding players. The usage frequency, success rate and subsequent connection effect of various techniques (such as backhand picking, short push, long cut) were studied. Some studies have also combined eye-tracking technology with synchronous video to explore the mechanism by which players predict the spin of their serves. Other teams used 3D motion capture systems combined with video to reconstruct biomechanical models during the hair-receiving stage. Although most current research still focuses on qualitative description or small sample analysis, the development of artificial intelligence and big data technologies is driving this field towards large-scale, high-precision, and real-time analysis, through deep learning-based automated action recognition.

2.3 The advantages of video analysis methods in studying table tennis receiving and serving techniques

Compared with traditional observation methods or investigations, video analysis has obvious advantages in the study of hair extension techniques. Firstly, it can conduct non-intrusive data collection under real competition conditions, avoiding the possible interference that the laboratory environment may have on the natural performance of athletes. Secondly, it can precisely quantify technical details such as the Angle of the racket face, wrist acceleration and stride distance at the moment of hitting the ball, thereby enhancing the objectivity of the analysis. Thirdly, it supports both vertical comparisons (comparisons of the same player at different times) and horizontal comparisons (such as

comparisons between domestic and foreign players), revealing the patterns of technological evolution. Finally, by integrating databases and machine learning, it can build predictive models of skills and tactics, helping coaches formulate personalized training plans. These advantages make video analysis an effective tool for parsing complex, rapid and subtle hair-receiving behaviors.

3 Development Trends of Table Tennis Receiving and Serving Techniques

3.1 The trend of technological diversification

Modern table tennis serving techniques are clearly showing a trend of diversification. The previous single response approach, mainly based on push (or slice) tactics, has been replaced by a variety of technical means, including backhand flicking (banana shot), quick blocking, forehand flicking, short push, long cut and side cut, among others. Especially the popularization of the backhand flicking technique, particularly its application when receiving short backhand balls, has greatly expanded the offensive options in the receiving stage. In the forehand short ball area, players can now flexibly switch between delicate short balls and sudden powerful bouncy balls, thus creating tactical surprises. This diversity is not only reflected in the richness of hitting types, but also in the multi-dimensional adjustments within a single technique - such as changes in spin intensity, speed and landing point. Facing increasingly complex serving strategies, athletes must master various receiving methods and make dynamic adjustments according to their opponents' habits, break their opponents' tactical expectations, and strive for the initiative in the game.

3.2 The trend of technological refinement

Continuous equipment reform and stricter rules have made the "millimeter battle" in table tennis more intense, promoting the development of receiving and serving techniques to a higher level of refinement. Top players are now pursuing extreme precision in minute technical details, such as adjusting the Angle of the racket, controlling the touch points, and grasping the timing of force application. For instance, an effective short block must just cross the net without bouncing or being too long, and usually comes with a weak backspin to limit the opponent's offensive options. Similarly, a successful jump requires an accurate judgment of the spin of the incoming ball and coordination with the explosive power of the wrist. High-definition video analysis shows that top athletes demonstrate outstanding body coordination, more effective center of gravity transfer and higher consistency during the hair receiving stage. In addition, integrating slow-motion replay, 3D motion modeling and biofeedback systems into training has further promoted the standardization of techniques and the reduction of execution errors. This refinement is not only a sign of technological maturity but also a key factor in determining the outcome of top-level competitions.

3.3 The trend of the integration of technology and tactics

In modern table tennis matches, receiving the ball is no longer an independent technical move but a deeply integrated part of the overall tactical framework. High-quality catches are designed to prepare for the offensive sequence of the third or fourth board. For instance, a backhand flick that reaches the opponent's backhand corner can create space for a forehand smash for oneself. Alternatively, an accurate short push might limit the attacking power of the serving side, thereby leading to a controllable counterattack. Video analysis confirms that top players start implementing their tactical intentions from the receiving stage - the landing points, spins and rhythms they choose are all aimed at guiding their opponents' returns to the designated areas. This concept of "receiving the ball is organizing" reflects the high degree of coordination between technique and tactics, transforming receiving the ball from a passive response to an active tool for shaping the dynamics of the game. Therefore, in high-level modern table tennis competitions, receiving the ball has become the key fulcrum that determines the "first three strokes" battle.

4 Conclusion

In summary, the analysis of table tennis receiving techniques via video has shown a clear progression, shifting from basic, responsive methods to more sophisticated, diverse, and strategically integrated approaches. The significance of modern technology in enhancing sports performance has been underscored, as video analysis provides objectivity, precision, and reproducibility, forming a solid basis for quantitatively evaluating receiving actions and the effectiveness of various return strategies. Looking ahead, the integration of big data and sports sci-

ence is poised to further advance the field, fostering more personalized and scientifically rigorous athlete training and competitive strategies. Grasping these trends will not only boost athletes' performance but also contribute to the evolution of the theoretical foundations of table tennis technique and tactics.

References:

[1]Akın, M., & Yılmaz, E. (2022). Biomechanical analysis of table tennis forehand loop drive using 3D motion capture system. Journal of Human Kinetics, 81(1), 25–36. https://doi.org/10.2478/hukin-2022-0003

[2]Qian, J., Liu, H., & Lu, Y. (2020). Tactical patterns in elite table tennis matches: A video-based notational analysis. International Journal of Performance Analysis in Sport, 20(3), 495–509. https://doi.org/10.1080/24748668.2020.1755221

[3]Malagoli Lanzoni, I., Felici, F., & Di Michele, R. (2014). Temporal and spatial constraints on serve and receive strategies in high-level table tennis. European Journal of Sport Science, 14(sup1), S362–S369. https://doi.org/10.1080/17461391.2012.740504

[4]Zhang, Y., Zhang, C., & Wang, D. (2021). Application of deep learning in sports video analysis: A case study on table tennis stroke recognition. Sensors, 21(12), 4015. https://doi.org/10.3390/s21124015

[5]Kondric, M., Zagatto, A. M., Sekulic, D., & Rattanaprasert, T. (2013). Influence of playing level and opponent's quality on tactical behavior in table tennis. Perceptual and Motor Skills, 117(3), 823–838. https://doi.org/10.2466/05.10.PMS.117x29z3

A Study on the Practical Path of Integrating "Tracing the Source and Footprints" into Youth Theoretical Lectures in Universities from the Perspective of School-Local Collaboration

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Abstract: Youth theoretical lectures in universities are a crucial link in ensuring the innovative theories of the Party are understood and embraced by the younger generation. Currently, this work faces practical dilemmas such as content disconnection, formal homogenization, and a weak sense of engagement among youth. "Tracing the Source and Footprints" , as a methodology emphasizing the triple coupling of historical logic, theoretical logic, and practical logic, offers a new perspective to solve these problems. This paper, grounded in the macro-perspective of school-local collaboration, deeply explores the intrinsic connection between "Tracing the Source and Footprints" and youth theoretical lectures, and systematically constructs a practical path model covering four key elements: subjects, content, carriers, and collaboration. The study argues that by integrating the theoretical research advantages of universities with the practical resource endowments of localities, and by building a closed-loop framework of "Tracing Regional Resources — School-Local Collaborative Transformation — Youth Theoretical Identification," we can effectively enhance the depth, warmth, and efficacy of theoretical lectures. This promotes the transition of youth from passive recipients of theory to firm believers and active practitioners, providing a valuable paradigm for ideological and political work in universities in the new era.

Keywords: Youth Theoretical Lectures; Tracing the Source and Footprints; School-Local Collaboration; Practical Path; Ideological and Political Education

1 Introduction: The Proposition of the Era and Practical Dilemmas

The youth are the future of the country and the hope of the nation. Arming the minds of the youth with the Party's innovative theories is a fundamental task concerning the succession of the Party's cause. As the main front for youth ideological and political education, universities have achieved significant results in enhancing young people's identification with and understanding of the Party's innovative theories by organizing university student lecture groups and conducting micro-lectures. However, with the development of the times and changes in the characteristics of the youth group, the limitations of traditional theoretical lecture models have become increasingly prominent.

It is widely believed in academia that current university theoretical lectures face numerous challenges. First, the disconnection between theory and locality, where the lectures on the Party's innovative theories lack localized interpretation, making it difficult for youth to perceive the practical logic that "theory is all around us." Second, the collaborative mechanisms of lecture teams are not sound, and the interactive experience is insufficient. Third, young lecturers themselves have shortcomings of "three inadequacies" and "three lacks"—inadequate theoretical knowledge, insufficient political experience, and limited practical exposure—leading to a lack of appeal, authenticity, and transformative power in their lectures. These issues collectively contribute to the "suspended" and "homogenized" dilemma of lectures, preventing theory from truly resonating with the youth.

Against this backdrop, how to innovate the methodology of theoretical lectures to make them more penetrating and appealing has become an urgent contemporary issue. "Tracing the Source and Footprints," as a local practical methodology for studying Xi Jinping Thought on Socialism with Chinese Characteristics for a New Era, has at its core the construction of a "localized knowledge production paradigm" by following the practical footsteps and theoretical germination of the leader. It breaks through the one-way indoctrination model of traditional theoretical education, forming a dynamic closed loop of "situational cognition—case transformation—two-way empowerment." Introducing this methodology into youth theoretical lectures in universities and examining it from the perspective of school-local collaboration undoubt-

edly provides a highly valuable exploratory path to solve the current dilemmas and enhance the quality and effectiveness of lectures. This study aims to systematically elucidate the internal mechanism of their integration and construct a set of operable and replicable practical path models.

2 Theoretical Coupling: The Intrinsic Connection Between "Tracing the Source and Footprints" and Youth Theoretical Lectures

Although "Tracing the Source and Footprints" and youth theoretical lectures belong to different categories, they share a high degree of intrinsic compatibility in terms of methodology and educational function. Their integration is not a simple superposition but a deep-level chemical reaction.

2.1 Methodological Interoperability: Strengthening Theoretical Depth Through Historical Context

The core of "Tracing the Source and Footprints" lies in revealing the fundamental logic of things by tracking their origin and evolution. It requires us to return to the historical scene to understand how theory took root, sprouted, blossomed, and bore fruit in concrete practice. The fundamental task of youth theoretical lectures is to concretize abstract theories and explain their profound connotations in ways that are popular among young people. The common ground between the two lies in their emphasis on starting from a historical dimension and restoring the practical soil where theory was generated through tracing its source.

For example, in the activity of "Tracing the Source and Footprints to Study Thought and Promote Practice," lecturers unearth practical cases along the leader's footsteps, combining the historical context of major strategic deployments with their theoretical connotations, thereby enhancing persuasiveness by "explaining great principles through small stories." This method transforms theory from dogma suspended in the air into a living entity with flesh, blood, and roots. In the process of tracing back through history, youth not only understand "what it is" but also gain insight into "why" and "how," thus achieving a deep identification with the theory.

2.2 Synergy in Educational Function: Cultivating Youth Mission with a Practice-Oriented Approach

"Tracing the Source and Footprints" is essentially a practical learning process. It cultivates youth's empirical thinking and problem awareness through field research, field investigations, and other methods. Youth theoretical lectures, especially the peer education model of "youth lecturing to youth," have the core function of internalizing theory in the heart and externalizing it in action, providing action guidance for youth.

The two form a perfect synergy in educational function. "Tracing the Source and Footprints" provides the most vivid and down-to-earth materials and cases for youth lectures, while youth lectures, in turn, offer an outlet for the dissemination and transformation of the results of tracing. In this two-way interaction, youth are no longer passive recipients of theory but transform into active explorers, thinkers, and disseminators. They deepen their understanding of theory through personal "tracing," strengthen their confidence in the path through diligent "sourcing," and reinforce their sense of mission through vivid "lecturing." This leap from "learning" to "thinking" and then to "lecturing" is the key to cultivating youth as the main force of theoretical dissemination and practice.

3 Path Construction: A Four-Dimensional Model for Integrating "Tracing the Source and Footprints" into Youth Theoretical Lectures

From the perspective of school-local collaboration, systematically integrating the "Tracing the Source and Footprints" methodology into youth theoretical lectures requires the construction of a multi-element, synergistic practical model. This model can be systematically designed from four dimensions: subjects, content, carriers, and collaboration.

3.1 Subject Element: Constructing a Composite Team of "Dual Tutors + Youth Backbone"

High-quality theoretical lectures depend on a high-quality lecture team. The integration of "Tracing the Source and Footprints" places higher demands on the team structure, requiring the construction of a composite subject structure composed of university faculty, local experts, and students.

University Faculty as Theoretical Tutors. University ideological and political education teachers and scholars in related fields are responsible for the in-depth interpretation and academic support at the theoretical level. They help young students clarify the historical context, core tenets, and contemporary value of theories, ensuring the political direction and academic depth of the lectures, acting as the "guiding star" for tracing the source.

Local Experts as Practical Tutors. Researchers from local party history research institutes, senior docents at memorial halls, and outstanding grassroots cadres are the "living dictionaries" of local practice and red resources. They provide vivid first-hand materials, lively practical cases, and down-to-earth public language, serving as the "bridge" connecting theory and practice.

Students as the Main Body of Lecturers. A broad and mobile youth theoretical lecture group should be formed by extensively selecting and cultivating a group of young students with good political quality and strong expressive skills. They are the core force of peer education, effectively delivering the theoretical and practical results guided by the "dual tutors" to more peers through their unique perspectives and discourse systems.

3.2 Content Element: Creating a Three-Dimensional Content Library of "Red Genes + Reform Practice + Youth Struggle"

Content is the soul of a lecture. The application of the "Tracing the Source and Footprints" methodology lies in building a content system that has both historical depth, contemporary warmth, and youthful passion.

Red Gene Library. Systematically sort out the local red historical context, deeply explore the spiritual core behind revolutionary sites and heroic deeds, and extract revolutionary spirits with regional characteristics. Transform static red resources into dynamic educational materials through field investigations and textual research, providing a profound historical foundation for lectures.

Reform Practice Library. Precisely correspond key events and typical experiences from the region's process of reform, opening up, and modernization with important discourses in the Party's innovative theories. For example, combine the innovative development of the private economy with the discourse on "Two Healths" (healthy growth of the non-public sector of the economy and healthy growth of those working in this sector), and link the successful practice of ecological governance with the "Two Mountains" theory (lucid waters and lush mountains are invaluable assets), using the "living textbooks" of local development to illustrate the practical power of theory.

Youth Struggle Library. Extensively collect the stories of outstanding local young scientists, entrepreneurial pioneers, and moral role models who have grown and succeeded under the guidance of the Party's theories. Construct a narrative chain of "theory guiding growth," allowing youth to see the real power of theory in the stories of their role models, stimulating their internal emotional resonance and conscious action.

3.3 Carrier Element: Innovating Diversified Platforms of "Virtual-Real Integration, Educating People Through History"

Carriers are the channels of lectures. The integration of "Tracing the Source and Footprints" requires us to break the limitations of traditional classrooms and build a diversified carrier matrix that combines online and offline, and integrates history and reality.

Historical Site Carriers. Make full use of "historical sites" such as red education bases, reform demonstration points, and corporate exhibition halls to conduct immersive and experiential "walking lecture classes." This allows youth to touch history and perceive development through on-site visits, achieving "situational cognition."

New Media Carriers. Adapt to the media usage habits of youth and build an all-media communication system covering "WeChat, Weibo, Douyin + Bilibili." Transform the results of tracing the source into cultural products popular among young people, such as short videos, animations, H5 pages, and graphic posts, to achieve precise reach and broad coverage of theoretical communication.

Brand Activity Carriers. Create brand activities such as "Red Study Tour Competitions," "Theoretical Lecture Arenas," and "Practical Story Sharing Sessions" to promote learning through competition and action through lectures. These platforms provide opportunities for youth to showcase their talents and exchange ideas, fostering a vibrant atmosphere of friendly rivalry.

3.4 Collaboration Element: Improving School-Local Linkage Guarantees of "Mechanism + Training + Resources"

School-local collaboration is the key to ensuring the smooth operation of the above paths. A set of linkage guarantee mechanisms with clear responsibilities and efficient operation must be established.

Mechanism Collaboration. Establish a joint conference system with the participation of multiple parties, including local government propaganda departments, education administrative departments, university party committees, and red bases. This system will coordinate lecture themes, solve key problems, and jointly evaluate lecture effectiveness, forming a synergistic force.

Learning and Training Collaboration. Regularly organize joint lesson preparation, thematic seminars, and combined training for university tutors, practical tutors, and youth lecturers. Through intellectual collision and sharing, continuously improve the overall quality of the lecture team, ensuring that lecture content is both "connected to the top line" and "grounded in the local context."

Resource Collaboration. Jointly contribute to the development, transformation, and sharing of resources from tracing the source. Universities leverage their research advantages to theoretically refine local resources, while localities provide practical platforms and create conditions for university teachers and students to conduct research. Both parties build and share a "case database" and "expert resource pool" to maximize resource efficiency.

3.5 Conclusion and Outlook

The analytical framework of "Tracing Regional Resources — School-Local Collaborative Transformation — Youth Theoretical Identification" constructed in this paper aims to provide a systematic solution to the practical dilemmas of youth theoretical lectures in universities. Through the construction of a four-dimensional path covering subjects, content, carriers, and collaboration, we attempt to create a new lecture model that is "rooted in theory, soulful in locality, and resonant with youth."

The practical value of this model lies in its transformation of theoretical lectures from one-way "indoctrination" to two-way "empowerment." It not only enhances youth's localized understanding of the Party's innovative theories but also cultivates their historical thinking, practical skills, and patriotism. The school-local collaboration mechanism provides solid organizational and resource guarantees for the sustainable operation of this model, offering a replicable sample for similar cities to carry out related work.

Looking ahead, with the rapid development of digital technology, the integration of "Tracing the Source and Footprints" and youth theoretical lectures will have even broader prospects. How to use big data, artificial intelligence, and other technologies to more accurately mine regional resources, more vividly present historical scenes, and more intelligently match youth needs will be a direction worthy of deeper exploration. Ultimately, our goal is to make the Party's innovative theories a true ideological beacon and guide to action for the growth of youth, inspiring generation after generation to contribute their youthful strength to the journey of achieving the great rejuvenation of the Chinese nation.

References:

[1] Rotolo, A. (2025). A Grammar Usage Guide to "To Trace Back" with Real-World Examples. New York: Language Research Press.

[2] Shanghai International Studies University Publicity Department. (2023). College Student Theoretical Propaganda Team Launches Bilingual Promotional Micro-Video "To the World, To the Future".

[3] Guangming Online. (2025, May 22). Survey on the Current Situation of Youth Theoretical Preaching in Zhejiang: Tasting the "Flavor of Truth" in Youth Preaching.