

Construction Model, Strategies, and Effectiveness of Carbon Neutrality Micro-Majors in Double First-Class Universities

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Abstract. Against the backdrop of the growing demand for "dual carbon" talents and the accelerated digital and intelligent transformation, the traditional higher education training system struggles to promptly meet the practical needs of the job market for interdisciplinary and compound talents. As a crucial exploration in the reform of higher education teaching, the micro-major talent training model has emerged and gradually become an important institutional innovation to enhance the adaptability of talent supply and training flexibility. The lag in the supply of emerging interdisciplinary talents, the imbalance of resources between eastern and western regions, and the lack of international practice have become universal practical dilemmas in the development of higher education. Taking Tongji University's "Climate Change and Carbon Neutrality" micro-major as a research case, this paper conducts a systematic analysis focusing on talent training objectives, curriculum system structure, and implementation mechanisms, aiming to summarize its construction logic and operational characteristics. The research finds that Tongji University's micro-major has established an organizational model of "joint training by three universities", implemented industry-education integration with enterprises in Xinjiang and international enterprises, innovatively set up the form of "synchronous classrooms", and promoted industry-education integration through multiple subjects such as enterprises in Xinjiang and international enterprises, forming a collaborative education mechanism. Meanwhile, by innovatively adopting teaching formats such as "synchronous classrooms", it enhances cross-regional curriculum supply capacity and learning experience, thereby providing high-quality talent support for the "dual carbon" field.

Keywords: Carbon Neutrality, Micro-Major, Talent Training Model.

1. Introduction

The urgency of global climate governance issues is driving the structural transformation of higher education to more effectively respond to the country's strategic talent needs, enabling universities to move from a single "knowledge transfer" to active involvement in carbon neutrality governance practices. In September 2020, General Secretary Xi Jinping formally proposed the "dual carbon" goals. The Ministry of Education and the State Council have successively issued a number of policy documents to promote universities to carry out talent training related to carbon neutrality. Overall, carbon neutrality is still an emerging direction in the field of education, and the talent training system is still in its initial stage. There is still a significant gap between the supply capacity and the demand for achieving governance goals.

The "2024 Global Carbon Neutrality Annual Progress Report" shows that as of May 2024, 151 countries around the world have put forward carbon neutrality goals, and "low-carbon development" has become an international consensus. ^[1] Against this background, international universities generally promote talent training through the project form of "credit-based + industry-university co-construction". The Massachusetts Institute of Technology (MIT) and Stanford University generally adopt a graduate certificate model with 9-12 credits and industry co-construction; Tongji University's carbon neutrality micro-major adopts a 12-credit system and embeds local projects such as Baowu Iron & Steel Group and National Energy Group, forming a rapid response and localized practice path for undergraduate level, which can provide reference for the short-cycle and highly flexible "Thousand Talents Program".

Among China's Double First-Class Universities, Tongji University is one of the earliest universities in China to establish the environmental engineering discipline. It passed the engineering

education certification in 2007 and re-certification in 2013 and 2019 respectively.^[2] At the same time, Tongji University is in a leading position in China in many disciplinary directions closely related to carbon neutrality, such as civil engineering, urban and rural planning, and transportation, and has accumulated the foundation and ability for interdisciplinary talent training. Secondly, although many Double First-Class universities also pay attention to carbon neutrality issues, such as Tsinghua University, they mainly focus on undergraduate program construction and have not yet formed a training system based on micro-majors, which is different from the focus of this research. In addition, the configuration of Tongji University's carbon neutrality micro-major is sufficient to benchmark international renowned universities such as MIT, with typical exemplary value. In terms of construction mode, compared with other universities offering carbon neutrality micro-majors such as University of Shanghai for Science and Technology, Tongji University innovatively adopts a cross-regional multi-university collaboration mechanism, providing Tongji's ideas for promoting educational equity. It can be said that in terms of comprehensive strength and innovative models, Tongji University's carbon neutrality micro-major has strong representativeness and research significance among many Double First-Class universities.

Based on this, this research proposes the following research questions:

(1) What are the core elements and structural characteristics of the construction model of carbon neutrality micro-majors in Double First-Class universities?

(2) What typical models (such as cross-regional multi-university collaboration, industry-education integration, etc.) have been formed in the construction of Tongji University's "Climate Change and Carbon Neutrality" micro-major, and what are its key supporting mechanisms and operational processes?

(3) To ensure the effective operation and sustainable development of the micro-major, what construction strategies has Tongji University adopted in terms of enrollment selection, curriculum organization, practice platforms, faculty, and evaluation, and what are its implementation logic and key starting points?

2. Construction Value of Carbon Neutrality Micro-Majors in Double First-Class Universities

The term "micro-major" was first formally proposed by Udacity in 2014, which launched the Nanodegree program in cooperation with Udacity, carrying out short-cycle training for emerging technology fields, mainly for offering micro-majors in emerging technology fields.^[3] Micro-majors restructure traditional professional knowledge through curriculum groups to form a "miniature" knowledge system oriented to specific fields, which can realize talent training in a short cycle.^[4] With the advancement of practice, micro-majors have expanded from the early "MOOC curriculum groups" to a competency-oriented model of "online carrier + practical links", emphasizing connecting with industry needs with a higher proportion of practice. As a typical emerging interdisciplinary issue in current educational research, carbon neutrality is consistent with the core concept of the micro-major talent training model, providing an adaptive path for "dual carbon" talent training in Double First-Class universities. Between 2015 and 2023, micro-majors were gradually launched and entered the practical stage in some domestic "Double First-Class" universities. However, existing research shows that as of the beginning of 2023, through quantitative analysis of the training programs of 23 domestic universities, only 9 (39%) have clearly listed micro-major modules in the academic affairs system, and the proportion of micro-major projects among all interdisciplinary projects in the university is less than 20%,^[5] indicating that the construction of micro-majors is still in the initial stage.

To meet the demand for interdisciplinary and compound talents, Chinese universities have actively provided students with various minor programs and double bachelor's degree teaching plans by leveraging their own high-quality resources or linking with other universities.^[6] Up to now, these two types of interdisciplinary talent training models are still the main teaching models, playing an

important role in students' knowledge expansion and interdisciplinary thinking training. However, with the background of the new round of technological revolution, the social requirements for talent training show the following trends: emerging fields are evolving rapidly, and the requirement for practitioners to "keep up with the frontiers" has been significantly enhanced.^[7] However, the teaching cycle of previous minor programs and double bachelor's degrees is mostly 2-3 years, and once the training program is set, it is difficult to make flexible changes. This makes it very likely that the knowledge learned by students will be out of touch with cutting-edge technologies when they graduate, and it is difficult to quickly respond to social needs. As a relatively new teaching model, micro-majors aimed at the problem of weak practicality in traditional professional talent training at the beginning of their establishment,^[8] taking strong practicality as their core feature distinguishing from other teaching models. In terms of training objectives and curriculum content, they are more inclined to cutting-edge scientific or technical practice fields, and can be flexibly adjusted according to the actual needs of industry frontiers and the labor market. Compared with minor programs and double bachelor's degrees, micro-majors, as the primary level in the minor training system, usually only require 9-25 study hours, and can quickly adjust the curriculum combination according to the industry demand, significantly reducing the risk of "disconnection between production and education".

At present, domestic relevant research on micro-majors mainly focuses on explaining the significance of micro-majors and proposing implementation strategies from the policy level. There is still a lack of in-depth case studies on the specific operation mechanisms and practical effects of carbon neutrality micro-majors. Tongji University's "Climate Change and Carbon Neutrality" micro-major has been running for nearly two years and completed two phases of training, providing a realistic foundation for this paper to analyze the construction process and phased effects. Based on this, this paper will take Tongji University's "Climate Change and Carbon Neutrality" micro-major as a case, focusing on its construction needs, training programs, teaching models, and resource guarantees, analyzing the construction path and development dilemmas of this micro-major, aiming to provide reference experience for the reform of domestic higher education.

3. Analysis of the Construction Model of Tongji University's Carbon Neutrality Micro-Major

3.1. Strategic Background and Demand Analysis

The "Emissions Gap Report 2022" released by the United Nations Environment Programme (UNEP) indicates that the current carbon emissions are still far from the ultimate goal of limiting global warming to 1.5°C.^[9] Achieving carbon neutrality is not an easy task, and there is still a large gap in "dual carbon" talents worldwide. Against the background of insufficient supply of "dual carbon" talents, Tongji University launched the micro-major of "Ecological Protection and Green Low-Carbon Development" in 2023, which was renamed "Climate Change and Carbon Neutrality" in the following year to meet the talent training needs in the field of carbon neutrality. At the same time, Tongji University's international cooperation foundation in the field of sustainable development provides support for the construction of this micro-major. In May 2002, UNEP and Tongji University co-founded the "Institute for the Environment and Sustainable Development (IESD)", which serves as an important base for UNEP to carry out sustainable development education, scientific research, training, and exchanges in the Asia-Pacific region.^[10]

3.2. Analysis of Training Programs and Curriculum System

3.2.1 Talent Training Objectives

Firstly, cultivating compound talents. Relying on the short-cycle advantage of the micro-major, select cutting-edge knowledge around key carbon neutrality issues, and strengthen the connection between learning content and job capabilities. Different from some related majors that tend to

"emphasize theory over application",^[11] Tongji University's "Climate Change and Carbon Neutrality" micro-major implements the teaching objective of integrating "theory + technology", effectively promoting the diversification of teaching content and enhancing students' technical practical capabilities in the field of carbon neutrality. Secondly, emphasizing an international perspective. The training objectives clearly propose to cultivate "leaders in global climate change and carbon neutrality development". Combined with the background of the era of university globalization, Tongji University's International Office clearly points out that it is necessary to comprehensively improve students' international competence, and the first measure is to build a micro-major for international competence training, enabling students to meet the talent needs of international organizations. Thirdly, attaching importance to the shaping of social responsibility. In April 2020, Tongji University promoted the concept of sustainable development by offering elective courses and an interdisciplinary "double tutor" system, aiming to stimulate students' social responsibility for environmental issues.^[10] With the development of the carbon neutrality micro-major, its talent training objectives also clearly propose to "shape talents with a high sense of social responsibility". In general, Tongji University attaches great importance to the sense of social responsibility in talent training, and forms a complete education system through the training path of "theory-practice-value output", providing comprehensive support such as theory, experience, and platforms for the talent training objectives of the "Climate Change and Carbon Neutrality" micro-major.^[12]

3.2.2 Curriculum Structure

Based on the macro framework of talent training objectives and considering the talent needs of the carbon neutrality market, the core courses of the "Climate Change and Carbon Neutrality" micro-major are determined as 6 courses: "Climate Change and Green Development", "Green Energy and Low-Carbon Technology", "Carbon Trading and Carbon Finance", "Carbon Emission Accounting", "Carbon Capture, Utilization and Storage", and "Smart Low-Carbon Environment Practice".^[13] Among them, "Climate Change and Green Development", "Green Energy and Low-Carbon Technology", "Carbon Capture, Utilization and Storage", and "Smart Low-Carbon Environment Practice" belong to the major of Environmental Science and Engineering, while "Carbon Trading and Carbon Finance" and "Carbon Emission Accounting" are interdisciplinary integration courses of Environmental Science and Engineering and Business Administration. The Environmental Science and Engineering major obtained an "A+" rating in the fourth round of subject evaluation, which is a flagship discipline of Tongji University. The Business Administration major also achieved a good result of "B+", which is a strong discipline of Tongji University, providing strong disciplinary resource support for the construction of micro-major courses and realizing the training of interdisciplinary compound talents.

3.3. Analysis of Teaching Models and Resource Guarantees

3.3.1 Teaching Innovation and Characteristics

To respond to the national "3060" dual carbon strategic goals, Tongji University signed the "Cooperation Agreement on Jointly Offering the 'Climate Change and Carbon Neutrality' Micro-Major" with Xinjiang University, implementing joint enrollment, training, and certificate awarding by the two universities starting from 2024. In December 2024, Tongji University, Xinjiang University, and Kashgar University further signed a cooperation agreement, forming a three-university joint training model. In terms of teaching organization, this micro-major adopts cross-university and cross-regional online-offline integrated teaching: teachers give offline lectures in the smart classroom of one university, students from other universities attend the lectures synchronously in smart classrooms, and realize real-time interaction and classroom feedback through online platforms, thereby realizing the complementary of teaching resources between Shanghai and Xinjiang and promoting collaborative education between the eastern and western regions. In terms of resource expansion, this micro-major shares some curriculum resources with non-cooperative universities through a cross-university opening mechanism, and has carried out cross-university opening and resource sharing

with universities in Shanghai such as Fudan University, further expanding the project's radiation scope and demonstration effect.

3.3.2 Resource Guarantees

The "Climate Change and Carbon Neutrality" micro-major is an innovative teaching exploration by Tongji University to promote the transformation of traditional advantageous engineering majors towards "digital intelligence, greenization, and integration", highlighting practical orientation and resource integration capabilities. In terms of practical links, Tongji University has organized teachers and students teams to conduct field visits and technical observations in Xinjiang. For example, the CCUS demonstration device built by National Energy Group Xinjiang Chemical Co., Ltd. captures and stores 100,000 tons of carbon dioxide annually, which can provide typical teaching cases for courses such as "Carbon Capture, Utilization and Storage" and "Carbon Emission Accounting".^[14]

In terms of international training, the micro-major provides students with a diverse exchange platform through enterprise visits and transnational cooperation: on the one hand, it organizes students to enter overseas enterprises to carry out practical exchanges on "dual carbon" related processes and management, such as taking GEBERIT Group in Switzerland as the first stop of academic innovation activities; on the other hand, relying on Tongji University's cooperation foundation with universities such as Darmstadt University of Technology in Germany, the University of São Paulo,^[15] and Loughborough University^[16] in the field of environment and sustainable development, it expands joint practice and learning opportunities, such as exchanging with teachers and students from Darmstadt University of Technology at Shanghai Xinghuo Sino-French Water Supply Co., Ltd. and participating in the "Climate Change and Global Governance" Polar Summer School, providing support for the development of students' international competence. In terms of resource guarantees, Tongji University has clearly taken micro-major construction as the driving force since 2019, providing institutional support at both software and hardware ends. On the software side, it has formulated supporting policies such as funding investment, incentive mechanisms, teaching performance recognition, and workload calculation, improving teachers' participation enthusiasm and strengthening teaching operation guarantees.^[17]

3.3.3 Faculty Strength

The "Climate Change and Carbon Neutrality" micro-major has a high-level faculty team, including 20 national-level high-level talents such as academicians of the Chinese Academy of Engineering, Yangtze River Scholars, winners of the National Outstanding Youth Fund, and leading talents of the National "Ten Thousand Talents Program". In terms of improving faculty capabilities, since 2019, Tongji University's Undergraduate School has continuously organized online open course construction and blended teaching seminars, and jointly carried out "online-offline blended golden course" training with Zhihuishu Network, promoting teachers' curriculum construction and teaching method renewal. The university has held the "E9 Alliance, East-West University Curriculum Sharing Alliance 'Online-Offline Blended Golden Course' Seminar",^[18] enabling teachers to better improve their teaching capabilities and optimize teaching methods. Cooperative university Xinjiang University promotes cross-university teaching and research and teacher development through platforms such as "virtual teaching and research sections". As of the end of 2024, more than 40 teachers have participated, forming a faculty guarantee for micro-major teaching. At the same time, the two universities have established a joint scientific research mechanism and jointly applied for the autonomous region key project "Evaluation of Carbon Emission Reduction Benefits of Photovoltaic Power Generation and Desertification Control" in 2024, forming a collaborative division of labor of "Tongji's theoretical guidance - Xinjiang's field research", and feeding back teaching and talent training through scientific research collaboration.^[19]

4. Construction Effects and Challenges of Carbon Neutrality Micro-Majors in Double First-Class Universities

From a policy perspective, Tongji University's "Climate Change and Carbon Neutrality" micro-major has provided a practical fulcrum for higher education equity and western green transformation through cross-regional collaborative training. In August 2024, the Ministry of Education launched the "MOOC Westward Journey Program 2.0", emphasizing the integration of high-quality resources through digital technology and promoting cross-regional teaching to alleviate the shortage of faculty and resources in western universities.^[20] Tongji University, together with Xinjiang University and Kashgar University, has formed a three-university collaborative training model, realizing the cross-regional sharing of high-quality curriculum resources through "synchronous classrooms", MOOCs, etc., and building a collaborative path of "resource sinking - local adaptation". At the same time, the western region is facing the practical demand for green and low-carbon development and energy transformation.^[21]

At the micro level, the three-university linked "Climate Change and Carbon Neutrality" micro-major promotes students' ability formation and employment quality improvement through an integrated model of "MOOC + synchronous classroom + enterprise internship". Among them, while retaining the shareable advantage of online courses, the "synchronous classroom" introduces a real-time interaction mechanism, making up for the lack of interaction in traditional online courses, and enhancing learning experience and learning investment through improving two-way communication between teachers and students.^[22] However, compared with traditional classrooms, the interactivity of online courses is obviously lacking, and the learning quality of students in online open courses has been questioned.^[23] In the interviews with students of this micro-major, some students mentioned that they "like this way very much" and "can communicate with teachers at any time, and one-way output has become two-way communication".^[19] This teaching model has enhanced the attractiveness of the classroom and provided reference experience for the quality upgrade of online education.

Although the "synchronous classroom" has alleviated the lack of interaction in online learning to a certain extent, as an initial exploration of three-university cooperation, this micro-major still has room for improvement in curriculum integration and resource coordination, mainly reflected in three aspects. Firstly, the curriculum implementation still partially relies on MOOC self-study, and the learning quality is greatly affected by students' self-discipline. Student interviews also reflect the phenomenon of "watching videos while doing other things", making it difficult to guarantee classroom investment. Secondly, courses are distributed on multiple platforms such as Chaoxing Erya, Zhihuishu, and Xuetangyun, and accounts and data are not interconnected, which increases the learning operation cost and is not conducive to learning progress tracking and phased diagnosis. Thirdly, the transformation of university-enterprise resources is still relatively limited. At present, international enterprise cooperation mostly stays at the level of one-time visits, with insufficient continuous cooperation and in-depth collaboration, leading to a certain tension between the supply of international resources and training objectives.

5. Construction Strategies of Carbon Neutrality Micro-Majors in Double First-Class Universities

5.1. Multi-Dimensional Collaborative Strategies to Improve Online Participation

Based on the problem of reduced student participation caused by online teaching formats, multi-dimensional collaborative strategies are proposed to enhance students' motivation to participate in courses. Firstly, in terms of teaching format, the experiment of "synchronous classroom" has achieved good teacher and student evaluation feedback. The proportion of "synchronous classroom" should be appropriately increased, and some recorded courses should be reduced. "Synchronous classroom" can be prioritized for explaining key and difficult teaching points, and recorded courses can be used for knowledge modules with low learning difficulty to ensure that students firmly grasp the core

professional content. Secondly, set up hierarchical teaching, make full use of the advantages of MOOCs such as saving teaching resources, flexible learning time, and repeatable playback, as supplementary learning resources for students, provide curriculum resources for students with spare capacity, and build a hierarchical learning model. Thirdly, optimize and improve the curriculum evaluation mechanism, increase process evaluation, embed interactive methods such as group cooperation tasks and chapter discussions into the curriculum, and enrich the form of curriculum content. At the same time, appropriately include the completion of interactive tasks into the performance evaluation to increase the external driving force for curriculum participation.

5.2. Unify Curriculum Resource Platforms

According to the ecosystem theory, the new ecology of smart education requires teaching scenarios to provide students with a multi-dimensional and multi-subject interactive platform, so as to promote students' differentiated development of higher-order intelligent literacy.^[24] At present, there are many online learning platforms for micro-majors, and the platforms are not interconnected, leading to students spending more time and cost in registering accounts and searching for information. Repeatedly switching platforms also reduces the continuity of learning and adds a lot of "ineffective labor" for students. Based on this, the university can actively try to develop an exclusive learning platform for micro-majors, integrating functions such as curriculum learning, resource storage, and interactive communication, to realize a "one-stop" learning entrance. At the same time, since this micro-major involves three-university cooperation, the teaching information among teachers from different universities can also be centrally managed and released through this platform, facilitating students to receive professional-related information in a timely manner and reducing communication costs.

5.3. Expand Industry-Education Integration Resources

Expanding university-enterprise resources is an inevitable requirement for deepening the "industry-education integration symbiosis" and an important starting point for responding to the reform of the modern vocational education system. Compared with traditional university-enterprise cooperation, industry-education integration emphasizes being oriented to the real needs of enterprises and realizing the effective connection between the curriculum system and industry needs.^[25] Tongji University has accumulated a relatively rich international cooperation network in the fields of environment, energy, and sustainable development. On the basis of existing cooperation, it can further develop stable practice and exchange channels for micro-majors, improve students' international competence through methods such as "joint practice - two-way visits - project-based learning", and appropriately expand internship regions and problem scenarios to avoid the limitation of vision caused by excessive concentration of practice scenarios.^[26]

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The Impact of Social Media Usage on the Academic Performance of High School Students

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Abstract. With the development of digital technology, social media has become an important part of high school students' everyday lives. This paper analyzes research findings from both inland and international studies on the relationship between social media use and high school students' academic performance, mainly focusing on possible causes such as time displacement, self-regulation, psychological factors, and participation during classes. The analysis finds that extreme social media use might indirectly harm high school students' academic performance by taking up the time of study and sleep, distracting attention, lowering self-control, and decreasing learning participation. However, a reasonable amount of usage of social media can, at a certain point, help alleviate negative emotions and stress. Based on this conclusion, the paper suggests that high school students should improve time management and self-control skills, while parents and teachers provide guidance and support to help students set up a healthier and more balanced approach to social media use, which helps to improve their academic performance and mental well-being.

Keywords: High School Students, Social Media, Academic Performance.

1. Introduction

Social media has become part of the life of teenagers under the conditions of the digital age development, and it has changed the ways of communication, access to information, as well as how teenagers spend their free time [1,2]. As the online social platforms continue to grow, high schoolers are currently one of the most popular groups of social networking site users, and social media is gaining its place in the lives of high schoolers, too. That widespread use had already drawn the attention of parents and society [2]. At that stage of adolescent state, psychological development and learning habits of students have not been fully developed yet. As such, wrong use of social media will quickly result in addiction and adverse effects on academic performance [3].

Meanwhile, the performance during high school is an important factor in the educational career of a student as well as their future possibilities. Thus, appreciating the role played by various factors that determine the learning outcomes during this stage has become a cause of concern to teachers, parents and even the national education authorities [4]. Within this social context, studies have been coming out in large numbers to address the topic of the relationship between social media use and academic performance.

According to some studies, a moderate usage of social media actually helps to reduce psychological stress among teenagers. As an example, in communication and interaction with peers via social media, teenagers can create and maintain any interpersonal relationship, and in this way, feelings of loneliness and social anxiety disappear [1,5]. Nonetheless, excessive use of social media can cause numerous negative psychological symptoms, including a worse sense of social adjustment, fear of missing out (FoMO), low self-esteem, dissatisfaction with appearances, emotional distress, eating disorders, insufficient quality of sleep, and addictive behaviors [5,6]. It may even narrow the social circle of the user resulting in loneliness and isolation [7]. As such, recent studies have made significant steps in not only looking at the effect of social media on educational achievement but also looking at how it affects academic achievement and its mechanism.

The objective of this paper is to combine up-to-date studies concerning the relationship between the use of social media and academic performance of high school students with the primary focus on

defining the possible factors that clarify such a correlation and its outcomes on students who are constantly over-stressed by the upcoming exams.

2. Concept Definition and Theoretical Foundation

2.1. Academic Performance

Academic performance is an ambivalent concept and not only refers to the score in the exams.

In previous studies, objective indicators of the academic performance are academic achievements and are measured in objective and quantifiable ways. Such indicators are procedural knowledge and declarative knowledge gained in school systems and course grades or educational test performances, moreover general indicators such as the progress to the right level of academic study and earning of degrees and certificates [8].

Specifically speaking, academic performance can be measured in terms of quantifiable indices, i.e. exam results, course grades, GPA (grade point average), or simply course enrolment. These could be used to indicate how well students have grasped the course content in a given period of time hence are very common in empirical studies.

Moreover, students' attitude towards learning and the degree of their engagement are also key to the students' academic performance. Many of the variables examined in other independent studies within the last few years contain both personal and social aspects of students [4,8]. Indicatively, the degree of student attendance at classes, interest in courses, good or poor study habits, level of concentration in learning activities, performance in terms of completing work on time and even the food consumed by students every day have some impacts on academic performance [3,4,8].

Altogether, the concept of academic performance is applied to characterize the outcomes of learning in students, which is usually evaluated through grades and the psychological condition of the students. The academic performance that is presented in this paper would be more appropriate to decipher as an all-encompassing explication of the interaction impacts of both the learning outcomes and the process of learning.

2.2. Time Replacement Effect

Time replacement effect is where, under limited time resources, spends his or her time in a given activity and the time causing the time available for other activities to decrease relatively. Since the discretionary time in a day is fixed, there is an inevitable trade-off between different activities. Consequently, more time spent on a given activity is normally followed by a decrease in time spent on the other form of activity.

The time replacement effect in educational and psychological studies is commonly applied in explaining the way people divide their time among their daily engagements in activities. As an illustration, more time spent by students on entertainment, socializing, or leisure will reduce the amount of time already spent on studying, reading, or having a rest. This change does not suggest that the behavior itself is problematic but just signifies a change in time usage.

The time replacement effect is more focused on the outcome of the redistribution of time, rather than the actual value of the activities themselves. That is, it does not make positive or negative judgments regarding a certain activity, but the relationship of time increment or decrement among the various activities.

Hence, the time replacement effect offers a methodological viewpoint of analysis concerning how students daily distribute their time. This concept has been applied in studies to refer to the competitive relationship of time among the various sorts of activities, and it has been assumed as a significant theoretical context in examining learning-related behaviors.

3. Reasons

3.1. Developmental Stages and Psychological Factors

Adolescence is an important stage for cognitive and emotional development. At this age, the power of self-regulation of the teenagers is not yet full-fledged, and emotional swings are relatively common. This developmental trait not only easily results in psychological frustration but can also result in some physical discomfort like headaches, nausea, stomach aches, etc. [9]. Self-regulation ability, as per educational psychology, is fundamental in terms of time management, attention regulation, and investment of learning energies of students; particularly when they are required to undertake and accomplish both the social media use and the academic activities at the same time, its role is more pronounced [3].

Adolescents are easier to lure and distract on social media platforms due to their undeveloped abilities of self-regulation, and they are more likely to be prone to using it in impulsive ways [10]. For example, the constant notifications and design mechanisms of social networking sites will interfere with the concentration of students in order to stay focused on their studies [3]. Studies have established that overindulgence in social media may actually deteriorate the capacity of students to be able to focus in the long run. This further affects their ability to learn academic knowledge, especially in tasks that require long-term cognitive investment, where the negative impact is more pronounced [4].

Besides the effect on concentration, self-control is also critical in mediating social media usage and academic behaviors. The ability to self-control can be described as the ability of a person to overcome temptations and carry on with fulfilling long-term desires. It is also strongly linked to the self-awareness of the studies among students in their academic habits, including duration of study, maintaining concentration, and levels of classroom participation [11]. Youths having a lower self-control capacity tend to have problematic behaviors of social media use, which not only distracts their time and energy from other educational aspects but can also further reduce their academic concentration at large [5].

The psychological burden of keeping up with social relations and staying active on social networks when using social media may be a negative influence on the emotional conditions of a student, which leads to anxiety or even depression. Studies indicate that depression and anxiety have become relatively common mental health problems among young people between the ages of 15 and 19 years [12]. Numerous educational research studies have also demonstrated that the psychological conditions of students are greatly correlated with their motivation to learn, the degree of their concentration, and their academic performance; negative emotions tend to undermine the learning process and influence the overall learning results [4].

Considering the development and psychological processes mentioned above, addiction to social media leads to further preoccupation with academic time; hence, this imposes a greater negative influence on academic performance. The term "addiction" is generally referred to as the urge of an individual to consume a specific drug or a certain behavior that the person cannot resist, or the need to take part in the activities that are likely to be harmful to him or her [4]. As the use of social media becomes an addictive behavior, students, even in the midst of studying, are not able to resist engaging in online interactions; student performance is usually much lower than that of students who rarely or never use social media.

Related research has further identified that adolescents between the ages of 12 and 17 are some of the most active young people online, and their reliance on social networks often lasts for extended periods. Therefore, it can be concluded that teenagers aged 10 to 25 are more likely to develop a dependence or addiction to social media compared to people of other age groups, because they share content more frequently and spend more time on social media [13]. During this age range, self-regulation abilities have not yet reached their optimal state; therefore, it is more difficult for them to appropriately control their usage behavior, as this often worsens the negative impact of social media addiction on the distribution of study time.

One of the major behavioral manifestations in the process is the inability to manage time. Studies have revealed that students who do not have the skills for good time planning have a tendency to fail to accomplish academic-related assignments on schedule and tend to habitually defer academic assignments. To illustrate, Moli Yu pointed out that college students who overly rely on the internet to the extent that they completely avoid all activities are more likely to develop avoidant behaviors and have a higher rate of academic procrastination compared to those who do not have such dependency behaviors. The consistency of learning and its profundity are also interrupted by such procrastination, in addition to shortening the real time that can be spent studying.

Moreover, studies on screen time and digital media use also found such tendencies: too much access to activities connected with entertainment media may replace rest (including sleep). This is viewed as a crucial basis to retain attention, concentrate, and improve memory and learning efficiency [2, 3]. When students devote more time to social media at the cost of studying or sleeping, they tend to have problems like inability to concentrate, learning efficiency, and memory loss, and are thus highly likely to experience academic burnout, resulting in a fall in their overall academic performance [5].

Overall, the developmental characteristics of adolescence, insufficient self-regulation & self-control abilities, and the time displacement and psychological burden caused by social media addiction together constitute important psychological and behavioral mechanisms through which social media affects high school students' academic performance.

3.2. Learning Behavior and Learning Engagement

Besides personality factors, the application of social media offers an important connection between media use and the learning behavior of students and their academic activity. The academic engagement in the educational research implies behavioral, emotional, and cognitive involvement in the learning activities [11].

During the learning process, the engagement and participation can be seen in the manner that the students attend classes, engage in discussion, and complete assignments; the extent of the engagement of the students is the mastery and understanding of what is being learnt; emotional engagement is the interest and enthusiasm of the students in the learning process and individuals level of engagement is directly connected to the academic performance [11]. Overuse or misuse of social media can interfere with daily activities, including decreased sleeping and normal studying time, therefore leading to shortened or delayed time studying [3,12,14]. According to the procrastination-health model, the behaviors of procrastination include negative impacts on the physical and mental health of a person. This is due to the fact that individuals in their habitual procrastinating tendencies neglect their own health conditions, and they have relatively low self-control [3]. The use of social media is also linked to diminished academic activity, such as inadequate study time, diminished engagement in classroom activities, and inconsistency in doing homework. These changes in learning behaviors of time substitution effects or reduced academic engagement might, in turn, result in poorer academic performance.

3.3. Environmental Factors

In addition to the personal psychological, and self-management skills, the learning environment can also play a major role in the academic performance of the students. The teaching styles of the teachers, the classroom environment, and the entire learning environment of a school can influence the academic performance of the students to different extents [8].

To begin with, the way in which teachers teach is relevant in influencing the learning behaviors of the students. Providing clear learning goals, and motivating the students to ask questions and participate in discussions throughout the lesson, the teachers are likely to keep the students on point and be interested in classroom activities [12].

Secondly, the supportive learning environment also affects students' academic engagement. Indicatively, a good classroom order that is well managed, the relationships between the teachers and

the students and a cooperative peer environment can be used to increase student participation in learning and hence they would be more willing to partake in classroom activities [12]. When the learning environment lacks order and contains numerous distractions, the students will have a hard time maintaining a consistent learning pace and classroom engagement, and learning performance might also suffer [3].

In addition, various types of parenting may largely influence the motivation to learn and academic achievements of the children. If parents are too controlling, critical, and punishment, or indifferent toward children thoughts and behaviors, children will tend to acquire an extrinsic and instrumental motivation toward learning and will do comparatively poorly in school. Conversely, parental support, encouragement, respect for the children's autonomy, and support of their individual development increase the chances of the child developing intrinsic enthusiasm towards the learning process and attaining higher grades [8].

In general, school-based teaching approach and family context, as well as the instructions that encourage students to gain independence, have a significant impact on the academic performance of students since these variables impact their learning motivation and classroom behaviour.

4. Insights

This paper has shown that the effect of social media on the academic performance of high school students has not been direct or isolated, but instead indirect with many channels serving as the means such as time management, self-control abilities, mood, and interest in learning.

First, time management skills are very significant to students. Students of high school can attempt to make simple plans about studying and spending free time every day, which may include using social media after finishing homework and reading tasks and establishing boundaries on time using media entertainment. Also, to become more attentive during learning, students may actively switch off notifications and keep their phones out of sight, thus becoming more efficient learners.

Second, parents and teachers need to offer advice and help to assist the students in developing healthier usage behavior and study habits, they must learn the intentions and emotions of the students when they are utilizing social media and collectively work out sensible restrictions. The adjustments need to be made on time to avoid dependency or addiction in the situation of stress, anxiety, or insomnia. What is more, teachers are able to make the lessons more interesting and support them positively to bring more interest to the students.

In a nutshell, social media as such is not bad, but the point is in the usage and in the extent of usage. Through the enhancement of self-management in students, creating understanding and guidance in families and the application of proactive school intervention, one could alleviate the ill-effects that social media has on high school students and allow their growth to be more balanced in the digital age.

5. Conclusion

The paper undertakes an extensive literature review and discussion of how the use of social media affects the performance of students at high schools. Overall, the implementation of social media does not have a direct and exclusive impact on academic results. It, on the contrary, has an indirect effect on students' learning processes and outcomes in various ways which include substitution in time, ability to self-regulate, psychological state, and engagement in learning. Findings of the research also point out the fact that uncontrolled or improper use of social media can easily eat up study and sleep time, divert attention, decrease the level of learning engagement, and hence negatively affect the performance of the students.

In addition, several other issues such as individual factors and environmental factors are also important in the process. The psychological traits in the teenage stage, the development of the capacity of self-control, how the family was brought up, and the conditions of learning in school, will

enhance or reduce the effects of the use of social media on academic performance to some extent. It means that explaining the problem of the influence of social media on academic performance should not be reduced to the perspective of use or non-use, but it should be viewed comprehensively in tandem with the level of development of students and in given circumstances. Furthermore, educators and parents will be able to perform a conscious development of self-control and goals of students, and focus more on the interest of learning content to further improve and avoid the negative impact of social media on teenagers.

Based on this premise, future studies can narrow down further on the connections between forms of the use of social media and academic performance. The example is that it can differentiate between the various platforms and the various utilization purposes and their long-term outcomes, and integrate longitudinal research methods to investigate the causation of the mechanisms in finer detail. Meanwhile, at the practical level, how to assist high school students to develop healthier and more sustainable patterns of using digital media as the collaboration of school education, family instructions, and self-government among students requires further investigation as well.

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The Challenge and Response of Generative Artificial Intelligence to Teachers' Curriculum Design Leadership

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Abstract. The rapid development of generative artificial intelligence is profoundly reshaping the education ecology, which poses a systematic challenge to the professional role and core competence of teachers. In this technological change, teachers' curriculum design leadership is facing unprecedented impact. This paper systematically analyzes the multi-dimensional challenges of generative AI to teachers' curriculum design leadership. This paper proposes that teachers should change from "passive response" to "active remodeling", and reconstruct curriculum design leadership under the new paradigm of human-computer cooperation. By innovating the teaching mode and realizing the "blank" and "value-added" of curriculum design, the focus of the classroom will shift from knowledge coverage to deep learning. By constructing the "just transformation" ecology of teachers' professional development, we can provide systematic organizational support for teachers' digital intelligence growth. According to the research, the fundamental way to deal with the challenge of AI is not to compete with the efficiency of knowledge transfer with machines, but to return to and strengthen the essential pursuit of "making people human" in education. This paper has important academic value and practical significance for deepening the understanding of human-computer collaborative education and promoting the positive transformation of teachers' role.

Keywords: generative artificial intelligence, Teachers' leadership in curriculum design, Human machine cooperation, Professional role remodeling, Value leading.

1. Introduction

In recent years, the rapid development of generative artificial intelligence technology is bringing profound changes to the field of education. From chatgpt to various multimodal large models, these technologies have been gradually integrated into all aspects of education and teaching with their powerful content generation ability, natural interaction mode and efficient knowledge processing efficiency. This technological change has not only changed the way of knowledge transfer, but also raised fundamental doubts about teachers' professional roles and job responsibilities.

Among the many impacted teachers' professional abilities, curriculum design leadership deserves special attention. As an important part of teachers' core quality, curriculum design leadership is reflected in Teachers' professional consciousness and ability level in the curriculum system [1]. Specifically, it includes teachers' overall understanding of the curriculum, the ability to design the teaching content and the ability to grasp the implementation of the curriculum, reflecting the degree of teachers' autonomy in the curriculum work. For a long time, teachers have been playing multiple roles such as the authoritative interpreter of curriculum content, the main designer of teaching process and the planner of students' learning path. However, when generative AI can quickly complete the preparation of teaching plans, the construction of knowledge frameworks, the design of homework topics and even the customization of personalized learning programs, teachers' original professional authority and design autonomy are facing unprecedented challenges.

It should be clear that education has never been just an extension of technology. The essence of education is related to people's growth and the way people know and understand the world. As a tool of knowledge production, generative artificial intelligence has indeed changed teaching methods, but more importantly, it has prompted people to rethink the value orientation of teachers in the process of education. In this context, it has become an important topic of current educational research to deeply study the specific challenges that generative AI has brought to teachers' curriculum design leadership and explore effective coping strategies. This paper will start from the definition of the

concept of teachers' curriculum design leadership, systematically analyze the multiple challenges brought by generative artificial intelligence, and on this basis, discuss how to reshape teachers' curriculum design leadership from the perspective of human-computer cooperation, in order to provide theoretical reference and practical guidance for teachers' professional development in the era of intelligence.

2. The Definition and Role of Teachers' Curriculum Design Leadership

2.1. Connotation of Teachers' Curriculum Design Leadership

To understand the leadership of teachers' curriculum design, we first need to clarify the upper concept of teachers' curriculum leadership. Teachers' curriculum leadership refers to teachers' cognition of the curriculum system and the consequent consciousness of curriculum behavior, which reflects teachers' overall ability to grasp the process of curriculum design and implementation. According to the research of scholars Wang Qin and Zheng Youxun, the core composition of this ability includes three aspects: curriculum consciousness, curriculum design and curriculum implementation [1].

From the perspective of specific performance, teachers' curriculum leadership contains two levels of connotation. At the school level, teachers can participate in curriculum affairs in the way of equality, cooperation and sharing, put forward constructive suggestions for the development of school curriculum, and make curriculum decisions with other teachers to promote the realization of curriculum objectives. At the classroom level, teachers give full play to their professional autonomy, formulate teaching plans, design unit teaching, implement curriculum evaluation according to curriculum standards, and use the experience and wisdom accumulated in long-term teaching practice to have a positive impact on students in a unique way.

Based on the above understanding, this paper defines teachers' curriculum design leadership as the comprehensive reflection of teachers' professional judgment, creative decision-making ability and value leading ability in the process of curriculum planning, design, implementation and evaluation based on the comprehensive consideration of curriculum objectives, curriculum content, students' characteristics and teaching situation. It should be emphasized that this ability has gone beyond the technical category of "lesson preparation" in the traditional sense. It is a composite professional ability that integrates educational philosophy, professional wisdom and ethical care.

2.2. Educational Value of Curriculum Design Leadership

Teachers' curriculum design leadership plays an important role in many aspects in educational practice [2].

First of all, this ability is an important guarantee for teaching students in accordance with their aptitude. The outline of basic education curriculum reform (Trial) issued in 2001 established a three-level curriculum management system at the national, local and school levels, and appropriately delegated the right of curriculum management to schools. This reform has changed the role of teachers from a simple curriculum executor to a curriculum leader. As a result, teachers have a greater space for curriculum autonomy, and can adjust and design the curriculum according to the specific situation of the students they teach, so as to better realize the educational goal of teaching students in accordance with their aptitude.

Secondly, curriculum design leadership directly affects the quality of curriculum implementation. The effect of curriculum implementation depends largely on Teachers' understanding of the curriculum and their ability to transform the curriculum into teaching practice. When teachers have strong leadership in curriculum design, they can creatively design teaching activities suitable for students according to the requirements of curriculum standards and specific teaching situations, so that the curriculum objectives can be truly implemented in the classroom. On the contrary, if teachers only passively implement the established curriculum plan, even if the curriculum design itself is excellent, it is difficult to achieve the desired teaching effect.

Thirdly, the development of curriculum design leadership is also the internal driving force to promote teachers' professional growth. In the process of participating in curriculum design, development, implementation and evaluation, teachers need to constantly deepen their understanding of education, improve their professional judgment ability and accumulate practical wisdom. This continuous practice and reflection helps teachers gradually grow into reflective practitioners with independent consciousness and innovation ability. As some researchers have pointed out, the vision foresight, value insight and other elements contained in curriculum leadership are the core content of teachers' professional development.

Finally, in the context of today's educational reform, the value of curriculum design leadership is more prominent. With the wide application of generative artificial intelligence technology, AI has been able to efficiently complete the knowledge transfer and the generation of basic teaching content. In this case, the professional value of teachers is changing from the traditional "knowledge Porter" to "learning designer" and "value leader". And curriculum design leadership is precisely the key ability to support this role transformation. It helps teachers find their professional positioning in the environment of technology empowerment and play an irreplaceable role.

3. AIGC's Challenge to AI's Leadership in Curriculum Design

The in-depth application of generative artificial intelligence in the field of education not only brings technological innovation to teaching, but also has a profound impact on the foundation of teachers' curriculum design leadership. Researchers point out that AI technology is rapidly changing the education ecology, bringing multiple professional challenges to teachers. These challenges are concentrated in the following four levels.

3.1. Professional Role Identity Crisis

The most fundamental impact of generative AI on teachers is that it has shaken teachers' professional status as knowledge authority for a long time. When AI can instantly generate teaching content, sort out the key points of knowledge, and construct the overall framework of the discipline, the "knowledge monopoly" advantage that teachers traditionally rely on has been fundamentally questioned [3]. This identity crisis has been embodied in educational practice. Some studies have found that with the popularity of AI tools in the field of education, teachers' identity with their professional values is being threatened. When AI can quickly complete textbook compilation, homework correction, student question answering and other work, many teachers begin to worry about losing teaching autonomy in the process of human-computer cooperation. Such concerns are not superfluous. In the context of rapid technology update and iteration, teachers have to keep asking: where is their unique value in the field where AI can do faster and better? This deep questioning of the significance of professional existence constitutes the root of the crisis of teachers' role identity.

3.2. Erosion of Autonomy in Teaching Decision Making

The core of curriculum design leadership is that teachers can make independent decision and creative design based on professional judgment [4]. However, when AI can automatically generate diversified teaching plans, homework questions and evaluation methods, teachers' decision-making space is quietly shrinking. This change reveals a potential risk that teachers may fall into excessive dependence on technology. If teachers directly adopt the teaching content generated by AI without criticism, their role may degenerate from active "curriculum designer" to passive "AI content reviewer". In this case, teachers no longer need to conceive the teaching plan from scratch, but only need to make a choice among several options provided by AI. In the long run, teachers' design thinking ability will face the risk of degradation, which poses a potential threat to the sustainable development of curriculum design leadership.

3.3. Absence Risk of Curriculum Value Guidance

The fundamental mission of education is to promote people's all-round development, including value guidance, emotional connection and spiritual growth. However, the technical characteristics of generative AI may pose a potential threat to this educational essence. Research shows that the content generated by AI may hide cultural bias, wrong information or defects in language logic [5]. For example, when dealing with historical or social issues, the AI system may tend to reflect the values of a particular culture and ignore other cultural perspectives. If teachers use the content generated by artificial intelligence uncritically in the curriculum design, and give up the value judgment and ethical check on the teaching content, it may make the curriculum deviate from the fundamental goal of moral education. There is objectively a certain tension between the efficiency, accuracy and standardization pursued by technology and the holistic development, personality growth and value creation pursued by education. Some scholars summarized this risk as "focusing on application and ignoring subject", pointing out that the application of AI in education may not only bring problems such as the alignment of ethics and values, but also lead to the weakening of the subjectivity of teachers and students in the process of human-computer cooperation, especially the lack and dislocation of teachers' roles.

3.4. Human Machine Collaboration Competency Lag

From the actual situation, the current teachers are facing a significant gap in technology learning and application in the process of adapting to the development of artificial intelligence [5,6]. Some studies have found that teachers need to invest a lot of time in learning the operation and application of AI tools, which is particularly challenging for more qualified teachers. They not only need to be familiar with the basic functions of various AI platforms, but also understand how to effectively integrate these tools into the teaching process, including how to design appropriate prompts and how to select appropriate AI tools according to different teaching situations. These learning requirements often conflict with the existing heavy work arrangements of teachers.

The existence of this ability gap makes it difficult for many teachers to truly realize the role transition from "AI tool user" to "AI controller". They may fall into the dilemma of "want to use but can't use" or "can use but can't use well", which can neither fully release the educational potential of artificial intelligence, nor maintain the professional dominant position in the process of human-computer cooperation. If this problem is not effectively solved, it will directly affect the sustainable development of teachers' curriculum design leadership in the intelligent era.

4. Coping Strategies

4.1. Adhere to the Education Standard and Reshape the Professional Core

The fundamental way to deal with the challenges brought by generative AI is to return to the essence of education, that is, to strengthen the core pursuit of "making people human" [5].

This means that teachers first need to complete an important change in concept, that is, from the traditional "knowledge Porter" to "meaning builder" [7]. The focus of curriculum design should no longer be the pursuit of comprehensive coverage of knowledge points, but should turn to the design of learning activities that can trigger students' in-depth thinking and promote the construction of meaning.

On this basis, teachers also need to play the role of "AI adjuster" and "critical coach", and strengthen the value judgment and ethical control of the curriculum content. Teachers need to take a critical view of the content generated by AI, and carefully evaluate it before introducing it into the curriculum, so as to ensure that the teaching content not only conforms to the educational objectives, but also can convey the correct values.

4.2. From "Single Lecturer" to "Designer of Human-Computer Cooperation"

As generative artificial intelligence enters the field of education as a "pilot", the role of teachers in the classroom is undergoing profound changes. Teachers are no longer the only source of knowledge and teaching subject in the classroom, but need to learn to work with the "teaching partner" of artificial intelligence to optimize the teaching effect in a reasonable division of labor and cooperation [8].

To achieve this role change, teachers first need to become "embodied architects" of learning experience. This means that the focus of curriculum design is no longer simply planning how to teach knowledge, but the top-level design of the respective advantages of "human teacher" and "aircraft teacher". Specifically, teachers need to carefully determine which links can be handled efficiently by AI assistants. Which links must be led by the teacher in person.

4.3. Innovate the Teaching Mode to Realize the "Blank" and "Value-Added" of Curriculum Design

Under the background that AI can efficiently complete the knowledge-based teaching task, the logic of curriculum design needs to be adjusted accordingly, from the pursuit of efficiency "addition" to the pursuit of depth "subtraction" and "blank". With the help of AI, teachers should learn to leave space for students to think, and schools should also leave space for teachers to innovate. This means that the curriculum design should not be a dense arrangement filled with knowledge points, but should be an elaborate blank for creating space for in-depth learning. Accordingly, teachers' work is no longer to fill every minute of teaching activities, but to design the core problems and key tasks that can stimulate thinking and lead to exploration [9].

It should be noted that AI is indeed helpful to promote students' autonomous learning, but teachers need to be careful not to change from a knowledge transmitter to a bystander. In the process of AI enabled education and teaching, teachers need to play a more active role in moral education, technical governance and teaching process reengineering to ensure that teaching is always under the professional leadership of teachers. Technology is only an auxiliary means, and the core of education is still teachers' professional judgment and value guidance.

4.4. System Support

The ability of individual teachers can not be reshaped without systematic organizational support. To help teachers smoothly adapt to the educational reform in the era of artificial intelligence, the government and educational institutions should provide systematic support for the transformation of digital intelligence, and gradually familiarize teachers with the application of artificial intelligence technology in teaching through phased and hierarchical training programs.

In terms of training design, we need to fully consider the differentiated needs of different groups of teachers. Specifically, the training should be targeted at teachers of different disciplines, different stages and different technical foundations. The purpose of this is to enable teachers to not only master the basic operation of tools, but also understand the teaching principles behind technology, and gradually form professional judgment to effectively integrate artificial intelligence into curriculum design [10].

What complements the training system is the concern for teachers' technical anxiety and the bridging of the digital gap. For those teachers who are anxious about the application of AI due to their lack of technical background, schools can design support mechanisms suitable for teachers with different levels of digital intelligence literacy. The deeper support lies in the establishment of an institutional culture that encourages innovation. Schools need to reform the traditional teacher evaluation system, establish appropriate fault-tolerant mechanism and effective incentive mechanism, and encourage teachers to boldly explore the new mode of man-machine collaborative teaching [5]. When innovation is encouraged, exploration is recognized, and cooperation is advocated, teachers can try new possibilities of human-computer collaborative teaching in a relatively safe environment, and the development of curriculum design leadership has been systematically guaranteed.

5. Conclusion

The challenge of generative AI to teachers' curriculum design leadership is essentially a profound dialogue between technical rationality and educational value in the era of intelligence. From the above analysis, it can be seen that this challenge is by no means a simple obstacle to the application of technology, but a systematic impact on the foundation of teachers' Professional Identity.

The fundamental way to deal with the challenge is not to compete with machines for the efficiency of knowledge processing, but to return to and strengthen the essential pursuit of "making people human" in education. This means that teachers need to adhere to the value guidance, innovate in human-computer cooperation, make breakthroughs in the practice mode, and grow up with the support of the system, and finally redefine and consolidate their professional status as curriculum leaders in the intelligent era. When teachers sublimate from "knowledge Porter" to "meaning builder", and transform from "single lecturer" to "designer of human-computer cooperation", the logic of curriculum design will change from knowledge coverage to deep learning, and the space of classroom will change from the place of indoctrination to the garden of thought growth. This transformation process is exactly the process that the irreplaceable professional value of teachers is rejuvenated in the era of technology.

Looking forward to the future, human-computer collaboration will become the normal paradigm of teachers' professional work. The relationship between teachers and AI will move from instrumental use to partnership collaboration, forming a new working mode of showing their strengths and synergy. At the same time, the spirit of educators will become the spiritual ballast for teachers' professional development in the era of digital intelligence, ensuring that the application of technology always serves the essence of education rather than dispelling the foundation of education.

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Intervention for Childhood Social Withdrawal from a Relational Perspective: A Nursing Education Perspective

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Abstract. Childhood social withdrawal, a common psychological and behavioral disorder during development, not only impairs children's current social functioning but also serves as a potential risk factor for long-term internalizing problems (e.g., anxiety and depression). However, the construction of a systematic theory-based psychological nursing pathway in nursing settings remains to be explored. Grounded in the relational perspective of attachment theory, this paper analyzes the mechanism of emotional security deficiency underlying childhood social withdrawal behaviors and develops a psychological nursing intervention pathway suitable for clinical and community nursing contexts. Centered on the core mechanisms of "secure base" and "safe haven", this pathway derives four core strategies: emotional validation, social skill modeling, progressive exposure, and therapeutic nurse-patient relationship building. It also emphasizes the necessity of professional capacity building for nurses and multidisciplinary collaboration during implementation. This paper aims to provide a localized intervention framework based on attachment theory for childhood psychological nursing practice, so as to expand the professional role and function of nurses in promoting children's mental health.

Keywords: childhood social withdrawal, attachment theory, psychological nursing, nursing intervention, secure attachment.

1. Introduction

From the perspective of nursing science, childhood social withdrawal is not only a developmental psychological and behavioral problem but also a core issue that urgently needs attention in the field of childhood psychological nursing. Childhood social withdrawal is a common behavioral problem in children's development, mainly manifested as active avoidance, reticence, keeping distance from peers, or excessive restraint in social situations[1]. Epidemiological data show that approximately 30 million children and adolescents in China suffer from various behavioral problems, with an increasing incidence. Among them, social withdrawal is particularly common in children with introverted temperament or behavioral inhibition characteristics. Social withdrawal not only directly hinders children's peer interaction and social skill acquisition but also induces a series of maladaptive consequences such as damaged self-esteem and aggravated anxiety and depression tendencies[1]. Without timely and effective intervention, it will exert a sustained negative impact on their long-term physical and mental health and social integration. Therefore, exploring effective intervention strategies from the perspective of nursing is of great significance.

In recent years, the nursing discipline has increasingly focused on the integration of children's psychological development and nursing practice, advocating a family-centered holistic nursing model. Against this background, attachment theory under the relational perspective provides an important framework for understanding and intervening in childhood social withdrawal behaviors. Attachment theory was systematically proposed by British psychologist John Bowlby in the 1960s. Its core claim is that infants and young children gain a sense of security through emotional bonds (attachment relationships) formed with primary caregivers, thereby safely exploring the environment and developing socio-emotional abilities[2]. Numerous studies have confirmed that children with secure attachment show better development in cognitive, emotional, and social aspects[3]. Accordingly, promoting secure attachment has become an important goal of many early childhood intervention programs[3]. In nursing practice, introducing the relational perspective of attachment theory helps

nurses understand the underlying causes of social withdrawal from children's interpersonal relationships and formulate more targeted intervention measures.

Based on the relational perspective and attachment theory, this study intends to explore the psychological characteristics and causes of childhood social withdrawal behaviors, and focus on the application pathway of attachment theory in nursing interventions, including specific nursing intervention strategies, as well as suggestions for nurse training and multidisciplinary collaboration. On the basis of relevant research results at home and abroad, this paper analyzes the applicability and limitations of this theoretical perspective, providing theoretical basis and practical implications for childhood psychological nursing practice.

2. Selected Theoretical Perspective and Core Claims

This study selects attachment theory as the core theoretical framework for analyzing childhood social withdrawal. The theory was first systematically proposed by British psychologist John Bowlby in 1969[4], emphasizing that infants and young children gain a sense of security through establishing emotional bonds with primary caregivers, and develop environmental exploration ability and psychological adaptability on this basis. Subsequently, Mary Ainsworth further verified and refined attachment theory through the "Strange Situation" experiment, proposing four attachment patterns: secure, avoidant, ambivalent, and disorganized[5]. Since its establishment, attachment theory has consistently emphasized that the quality of early parent-child relationships exerts a profound impact on children's lifelong development.

From this perspective, the core goal of parenting should shift from emphasizing external behavioral discipline or early independence to building an internal emotional security foundation for children to promote their mental health development. The primary task is to help children develop secure attachment, a stable, predictable, and emotionally supportive relational experience[6]. This sense of security provides a psychological foundation for children to explore the outside world—when children are convinced that "parents will be there when I need them no matter where I go", they are more willing to leave their parents to try interacting with others, learn new skills, or face challenges. Therefore, parenting focuses on promoting the development of emotion regulation ability, enhancing self-worth, and cultivating empathy and interpersonal trust, which are regarded as the key cornerstones of future social adaptation and mental health.

Attachment theory redefines parents' roles as children's "secure base" and "safe haven". A "secure base" means parents provide sufficient psychological support for children to dare to explore outward; a "safe haven" means children can return to their parents for comfort and protection when encountering setbacks, fears, or pressures[6][7]. The key to fulfilling this role lies in parents' "responsive parenting": sensitively detecting children's emotional signals and responding in a warm, consistent, and timely manner. Such continuous positive interactions gradually shape high-quality parent-child relationships, which become a hotbed for children's psychological growth.

Attachment theory also puts forward the concept of children's internal working model, referring to the cognitive schema formed by children in repeated parent-child interactions about "whether I am worthy of being loved" and "whether others are trustworthy"[6][8]. These internal working models are not fixed psychological schemas; instead, they are dynamically shaped, confirmed, or revised throughout childhood through continuous interactions with attachment figures. For example, children who are often responded to promptly and tenderly develop positive beliefs such as "I am important" and "Others are reliable"; conversely, long-term lack of attention or rejection may lead to negative expectations such as "I am not good enough" and "Others are untrustworthy". These early internal models not only affect children's current emotional and behavioral responses but also extend to interpersonal relationships and parenting styles in adulthood, exerting long-term influences.

In summary, the quality of early parent-child emotional bonds is crucial to children's development[4][6][8]. This understanding also provides enlightenment for nursing practice: when assessing and intervening children's behavioral problems, nurses should pay special attention to

children's early attachment relationships and take improving parent-child relationships as an important entry point for psychological nursing.

3. Analysis of Specific Childhood Behavioral Problems: Taking Social Withdrawal as an Example

Social withdrawal is a common type of behavioral problem in childhood, characterized by children's avoidance, silence, isolation, or excessive restraint in social situations[9]. In collective environments such as kindergartens, schools, or family gatherings, some children show such withdrawal tendencies, which are particularly common in children with introverted and emotionally sensitive temperaments. The manifestation of social withdrawal is often similar to temperamental shyness, but from the relational perspective, its deep root is more likely to point to the lack of emotional security or the internalization of insecure attachment relationships. Under the relational perspective framework, social withdrawal can be regarded as a defensive strategy for children who lack trust in the outside world—if they fail to establish a stable sense of security in their closest relationships, they are more likely to view the outside world as unpredictable or even dangerous.

Therefore, the focus of nursing intervention is to guide parents to adopt supportive parenting strategies based on attachment theory instead of traditional mandatory socialization or negative education methods. Specifically, effective coping methods include emotional validation, social skill modeling, and progressive exposure. First, emotional validation means parents sincerely acknowledge and accept children's expressed emotions such as tension and fear. For example, parents can say to their children: "I know you are a little scared to play with other kids now, and that's normal." Such understanding and respect help alleviate children's anxiety and avoid aggravated withdrawal due to emotional negation. Second, parents can provide positive social models for children through their own demonstration: demonstrating how to take the initiative to greet others, take turns in communication, or resolve small conflicts friendly in daily life, so that children can learn specific interaction skills through observation. In addition, low-pressure social opportunities should be created, such as inviting one or two familiar playmates to play at home or participating in small parent-child activities organized by community nurses, so that children can gradually practice social skills in a familiar environment without feeling overwhelmed.

In conclusion, improving parent-child relationships to establish secure attachment can gradually enhance children's sense of security and social confidence, reducing their immediate anxiety while increasing social participation. In the long run, such interventions also help improve children's social skills, cognitive evaluation, and emotion regulation abilities, pointing out a clear direction for childhood psychological nursing practice[10].

4. Limitations of the Perspective and Practical Considerations

Attachment theory provides important insights for understanding children's development, but its application also has certain limitations. First, while emphasizing the core role of early parent-child relationships, attachment theory may insufficiently consider the mechanisms of other influencing factors (such as children's own temperament characteristics and peer relationships). For example, children's innate temperament greatly affects their social behavior[11]. For instance, children with behavioral inhibition temperament (Kagan, 1998) may show persistent social caution or withdrawal even in a supportive family environment. This reminds us to avoid single attribution of social withdrawal behaviors to the quality of attachment relationships, so as to prevent inappropriate blame on the family system and ensure the accuracy of intervention focus.

Attachment theory implies an ideal premise that parents have sufficient time, energy, and emotional investment. However, in real life, many parents face work pressure, financial burden, marital conflicts, or their own psychological trauma, making it difficult to always provide high-quality emotional responses. This situation is particularly prominent in single-parent families,

economically disadvantaged families, etc. If only emphasizing "high-quality parent-child relationships" while ignoring the constraints of these structural factors on parenting practices, it may lead to disconnection between theory and reality.

In addition, cultural differences are a factor that cannot be ignored. Attachment theory originated from Western individualistic culture, emphasizing independence, emotional expression, and the satisfaction of personal needs. However, in many collectivist cultures (such as East Asia), parenting places more emphasis on obedience, responsibility, and family harmony, and the expression of intimate relationships is more implicit[12]. Cross-cultural studies show that although the basic function of secure attachment is universal, its specific manifestations and evaluation criteria vary across cultures. Therefore, mechanically copying Western attachment patterns may mistakenly regard normal parenting methods in some cultures as "insensitive" or "alienated".

In nursing practice, nurses should flexibly apply attachment theory according to children's temperament characteristics, family status, and cultural background, appropriately combine other methods such as behavior management, and closely cooperate with multidisciplinary teams including psychology and education to formulate integrated individualized intervention plans. Only in this way can we truly meet the diverse developmental needs of different children and achieve scientific and effective parenting in a complex and changing environment.

5. Nursing Intervention Strategies Based on Attachment Theory

The relational orientation based on attachment theory emphasizes promoting children's social adaptation by enhancing the emotional bond between children and primary caregivers, rather than simply relying on behavior modification or forced exposure. In nursing practice, this orientation is reflected in supportive, relationship-oriented intervention designs, aiming to create a social environment full of security and trust for children, so that they can naturally take steps in social interaction[13]. Combined with the principles of attachment theory, several specific strategies for nursing intervention are proposed below:

5.1. Emotional validation and security building

Nurses or parents should sincerely acknowledge and accept children's expressed emotions such as anxiety and fear, avoiding direct negation or criticism. For example, when facing children with withdrawal behaviors, nurses can use words such as "I know you feel a little nervous now, and that's normal" to acknowledge and label their emotional experiences. This aims to make nurses become children's emotional "secure base" through affect attunement. Such response conveys understanding and support to children, helping them face and accept their own emotions and avoid further withdrawal due to emotional negation. Through emotional validation, nurses actually act as children's "secure base", making them feel that their emotions are seen and protected. Studies point out that when children can get comfort from attachment figures and confirm that someone is backing them up when in pain, their confidence in exploring the world will be significantly enhanced[14]. Therefore, in hospital or community nursing settings, nurses should be good at capturing subtle emotional signals of withdrawn children and provide comfort and positive attention in a timely manner.

5.2. Social skill modeling and guidance

Many socially withdrawn children are not lacking in willingness to interact, but in appropriate social skills and successful experiences[15]. Therefore, nurses can use the modeling learning and emotional empathy mechanisms in attachment theory to provide positive social behavior models for children. For example, nurses can demonstrate positive interactions such as friendly greetings and toy sharing in play therapy, and guide parents to teach children to welcome peers politely and resolve conflicts calmly in daily life. By observing the behaviors of trustworthy adults (attachment figures), children can subtly acquire social skills and reduce fear of unfamiliar interactions. In addition, nurses can design structured role-playing and scenario simulation activities to let withdrawn children

practice skills such as self-introduction, making requests, and polite refusal in a safe atmosphere. When children gradually experience positive social outcomes (such as being welcomed or praised by peers), previous negative cognitions will be revised, making them more willing to participate in social interactions[15].

5.3. Progressive social exposure

Attachment theory holds that children's exploratory behaviors are based on a sense of security[13]. For socially withdrawn children, directly placing them in high-pressure large-scale social environments (such as whole-class group activities) may backfire and increase anxiety. Therefore, nursing intervention should adopt a progressive social exposure strategy: start with low-pressure, small-scale one-on-one interactions, and after children gradually adapt, expand to multi-person activities, and finally transition to formal group environments. In each step, nurses and parents should provide emotional support—comfort children in a timely manner when they are uneasy, and give positive reinforcement when they try to interact. Studies show that securely attached children dare to explore more in unfamiliar environments because they know they can return to attachment figures for comfort even if they encounter difficulties[13]. The long-term goal of progressive exposure is to help children gradually reinterpret the originally "terrifying" social situations as "manageable" scenarios and accumulate confidence through many successful small experiences.

5.4. Establishing a trusting nurse-patient relationship

In clinical nursing practice, nurses can also become secondary attachment figures or important supporters for children[13]. Especially for hospitalized children or those requiring long-term follow-up, nurses become "secondary attachment figures" in the medical environment for children by establishing a stable therapeutic alliance with children and their families. Nurses should try to maintain consistency and predictability of nursing care, such as arranging a fixed nursing team to take care of a certain child, so that children can become familiar with and trust nurses. When children show withdrawal and avoidance, nurses should wait patiently and give encouragement, avoiding blame or coercion. Such a therapeutic attachment relationship not only helps reduce children's anxiety in the medical environment but also improves their treatment compliance.

5.5. Nurse training and multidisciplinary collaboration

To ensure the effective implementation of the above strategies, nursing training should be strengthened and multidisciplinary cooperation promoted. Pediatric and community nurses should be provided with training on children's psychological development and attachment theory to improve their ability to identify social withdrawal and implement psychological interventions. At the same time, nursing interventions should integrate multidisciplinary resources such as psychology, education, and social work to provide comprehensive support for socially withdrawn children[13]. Through professional training and team collaboration, nurses can form joint forces in hospitals, families, and communities to more comprehensively help children overcome social withdrawal and promote their healthy growth.

After the above interventions, children's anxiety levels usually decrease and their willingness to participate in social interactions increases. With the continuation of the intervention, children may gradually develop from only willing to stay in the corner and observe, to willing to stand on the edge of peer activities and watch, and then try to participate in interactions accompanied by familiar relatives and friends. Although this change is a slow and non-linear process, the success of each positive attempt will accumulate children's self-confidence and strengthen their positive cognitive evaluation of social situations. In the long run, children will be more proactive in interacting with others in behavior, with significantly reduced social avoidance; cognitively, they will form more optimistic self and interpersonal cognitions with enhanced self-esteem; emotionally, they will gradually master emotion regulation methods and cope with pressure more calmly.

6. Conclusion

Childhood social withdrawal is a psychological and behavioral problem affected by multiple factors, and its formation is closely related to children's early attachment relationships and emotional security. The relational perspective based on attachment theory helps nurses understand the internal mechanism of childhood social withdrawal from the level of emotional bonds and psychological security, and provides a clear theoretical basis for nursing interventions. Different from interventions that simply emphasize behavior modification, psychological nursing places more emphasis on helping children gradually enhance social confidence in a safe environment through emotional support, relationship establishment, and progressive guidance. The strategies proposed in this paper, including emotional validation, social skill modeling, progressive social exposure, and establishment of a trusting nurse-patient relationship, have strong adaptability to nursing contexts and can be applied to pediatric clinical nursing, community child health care, family follow-up and other practical scenarios. In addition, strengthening nurses' professional training in children's psychological development and attachment theory, and integrating resources such as psychology and education through multidisciplinary collaboration are important guarantees to improve the effect of nursing interventions. Future nursing research can further combine empirical research methods to evaluate the effect of attachment theory-based psychological nursing interventions in different child populations, providing a more solid evidence-based basis for childhood psychological nursing.

In summary, attachment theory provides a relational perspective beyond the behaviorist paradigm for understanding and intervening in childhood social withdrawal. The nursing intervention pathway constructed in this paper transforms abstract attachment principles into operable practical strategies in clinical and community nursing, which not only improves the theoretical depth and targeting of nursing interventions but also lays a theoretical foundation for nurses to play a more active and professional role in multidisciplinary teams for children's mental health. Future research should strive to test the validity and applicability of this intervention pathway in different child populations and nursing contexts through rigorous empirical design, so as to provide a basis for constructing evidence-based childhood psychological nursing programs.

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To Gen-AI or not to Gen-AI: Sensory-Economic Framework for Aligning Post-secondary Education with an AI-Transformed Labor Market

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Abstract. Generative AI is restructuring labor markets, challenging post-secondary institutions to adapt curricula. This paper develops the GRASP Framework, predicting occupation-specific AI penetration and generating curriculum optimization strategies. Grounded in O*NET data, PULSE forecasts labor demand evolution via a Sensory Resistance Coefficient establishing automation ceilings; CALIBER employs constrained Cobb-Douglas optimization for curriculum transitions. Three career segments are examined: Library Music Producers (Berklee), Gameplay Programmers (USC), and Full-Service Chefs (CIA). Extending beyond employment, COMPASS maps eighteen occupations onto a strategy space of sensory resistance and demand elasticity, classifying careers into Sanctuary, Augmentation, and Pivot zones. The primary innovation disaggregates occupation-level analysis into career segments, revealing within-occupation variation obscured by aggregate assessments.

Keywords: Generative AI, Task Digitalization, Sensory Resistance, Career Segments, Educational Policy.

1. Introduction

1.1. Background

In fewer than five years, Generative AI has evolved from a technical curiosity into an economic force reshaping knowledge production. Unlike earlier automation that displaced routine manual labor, Gen-AI penetrates cognitive and creative domains—writing, coding, composing, designing—once considered uniquely human.

Yet the impact is strikingly uneven. The ILO estimates that 3.3% of the global workforce occupies roles at the highest tier of Gen-AI exposure, rising to 6.2% in high-income economies [1]—but these aggregates mask radical variation. A library music producer faces existential displacement while a chef remains untouched because no model can taste a sauce. Within single professional categories, practitioners face radically different AI exposure.

This heterogeneity presents a critical challenge for post-secondary institutions. How should a music conservatory redesign its curriculum when much of its graduates' output may be AI-generated? Should computer science programs teach students to write code, or to verify AI-written code? Generic prescriptions for “AI literacy” are insufficient. What is needed is a principled framework connecting professional task characteristics to AI disruption magnitude and, from there, to actionable curriculum redesign.

1.2. Problem Restatement

This paper addresses the following questions:

1. Career Analysis: For three careers spanning STEM, Trade, and Arts domains, what are the expected AI disruption trajectories, and what task-level characteristics determine vulnerability?
2. Institutional Recommendations: For a specific institution serving each career, how should curriculum composition, enrollment strategy, and pedagogy evolve?

3. Beyond Employability: What dimensions beyond employment—sustainability, ethics, cognitive autonomy—should inform strategy, and how do recommendations change when these are weighted?
4. Generalization: To what extent can recommendations be extended to the broader occupational landscape?

1.3. Literature Review and Theoretical Foundations

The framework synthesizes four research traditions:

Task Displacement and Productivity Dynamics. The task-based framework [2, 3] establishes that automation reallocates tasks between labor and capital, generating displacement and reinstatement effects. Acemoglu [4] formalizes this macroeconomically; Brynjolfsson et al. [5] document adoption-phase productivity slowdowns; METR [6] confirms short-term friction on complex tasks, justifying verification-cost parameters.

Physical and Cognitive Resistance. Exposure indices [1, 7] map AI capabilities to occupations but mask within-occupation variation. Embodied Cognition theory [8] posits that tasks requiring physical manipulation or sensory feedback resist digital substitution, motivating the Sensory/Physical Resistance Coefficient (S_i).

Human Capital Complementarity. Following Deming [9] and Heckman and Kautz [10], skills are modeled as Cobb-Douglas complements: soft skills account for 25–35% of wage variance, ensuring curriculum retains human-centered training.

Systemic Constraints. Shumailov et al. [11] demonstrate Model Collapse on synthetic data; Luccioni et al. [12] quantify LLM carbon costs, motivating the environmental penalty (θ_{env}) and ethical constraints.

Contribution. No existing framework integrates task exposure, macro dynamics, and skill complementarity into institution-specific recommendations. Prior work operates at occupation-level granularity, missing within-occupation heterogeneity. This synthesis grounds segment-level exposure in Embodied Cognition and optimizes curriculum under complementarity constraints.

2. Case Selection: Careers, Segments, and Institutions

2.1. Career Selection: Spanning the Digitalization Spectrum

This paper selects three career segments spanning the digitalization spectrum:

Library/Stock Music Producer (Arts). Professionals creating functional background music for advertisements, games, and content platforms. Output is a digital audio file valued for functional fit; industry projections estimate 60% AI penetration by 2028 [13].

Gameplay Programmer (STEM). Developers specializing in interactive systems requiring both code generation and embodied judgment about player experience. METR [6] found experienced developers using AI tools took 19% longer on complex tasks—the "efficiency paradox."

Full-Service Restaurant Chef (Trade). Culinary professionals exercising real-time sensory judgment (taste, smell, texture). AI serves only peripheral functions without penetrating core value creation.

These segments maximize analytical variance: purely digital (music), hybrid (games), and purely physical (culinary) (as shown in Figure 1).

Justification. These satisfy: (i) data availability; (ii) reform urgency; (iii) GRASP value demonstration—GRASP agrees with ILO on homogeneous occupations (Chef) but refines variation where it matters (Music, Software).

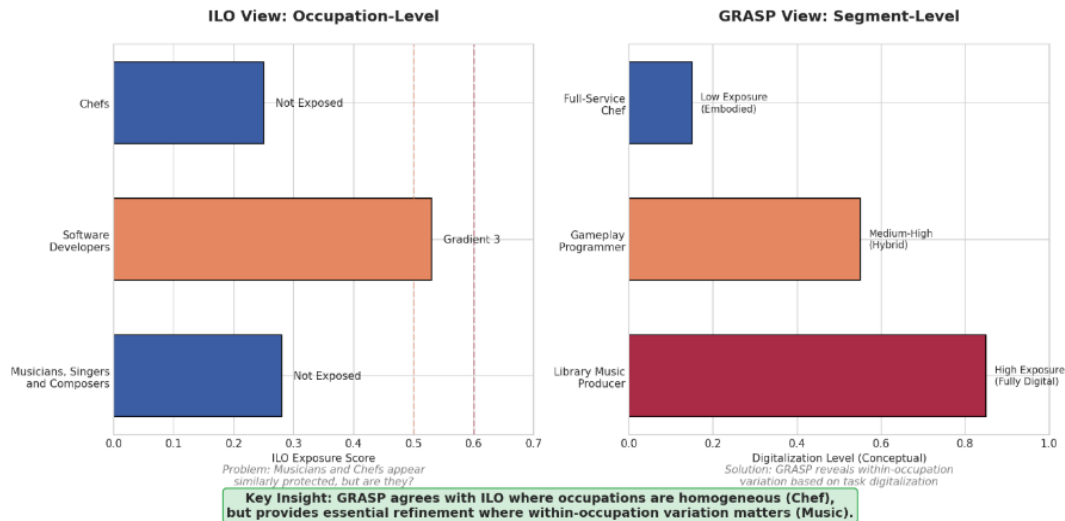


Figure 1. Three career segments spanning the digitalization spectrum, from fully digital (Library Music) through hybrid (Gameplay Programming) to irreducibly physical (Culinary Arts).

Justification. Beyond spanning the digitalization spectrum, these satisfy: (i) data availability—robust empirical ecosystems; (ii) educational reform urgency—distinct reform pressures; (iii) GRASP value demonstration—GRASP agrees with ILO where homogeneous (Chef) but provides essential refinement where variation matters (Music, Software).

2.2. Institutional Anchoring

For each segment, this study identifies a leading institution, as shown in Table 1:

Table 1. Institutional anchoring for each career

Career Segment	Institution	Program	Type
Library Music Producer	Berklee College of Music	Music Production & Engineering	Private Conservatory
Gameplay Programmer	USC	USC Games (B.S. CS + Games)	Research University
Full-Service Chef	Culinary Institute of America	Culinary Arts	Trade School

These institutions align with GRASP's predictions: high-exposure careers require aggressive curriculum transformation, hybrid careers balanced integration, and physical-sanctuary careers conservative stability [14–16] (as shown in Figure 2).

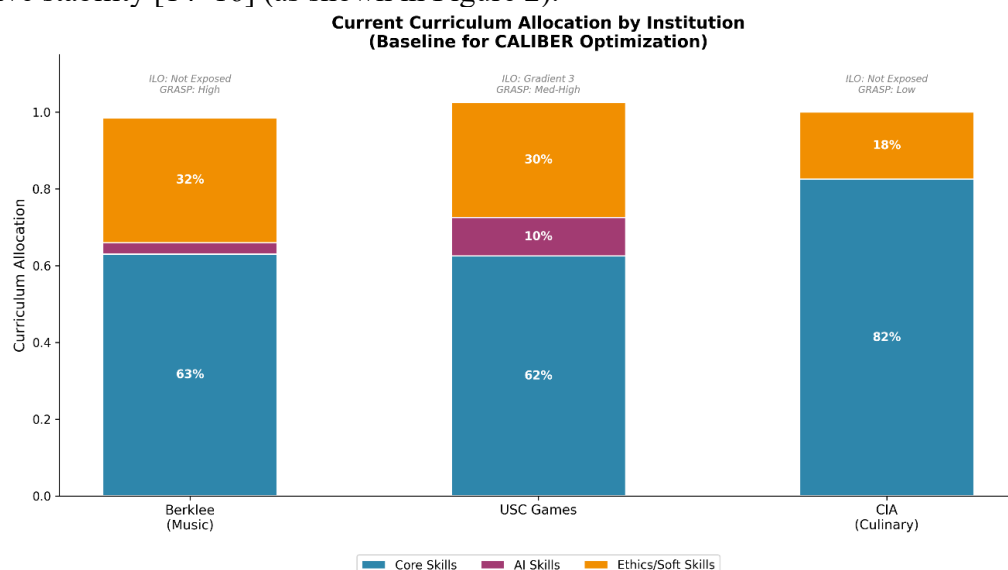


Figure 2. Current curriculum allocation. CIA devotes the largest share to core hands-on skills, Berklee emphasizes core music/production, and USC balances CS fundamentals with general education. AI-specific curriculum is minimal at all three as of 2025.

3. Predicting Labor Market Trajectories Under AI Disruption

This section presents the **PULSE Model**, a dynamic framework translating GRASP insights into quantitative labor demand forecasts. The model synthesizes: (1) the task-based automation framework [2, 3], modeling AI as replacing tasks rather than occupations; and (2) sensory resistance from Embodied Cognition Theory.

3.1. Model Architecture

PULSE operates in two stages: micro-level prediction of AI penetration subject to sensory/physical ceilings, and macro-level conversion into employment changes through three economic forces [4].

Stage 1: Task Penetration (Bounded Logistic Diffusion).

$$E_i(t) = \frac{1 - S_i}{1 + e^{-k \cdot (t - t_{mid})}}$$

Where $S_i \in [0,1]$ is the Sensory/Physical Resistance Coefficient, k is the AI diffusion rate (year^{-1}), and t_{mid} is the inflection point (year 5 of the 12-year horizon). The asymptote is $(1 - S_i)$, not 1: AI cannot breach the physical ceiling—the “embodiment wall.” A chef’s resistance ($S_i = 0.78$) caps penetration at 22%, while a music producer’s ($S_i = 0.19$) permits 81%.

Parameters are calibrated via O*NET v30.1 [18] and industry evidence: for {Library Music, Gameplay, Chef}; demand elasticity [19–21]; verification cost [6].

Stage 2: Labor Demand Evolution (Master Equation).

Building on [2, 3], the model treats employment change as three competing forces:

$$\frac{\Delta L_t}{L_{t-1}} = \underbrace{-\beta \sum w_i \Delta E_i(t)}_{\text{Displacement}} + \underbrace{\rho \sum w_i \Delta E_i(t)}_{\text{Reinstatement}} + \underbrace{\eta \cdot \Delta \ln Y_t}_{\text{Productivity}}$$

- (A) Displacement ($-\beta$): Direct labor demand reduction as AI automates tasks. $\beta = 0.65$ from [2].
- (B) Reinstatement ($+\rho$): New human tasks catalyzed by AI-driven reorganization. Scenario-dependent, reflecting uncertainty.
- (C) Productivity ($+\eta \cdot \Delta \ln Y$): AI lowers costs, prices drop, demand expands. Derived from Hulten’s Theorem [4]: $\Delta \ln TFP_t = \bar{\pi} \cdot \sum_i w_i \Delta E_i(t)$, where $\bar{\pi} = 0.27$. GDP growth converts via capital share $s_K = 0.37$ [17].

Verification Cost Adjustment. This paper introduces V_i , so the effective productivity contribution is:

$$\text{Productivity Gain}_i = E_i(t) \cdot (1 - V_i)$$

For Gameplay Programmers, $V_i = 0.19$ directly measured by METR [6] as productivity decrease on complex tasks. This explains why AI assistance can slow down experts—the “Efficiency Paradox.”

3.2. Three Futures: Scenario Analysis

Gen-AI is in its initial explosive phase; long time-series data is unavailable. This paper defines three scenarios grounded in an **Inverted-U Hypothesis**: the relationship between AI evolution speed (k) and new task creation (ρ) is non-monotonic. At moderate speed, displacement pace allows human adaptation; at extreme speed, the “Red Queen Effect” suppresses reinstatement as new tasks are automated immediately (as shown in Table 2).

Table 2. Three scenario definitions for AI evolution

Scenario	k	ρ	Interpretation
A: Stagnation	0.05	0.20	AI constrained; weak complementarity
B: Symbiosis	0.15	0.50	Optimal complementarity; hybrid roles flourish
C: Singularity	0.40	0.30	Rapid evolution; Red Queen suppresses reinstatement

$k_{med} = 0.15$ reflects McKinsey surveys showing enterprise AI adoption rose from 50% (2022) to 88% (2025) [22, 23].

3.3. Results and Interpretation

3.3.1 Task Penetration Curves

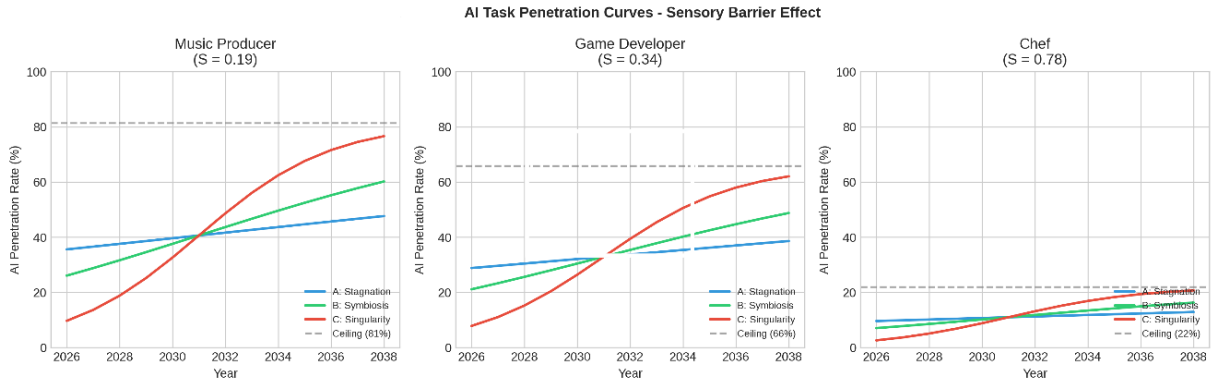


Figure 3. AI Task Penetration showing the sensory barrier effect. Dashed lines mark penetration ceilings ($1 - S_i$). Music Producer (ceiling 81%) faces aggressive penetration; Chef (ceiling 22%) is protected by the “embodiment wall.”

As shown in Figure 3 and Table 3, final-year penetration (2038) is:

Table 3. AI task penetration rates by scenario (2038)

Occupation	Stagnation	Symbiosis	Singularity
Music Producer	48%	60%	77%
Game Developer	39%	49%	62%
Chef	13%	16%	21%

3.3.2 Employment Trajectories

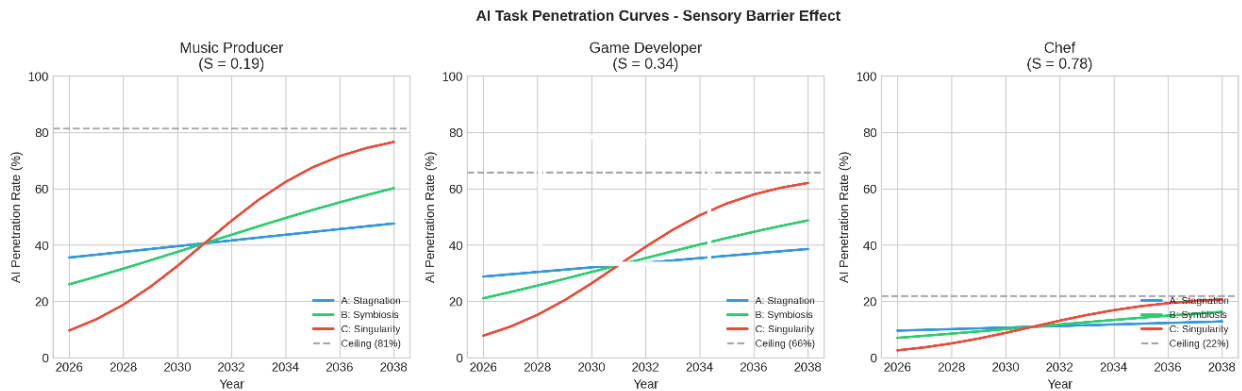


Figure 4. Employment index trajectories (2026=100). Game Developer shows strongest growth potential under Symbiosis (driven by $\eta = 1.8$). Chef remains stable. Music Producer shows moderate growth under Symbiosis but is scenario-sensitive.

As shown in Figure 4 and Table 4, employment index (2038) is:

Table 4. Employment index by scenario (2026=100)

Occupation	Stagnation	Symbiosis	Singularity
Music Producer	100.2	111.2	107.8
Game Developer	101.7	114.0	116.0
Chef	99.5	101.4	99.1

Key finding: Under Symbiosis, all three occupations show stable or growing employment.

4. Aligning Curriculum with a Shifting Labor Market

With labor market trajectories established, this paper addresses: How should programs restructure curricula to maximize graduate viability? This section presents the CALIBER Model.

4.1. Design Philosophy: Skills as Complements, Not Substitutes

CALIBER’s central insight: skills are complements. A graduate mastering core skills but lacking AI literacy is poorly prepared; one with AI proficiency but no domain fundamentals lack foundation. This motivates a Cobb-Douglas viability function:

$$V(\mathbf{w}, E_t) = w_{\text{core}}^{(1-E_t)} \cdot w_{\text{AI}}^{E_t} \cdot w_{\text{ethics}}^C$$

Where $\mathbf{w} = [w_{\text{core}}, w_{\text{AI}}, w_{\text{ethics}}]$ sums to 1, E_t is net AI penetration from PULSE, and $C = 0.30$ is a universal utility constant. Equivalently maximizing:

$$\ln V = (1 - E_t) \cdot \ln(w_{\text{core}}) + E_t \cdot \ln(w_{\text{AI}}) + C \cdot \ln(w_{\text{ethics}})$$

The parameter $C = 0.30$ reflects Deming [9] and Heckman and Kautz [10] finding soft skills account for 25–35% of wage variance.

4.2. Optimization Framework

CALIBER solves a constrained nonlinear program (SLSQP) maximizing $\ln V$ subject to:

1. Normalization: $w_{\text{core}} + w_{\text{AI}} + w_{\text{ethics}} = 1$
2. Accreditation Floor: $w_{\text{core}} \geq w_{\text{min}}$ (Berklee/USC: 0.50; CIA: 0.60)
3. Ethics Floor: $w_{\text{ethics}} \geq 0.10$
4. Faculty Inertia: $|w_k(t) - w_k(t-1)| \leq \Delta_{\text{max}}$

The faculty inertia constraint (Δ_{max}) captures institutional “speed limits.” The analysis tests: Conservative (0.05), Moderate (0.10, baseline), and Aggressive (0.20). Initial conditions (2025): Berklee (0.87, 0.03, 0.10), USC (0.80, 0.10, 0.10), CIA (0.88, 0.02, 0.10).

4.3. Differentiated Institutional Strategies

Under Scenario B (Symbiosis), the optimal curriculum allocations are as shown in Figure 5:

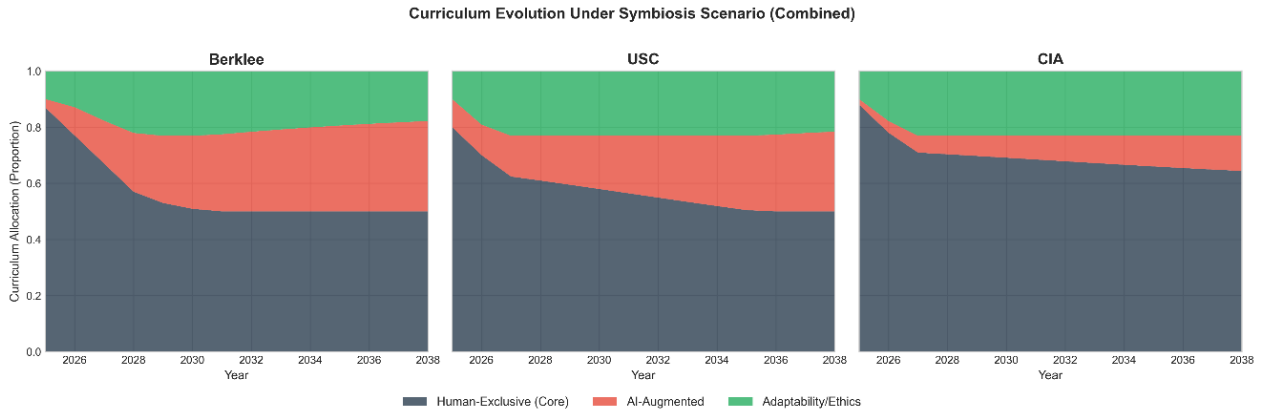


Figure 5. Optimal curriculum allocation trajectories under Scenario B (Symbiosis) for all three institutions. Shaded bands indicate constraint-binding regions.

Berklee: Aggressive Transformation. With highest penetration ($E_t \rightarrow 0.54$), core skills decline from 87% to the accreditation floor of 50%, AI grows from 3% to 32%, ethics rises to 18%. By ~2030, the accreditation floor binds.

USC Games: Balanced Integration. Moderate penetration ($E_t \rightarrow 0.40$) tempered by verification costs. Core CS declines from 80% to 50%, AI grows to 28%, ethics to 22%.

CIA: Conservative Stability. Culinary arts remain largely immune ($E_t < 0.17$). Core skills remain at 64%, modest AI allocation of 13% for back-of-house optimization, ethics at 23%.

4.4. Enrollment and Policy Recommendations

4.4.1 Enrollment Size

Table 5. Optimal curriculum allocations (2038) under Scenario B

Institution	E_t (2038)	w_{core}	w_{AI}	w_{ethics}	Strategy
Berklee	0.54	0.50	0.32	0.18	Aggressive pivot
USC	0.40	0.50	0.28	0.22	Balanced integration
CIA	0.16	0.64	0.13	0.23	Conservative stability

Inertia Sensitivity. As shown in Table 5, under Conservative inertia, Berklee cannot reach optimal AI allocation—becoming "reform-limited." This implies: high-exposure institutions should adopt aggressive reform timelines early.

Recruitment follows naturally from curriculum positioning: Berklee redirects applicants toward AI-curation tracks; USC expands interdisciplinary pipelines; CIA maintains stable enrollment with craft-differentiation marketing.

5. Beyond Employability: Environmental, Ethical, and Cognitive Dimensions

Employment demands are not the only measure of institutional success. This section extends the optimization framework with penalties capturing environmental and ethical costs.

5.1. Extending the Objective

$$J_{\text{ext}} = \underbrace{(1 - E_t)\ln(w_{\text{core}})}_{\text{Base Viability}} + \underbrace{E_t\ln(w_{\text{AI}})}_{\text{Carbon Cost}} + \underbrace{C\ln(w_{\text{ethics}})}_{\text{Model Collapse Risk}} - \theta_{\text{env}} \cdot w_{\text{AI}} - \theta_{\text{eth}} \cdot \max(0, w_{\text{AI}} - 0.4)$$

Environmental Penalty (θ_{env}). Every unit of AI curriculum incurs energy cost through compute resources [12].

Ethical Penalty (θ_{eth}). Triggers only when $w_{\text{AI}} > 0.40$, representing the Model Collapse Threshold [11].

This section explores four policy scenarios (as shown in Table 6):

Table 6. Policy scenario definitions for the extended objective

Scenario	θ_{env}	θ_{eth}	Interpretation
Baseline	0.0	0.0	Pure market forces
Green Campus	0.2	0.0	High environmental priority
Human Guardian	0.0	0.3	Prioritize human knowledge preservation
Balanced Responsible	0.1	0.15	Moderate compromise

5.2. Results: Smooth Trade-offs

Under Cobb-Douglas formulation, environmental constraints produce smooth trade-offs, as shown in Table 7:

Table 7. AI curriculum allocation under Baseline vs. Green Campus policy

Institution	Baseline w_{AI}	Green Campus w_{AI}	Change
Berklee	0.322	0.308	−4.3%
USC	0.284	0.266	−6.3%
CIA	0.125	0.110	−12.0%

The institutional hierarchy is preserved under all four policy scenarios, as shown in Figure 6.

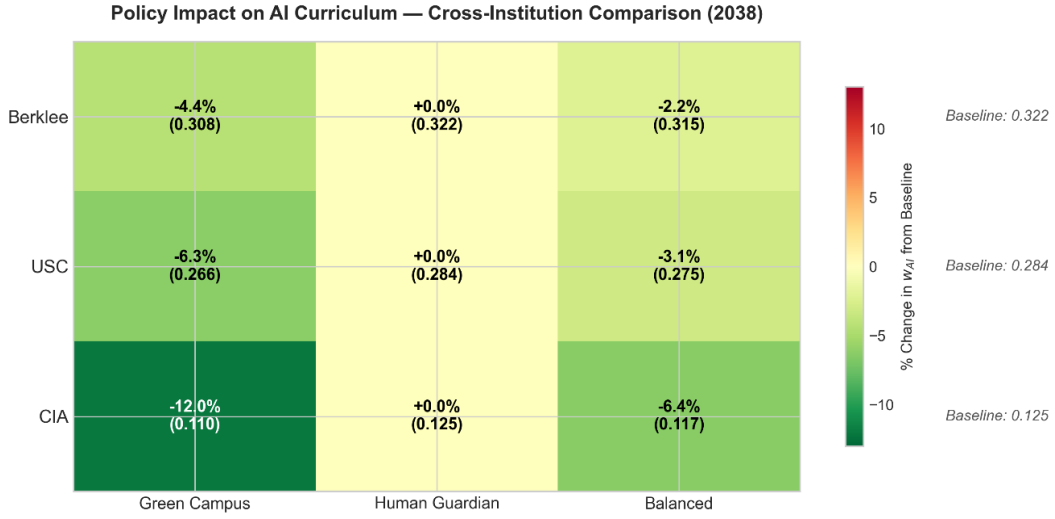


Figure 6. Multi-dimensional policy comparison across institutions. The institutional ranking and relative curriculum allocations remain stable across all policy scenarios.

5.3. The Human-in-the-Loop Necessity

Model Collapse [11] implies that if all content creation is delegated to AI, the knowledge ecosystem destabilizes. Therefore:

- Institutions must maintain authentically human-generated knowledge supply.
- “Human-Exclusive” curriculum is a structural requirement for AI ecosystem health.
- Cobb-Douglas naturally supports this: $\ln(w_{\text{core}})$ always receives positive allocation.

This provides quantitative foundation for the ethical argument that institutions should not abandon human-centered pedagogy.

6. Generalizing Across the Occupational Landscape

This section presents the **COMPASS Framework**, demonstrating that the findings generalize to any occupation.

6.1. The Two-Parameter Generalization Space

An occupation’s optimal educational strategy is determined by two orthogonal factors:

- Sensory/Physical Resistance ($\bar{S}$): Protection from AI due to embodied requirements (determines penetration ceiling).
- Demand Elasticity (η): Market responsiveness to AI productivity gains (determines whether penetration helps or hurts employment).

Zone boundaries derive from constraint hierarchies, as shown in Table 8:

$$Z(\bar{S}, \eta) = \begin{cases} \text{Sanctuary} & \text{if } \bar{S} > 0.7 \\ \text{Pivot} & \text{if } \bar{S} < 0.3 \\ \text{Augmentation} & \text{if } 0.3 \leq \bar{S} \leq 0.7 \text{ and } \eta > 1.0 \\ \text{Pivot} & \text{if } 0.3 \leq \bar{S} \leq 0.7 \text{ and } \eta \leq 1.0 \end{cases}$$

Table 8. COMPASS strategic zone definitions

Zone	Criteria	Representative	Strategy
Sanctuary	$\bar{S} > 0.7$	Chef, Nurse, Electrician	Preserve Craft
Augmentation	$0.3 \leq \bar{S} \leq 0.7, \eta > 1.0$	Game Dev., UX Designer	AI Integration
Pivot	$\bar{S} < 0.3$ or mod. $\bar{S}, \eta \leq 1.0$	Music Prod., Copywriter	Brand Differentiation

A key finding is the “Identity Crisis” condition: even with high elasticity, if $\bar{S} < 0.3$, the occupation enters Pivot Zone. The Music Producer ($\bar{S} = 0.19$, $\eta = 1.2$) illustrates this—despite elastic demand, AI performs over 80% of core tasks, fundamentally redefining the human role.

6.2. The Career Strategy Phase Diagram

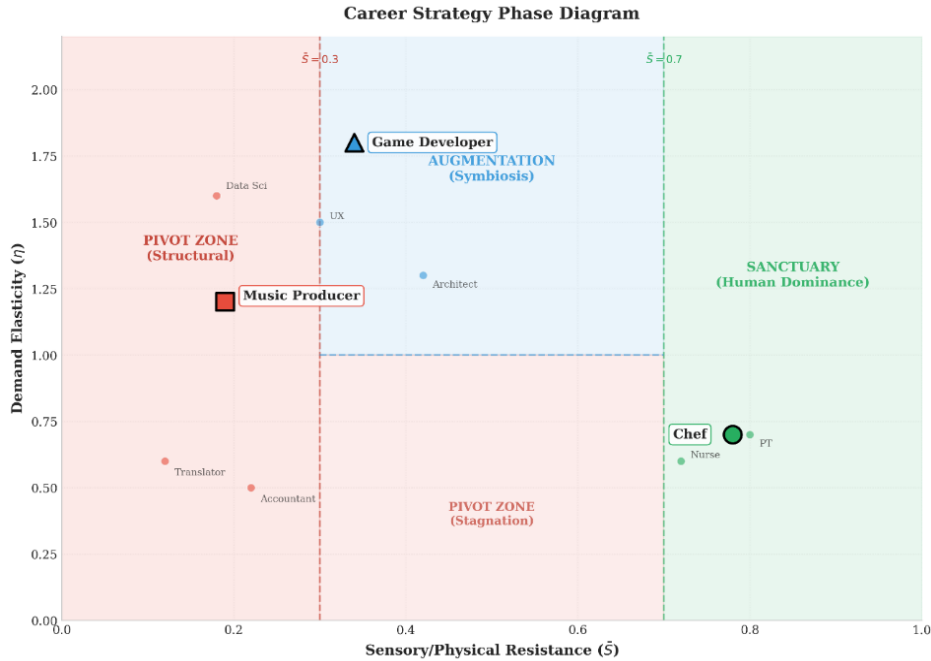


Figure 7. Career Strategy Phase Diagram. Three strategic zones emerge: Sanctuary (green), Augmentation (blue), and Pivot (red). The core occupations anchor different zones, demonstrating the framework captures occupational diversity.

Selected classifications (as shown in Figure 7 and Table 9):

Table 9. Selected occupations classified by COMPASS

Occupation	$\bar{S}$	η	Zone	Strategy
Physical Therapist	0.80	0.7	Sanctuary	Preserve Craft
Registered Nurse	0.72	0.6	Sanctuary	Preserve Craft
Electrician	0.75	0.7	Sanctuary	Preserve Craft
UX Designer	0.30	1.5	Augmentation	AI Integration
Architect	0.42	1.3	Augmentation	AI Integration
Data Scientist	0.18	1.6	Pivot	Differentiate
Translator	0.12	0.6	Pivot	Differentiate
Copywriter	0.15	0.8	Pivot	Differentiate

Zone membership predicts strategy: All Sanctuary occupations share maintaining dominant core skills with modest AI; all Pivot occupations require highest AI allocation for curation and verification.

7. Conclusion

Through the PULSE model, this study demonstrates that employment trajectories under AI disruption depend on the interaction of displacement, reinstatement, and productivity—high exposure does not automatically entail job losses. CALIBER translates these forecasts into differentiated curriculum strategies: aggressive AI-curation transformation for Berklee, balanced verification-centric integration for USC Games, and craft-preserving conservatism for the Culinary Institute. Beyond employability, environmental and ethical trade-offs are smooth rather than discontinuous, while institutional inertia naturally safeguards against Model Collapse. COMPASS generalizes these

findings to any occupation via the strategy space, classifying careers into Sanctuary, Augmentation, and Pivot zones with systematic educational responses. For institutional leaders: programs in Sanctuary should preserve craft pedagogy; those in Pivot must transform aggressively; those in Augmentation should integrate AI as a tool while maintaining irreducible human judgment. For policymakers: accreditation frameworks must permit—and in high-exposure sectors, require—accelerated curriculum adjustment cycles. The question "To Gen-AI, or Not to Gen-AI?" admits no universal answer; it depends on task digitizability, market elasticity, and the pace of reinstatement.

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The Spatial Narrative of Beijing City from the Perspective of Literary Geography: A Study on Wang Shuo's *Wild Beast*

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Abstract. This paper explores the spatial narrative of Beijing depicted in Wang Shuo's *Wild Beast* from the perspective of literary geography. Combining close textual reading, spatial event annotation, event group coding and literary mapping based on QGIS, this study analyzes how the novel constructs the urban landscape of Beijing through character movements, named locations and spatial containers. A spatial container in this research refers to a repeatedly mentioned region consisting of multiple internal nodes in the narrative. The research identifies 209 spatial events, 34 event groups, 34 points of named locations, 6 routes of event groups and 2 major spatial containers. The results reveal that movement ranks as the most frequent type of spatial event. Most named locations do not serve as narrative centers, but function as route markers or reference points throughout the story. Narrative intensity is concentrated in two core spatial containers: the protagonist's residential compound and the area in front of the school gate near Milan's residence. Together, these two areas cover 23 out of the 34 event groups. It can be concluded that Beijing in *Wild Beast* is not presented as a static geographical image. Instead, it forms a layered narrative space shaped by the interplay of geographical points, travel routes, spatial containers and fragmented memories.

Keywords: *Wild Beast*, spatial narrative, literary geography, literary mapping, Beijing city.

1. Introduction

Wang Shuo is a highly distinctive writer in contemporary Chinese literature from the 1980s to the 1990s. His works emerged amid the rise of new-era literature, urban culture and popular culture. He is widely recognized for colloquial narration, ironic tones and subversion of solemn narrative styles. Beijing repeatedly appears across his novels, yet the Beijing depicted in his writings is neither a mere collection of local customs nor a nostalgic backdrop for reminiscence. Rather, it is an urban world shaped by social institutions, personal desires, youth culture and daily mobility. *Wild Beast* stands out prominently in this regard. Set in Beijing in the late Cultural Revolution period, the novel adopts a teenage perspective and interweaves growth experiences with urban spatial perceptions. In this sense, Beijing acts not only as the setting for the story, but also a force that shapes memories, perceptions and personal identities.

In *Wild Beast*, Beijing is never a pure object of nostalgia or a static background. The characters' walking, chasing, staying and observing continuously reconstruct it into a capital city space, a space of youthful memories and a space of urban perception. Taking the urban spatial presentation of Beijing in *Wild Beast* as the research subject, this paper adopts Henri Lefebvre's theory of space production and the perspective of literary geography, and combines qualitative and quantitative research methods including close textual reading, manual annotation, spatial event analysis and literary mapping. By tracing place names, travel routes, recurring spatial nodes and characters' movement patterns, this paper intends to illustrate how characters' trajectories construct urban space and define identity boundaries, and further explore the new implications of Wang Shuo's depiction of Beijing in the literary context of the 1990s.

2. Literature review

Recent studies have moved beyond regarding Wang Shuo merely as a cultural phenomenon, and started to pay more attention to the spatial dimension in his portrayal of Beijing. Yang (2021) argues that Wang Shuo's novels maintain an intimate connection with Beijing, and the urban spaces in his works can be divided into two categories: ordinary urban spaces and military compounds. Characters exhibit different behaviors and mental states in different spaces, and spaces gain meanings through characters' activities and perceptions [1]. Hong (2025) also points out that Wang Shuo presents a unique portrayal of Beijing. Different from writings focusing on old city traditions and folk nostalgia, his depiction of Beijing maintains a strong political connection with urban spaces and cultural transformations from the late 1980s to the early 1990s [2].

Against this research background, the academic value of *Wild Beast* has been gradually recognized. Chen (2020) states that this novel marks a shift in Wang Shuo's writing style from pure satire to growth narratives with generational memories and historical depth [3]. More relevant to this study, Xu (2009) analyzes the movements of the protagonist Ma Xiaojun across the political heart of Beijing, and holds that such movements reflect the tensions between the sacred image of the national capital and the mundane urban life [4]. Zheng (2013) further notes that the military compounds in Wang Shuo's novels represent spaces embedded with hierarchy, discipline and symbolic power, rather than simple story settings [5]. These studies have proven that the Beijing in *Wild Beast* is not a homogeneous urban backdrop, but a complex urban field intertwined with daily spaces, compound spaces, political symbols and youthful experiences. Nevertheless, most existing researches stay at the level of thematic interpretation, and fail to fully explain how characters' movements, recurring spatial nodes and boundary-crossing behaviors form the internal narrative mechanism of the text.

The theoretical achievements of the spatial turn provide effective support for further research. Lefebvre (1991) redefines space as a product of social production, and proposes that space takes shape through the interaction of spatial practice, representations of space and representational spaces [6]. This theory enables us to interpret the Beijing in *Wild Beast* as a socially and symbolically constructed space, instead of a passive setting. Harvey's (1990) theory of time-space compression reveals the historical dynamics of urban space under modernity [7]. Bakhtin's (1981) chronotope theory clarifies that time and space are inseparable in narratives [8]. Genette's (1980) distinction between story time and narrative discourse also helps classify event groups, especially when narratives involve time shifts, time compression, plot interruptions and retrospective revisions [9]. In domestic academic circles, Fang (2016, 2018) points out that research on spatial narrative has shifted from viewing space as a passive scene to exploring the interactions among physical, psychological and social spaces. In her follow-up studies, she connects cognitive maps with literary mapping, and interprets spatial narrative as a narrative structure organized by spatial order [10][11].

From the perspective of literary geography, relevant theories also provide solid methodological guidance. Mei (2015) regards the spatial turn as an important research transformation, and advocates reconstructing literary spaces through maps, scenes and implied meanings [12]. Tally (2013) systematically elaborates the relationships among literary mapping, literary geography and geocriticism. He believes that literature not only represents spaces, but also helps readers perceive and understand the integrated world of reality and imagination [13]. These viewpoints lay a methodological foundation for this study to trace travel routes, identify recurring spatial nodes and visualize textual spaces.

To sum up, existing studies have identified multiple spatial contradictions in *Wild Beast*, including ordinary urban spaces versus compound spaces, the sacred capital versus the mundane city, and enclosed sites versus mobile routes. Further research is still needed to explore how these spatial differences are organized at the narrative mechanism level. Specifically, how do travel routes, recurring nodes, stays, boundary crossings, time transitions and retrospective revisions construct Beijing into a complete spatial narrative, and influence character growth and plot development? Combining close textual reading, route tracking, node annotation, event group coding and literary

mapping, this study aims to explore Wild Beast as a spatial narrative that shapes the image of Beijing through mobility, boundaries, memories and spatial imagination.

3. Methods

3.1. Textual Coding: Spatial Events and Event Groups

This study takes Wang Shuo's Wild Beast as the sole research text to explore how urban spaces of Beijing organize the narrative. The research methods are formulated based on the aforementioned theoretical framework. Guided by Lefebvre's (1991) theory of space production, this research treats Beijing as a social space constructed by spatial practice, representations of space and personal life experiences, rather than a neutral setting. Bakhtin's (1981) chronotope theory supports the adoption of spatial events as the basic analytical unit, because narrative spaces gain real meanings only when locations, time, actions and narrative perspectives integrate into complete narrative fragments. Therefore, this research starts with spatial behaviors rather than isolated place names.

A spatial event refers to the smallest narrative unit formed when characters enter, exit, traverse, stay in, observe or relocate within a certain space. Only concrete spatial actions or positional descriptions in the text are extracted as spatial events. Hypothetical, habitual or purely descriptive mentions of spaces are retained as contextual information, but will not be coded as spatial events without actual actions. If a single sentence contains multiple consecutive actions that change characters' spatial states, it will be divided into multiple independent spatial events. Observation or surveillance conducted from specific positions with prominent narrative significance is also coded as a spatial event. Boundary-crossing behaviors are recorded through the coding of "entry" and "exit", with additional notes added to mark boundary crossings when necessary.

Each spatial event is classified into one of six categories to describe its spatial form, while its narrative function is coded separately. These classifications translate Lefebvre's concept of spatial practice into recordable actions, including characters' movements, stays, boundary crossings and observations.

Table 1. Event Type Categories and Definitions for Spatial Event Coding

Event Type	Definition
movement	Bodily displacement through space, such as walking, riding, following, or crossing.
entry	Crossing into a bounded or delimited space, such as a room, courtyard, building, station, restaurant, cinema, or pool area.
exit	Crossing out of a bounded or delimited space.
stop	Remaining, waiting, standing, sitting, lying, hiding, or staying in position without significant relocation.
observation	Seeing, watching, noticing, or monitoring from a spatial position when looking is narratively foregrounded.
transition	A real spatial shift narrated in compressed form without the movement process being unfolded in scene-time.

After the first round of annotation, a total of 209 spatial events are extracted in chronological order throughout the text. Among them, 192 events are categorized into the six types mentioned above, and the remaining 17 are recorded as contextual spatial descriptions. Detailed coding may split continuous narrative fragments, so the full text is reviewed again to divide all contents into 34 event groups.

An event group refers to a relatively continuous narrative fragment composed of multiple spatial events that serve the same action sequence, encounter, conflict, chase, observation scene, memory segment or retrospective revision. Event groups are divided according to narrative continuity, unified action goals, time continuity, consistent spatial containers or travel routes, narrative focus and narrative level changes.

This division embodies Bakhtin's (1981) chronotope theory at a macro level, which restores the integrity of time and space based on individual spatial actions. Genette's (1980) distinction between

story time and narrative discourse also guides the division of event groups. A new event group starts once the narrative changes the time frame, compresses action sequences, interrupts past storylines, switches core spatial containers or introduces retrospective revisions. The final numbered event groups (G001–G034) connect spatial events, mapping elements and narrative fragments in the research results.

3.2. Narrative Reliability, Place Normalization, and Data Cleaning

In accordance with Tally’s (2013) theory of literary mapping, a literary map is not a pure cartographic restoration, but an interpretive practice. The maps produced in this study illustrate how the novel organizes the urban space of Beijing through named locations, travel routes, recurring nodes and spatial containers.

The Beijing Urban Traffic Map (1976) is adopted as the main historical base map [14]. This map is obtained from WardMaps LLC, titled Beijing, China 1976 (Side A). Classified as a city map in the collection, it measures 19.5 inches in width and 28.5 inches in height, with the serial number 2024112614A. The original publisher is not indicated in the online catalog.

Georeferencing and vector annotation are completed in QGIS 4.0.1-Norrköping [15]. The coordinate reference system of the project is EPSG:3857 (WGS 84 / Pseudo-Mercator), with meters as the map unit. This coordinate system is suitable for alignment and visualization with online maps, rather than high-precision measurement of distances and areas. The 1976 raster map is georeferenced using the first-order polynomial transformation. Twelve out of eighteen candidate ground control points are selected for georeferencing. These control points are chosen from stable large-scale urban landmarks and road intersections, including Tiananmen Square, Beijing Railway Station, Dongdan, Xidan, Chang’an Avenue and Chaoyangmen. Small hutongs, bus stops and ambiguous building entrances are excluded. The average georeferencing error is 75.408 pixels. Since the data is marked as average pixel error instead of root mean square error (RMSE), this research defines it as average georeferencing error rather than survey-level RMSE.

OpenStreetMap is only used as an auxiliary modern reference layer to identify existing streets, hutongs and major urban landmarks. It is not used to restore the road layout of the 1970s, nor displayed as the base map of Figure 1. In compliance with the regulations of OpenStreetMap, all relevant data is noted to be sourced from OpenStreetMap under the Open Database License.

All vector data is stored in a GeoPackage file and divided into three core layers: `wb_named_places` for point elements, `wb_routes` for line elements, and `wb_spatial_containers` for polygon elements. Point elements represent named or roughly locatable places; line elements represent routes of event groups instead of exact walking paths; polygon elements represent spatial containers, mainly the protagonist’s residential compound and the area in front of the school gate near Milan’s residence.

The named locations in the point layer are further divided into two functional categories for separate analysis, independent of the polygon spatial containers.

Table 2. Functional Classification of Named-place Points

Point function	Definition	Examples
route/reference point	A named or inferred point that mainly marks a route node, direction, transfer, temporary stop, or urban reference.	Beijing Station; Trade Union Building stop; Children’s Cinema; Red Sun Snack Shop
episode focal point	A named point where a distinct local episode is staged more fully, often through confinement, confrontation, gathering, or a scene-based event.	Dongfeng Market police station; Xinqiao Hotel; Moscow Restaurant; Workers’ Stadium pool

Note. This binary classification applies only to the point layer named places. Polygonal spaces such as the protagonist’s compound and the school-front / Milan residential block are coded separately as major spatial container in the spatial containers layer.

This table 2 distinction was necessary because geographical visibility and narrative centrality are not identical. A named place may be easy to plot on the map but function mainly as a route or

reference point, while a spatial container may be difficult to delimit precisely but contain a high concentration of event groups. Polygonal spaces such as the protagonist's compound and the school-front / Milan residential block were therefore coded separately as major spatial container in the wb spatial containers layer.

Each mapped object was assigned a Geo Status, such as exact, approximate, inferred site, inferred segment, OSM assisted, or relational container, to avoid over-claiming locational precision. The boundaries of spatial containers are interpretive rather than cadastral. They were estimated from repeated textual references to internal nodes, entrances, circulation paths, adjacent streets, and recurrent movement sequences. The polygons therefore indicate approximate narrative extents rather than survey-level boundaries. The internal structures of C001 and C002 were visualized through schematic insets rather than through precise geographic coordinates. These insets represent topological and narrative relations among internal nodes, not reconstructed architectural layouts. Node positions were arranged according to textual sequence and narrative function: boundary nodes such as gates and entrances are placed at the margins; circulation nodes such as corridors or verandas are placed between exterior and interior spaces; and focal nodes such as the rockery, pavilion, Milan's room, and photograph are placed inside the containers.

During QGIS annotation, only object IDs such as place id, route id, or container id were entered manually. Python scripts run in the QGIS Python Console then synchronized labels, point functions, geographic status, event-group IDs, evidence, and notes from controlled CSV tables. The resulting map should therefore be read as a literary-geographical visualization of the spatial organization of Wild Beast, not as a complete historical GIS reconstruction. In sum, the method moves from spatial event extraction to event-group coding, from place normalization to map-layer classification, and from QGIS visualization back to textual interpretation. This procedure shows not only where Beijing appears in Wild Beast, but how Beijing is organized as a narrative space through movement, routes, recurrent nodes, spatial containers, and unstable memory.

4. Results

This section presents the spatial patterns reflected by 209 spatial events, 34 event groups and QGIS visual maps, including 34 points of named locations, 6 routes of event groups and 2 major spatial containers. The results are analyzed from four aspects: movement as the dominant spatial practice, the route and reference function of most named locations, the constrained axis-turn pattern of travel routes, and the concentration of event groups in two major spatial containers.

4.1. Mobility as the Dominant Spatial Practice

Among the 209 extracted spatial events, 192 are categorized into the six predefined types. Movement occurs 96 times, accounting for 50.0% of all classified events and ranking as the most common type. It is followed by entry (24 times, 12.5%), exit (21 times, 10.9%) and stop (20 times, 10.4%). Transition and observation appear less frequently, with 16 times and 15 times respectively.

Table 3. Distribution of Event Type in the spatial event table

Event Type	Count	Share (%)
movement	96	50.0
entry	24	12.5
exit	21	10.9
stop	20	10.4
transition	16	8.3
observation	15	7.8
Total typed events	192	100.0

This table 3 distribution shows that spatial practice in Wild Beast is organized primarily through movement rather than static location. The movement category includes both city-crossing travel and

local passages. The narrator’s daily commute is described as travelling “across the whole city from East City to West City by bus” (Wang, 2012, p. 70)^[16], while other sequences involve shorter street-level movements through Beixiaojie and Nangongjiangying Hutong. The statistical dominance of movement therefore provides the basis for treating routes as a central spatial form in the map.

4.2. Named-place Visibility and Route/Reference Function

The point layer contains 34 points of named locations, covering major urban landmarks, commercial nodes, institutional sites, traffic points and several roughly confirmed historical locations. These points are divided into two functional categories: route / reference points and core scene points. As shown in Table 4, route / reference points take the dominant position, with 29 points accounting for 85.3% of the total. The remaining 5 points are classified as core scene points, occupying 14.7%.

Table 4. Functional Classification of Named-place Points

Point function	Count	Share (%)
route/reference point	29	85.3
episode focal point	5	14.7
Total	34	100.0



Figure 1. Named-place points, event-group routes, and major spatial containers in Wild Beast on a georeferenced 1976 Beijing city traffic map.

Base map: Beijingshiqu jiaotong tu [Beijing City Traffic Map], accessed through WardMaps LLC as “Beijing, China 1976 (Side A).” The map was georeferenced in QGIS 4.0.1-Norrköping using EPSG:3857. Green points represent route/reference points; red star-shaped points represent episode focal points; purple lines represent event-group routes; red polygons represent major spatial containers as the dual narrative core. Polygon boundaries indicate estimated narrative zones rather than survey-level boundaries.

This result reveals that most named locations gain geographical visibility due to clear names and fixed positions, yet they mainly serve as route markers, transfer stops, temporary rest spots and urban references in the narrative. Typical examples include Beijing Railway Station, Trade Union Building Bus Stop, Children’s Cinema, Red Sun Snack Bar (the former Xideshun Restaurant) and multiple street and hutong nodes.

The difference between Children’s Cinema and Dongfeng Market Police Station clearly illustrates this classification. In the plot of detention in Wangfujing, Children’s Cinema is only a

temporary stop during escort. By contrast, Dongfeng Market Police Station becomes the main site for confinement and staged plots. Therefore, Children's Cinema is defined as a route / reference point, while Dongfeng Market Police Station is categorized as a core scene point.

The five core scene points are Wangfujing, Dongfeng Market Police Station, Xinqiao Hotel, Moscow Restaurant and Workers' Stadium (including the stadium swimming pool). These locations carry complete local plots but do not repeatedly act as major spatial containers. Figure 1 visually presents this difference: most green dots are distributed along travel routes, and only a small number of red dots form local plot centers.

4.3. Constrained Axial-and-Turning Routes

The line layer includes 6 routes of event groups, which represent narrative routes rather than exact walking paths. Table 5 displays how named locations are connected into continuous movement sequences in the text.

Table 5. Event-group Routes

Route ID	Route Label	Route Type	Event Group
R001	Parade route: school-central square-return	parade route	G007
R002	West-city school-Wangfujing South Entrance-Children's Cinema-Dongfeng Market police station route	episode route	G012
R003	Chaonei Beixiaojie-Shaojiu Hutong mouth-Nangongjiangying-old school route	composite walk route	G010
R004	Liutiao East conflict pursuit route	conflict pursuit route	G013
R005	Liutiao East-Beijing Station-Chang'an Avenue-Trade Union Building-Milan's residential block tracking route	tracking route	G033
R006	Chang'an Avenue urban axis segment	main road axis	G033

Figure 1 shows that these routes form a constrained axis-turn layout. One main axis extends from nodes in eastern Beijing, via Beijing Railway Station, Chang'an Avenue and Trade Union Building, towards the area in front of the school gate near Milan's residence. Another set of routes turns into local streets and hutongs around Wangfujing, Beixiaojie and Nangongjiangying Hutong as well as Liutiao East Entrance.

The description of "L-shape" is only a simplified visual summary of the route distribution on the map, without inherent geometric meaning. This layout is shaped by mapping methods, the east-west distribution between the protagonist's home and school, the location of Milan's residence and the author's choice of narrative routes. More accurately, it is an interconnected field formed by limited main axes and turning routes, rather than an abstract geometric figure.

R005 is the longest route with the densest nodes, connecting Liutiao East Entrance, Beijing Railway Station, Chang'an Avenue, Trade Union Building and the area near Milan's residence. R002 links the school area in western Beijing, South Wangfujing Road, Children's Cinema and Dongfeng Market Police Station. R003 presents local walking sequences around Beixiaojie, Shaojiu Hutong Entrance and Nangongjiangying Hutong.

Taking the current Third Ring Road of Beijing as a reference, almost all recorded routes in the story are located within this scope. The westernmost destination that repeatedly appears is the area in front of the school gate near Milan's residence, and Moscow Restaurant serves as a secondary node in the northwest. Thus, the mapped routes do not represent unrestricted urban wandering, but constrained mobility regulated by social relations and narrative settings.

4.4. Dual Spatial Containers and Event-group Concentration

The polygon layer consists of two major spatial containers: C001 refers to the protagonist's residential compound, and C002 refers to the area in front of the school gate near Milan's residence. Table 6 summarizes the distribution of event groups in different spatial containers.

Table 6. Distribution of Event Groups by Spatial-container Category

Spatial-container category	Event groups	Count
C001 Protagonist's compound	G008, G009, G010, G011, G013, G018, G019, G020, G021, G022, G023, G025, G028, G031, G032	15
C002 School-front / Milan residential block	G005, G006, G014, G015, G016, G017, G024, G033	8
Other spaces	G001, G002, G003, G004, G007, G012, G026, G027, G029, G030, G034	11

The protagonist's residential compound is associated with 15 event groups, and the area near Milan's residence corresponds to 8 event groups. In total, the two spatial containers cover 23 out of the 34 event groups. The remaining 11 event groups are distributed in the present narrative framework, memory-triggering scenes, urban travel routes and several independent enclosed spaces.

These two areas are defined as polygons instead of isolated points because both contain multiple internal nodes. The residential compound includes the protagonist's home, Gao Jin's home, compound gate, corridors and verandas, internal passages, rockeries and pavilions. The area near Milan's residence covers the school gate, open spaces between buildings, building entrances, corridors and stairwells, Milan's room, photos and waiting spots.

From the perspective of the whole city, the two spatial containers occupy a small area on the map compared with widely distributed named locations and routes. However, they gather the largest number of event groups and form the core of the narrative. Figure 2 further supplements the internal narrative structures of the two containers.

4.5. Internal Nodes and Boundary Positions within the Two Containers

Figure 2 is a schematic diagram showing the internal narrative relationships of the two major spatial containers, rather than a restoration of architectural layouts.

In C001, the diagram highlights the cyclic movements among the protagonist's home, Gao Jin's home, compound gate, corridors and verandas, internal passages, rockeries and pavilions. Repeated movements among these nodes turn the residential compound from a simple living place into a core container that continuously drives the narrative.

In C002, the diagram presents a complete sequence of approaching, entering, waiting and observing. The routes extend from the school gate and open spaces between buildings to building entrances, corridors and stairwells, and finally reach Milan's room, photos and waiting spots. These nodes show that C002 is defined by threshold crossing and visual fixation.

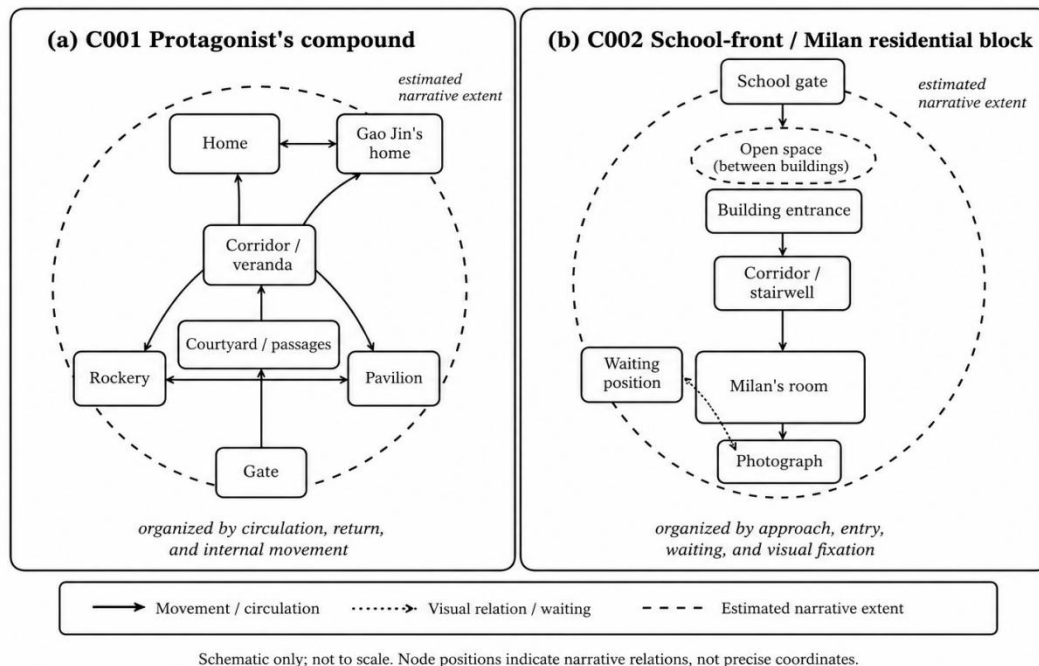


Figure 2. Schematic structure of the two major spatial containers in Wild Beast.

The figure visualizes the internal narrative structure of C001, the protagonist's compound, and C002, the school-front / Milan residential block. It is a topological schematic rather than a reconstructed floor plan. Node positions indicate narrative relations, not precise coordinates. Solid arrows indicate movement or circulation; dotted arrows indicate visual relations or waiting; dashed outlines indicate estimated narrative extents.

The internal node structures lay a foundation for the discussion of identity boundaries in the next section. C001 contains nodes related to family life, peer gatherings, family supervision and returning home. C002 consists of nodes connected with skipping school, entering others' living spaces, waiting, observing and personal desires. It can be seen that the point-route-container model not only describes spatial organization, but also explains how spatial locations define social and individual boundaries.

5. Discussion

The above research results prove that the urban space of Beijing in *Wild Beast* is not a uniform urban field. Its spatial narrative forms a hierarchical system composed of points, routes and containers. Most named locations only act as route and reference points; travel routes present a constrained axis-turn layout; and the densest narrative contents concentrate in two major spatial containers. These findings answer the core research question: Wang Shuo constructs Beijing into a complete spatial narrative through characters' movements, boundary crossings, repeated returns and fragmented memories.

More importantly, these spatial patterns reveal how characters' identity boundaries take shape in the novel. The protagonist's identity does not develop naturally in a neutral urban environment. It is gradually formed during his repeated travels among home, residential compound, school, public authority spaces and Milan's living area. Therefore, space in *Wild Beast* is far more than a narrative backdrop; it acts as a social mechanism that shapes family discipline, male peer relationships, youthful desires and self-perception in retrospective narration.

5.1. Dual Spatial Containers and the Production of Social Space

The most important finding is the concentration of event groups in two spatial containers: C001 (the protagonist's residential compound) and C002 (the area near Milan's residence). Though occupying a small area on the map, the two containers cover 23 out of 34 event groups. The sharp contrast between limited geographical scope and intensive narrative events indicates that narrative density is not determined by geographical area.

The reason lies in the different social operation mechanisms embodied by the two containers, rather than their frequent appearances. Lefebvre's (1991) theory of space production provides effective interpretation here. This theory regards space as the materialization of social relations, which means C001 and C002 are not mere venues. They are produced by repeated spatial practices including returning, entering, waiting, gathering, hiding, observing and crossing thresholds.

As a carrier of discipline, hierarchy and male peer relationships, C001 (the residential compound) is activated repeatedly through cyclic movements among internal nodes such as homes, compound gates, corridors, passages, rockeries and pavilions. The residential compound is not only the protagonist's living place. It is an intersection of family authority, adult supervision, military compound disciplines and teenage group solidarity. The compound gate marks the boundary between the compound and the outer city; individual homes represent family discipline; Gao Jin's home, rockeries and pavilions become gathering places for peers and stages for teenage performances. In this way, the residential compound materializes a specific social order, and endows hierarchy, belonging and discipline with spatial forms.

C002 (the area near Milan's residence) follows a completely different social logic. Its internal sequence extends from the school gate and open spaces between buildings to building entrances, corridors, stairwells, Milan's room, photos and waiting spots. This space centers on approaching, entering, waiting and observing. Institutionally, the residential area belongs to ordinary government

staff quarters adjacent to the school. However, in the protagonist's perception, this ordinary residential space is transformed into a space filled with desires. Milan's room and photos turn the residential area into an object of fantasy, intrusion and visual possession.

The dual-core spatial structure cannot be simply summarized as the opposition between "home" and "outer city". More precisely, the whole novel is organized by the tensions between two social spaces with distinct attributes. One is built on compound disciplines and male peer relationships, and the other is dominated by desires, secrets and teenage fantasies. C001 shapes the protagonist's identities as a son, an insider of the compound and a member of the male peer group. C002 constructs his identities as a school truant, an intruder, an observer and a subject with youthful desires. The core narrative of the novel develops exactly from the protagonist's travels between the two social spaces.

This conclusion supports Zheng's (2013) viewpoint that military compounds in Wang Shuo's novels carry unique cultural and social structures. Meanwhile, this study revises the existing research results: the residential compound is only one pole of the whole spatial system. The area near Milan's residence also occupies a core narrative position, even though it has weaker institutional attributes. This second pole introduces a new spatial logic featured by desires, waiting, visual observation and boundary crossings. Therefore, the Beijing in *Wild Beast* is not merely the "compound-style Beijing". It is a conflicting field formed by the tensions between compound orders and desire-oriented living spaces.

This research also enriches Chen's (2020) discussion on *Wild Beast* as a growth narrative. This study does not deny the framework of growth narration, but further explores its internal spatial mechanism. The protagonist's growth is not an abstract psychological development. It is arranged through his repeated travels between C001 and C002. The teenage identity of the protagonist is shaped at various spatial thresholds: between a child and a peer group member, between a student and a truant, between a compound insider and a wandering urban dweller, between an observer and an intruder, and between a teenage actor and a retrospective adult narrator.

5.2. Constrained Routes and the Social Logic of Mobility

The second key finding focuses on the structural characteristics of travel routes. The mapped routes do not form an open network for free urban wandering. They connect limited areas including eastern Beijing nodes, Wangfujing and urban central areas, Beijing Railway Station, Chang'an Avenue, Trade Union Building and Milan's residential area. This research defines such a structure as a constrained axis-turn layout. The previously mentioned "L-shape" is only a visual description and has no essential connection with the textual content.

This layout is shaped by both geographical conditions and social relations. The protagonist's movements are driven by commuting to school, skipping classes, returning to the compound, participating in peer activities, tracking Milan and facing public power. His travels are never free urban strolls, but activities constrained by daily conventions, prohibitions, personal desires and disciplinary pressures. In Lefebvre's terms, these routes are typical spatial practices, which reproduce social relations through repeated urban movements.

This finding supplements Xu's (2009) research on urban wanderers in the late Cultural Revolution period. Xu emphasizes that the protagonist's travels across the political heart of Beijing reflect the tensions between the sacred national capital and mundane urban life. The mapping results of this study confirm the importance of mobility, and further prove that such travels are not evenly distributed across the city. The protagonist is never a completely free urban wanderer. His routes follow fixed patterns and constraints, and he is constantly drawn back to the residential compound and Milan's residential area.

The longest tracking route for Milan is a typical example. It is not a neutral east-west cross-city journey, but a desire-driven chase. Although the route runs across Beijing, its final destination is Milan's residence. Similarly, the routes around Wangfujing do not stay in open commercial or youth activity spaces, but end with detention and the emergence of public power. The routes around Beixiaojie and Nangongjiangying Hutong pass through local streets and hutongs, and finally lead

back to the former school and the residential compound. Different routes correspond to different social identities: student, truant, chaser, peer partner, detainee and returnee to the compound.

Bakhtin's (1981) chronotope theory explains the connotation of this route structure. Travel routes in the novel form unique time-space frameworks for plots, rather than simple physical paths. A route gains narrative significance only when it integrates movements, time, social relations and narrative pressures. The Wangfujing route is linked with skipping school and subsequent detention; the Beixiaojie-Nangongjiangying route is associated with returning home and a sense of familiarity with local areas; the tracking route for Milan is combined with desires and chases. Each route undertakes different chronotope functions.

5.3. Retrospective Correction and the Distortion of Mapped Space

The third discussion focuses on memory. The maps produced in this study do not restore the protagonist's real movements in the past. They present spaces reconstructed by narrative discourse. In *Wild Beast*, all spatial descriptions are filtered by the adult narrator's retrospective consciousness. Genette's (1980) distinction between story time and narrative discourse plays a key role here. The teenage protagonist's actions belong to the past story time, while the adult narrator selects, compresses, interrupts and revisits these actions in the narrative process.

The narrator frankly admits that he is "fabricating stories" and that it is technically impossible to restore the truth. This statement changes the nature of spatial narration. It means that routes, encounters and locations are reorganized by memories, desires, shame and subsequent self-explanations. Thus, the maps contain temporal folds. Some spaces are magnified because the adult narrator repeatedly recalls them; some routes are compressed into simple connecting descriptions; some plots are revised or even deleted; some areas become narratively dense not because of their large geographical size, but because memories continuously activate them.

These temporal folds also explain why C001 and C002 dominate the overall spatial structure. Their importance lies not only in the large number of associated event groups, but also in the strong emotional investment of the adult narrator in retrospection. C001 is constantly revisited as a space carrying origins, disciplines, male friendships and compound life. C002 is also repeatedly recalled as the source of initial visual shock, youthful desires, waiting and narrative uncertainties. The adult narrator's memories form a clear spatial hierarchy. The maps not only record where the teenage protagonist has been, but also reflect which spaces the adult narrator remembers, revises and endows with emotional weight.

In this sense, the spatial distortion on the maps is not a methodological defect, but an inherent part of the research object. Literary maps must retain the differences between historical geographical coordinates and narrative importance. A purely geometric map will erase such differences. The event group method is designed to solve this problem. It reorganizes movements according to narrative continuity, plot interruptions and retrospective revisions. The final maps are chronotope-oriented rather than purely cartographic, which fully show how narrative time reshapes urban spaces.

5.4. Named Places and the Problem of Toponymic Visibility

The fourth research finding concerns named locations. Among the 34 points of named locations, 29 are classified as route / reference points and only 5 as core scene points. This distribution proves that most locations with clear names gain geographical visibility, but do not carry intensive narrative contents.

This conclusion has important implications for literary mapping research. If literary maps are produced merely based on named locations, Beijing Railway Station, Wangfujing, Chang'an Avenue and Children's Cinema will be overly highlighted. However, this study verifies that most recognizable locations only serve as route nodes, transfer stops and temporary reference points. On the contrary, the most important narrative spaces are two polygon containers with vague boundaries and complex internal structures. These spaces are difficult to map accurately, yet they occupy the core position of the narrative.

This result expands Tally's (2013) viewpoint that literary mapping is an interpretive practice. The task of literary mapping is not only to mark named locations on maps, but also to judge the narrative functions of different spatial forms. Therefore, this study distinguishes the geographical visibility and narrative centrality of named locations, which is summarized as the problem of geographical visibility: locations with fixed names are easier to map, but they are not necessarily the most important narrative spaces.

The binary classification of named locations also explains the functions of local enclosed spaces. Wangfujing, Dongfeng Market Police Station, Xinqiao Hotel, Moscow Restaurant and Workers' Stadium (including the swimming pool) are all defined as core scene points. They carry complete local plots but never evolve into major recurring spatial containers. This distinction separates partial plot intensity from structural narrative centrality.

5.5. From Spatial Structure to Identity Boundaries

The above spatial analysis also answers the question of identity boundaries raised in the introduction. In *Wild Beast*, identities are formed through spatial travels. The protagonist's movements between C001 and C002 mark his shifts among different social roles. Inside the residential compound, he acts as a child, a member of the male peer group and a subject supervised by adult disciplines. Around Milan's residential area, he turns into a school truant, an intruder, an observer and a teenager with inner desires. In public spaces such as Wangfujing and Dongfeng Market Police Station, he is exposed to urban public power and reduced to a regulated individual temporarily.

Identity boundaries are first reflected in spatial forms, and then present psychological characteristics. Gates, windows, corridors, school exits, building doorways and police station rooms are all symbols of social role transformation. For this reason, the point-route-container model is not only a mapping tool, but also a theoretical model for analyzing the formation of individual subjects. Points represent geographical visibility, routes represent role transitions, and containers represent fixed social and emotional positions that appear repeatedly.

This is the core conclusion of this study. The Beijing depicted in *Wild Beast* is a space for shaping teenage identities, rather than a simple objective representation. The city does not merely accommodate the protagonist's growth; it constructs the basic conditions for narrating the growth experience. Therefore, the spatial narrative is not an accessory to the growth story, but the essential form that supports the development of the growth narrative.

6. Conclusions

This study explores how Wang Shuo's *Wild Beast* constructs Beijing into a complete spatial narrative. Combining close textual reading, spatial event annotation, event group coding and QGIS-based literary mapping, the research proves that the novel does not present Beijing as a uniform urban field. Instead, its spatial structure is built on the hierarchical relationships among named location points, event group routes and major spatial containers. Therefore, literary maps not only record the locations of story plots, but also reveal how movements, memories, desires and repeated spatial activities shape Beijing into a unique literary space.

The core research finding is that the spatial narrative of *Wild Beast* follows the point-route-container model. Named locations form the most visible layer of the urban space, while most of them only serve as route and reference points instead of lasting narrative centers. Travel routes connect these points into constrained movement sequences, rather than forming unrestricted urban roaming paths. The densest narrative contents gather in two major spatial containers: the protagonist's residential compound and the area in front of the school gate near Milan's residence. Though covering a limited geographical area on the map, the two containers jointly include 23 out of 34 event groups.

The dual spatial container structure revises existing research on Wang Shuo's depiction of Beijing. The novel is neither organized purely around the residential compound, nor based on the simple opposition between the compound and the outer city. Its narrative core derives from the tensions

between two socially functional containers. The protagonist's residential compound integrates family disciplines, peer life, internal cyclic movements and repeated returns. The area near Milan's residence gathers elements including desires, space intrusion, observation, waiting and uncertain retrospective memories. The protagonist's travels between these spaces represent not only spatial shifts, but also changes of identity boundaries: between a child and a peer group member, between a student and a truant, between a compound insider and a wandering urban dweller, and between an observer and an intruder.

Methodologically, this study reveals the limitations of literary mapping that only relies on named locations. If maps are produced merely based on recognizable place names, Wangfujing, Beijing Railway Station, Chang'an Avenue and Children's Cinema will be excessively prominent. However, the analysis shows that these locations are mostly route markers and temporary reference points. The spaces with the richest narrative meanings usually have vague boundaries and complex internal structures, and are constantly reshaped by memories. Therefore, literary mapping research should focus not only on discrete spatial points, but also on the narrative relationships among routes, spatial containers and internal nodes.

Admittedly, this research has certain methodological limitations. The polygon boundaries of spatial containers are interpretive and cannot be regarded as cadastral boundaries. The georeferenced 1976 historical map is only used to identify the general spatial pattern, not for high-precision distance and area measurement. Figure 2 only presents the topological relations of internal structures in the two containers as schematic diagrams, without restoring the actual architectural layouts. The event group coding is completed by a single researcher based on textual reading. This method is feasible for single-text research, while supplementary detailed coding manuals and cross-coding verification can be added in the appendix to improve the repeatability of research results.

Beyond the research on *Wild Beast* itself, the point-route-container model can be applied to analyze other growth narratives and urban novels created in the post-socialist era. Many literary works do not describe urban experiences through a complete city map. They organize narratives around a small number of emotionally and socially significant spatial containers connected by repeated travel routes. In this sense, the contributions of this study lie not only in mapping the image of Beijing in Wang Shuo's works, but also in proposing a new method for reading modern urban narratives: analyzing how literature transforms physical spaces into structures carrying movements, memories, desires and identity formation.

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