Volume 3, Issue 1, 2025

Print ISSN: 2959-992X
Online ISSN: 2959-9938

TRENDS IN SOCIAL SCIENCES AND HUMANITIES RESEARCH

Trends in Social Sciences and Humanities Research

Volume 3, Issue 1, 2025

Published by Upubscience Publisher

Trends in Social Sciences and Humanities Research
Print ISSN: 2959-992X Online ISSN: 2959-9938
Email: info@upubscience.com
Website: http://www.upubscience.com/

Table of Content

THE IMPACT OF DIALECT ABILITY OF CHINESE FEMALE DOMESTIC WORKERS ON OCCUPATIONAL DISCRIMINATION 1-7
ShuangLe Fu

ASSESSMENT OF CHINESE CITIES' INTERNATIONAL TOURISM COMPETITIVENESS USING AN INTEGRATED ENTROPY-TOPSIS AND GRA MODEL 8-12
BoZhi Yang*, XinYu Gu, ShiRong An, KeXin Song, ShiMan Wang, Xian Qiu, XiangMing Meng

THE IMPACT OF THE COMBINED ECONOMIC SYSTEM OF ARTIFICIAL INTELLIGENCE, BLOCKCHAIN AND BIG DATA ON RURAL ECONOMY IN SOUTHWEST CHINA 13-19
XueYun Wang, YiFan Chu, JingDan Ma*

CONVERTIBLE BOND PRICING BASED ON MONTE CARLO SIMULATION 20-24
YiHang Xie*, Quan Zhou, ZhanZhao Zhang

THE PROBLEM OF BENCH DRAGON ENTERING AND EXITING THE SPIRAL MOTION WITH CONSTANT DISTANCE 25-32
YiHeng Zhang

TRANSFORMATIVE CURRICULUM DESIGN FOR ADVANCED CRITICAL THINKING AND COMPLEX PROBLEM-SOLVING: THEORETICAL MODELS AND PRACTICAL APPLICATIONS 33-42
Stephen Kelvin Sata

DIGITAL MARKETING IN AFRICA: INSIGHTS AND TRENDS 43-47
Okechukwu Chidoluo Vitus

EXPLORING THE REFORM OF COLLEGE ENGLISH CLASS IN "TELLING CHINA'S STORIES WELL" 48-52
JuHua Xue

EXPLORING THE EFFECT OF CODE-MIXING AND CODE-SWITCHING ON ACADEMIC ACHIEVEMENT IN MATHEMATICS AMONG SECONDARY SCHOOL STUDENTS IN OYO METROPOLIS, OYO STATE, NIGERIA 53-57
Gift Chioma Okeke*, Babatunde Ojo Badmus, Adewumi Modinat Adeleke, Temitope Dasola Alabi, Kamoru Abiodun Sabitu

ARTIFICIAL INTELLIGENCE-ENHANCED BLENDED LEARNING FOR ECONOMIC LAW: A NEW APPROACH FOR ECONOMICS AND MANAGEMENT EDUCATION IN CHINA 58-62
Jing Yu

Trends in Social Sciences and Humanities Research
ISSN: 2959-9938
DOI: https://doi.org/10.61784/tsshr3128

THE IMPACT OF DIALECT ABILITY OF CHINESE FEMALE DOMESTIC WORKERS ON OCCUPATIONAL DISCRIMINATION

ShuangLe Fu[1,2]
[1] *School of Elderly Care Services and Management, Nanjing University of Chinese Medicine, Nanjing 210023, Jiangsu, China.*
[2] *School of aging industry, Nanjing University of Chinese Medicine, Nanjing 210023, Jiangsu, China.*
Corresponding Email: hdsgfsl1101@126.com

Abstract: Due to some reasons, such as the irregularity of work, domestic workers are susceptible to occupational discrimination. Studies have shown that language ability can reduce discrimination. So, is the ability of dialect of the working city related to occupational discrimination, can it reduce occupational discrimination? To answer this question, the research discussed its impact on the occupational discrimination of female domestic workers. Using the survey data and the instrumental variable CMP estimation method, it were found that female workers in domestic dialects with a worse dialect of the working city were significantly more likely to perceive occupational discrimination. The results show that the dialect ability of the working city has a significant impact on occupational discrimination. On these basis, the mechanism of the working city dialect ability on occupational discrimination was analyzed and discussed.
Keywords: Dialect ability; Occupational discrimination; Instrumental variable; Female domestic worker

1 INTRODUCTION

Language serves not merely as a tool for communication but also as a mirror reflecting one's identity and image. It has a direct bearing on both the effectiveness of communication and work efficiency, while also exerting a profound influence on the impressions and evaluations that others form of individuals and even entire groups. Remarkably, infants can discern between their mother tongue and foreign languages within just four days of birth[1]. In everyday interactions, people can swiftly ascertain whether a person's language is standard or non-standard based on just a few sentences or words. Those whose language is non-standard often confront negative evaluations and, at times, discrimination, particularly from language normative groups[2-6]. Conversely, enhancing language proficiency has been shown to mitigate the incidence of such discrimination[7].

Language exhibits regional characteristics, which manifest in the form of dialects. Serving as a communication medium within a defined geographical area, dialects hold profound social significance within the service industry. The use of standard dialects can bolster the appeal and competitiveness of services, elevate the social standing and reputation of practitioners[8-10], and their importance is particularly pronounced in the domestic service sector. Domestic workers in cities where the dialect is spoken more proficiently can garner greater respect and trust from employers, thereby fostering equitable and harmonious relationships between both parties[11-13].

Home services touch the lives of countless households. Domestic workers, often facing informal work arrangements and a low social standing, are particularly vulnerable to professional discrimination. This occupational discrimination can not only induce health issues such as anxiety and depression among individual domestic workers but also pave the way for distressing incidents like abuse of the elderly and children, posing risks to the safety of employers and even undermining social stability. Consequently, addressing occupational discrimination and ensuring decent work conditions for domestic workers demands the urgent attention of both the academic community and all sectors of society. Given the substantial value of dialects in the domestic service industry and the fact that language proficiency can mitigate discrimination, this article focuses on exploring whether there is a correlation between female domestic workers' proficiency in speaking the local dialect of their work city and the level of occupational discrimination they face. Specifically, it investigates whether a limited ability to speak the local dialect exacerbates discrimination, whereas a stronger proficiency can alleviate it.

2 LITERATURE REVIEW

Discrimination has consistently been a focal point in sociological research. Conceptually, discrimination entails the unfair treatment of individuals solely based on their membership in a specific group or category[14]. From a sociological lens, the discrimination includes three dimensions: attitude, behavior, and systemic structures[15]. The forms of discrimination are intricate and multifaceted, ranging from prejudice and verbal abuse to belittlement and unequal treatment[16]. The triggers and underlying factors of discrimination span numerous realms, including individual, familial, and societal dynamics. In the following sections, the research will delve into the impact of language proficiency on discrimination.

Research has revealed that language ability in the destination location holds immense sociocultural significance and plays a pivotal role in various aspects of migrants' work and life. Issues related to language proficiency not only lead to differential treatment in the labor market, which amounts to actual discrimination against migrant populations, such as

fewer job opportunities and lower wages for those with poorer proficiency in the local dialect[17-21], but also have profound impacts on breaking down identity-based discrimination and facilitating social interactions[22-24].

Although research on the functions of language ability has achieved a relatively mature and comprehensive state, studies directly examining the impact of language ability on discrimination have emerged more recently and are still in their developmental phase. However, a handful of scholars have ventured into this territory. Broadly speaking, prejudice is a negative attitude or inclination towards individuals belonging to specific groups, often manifesting through language use[25]. Discrimination frequently originates from prejudice, prompting individuals to discriminate against those who do not share the same language. Research indicates that respondents whose mother tongue or primary language is not the mainstream language may confront discrimination due to linguistic factors. Even when the mother tongue or primary language aligns with the mainstream, many individuals still face discrimination because of their impure or non-standard accents[2-5,26]. Language proficiency plays a crucial role in employment discrimination: incorporating language proficiency information can enhance interview opportunities for non-native applicants and mitigate the discrimination they encounter. In roles requiring high levels of oral expression and communication skills, such as secretarial positions, language proficiency can even alleviate racial discrimination[7].

As a profession characterized by close interpersonal communication and frequent interactions, female domestic workers are particularly susceptible to discrimination based on their language proficiency, particularly in the workplace. In a study by Piller, a cleaning worker who had resided in Germany for several decades faced criticism for her inadequate German-speaking skills when she filed a harassment lawsuit against her employer[27]. Similarly, Hall et al conducted a qualitative study in the Macau region of China, revealing that most Filipino domestic helpers have limited knowledge of the primary languages spoken there: Chinese and Portuguese. These language barriers hinder their ability to fully understand their employers' instructions and result in differential treatment when accessing medical services, legal support, and government public services[28]. A survey by scholars on Beijing's high-income families and their employed domestic workers found that some workers perceive Mandarin (the main language spoken in Beijing) as carrying significant social weight. Proficiency in Mandarin is viewed as a reflection of one's quality, cultivation, public image, and social status. Fluent Mandarin speakers can bridge the psychological gap between employers and urban residents, earning them greater respect from others[29].

After reviewing the existing literature, it has been discovered that scholars have delved into the impact of language on discrimination and have garnered certain insights. However, several shortcomings persist: (1) The majority of studies primarily focus on populations in developed countries or regions like the United States, Canada, and France, neglecting the group of domestic workers who exhibit distinct occupational characteristics and are highly susceptible to discrimination due to their work; (2) Scholars have acknowledged that individuals, particularly vulnerable groups such as immigrants, may encounter discrimination stemming from language barriers, and that enhancing language proficiency can mitigate this discrimination. However, relevant research is still nascent and has yet to delve deeply into the socio-cultural implications of language; (3) Although some scholars have recognized the link between language proficiency and discrimination, the exploration of causal mechanisms remains largely confined to qualitative analysis or basic descriptive analysis, with a notable absence of high-quality quantitative research; (4) Existing quantitative analyses insufficiently address the endogeneity issues commonly encountered in empirical research on language function, and there is a tendency to simplify data processing and model selection. Consequently, the validity of these conclusions urgently requires further validation. Therefore, this study focuses on the Chinese domestic worker group, employs the instrumental variable method to address endogeneity problems, and examines the role of dialect proficiency in occupational discrimination within their work cities.

3 MATERIAL AND METHODS

3.1 Data and Participants

The research analyzed questionnaire survey data collected in 2019 from domestic workers in four cities in China: Nanjing, Wuxi, Guangzhou, and Foshan. The survey employed the Respondent Driven Sampling (RDS) method, effectively addressing the challenge of lacking scientific sampling frames in domestic worker surveys. A total of 1,029 questionnaires were gathered, with 1,007 being deemed valid. Specifically, 303 were collected in Nanjing, 183 in Wuxi, 315 in Guangzhou, and 206 in Foshan. The research team conducted a thorough analysis to assess the balance and homogeneity of the survey sample, finding that it achieved equilibrium, mimicking a random sample.

The survey data offers a comprehensive exploration of domestic workers' dialect proficiency, household registration locations, and other pertinent information in their respective work cities. Notably, the survey locations of this data are all economically developed cities with obvious local dialect characteristics and important positions[30-31], providing an excellent data foundation for the author to investigate the dialect proficiency of domestic workers in their work cities and its impact on occupational discrimination.

The focus of this article is on female domestic workers (hereinafter referred to as "female domestic workers"). Among the 1,029 surveyed workers, 988 were women. Due to missing values in some variables within individual samples, the final analytical sample size was 983.

3.2 Measurement

3.2.1 Occupational discrimination

Discrimination can manifest in both real forms (such as unequal treatment and institutional segregation) and perceived forms (where individuals subjectively perceive discrimination through the words and actions of others). Since real discrimination is frequently prohibited by law, perceived discrimination often serves as a more accurate reflection of discriminatory practices[32]. Consequently, this study employs perceived occupational discrimination as the primary measurement indicator of occupational discrimination. The survey inquired about respondents' perceptions of discrimination based on their status as domestic service workers, offering five response options: "never," "rarely," "sometimes," "often," and "always." This study utilizes this perception as an operational indicator of occupational discrimination and treats it as a binary variable. Specifically, a value of 0 is assigned if a female domestic worker has never felt discriminated against due to her occupation, while a value of 1 is assigned if she has experienced any form of perceived discrimination.

3.2.2 Dialect ability

The survey inquired about respondents' proficiency in speaking the dialect of their work city, allowing them to self-evaluate their ability. During the data processing phase, the level of dialect proficiency in the work city was categorized into three distinct groups based on their responses: poor (encompassing those who were "completely unfamiliar" or "somewhat familiar"), average, and good (amalgamating those who rated themselves as "good" or "very good").

3.2.3 Covariates

The research strives to account for as many factors as feasible that contribute to occupational discrimination against female domestic workers. Prior research has highlighted several key factors, including low employment barriers (predominantly middle-aged rural women with advanced age and limited education), minimal work experience requirements, low technical skills, modest income, and a low social standing, which significantly impact discrimination towards domestic workers[33-38]. Furthermore, inadequate food provision, inability to meet basic needs for nourishment and shelter, and a lack of privacy protection due to employers' reluctance to install cameras in their homes can exacerbate feelings of disrespect among domestic workers[28]. Additionally, the nature of work (categorized as care-oriented, such as nannies, childcare providers, and elderly caregivers, versus work-oriented roles like housekeepers and cleaners) and work schedules (non-residential, including hourly and day shifts, versus residential arrangements) constitute fundamental work conditions. The city of employment also plays a crucial role in shaping the social environment and must be considered as a control variable. In summary, the research incorporates a comprehensive range of control variables, including age, education level, type of household registration, job type , work schedule, monthly salary, years of experience in domestic work, score for the ability to use intelligent tools, employer's home installation monitoring, being able to eat enough at the employer's house, satisfaction with meals at the employer's house, can the income from work meet the economic needs, and the city of work.

3.3 Data Analysis

Firstly, descriptive statistics were computed for all variables in Stata 17.0, encompassing frequency, mean, standard deviation, and percentage. Secondly, a causal analysis was conducted to investigate the relationship between dialect proficiency among female domestic workers and occupational discrimination. Existing research indicates potential endogeneity concerns in the empirical analysis of individual language proficiency and occupational discrimination. Consequently, this study employed the instrumental variable (IV) method to address these issues. Given that dialect proficiency is an ordinal multicategorical variable, traditional IV methods such as Probit and two-stage least squares (2SLS) may not be applicable. Instead, this study utilized Roodman's Conditional Recursive Mixed Process (CMP) IV model. CMP is a versatile mixed model estimation approach tailored for categorical endogenous explanatory variables or truncated data[39], which has garnered widespread recognition and application in academic circles[40]. Therefore, the author chose to apply the CMP estimation method to mitigate endogeneity challenges.

4 RESULT

4.1 Preliminary Analysis

The frequent and percent for major variables in this investigation were shown in Table 1.

Table 1 Key Variable Description Statistics (N=983)

Variable	Option	Freq	Percent
Occupational discrimination	No	601	61.14
	Yes	382	38.86
dialect ability	Poor	399	40.59
	General	86	8.75
	Good	498	50.66

4.2 Regression Analysis

Table 2 presents the regression analysis results of the impact of dialect proficiency of female domestic workers on occupational discrimination. Model 1 is the Probit analysis result, and Model 2 is the CMP analysis result. In Model 1,

the coefficient for average dialect ability is 0.402 ($p<0.01$), while the coefficient for good dialect ability is -0.013 ($p>0.05$). In Model 2, the average and good coefficients for dialect ability were -0.396 ($p<0.05$) and -1.396 ($p<0.001$), respectively.

In order to satisfy the prerequisites for employing instrumental variables, it is imperative to report several crucial statistical indicators prior to delineating the regression outcomes of these variables, thereby ensuring the credibility of the results. Initially, during the first stage of regression, a notable correlation emerges at the 0.001 significance level between whether an individual's household registration and work city fall within the same dialect region and their dialect proficiency in the work city. This underscores a robust relationship between the instrumental variables and the endogenous explanatory variables, confirming the suitability of the selected instrumental variables and ruling out the possibility of weak instrumental variables. Furthermore, the endogeneity test parameters achieve significance at the 0.05 level, highlighting a systematic disparity between the traditional model and the instrumental variable model. This observation implies a definitive endogeneity between dialect proficiency and occupational discrimination, necessitating the abandonment of the Prbit model and the adoption of the CMP analysis results instead.

The estimation results of the instrumental variables reveal that, after accounting for other variables, domestic workers who possess general proficiency in the work city dialect are 32.70% less likely to encounter occupational discrimination compared to those with poor dialect skills. Furthermore, those with superior dialect proficiency in the work city are 75.24% less likely to experience occupational discrimination. In simpler terms, as the proficiency in the work city dialect diminishes, the likelihood of domestic workers perceiving occupational discrimination increases.

Table 2 Regression Analysis Results of The Impact of Dialect Ability on Occupational Discrimination

	Model 1 (Probit)	Model 2 (CMP)
Dialect ability (poor as a reference)		
general	0.402**(0.155)	-0.396*(0.183)
good	-0.013(0.099)	-1.396***(0.214)
Age (≤39 as reference)		
40-55	0.134(0.182)	0.132(0.125)
≥56	0.160(0.211)	0.134(0.146)
Educational level (without any education as a reference)		
primary school	-0.321(0.188)	-0.251(0.140)
junior high school	-0.285(0.184)	-0.219(0.136)
high school and above	-0.370(0.217)	-0.274(0.165)
Type of household registration (non rural registered residence as reference)	0.116(0.108)	0.045(0.079)
Job type (mainly cleaning and cooking as a reference)	-0.112(0.119)	-0.075(0.084)
Work schedule (not staying at the employer's house at night as a reference)	-0.032(0.119)	-0.014(0.085)
Monthly salary (in thousands of yuan)	0.058**(0.019)	0.038*(0.019)
Years of experience in domestic work	0.006(0.007)	0.005(0.005)
Score for the ability to use intelligent tools	-0.010(0.008)	-0.007(0.006)
Employer's home installation monitoring (not used as a reference)		
Yes	0.269**(0.099)	0.170*(0.085)
not sure	0.234(0.142)	0.163(0.105)
Being able to eat enough at the employer's house (No as a reference)	-0.539*(0.255)	-0.340(0.200)
Satisfaction with meals at the employer's house (dissatisfaction as a reference)	-0.303(0.158)	-0.248*(0.113)
Can the income from work meet the economic needs? (No as a reference)	-0.266**(0.090)	-0.183*(0.073)
City of work (Nanjing as a reference)		
Wuxi	-0.382**(0.132)	-0.352***(0.097)
Guangzhou	0.202(0.117)	0.015(0.103)
Foshan	-0.111(0.138)	-0.186(0.099)
cons	0.481(0.377)	1.191***(0.265)
N	983	983
R^2	0.0568	
The relevance of the first stage		0.271***(0.076)
Atanhrho (Endogenous test parameters)		1.270*(0.564)

Note:The numbers in parentheses are standard errors; *** is p< 0.001, ** is p< 0.05, * is p< 0.01

5 CONCLUSION AND DISCUSSION

The objective of this study is to investigate how the proficiency in the local dialect of female domestic workers in their work city influences occupational discrimination. The findings, after addressing endogeneity concerns, indicate that

female domestic workers who speak the local dialect fluently are notably less likely to experience occupational discrimination.

What accounts for the significant impact of dialect proficiency on occupational discrimination faced by female domestic workers? Are there additional mechanisms beyond dialects serving as a vital cultural capital? The author contends that the capacity to speak authentic and fluent local dialects reduces occupational discrimination against domestic workers because dialects possess a broad and profound social function. They transcend being mere communication tools for specific regions; they are crucial indicators of regional identity and reflect the identity status of their speakers. Specifically:

Firstly, humans speak multiple languages and use a shared linguistic symbol system to form a community, known as a language community[41]. Members of the same language community naturally bond and engage in more daily interactions. For female domestic workers, speaking the same language fosters a sense of closeness and trust with employers, paving the way for the establishment and maintenance of intimate working relationships[11-13]. Such intimate relationships can mitigate the occurrence of discrimination.

Secondly, in certain societies where speech is paramount, specific discourses share identical forms and meanings[41]. Put simply, individuals who speak the same dialect understand each other more precisely and with less ambiguity. Consequently, female domestic workers proficient in their work city's dialect can communicate more effectively with employers, enhancing work efficiency, minimizing conflicts, and ensuring a harmonious employment relationship[28]. This facilitates a relatively equal and friendly interaction between both parties.

Again, language signifies identity and status, and distinct dialects carry different social reputations, reflecting varying levels of identity and status. In particular regions, dominant languages (like Cantonese and Shanghainese) enjoy a high social standing. Domestic workers who use these languages are more likely to gain respect and recognition, thus experiencing less occupational discrimination.

Finally, the ability to speak the local dialect is a crucial means for individuals, particularly migrant populations, to integrate into the local society[42-44,19,24]. The more fluent and authentic a domestic worker's dialect is, the higher their acceptance within the local community. This aids their integration into mainstream society and enhances communication across different groups. As time spent together increases, mutual understanding deepens, leading other groups to gradually recognize the work value and social significance of domestic workers, thereby reducing occupational discrimination.

6 LIMITATIONS AND FUTURE RESEARCH DIRECTIONS

Due to the constraints of the research topic and the accessibility of data, several issues remain unresolved in this paper. Firstly, the model outcomes indicate that as the actual monthly salary increases, so does the likelihood of female domestic workers feeling occupational discrimination. The author speculates that this correlation may stem from the higher expectations these workers, particularly confinement wives, hold for their profession and social standing. They perceive a greater need for societal respect and heightened sensitivity towards others' words and actions, potentially heightening their awareness of occupational discrimination. However, this is merely speculative and requires further validation. Secondly, Mandarin, as the prevalent language in China, holds significant importance in both professional and personal contexts. Regrettably, this study did not incorporate Mandarin proficiency into its analysis regarding its impact on occupations, leaving the influence and mechanics of Mandarin proficiency on occupational discrimination among domestic workers unclear. Thirdly, within the domestic service industry, it is imperative to investigate which language proficiency—Mandarin or workplace dialects—has a more profound impact on occupational discrimination. Understanding the similarities and differences in their functional roles is a critical question meriting further research and in-depth analysis.

COMPETING INTERESTS

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

FUNDING

This work was funded by Jiangsu Education Department(2023SJYB0323); School of Elderly Care Services and Management(School of aging industry), Nanjing University of Chinese Medicine (2024YLFWYGL009).

REFERENCES

[1] Mehler J, Jusczyk P, Lambertz G, et al. A precursor of language acquisition in young infants. *Cognition*, 1988, 29(2): 143-178.

[2] Boudreau A, Dubois L. French in Parkton: from the backyard to the call centre. *Francophonies d'Amérique*, 2002, (14): 29-36.

[3] Bourhis R Y, Montreuil A, Helly D, et al. Discrimination and linguicism in Quebec: A survey on ethnic diversity in Canada. *Canadian Ethnic Studies*, 2007, 39(1): 31-49.

[4] Noël J, Beaton A M. Perceptions of groups, collective identity profiles and psychological well-being: The perspective of young Acadians in southeast New Brunswick. *Revue de l'Université De Moncton*, 2010, 38(4): 211-246.
[5] Freynet N, Clément R, Sylvestre J. A qualitative investigation of the experience of accent stigmatisation among native and non-native French speakers in Canada. *Journal of Language and Discrimination*, 2018, 2(1): 5-31.
[6] Calamai S, Ardolino F. Italian with an accent: the case of "Chinese Italian" in Tuscan High Schools. *Journal of Language and Social Psychology*, 2020, 39(1): 132-147.
[7] Edo A, Jacquemet N, Yannelis C. Language skills and homophilous hiring discrimination: Evidence from gender and racially differentiated applications. *Review of Economics of the Household,* 2019, 17(1): 349-376.
[8] Cameron D. *Good to Talk? Living and Working in a Communication Culture.* London: Sage, 2000.
[9] Nickson D, Warhurst C, Dutton E. Aesthetic labour and the policy-making agenda: time for a reappraisal of skills. *SKOPE Research Paper 48*, 2004.
[10] Warhurst C, Nickson D. A new labour aristocracy? Aesthetic labour and routine interactive service. *Work, Employment and Society*, 2007, (4): 785-798.
[11] Stiell B, England K. Domestic distinctions: constructing difference among paid domestic workers in Toronto. *Gender, Place and Culture*, 1997, 4(3): 339-359.
[12] Anderson B, Ruhs M, Spencer S. *Fair enough? central and east European migrants in low wage employment in the UK*. London: Joseph Rowntree Foundation, 2016.
[13] Moras A. Colour-blind discourses in paid domestic work: foreignness and the delineation of alternative racial markers. *Ethnic and Racial Studies*, 2010, 33(2): 233-252.
[14] David P. *Sociology*. Beijing: China Renmin University Press, 2007.
[15] Huang Jialiang. On social discrimination and its governance—a theoretical analysis of sociological perspective. *Journal of East China University of Science and Technology(Social Science Edition)*, 2008, (3): 1-6.
[16] Agudelo-Suarez A, Gil-González D, Ronda-Pérez E, et al. Discrimination, work and health in immigrant populations in Spain. *Social Science & Medicine*, 2009, 68(10): 1866-1874.
[17] Chiswick B R. The effect of Americanization on the earnings of foreign-born men. *Journal of Political Economy,* 1978, 86(5): 897-921.
[18] Chiswick B R, Miller P W. The endogeneity between language and earnings: international analyses. *Journal of Labor Economics,* 1995, 13(2): 246-88.
[19] Dustmann C, Fabbri F. Language proficiency and labour market performance of Immigrants in the UK. *The Economic Journal*, 2003, 113(489): 695-717.
[20] Chen Z, Lu M, Xu L. Returns to dialect Identity exposure through language in the Chinese labor market. *China Economic Review*, 2014, 30: 27-43.
[21] Cheng Mingwang, Wang Na, Shi Qinghua.The impact of language ability on earnings of rural migrant workers—based on the investigation on rural migrant workers in Shanghai. *Research on Economics and Management*, 2016, 37(8): 70-77.
[22] Guven C, Islam A. Age at migration, language proficiency, and socioeconomic outcomes: evidence from Australia. *Demography*, 2015, 52(2): 13-542.
[23] Wei Xiahai, Chen Siyu, Li Jiahui. Floating population's dialect skill and entrepreneurial choice. *Chinese Journal of Population Science*, 2016, (6): 36-46.
[24] Lu Shengfeng, Chen Yue. The power of language: does speaking local dialect enhance the social integration of floating population. *Economic Science*, 2019, (4): 118-128.
[25] Bourhis R Y, Gagnon A. Préjugés, discrimination, et relations intergroupes. *Dans Les fondements de la psychologie sociale*, ed. R. J. Vallerand, 532-598. Boucherville, QB: Chenelière Éducation, 2006.
[26] Jones B, Victor K F, Vannette D. Alien citizens and the canonical immigrant: do stigmatized attributes affect latina/o judgment about discrimination. *American Journal of Political Science,* 2019, 63(4): 740-757.
[27] Piller I. *Linguistic diversity and social justice*. Oxford, UK: Oxford University. Press, 2016.
[28] Hall B J, Garabiles M R, Latkin C A. Work life, relationship, and policy determinants of health and well-being among Filipino domestic Workers in China: a qualitative study. *BMC Public Health,* 2019, 19: 229.
[29] Yin Jing. On parents' attitudes and cognitions to babysitters' dialects. *Studies in Early Childhood Education,* 2009, (5): 64-67.
[30] Miao R, Li J. Urban migration and functional bilingualism in Guangdong province, China. *Journal of Asian Pacific Communication*, 2006, 16(2): 237-257.
[31] Gong Y, Chow H S, Ahlstrom D. Cultural diversity in china: dialect, job embeddedness, and turnover. *Asia Pacific Journal of Management*, 2011, 28(2): 221-238.
[32] Gherghina S, Plopeanu A P, Necula C V. The impact of socio-cultural integration on return intentions: evidence from a survey on Romanian migrants. *Journal of Immigrant and Refugee Studies*, 2020, 18(4): 515-528.
[33] Messing K. Hospital trash: Cleaners speak of their role in disease prevention. *Medical Anthropology Quarterly*, 1998, 12(2): 168-187.
[34] Browne I, Misra J. The intersection of gender and race in the labor market. *Annual Review of Sociology*, 2003, 29(1): 487-513.
[35] EU-OSHA. *The occupational safety and health of cleaning workers*. European Agency for Safety and Health at Work, 2009.

[36] Zhao Shuhai, Wang Xiyun, Xing Linhe. Research and analysis on the status of domestic service industry employees in Beijing. *Journal of Beijing Administration Institute,* 2011, (1): 107-110.
[37] Zhang Lin, Yang Yi. Research on the survival and development status of rural domestic workers under the background of the new normal population: A Sample Analysis Based on Beijing, Guangzhou, Wuhan, and Xi'an. *Hubei Social Sciences*, 2016, (5): 51-57.
[38] Zhou Qunying. "Outsiders in family": an anthropological analysis of the status transformation of domestic workers ——from the perspective of threshold theory. *Journal of Hubei Minzu University(Philosophy and Social Sciences)*, 2019, (2): 88-96.
[39] Roodman D. CMP: Stata module to implement conditional (recursive) mixed process estimator. *Boston College, Department of Economics*, 2007, (S4): 568-582.
[40] Russo G. Job and life satisfaction among part-time and full-time workers: The "identity" approach. *Review of Social Economy*, 2012, 70(3): 315-343.
[41] Bloomfield L. *Language*. Beijing: The Commercial Press, 1980.
[42] Chiswick B. Jewish immigrant skill and occupational attainment at the turn of the century. *Explorations in Economic History*, 1991, 28(1): 64-86.
[43] Yang Jvhua. Research on the assimilation of the floating population in China. *Social Sciences in China*, 2015, (2): 61-79.
[44] Yu Weiqi. Language urbanization of rural migrant workers and their integration into urban society in the new pattern urbanization of Shanghai. *Applied Linguistics*, 2017, (1):14-22.

Trends in Social Sciences and Humanities Research
ISSN: 2959-9938
DOI: https://doi.org/10.61784/tsshr3129

ASSESSMENT OF CHINESE CITIES' INTERNATIONAL TOURISM COMPETITIVENESS USING AN INTEGRATED ENTROPY-TOPSIS AND GRA MODEL

BoZhi Yang*, XinYu Gu, ShiRong An, KeXin Song, ShiMan Wang, Xian Qiu, XiangMing Meng
School of Mathematics and Statistics, Anyang Normal University, Anyang 455000, Henan, China.
Corresponding Author: BoZhi Yang, Email: 19836962962@163.com

Abstract: Amid fierce competition in the international tourism market, enhancing the tourism competitiveness of Chinese cities has become a pressing issue. However, existing studies often face limitations in evaluation methodologies and indicator selection. This study proposes an integrated evaluation model combining the Entropy Weight Method, the Technique for Order Preference by Similarity to Ideal Solution (TOPSIS), and Grey Relational Analysis (GRA) to assess and rank the attractiveness of Chinese cities to foreign tourists. Using data from 352 cities, the analysis incorporates six critical factors: city scale, environmental protection, cultural heritage, transportation accessibility, climate, and cuisine. The data underwent preprocessing through linear regression and Kaiser-Meyer-Olkin (KMO) tests, with Principal Component Analysis (PCA) and Locally Linear Embedding (LLE) employed as dimensionality reduction techniques for different data categories based on R^2 values. To ensure consistency across variables, normalization was applied, and indicator weights were objectively calculated using the Entropy Weight Method. The integrated TOPSIS and GRA approach was then utilized to evaluate and rank the 352 cities, ultimately deriving their composite scores. The findings reveal that the top 37 towns exhibit relatively concentrated scores, while scores for subsequent cities show a gradual downward trend. This study provides a systematic evaluation framework and decision-making support for Chinese cities to develop differentiated strategies in the global tourism market.
Keywords: Tourism competitiveness; Entropy Weight Method; TOPSIS; GRA; PCA; LLE

1 INTRODUCTION

In recent years, with the rapid advancement of economic globalization and the continuous improvement in living standards, the international tourism industry has witnessed unprecedented growth. As the world's largest developing country, China has seen its tourism sector evolve into a crucial component of its national economy, playing an increasingly vital role in fostering economic growth and driving social development. Notably, with the deepening implementation of the Belt and Road Initiative, the level of internationalization in Chinese cities has significantly increased, fully unleashing the potential of the tourism industry. However, in the face of intensifying competition in the global tourism market, a critical challenge remains: how can Chinese cities effectively enhance their tourism competitiveness and attract more international tourists.

Traditional methods for evaluating urban tourism competitiveness often focus on single-dimensional analyses [1],such as the Analytic Hierarchy Process (AHP) or Factor Analysis (FA), which fail to capture the multidimensional characteristics of urban tourism competitiveness. Furthermore, existing research tends to over-rely on objective data, overlooking the significance of tourists' subjective experiences in their decision-making processes. Consequently, current evaluation systems struggle to provide accurate insights for decision-making or formulate effective competitive strategies.

To address these gaps, this study introduces an integrated evaluation approach aimed at overcoming the limitations of traditional methods and providing a comprehensive, objective assessment of Chinese cities' competitiveness in the international tourism market. Drawing on web-scraped data from 352 cities, the study examines six critical dimensions: city scale, environmental protection, cultural heritage, transportation accessibility, climate, and cuisine. The data was preprocessed using linear regression [2] and the Kaiser-Meyer-Olkin (KMO) test, followed by appropriate dimensionality reduction techniques.

To ensure the objectivity of the assessment, this research employs a combined Entropy-TOPSIS [3] and Grey Relational Analysis (GRA) model [4], constructing a robust weighting mechanism and standardizing the data to ensure consistency and comparability. Ultimately, the study identifies the "50 most desirable cities for international tourists" and provides quantitative analyses and decision-making support for enhancing the competitiveness of Chinese cities in the global tourism market.

2 DATA COLLECTION AND PREPROCESSING

This study takes cities as the primary unit of analysis, integrating multiple dimensions such as city scale, environmental protection, cultural heritage, transportation accessibility, climate, and cuisine. Relevant data were systematically collected and organized to ensure a comprehensive evaluation of urban characteristics. The data was sourced primarily from various publicly accessible platforms, providing a robust foundation for analysis. Details of the data sources and

their respective contributions are outlined in Table 1:

Table 1 Data Source Website

Website	URL
China National Environmental Monitoring Center	http://www.cnemc.cn/
National Bureau of Statistics of China	http://www.stats.gov.cn/
Ministry of Culture and Tourism	http://www.mct.gov.cn/
Ministry of Transport	http://www.mot.gov.cn/
China Meteorological Administration	http://www.cma.gov.cn/
Dianping	https://www.dianping.com/

The data for this study were sourced from various platforms, covering key indicators related to city scale, environmental protection, cultural heritage, transportation accessibility, climate characteristics, and cuisine. Specifically, the data includes metrics such as Air Quality Index (AQI), green coverage rate, and wastewater treatment rate under environmental protection; line density and the number of airport flights for city scale; the number of historical landmarks and museums for cultural heritage; public transportation coverage and highway mileage for transportation accessibility; annual average temperature and precipitation for climate; and the number of restaurants and signature dishes for cuisine.

To facilitate subsequent analysis, the 20 collected indicators were systematically categorized. Based on their attributes and functional significance, the indicators were grouped into six primary categories: city scale, environmental protection, cultural heritage, transportation accessibility, climate, and cuisine. The detailed classification results are presented in Table 2:

Table 2 Indicator Classification

Category	Indicator
City Size	Line Density (km/km²)
	Number of Airport Flights
Environmental Protection	Air Quality Index (AQI)
	Green Coverage Rate (%)
	Wastewater Treatment Rate (%)
	Exhaust Gas Treatment Rate (%)
	Waste Sorting and Treatment Rate (%)
Cultural Heritage	Number of Historical Sites
	Number of Museums
	Frequency of Cultural Events
	Number of Cultural Facilities
Transportation Convenience	Public Transportation Coverage Rate (%)
	Highway Mileage (km)
Climate	Average Annual Temperature (°C)
	Annual Precipitation (mm)
	Number of Days Suitable for Tourism
	Air Humidity (%)
Gastronomy	Number of Restaurants
	Number of Specialty Dishes
	Frequency of Gastronomy Events

During the data preprocessing stage, the raw data were systematically cleaned to remove missing and outlier values, ensuring the accuracy and completeness of the dataset. This critical step enhanced the reliability of the data, laying a robust foundation for the subsequent evaluation of urban tourism competitiveness. By integrating data collection with meticulous preprocessing, this study provides a solid basis for assessing the tourism competitiveness of cities. Furthermore, it offers reliable data support for comparative analyses of various aspects of competitiveness across

different cities.

3 DATA DIMENSIONALITY REDUCTION AND STANDARDIZATION

To facilitate a comprehensive analysis of urban tourism competitiveness, the collected indicators across six categories were subjected to dimensionality reduction and standardization. The primary objective of dimensionality reduction was to minimize redundant information and extract the most representative features, thereby improving the accuracy and efficiency of subsequent analyses. Different dimensionality reduction techniques were applied based on the correlation among indicators within each category [5].

Initially, a linear relationship analysis was conducted for the indicators in all six categories to evaluate their inter-correlations. Through linear regression analysis, the coefficient of determination (R^2) was calculated for each category, providing insights into the strength of the relationships among the indicators. The results of this analysis are presented in Table 3.

Table 3 R-squared Values for Linear Relationship Detection

Category	R-squared Value
City Size	0.8856
Environmental Protection	0.1250
Cultural Heritage	0.9483
Transportation Convenience	0.8412
Climate	0.7125
Gastronomy	0.9432

As shown in Table 3, the R^2 values for the Cultural Heritage and Gastronomy exceed 0.9, indicating a significant linear correlation among the indicators within these categories. This makes them well-suited for dimensionality reduction using Principal Component Analysis (PCA) [6]. In contrast, the R^2 values for the City Size, Transportation Convenience, and Climate categories are all above 0.7, suggesting a strong linear correlation. For these categories, further evaluation through the Kaiser-Meyer-Olkin (KMO) test was conducted to determine the appropriate dimensionality reduction method.

On the other hand, the Environmental Protection category has an R^2 value of only 0.1250, indicating almost no linear correlation among its indicators. Therefore, the Locally Linear Embedding (LLE) method was selected for dimensionality reduction for this category [7].

Subsequently, the KMO test results for the City Size, Transportation Convenience, and Climate categories were assessed. The detailed KMO values are presented in Table 4.

Table 4 City Size, Transport, Climate (KOM) Values

Category	KMO Value
City Size	0.5000
Transportation Convenience	0.5000
Climate	0.5091

Based on the results of the KMO test, the KMO values for the City Size, Transportation Convenience, and Climate categories were all below 0.6, indicating that these datasets are more suitable for dimensionality reduction using the Locally Linear Embedding (LLE) method. Consequently, this study employed LLE to reduce the dimensions of the indicators in the City Size, Transportation Convenience, Climate, and Environmental Protection categories. This approach allowed for the effective extraction of the primary features within each category.

During the dimensionality reduction process, the LLE method successfully captured the key components of each category. The results were visualized using contour maps, providing an intuitive representation of the extracted features. The visualization of the dimensionality reduction outcomes is presented in Figure 1.

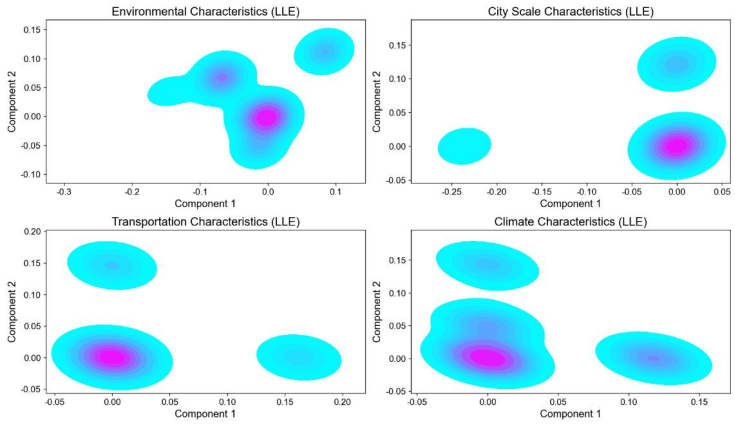

Figure 1 Contour map processed by LEE

After completing the dimensionality reduction process, a further step of standardization was undertaken to eliminate the impact of dimensional differences among indicators on the analysis results. All indicators were normalized, converting the raw data of varying scales into unit-free standardized evaluation values. By applying standardization formulas, each indicator's values were adjusted to a uniform evaluation basis, ensuring consistency and comparability across all metrics. This standardization process provided robust data support for subsequent comprehensive evaluations and ensured comparability between indicators from different categories.

Through the combination of dimensionality reduction and standardization, this study established a solid foundation for an in-depth analysis of urban tourism competitiveness. The dimensionality reduction methods effectively simplified the data structure, while the standardization process eliminated dimensional disparities. Together, these steps offer a more accurate and scientifically grounded basis for evaluating and comparing the tourism competitiveness of cities.

4 CONSTRUCTING A COMPREHENSIVE EVALUATION MODEL

To comprehensively assess the overall performance of cities across six key indicator categories, a hybrid evaluation model was developed, integrating the Entropy Weight Method, the Technique for Order Preference by Similarity to Ideal Solution (TOPSIS) [8], and Grey Relational Analysis (GRA). This approach enhances both the scientific rigor and reliability of the evaluation results.

First, the Entropy Weight Method was employed to objectively determine the weight of each indicator. By analyzing the contribution of each indicator, the entropy value was calculated to reflect its discriminative capacity. Lower entropy values indicate greater importance in distinguishing among samples. Based on the normalized data, an evaluation matrix was constructed, and corresponding weights were assigned to each indicator, resulting in a weighted evaluation matrix.

Building on this foundation, the TOPSIS method was applied to perform a comprehensive evaluation. This method calculates the Euclidean distance of each city from the positive and negative ideal points, which represent the optimal and least favorable values of each indicator, respectively. Specifically, for indicators classified as “larger-is-better,” the positive ideal point is the maximum value, and the negative ideal point is the minimum value. The proximity of each city to the ideal points was calculated to derive its composite score.

To further enhance the robustness and comprehensiveness of the evaluation, Grey Relational Analysis (GRA) was introduced. GRA evaluates the similarity in trends among indicators by calculating the correlation coefficients and degrees of association. Through the construction of a reference sequence and a different matrix, correlation coefficients, indicator weights, and final scores were sequentially computed. The degree of correlation reflects the similarity and variation in cities’ overall performance.

Finally, the results from the Entropy-TOPSIS and GRA methods were combined to construct an integrated evaluation model. Equal weights of 0.5 were assigned to each method, ensuring a balanced and comprehensive evaluation of urban competitiveness. The combined scores provide a reliable basis for comparison across cities. A visualization of the scores for selected cities is presented in Figure 2.

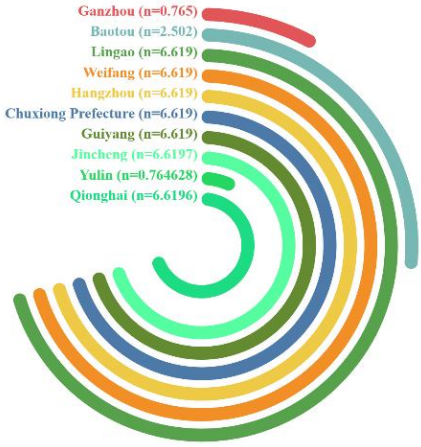

Figure 2 Rating Scores of Selected Cities

This integrated evaluation model effectively incorporates the heterogeneity and correlations of multidimensional data, overcoming the subjectivity and limitations of traditional weight assignment methods. By providing a scientific foundation for the quantitative analysis of cities' overall performance, the study results offer both theoretical support for enhancing tourism competitiveness and empirical evidence for policy formulation.

5 CONCLUSIONS

This research offers a novel framework and methodology that can be applied to tourism management and urban planning. The feasibility of the proposed approach is validated through its integration of entropy weighting, dimensionality reduction techniques (PCA and LLE), and multi-method evaluation, ensuring the objectivity and scientific rigor of the analysis. The framework not only enables stakeholders to devise differentiated development strategies based on objective data but also provides strong support for enhancing the global competitiveness of Chinese cities in the tourism market. Moreover, the methods and framework presented in this study demonstrate their potential applicability in broader fields of tourism and urban planning, offering valuable references for decision-making and research in these domains. This work contributes significantly to advancing the evaluation and strategic development of urban tourism competitiveness.

Future research can further advance the innovation and practicality of the proposed framework and methodology, emphasizing the progressive development of models and their applications. For instance, integrating artificial intelligence and big data technologies with dynamic scenario modeling and real-time data analysis could enhance predictive and decision-making capabilities in complex scenarios related to tourism management and urban planning.

COMPETING INTERESTS

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

REFERENCES

[1] Zhou Chengming. Research on the High-Quality Development Evaluation of Urban Tourism Based on Entropy Weight-TOPSIS Method: A Case Study of 21 Cities in Guangdong Province. Journal of Southwest China Normal University (Natural Science Edition), 2021, 46(07): 58-66.

[2] Yang K, Jia Q, Feng C, et al. Force model of robot bone grinding based on finite element analysis. Measurement, 2025, 243: 116124.

[3] Cao, P. On the Evaluation of Coordination between Urban Tourism and Urban Development Based on Entropy Weight-TOPSIS Method: A Case Study of 13 Cities in Jiangsu Province. Modern Urban Studies, 2017, (07), 124-129.

[4] Xiaoyan Y, Min L, Changbiao Z. Evaluation of rural tourism development level based on entropy-weighted grey correlation analysis: the case of Jiangxi Province. Grey Systems: Theory and Application, 2023, 13(4): 677-700.

[5] Yang Meng, Hu Daohua. Research on High-Quality Development of Tourism in the Central Six Provinces Based on Entropy Weight-TOPSIS Method. Journal of Nanyang Normal University, 2024, 23(01): 9-16.

[6] Yateh M, Li C, Li F, et al. Understanding the influence of energy and chemical use on water treatment plants carbon emissions accounting. Journal of Water Process Engineering, 2025, 69: 106669.

[7] Kadhum H A, Hammood M K, Arif M A. Assessment of Two Extraction Methods LLE and QUEChERS to Determine Pesticides Residues in Vegetables by Gas Chromatography. IOP Conference Series: Earth and Environmental Science, 2024, 1371(6): 62034.

[8] Chembedu G, Manu P V. Investigation and optimisation of performance and emission data of CI engine ternary blends under distinct conditions. Fuel, 2025, 383: 133823.

Trends in Social Sciences and Humanities Research
ISSN: 2959-9938
DOI: https://doi.org/10.61784/tsshr3130

THE IMPACT OF THE COMBINED ECONOMIC SYSTEM OF ARTIFICIAL INTELLIGENCE, BLOCKCHAIN AND BIG DATA ON RURAL ECONOMY IN SOUTHWEST CHINA

XueYun Wang[1], YiFan Chu[2], JingDan Ma[3*]
[1]*School of Management, Shijiazhuang Tiedao University, Shijiazhuang 050043, Hebei, China.*
[2]*School of Mechanical engineering, Shijiazhuang Tiedao University, Shijiazhuang 050043, Hebei, China.*
[3]*School of Marxism, Shijiazhuang Tiedao University, Shijiazhuang 050043, Hebei, China.*
Corresponding Author: Jingdan Ma, Email: jingdanma@163.com

Abstract: With the continuous development and innovation of science and technology, artificial intelligence, blockchain and big data have become the representative technologies of the new era, and they play an increasingly important role in the development of economic society. Especially in southwest China, the rural economy is facing many challenges, and these three technologies are widely seen as effective means to solve these problems. This paper first discusses the role of these technologies in the economic field, as well as the potential and challenges they can bring, through a comprehensive introduction to artificial intelligence, blockchain, and big data. Then, according to the specific situation and needs of the rural economy in southwest China, the responsibilities and opportunities in the rural economic development after the combination of these three technologies are deeply analyzed, such as the specific application of artificial intelligence in agricultural production, blockchain in agricultural product traceability, big data in precision poverty alleviation and other aspects, as well as the transformation and driving force of these technologies on the rural economic structure. The results show that the integration of these three technologies can not only improve the efficiency, accuracy and reliability of rural economy, but also open a new door for rural technological innovation and economic development. However, this also raises issues such as technical standards, adaptability, and security, which pose a challenge to policy makers' decision-making. Therefore, relevant preparations should be made to seize opportunities, cope with challenges and promote the vigorous development of rural economy in southwest China.
Keywords: Artificial intelligence; Blockchain; Big data; Rural economy; Fusion application

1 INTRODUCTION

In the wake of rapid technological advancements, artificial intelligence (AI), blockchain, and big data have become instrumental in propelling socio-economic progress. This paper examines their potential to address the transformational challenges faced by the rural economy in China's southwestern region, a region rich in resources but grappling with development disparities. The study will elucidate the impact of these technologies and project their developmental prospects in this context.

The paper will first assess the current rural economic landscape in China's southwestern region, focusing on resource endowments, demographic structures, and the influence of external funding and policy support. It will then identify the critical needs for rural economic development, such as improving agricultural efficiency, enhancing product circulation and traceability, precision poverty alleviation, and modernizing educational and healthcare services.

Subsequently, the paper will dissect the roles, potentials, and challenges of AI, blockchain, and big data within the economic sphere. It will explore their applications in agricultural production, financial services, and the traceability of agricultural products, as well as their capacity to drive precision agriculture and market forecasting. The discussion will also address the adaptability and security concerns of integrating these technologies into the rural economy, offering policy recommendations to foster their effective integration.

In conclusion, this paper aims to provide a structured analysis that underscores the significant influence of AI, blockchain, and big data on the rural economy of China's southwestern region. It will highlight the transformative potential of these technologies and suggest future research directions to guide policy-making and rural economic advancement.

2 TECHNICAL PANORAMA

2.1 Potential and Challenges of Artificial Intelligence in Rural Economy

As an important representative of modern science and technology, artificial intelligence (AI) has achieved remarkable results in its application in various fields of the global economy [1-2]. For the rural economy in southwest China, AI technology also shows great potential. The application of artificial intelligence technology in agricultural production, agricultural product management, financial services and other fields is expected to effectively improve the efficiency and income of rural economy [3-6].

In agricultural production, artificial intelligence can accurately predict weather, pests and diseases through big data

analysis, machine learning and other technical means, so as to assist farmers to develop scientific planting plans. By using drones and smart sensors, artificial intelligence can also realize real-time monitoring and management of farmland, greatly improving the degree of automation of agricultural production [7-9]. By analyzing soil, climate, and crop growth data, AI can provide precise irrigation and fertilization recommendations to reduce resource waste and increase yields.

In the management of agricultural products, artificial intelligence technology can run through all aspects of production, processing, and circulation. From planting to harvesting, packaging, and transportation, intelligent supply chain management systems can optimize resource allocation, reduce losses, and improve product quality. The intelligent agricultural product traceability system allows consumers to understand the whole process of products from field to table through blockchain and other technologies, thus enhancing the trust and market competitiveness of agricultural products.

The informatization and intellectualization of financial services is another important aspect of rural economic development [10-12]. Through credit scoring and risk assessment of farmers and agricultural enterprises, artificial intelligence can provide a reliable basis for financial institutions to make decisions, reduce capital risks, and promote more financial resources to flow to rural areas. AI applications such as intelligent customer service and intelligent financial advisors can provide farmers with convenient financial services and improve their financial literacy and financial management ability.

In seeing the broad prospects of artificial intelligence application, we can not ignore the challenges it faces. The high cost and maintenance of artificial intelligence technology puts economic pressure on widespread application. The economic foundation of southwest rural areas is relatively weak, so how to reduce the application cost and improve the penetration rate of technology has become a key issue. The lack of relevant technical personnel is also an important factor restricting the application of AI. Education resources in rural areas are relatively insufficient, and the technical training and personnel training system still needs to be improved to support the wide application of artificial intelligence technology.

Data privacy and security issues are equally important. For rural areas, data management and protection mechanisms are not yet mature, and the risk of data leakage and abuse is higher. In the process of data collection, storage and analysis in the application of artificial intelligence, it is necessary to establish a perfect data privacy protection mechanism to protect the rights and interests of farmers.

The application potential of artificial intelligence in the rural economy is huge, which can significantly improve agricultural production efficiency and product quality, and promote the development of rural financial services. However, in the face of challenges such as technology cost, shortage of talents and data security, it is necessary to establish perfect supporting measures and policy guarantees to promote the effective promotion and application of technology and realize the sustainable and healthy development of rural economy in southwest China.

2.2 Impact of Blockchain Technology on Rural Economic Development

Blockchain technology, as a distributed ledger technology, has the characteristics of decentralization, immutability and transparency, and is setting off a technological revolution in various fields. In terms of rural economic development, the application of blockchain technology also shows great potential. Agricultural traceability is a key area where blockchain technology plays an important role. By recording the data of every production, transportation and storage link on the blockchain, the problems of counterfeiting and shoddy and information asymmetry existing in the agricultural product market at this stage can be effectively solved. Consumers can query the entire production process of agricultural products through the blockchain traceability system, thereby enhancing trust in the quality of agricultural products.

The application of blockchain technology in the flow of agricultural funds also shows its potential to improve the rural economy. The traditional rural financial system is difficult to obtain loans and financial services because of information asymmetry and imperfect credit system. Blockchain technology can promote agricultural production and rural economic development by creating a transparent and credible agricultural financial system, linking farmers' production and operation data such as planting information and sales records, forming a credible credit system, improving farmers' loan capacity and the availability of financial services.

The application of blockchain technology in rural land ownership can not be ignored. Land ownership confirmation is a major issue involving the vital interests of farmers. At present, the work of rural land ownership confirmation in China still faces many challenges, mainly in the unclear definition of land ownership and complicated work. Through blockchain technology, land ownership confirmation information can be tampered with, transparent and open, to ensure that the ownership and use rights of each piece of land are clear, reduce land disputes, protect the legitimate rights and interests of farmers, and also provide strong support for rural land transfer and financing.

Although blockchain technology has great potential in promoting rural economic development, it also faces many challenges in practical application, such as the high cost of technology implementation, technical complexity, and weak network infrastructure in rural areas. Policy makers and technology developers need to consider these challenges and develop appropriate roll-out strategies and technical standards to ensure that blockchain technology truly benefits rural economic development.

Through the analysis of the potential and challenges of blockchain technology in rural economic development, it can be seen that its wide application prospects and far-reaching impact are expected to bring new development opportunities for the rural economy in southwest China.

2.3 Impetus and Challenge of Big Data to Rural Economic Transformation

As a revolutionary technology, big data is having a profound impact on the transformation of rural economy in southwest China. The role of big data in rural economy is mainly reflected in precision agriculture, market forecasting and resource allocation. In precision agriculture, large amounts of environmental data such as soil, climate and crop growth can be obtained and analyzed through big data technology, so as to scientifically guide farmers to make planting decisions and improve agricultural production efficiency and crop yield. Big data also plays an important role in market forecasting, by analyzing consumption trends and market demand, farmers and agricultural practitioners can more accurately carry out market layout and product sales, reducing the imbalance between supply and demand. Big data can also optimize the allocation of rural resources, which is reflected in the procurement of agricultural materials, the circulation of agricultural products and the improvement of resource utilization.

In the process of promoting big data technology also faces many challenges. For example, problems with the integrity and accuracy of data acquisition limit its effective application. Data security and privacy issues need to be given adequate attention to prevent the risk of data misuse and leakage. The information infrastructure in rural areas is relatively weak, and the breadth and depth of technology application are limited [13-15]. To realize the full application of big data in the rural economy, continuous improvements in technical training, policy support and infrastructure construction are also needed. The popularization of big data not only depends on the advanced nature of the technology itself, but also needs to pay attention to its adaptability and operability in combination with the actual situation in rural areas [16-19].

3 DEVELOP BACKGROUND AND NEEDS OF RURAL ECONOMY

3.1 Status of Rural Economy in Southwest China

The present situation of rural economy in southwest China not only has its unique resource advantages, but also faces many challenges. Geographically, southwest China includes Yunnan, Guizhou, Sichuan and other provinces and autonomous regions. The region's climatic conditions, topographic features and ecological environment provide abundant resources for its agricultural production, but these factors also pose multiple challenges to economic development.

(1) Resource advantage and agricultural diversity. The natural conditions in southwest China are very suitable for the cultivation of a variety of special agricultural products, such as flowers from Yunnan, tea from Guizhou, fruit from Sichuan, etc. These agricultural products not only have distinct regional characteristics, but also enjoy a high market reputation at home and abroad. Due to the mountainous terrain and relatively inconvenient transportation, the market circulation of agricultural products has been restricted. The construction of rural infrastructure is relatively weak, the popularization of modern agricultural production technology is low, resulting in low production efficiency and slow growth of farmers' income.

(2) In terms of population, the labor force in the rural areas of southwest China is generally engaged in agricultural production, and the quality and skill level of the labor force is relatively low. Due to the lack of adequate technical training and educational resources, agricultural production efficiency is not fully utilized. In this context, farmers' acceptance of new technologies and new knowledge is also low, which further restricts the development of rural economy. In addition, there is a phenomenon of population outflow in some areas, and a large number of young labor forces are lost, making the problem of rural population aging gradually prominent.

(3) The lack of external financial and policy support is also an important issue. Although the state has issued a series of policies to promote rural economic development, aiming at promoting agricultural modernization and rural infrastructure construction, the actual effect of many policies has failed to meet expectations due to the problems such as insufficient execution and unreasonable allocation of resources in the specific implementation process of policies. Private and external capital investment in rural areas is also insufficient, resulting in the rural economic development faced with a shortage of funds.

(4) The low degree of marketization and information asymmetry seriously restrict the vitality of rural economy. Farmers' individual economic activities and loose cooperative organizations make the market circulation of agricultural products less organized and difficult to obtain market information. Many farmers still follow the traditional production and sales model, lack of brand awareness and market development ability, which makes them at a disadvantage in the market competition.

(5) In terms of technology, although some rural areas in southwest China have begun to introduce the concept of digital agriculture and intelligent management, the application of modern agricultural technology is still quite limited due to backward infrastructure and limited capital technology. The slow process of the popularization of this technology makes it difficult to significantly improve agricultural production efficiency .

In general, the current situation of rural economy in southwest China is characterized by abundant resources but insufficient utilization, pending strengthening of policy support, prominent problems of population structure and labor quality, asymmetric market information, and limited application of modern technology. In this context, how to effectively introduce and apply the three major technologies of artificial intelligence, blockchain and big data has become the key to solve this development dilemma. It is in this complex and multiple economic situation that the future technology integration application is more necessary and urgent.

3.2 Needs of Rural Economic Development

The rural economic development in southwest China is faced with many demands, which are mainly reflected in the following aspects:

The need to improve the efficiency of agricultural production is particularly prominent. Due to the complex terrain and diverse natural conditions in this region, the traditional agricultural production mode has been difficult to meet the requirements of modern development, and there are problems such as insufficient labor force, single production mode and waste of resources. Through the introduction of artificial intelligence, precision agriculture technology and automation equipment, it is expected to achieve optimal allocation of resources and improve the yield and quality of food crops and cash crops.

Agricultural product circulation and traceability systems need to be upgraded. In southwest China, agriculture is the main economic pillar, but the circulation channels of agricultural products are not smooth, and the information asymmetry between producers and consumers is prominent, which leads to the instability of farmers' income. The addition of blockchain technology can realize the full traceability of agricultural products from production to sales, enhance the trust of consumers, reduce transaction costs, improve the circulation efficiency of agricultural products, and thus increase the economic benefits of farmers.

Targeted poverty alleviation in rural areas needs the support of big data. The region's poverty problems are complex and diverse, and traditional poverty alleviation models have limited effect. Big data technology can provide data support for the country to formulate scientific and effective poverty alleviation policies through the collection and analysis of multi-dimensional data of rural households, economic activities, environmental resources and so on. Accurately identify the poor population, rationally allocate poverty alleviation resources, and effectively evaluate the effect of poverty alleviation, so as to achieve the target of precise poverty alleviation.

There is an increasingly urgent need to modernize rural education and medical services. Limited by geographical location and economic conditions, there is a big gap in educational resources and medical conditions in southwest rural areas. Through big data analysis and artificial intelligence technology, online education and telemedicine services can be introduced to make up for the imbalance of urban and rural education and medical resources, and improve the comprehensive quality and health level of the rural population.

The demand for rural economic restructuring and industrial upgrading is obvious. At present, the southwest rural economy is dominated by traditional agriculture, with a single industrial structure and weak ability to resist risks. With advanced technologies, emerging industries such as agricultural product processing, tourism and agriculture, and modern logistics can be developed, the integrated development of the primary, secondary and tertiary industries can be promoted, the sustainability and resilience of the rural economy can be enhanced, and the overall revitalization of the rural regional economy can be promoted.

The development needs of rural economy in southwest China mainly focus on five aspects: production efficiency improvement, circulation system improvement, targeted poverty alleviation, education and medical care improvement, and economic restructuring.

3.3 Possibility and Challenge of Technology Application

The application of technology in the rural economy of southwest China has shown great potential, but it also comes with many challenges. The application of artificial intelligence in agriculture can improve production efficiency and yield, but it needs to address issues such as technology access, operational complexity and cost. Blockchain technology can ensure transparency and trust in agricultural product traceability, and inconsistent technical standards and imperfect infrastructure may limit its wide application. Big data provides personalized services and reasonable allocation of resources in targeted poverty alleviation, and data privacy and data security issues need special attention. Technology acceptance and training of technicians in rural areas are also important challenges. Taken together, only the system to deal with these problems, in order to fully unleash the potential of technology.

4 PROSPECTS FOR THE FUTURE DEVELOPMENT OF RURAL ECONOMY IN SOUTHWEST CHINA

4.1 Transformation and Driving Force of the Integration of Three Technologies on Rural Economic Structure

The integration of artificial intelligence, blockchain, and big data has brought about significant transformations and impetus to the economic structure of rural areas in Southwest China. The synergistic effects of these advanced technologies can markedly enhance the efficiency, transparency, and sustainability of the rural economy. The confluence of artificial intelligence, blockchain, and big data has propelled the vigorous development of the rural economy in Southwest China. Combining blockchain with big data analytics is beneficial in addressing issues of low production efficiency, information isolation, and irrational resource allocation in the Southwest region.

Firstly, the distributed ledger technology and cryptographic mechanisms of blockchain ensure the security and immutability of agricultural data, preventing malicious tampering and data leaks. Big data, on the other hand, can efficiently store, manage, and analyze massive and heterogeneous agricultural data, extracting valuable information. The integration of blockchain and big data technologies enables trustworthy data sharing among different entities, breaking down data silos and enhancing the efficiency and collaboration in agricultural production and management in

Southwest China. Secondly, utilizing big data analytics, multidimensional data such as soil, meteorology, crop growth, and pest and disease information can be mined and analyzed to provide farmers with precise decision-making recommendations for planting, irrigation, fertilization, and pest control. Blockchain technology can record the generation and updating process of these data, ensuring their credibility and traceability. The convergence of blockchain and big data technologies allows farmers to confidently base their agricultural production decisions on data analysis results, improving the precision of agricultural production and the efficiency of resource utilization. Lastly, blockchain facilitates real-time information sharing and synchronization among all participants in the supply chain, enhancing its transparency and collaboration, reducing information asymmetry and communication costs in intermediary links, and lowering the risks of logistics loss and delays. Big data analytics can integrate and analyze logistics, information flow, and financial flow data within the supply chain, optimizing resource allocation and processes, and improving the efficiency and profitability of the supply chain.

At present, the rural economy in Southwest China is confronted with the issues of excessive costs and incomplete information. The integration of automated processing, utilizing artificial intelligence (AI) to analyze big data, can effectively address these challenges. On one hand, AI in agricultural production can accurately predict weather, pest and disease conditions, and other factors through big data analysis and machine learning technologies. The use of drones, smart sensors, and AI enables real-time monitoring and management of farmlands, significantly enhancing the level of agricultural automation and thus saving considerable time and labor costs associated with data processing. On the other hand, AI, by analyzing big data related to soil, climate, and crop growth, provides farmers with precise recommendations for irrigation and fertilization, reducing resource waste and increasing yield. In terms of market forecasting, the combination of AI and big data technologies allows farmers and agricultural practitioners to clearly understand consumption trends and market demands, thereby enabling more precise market positioning and product sales, reducing the imbalance between supply and demand. Concurrently, the fusion of blockchain and AI has a significant impact on the rural economy. Firstly, the combination of these two technologies helps to tackle challenges related to data security. Blockchain, as a distributed data storage and sharing platform, ensures the security, transparency, and traceability of data. When AI utilizes blockchain data for analysis and prediction, the ownership and usage of data can be clearly recorded, allowing users to better control the scope and manner of data sharing, preventing data misuse, and protecting privacy. Secondly, the integration of blockchain and AI is beneficial for enhancing the sharing of agricultural information in the Southwest region. Blockchain can standardize data formats and standards, while AI transforms data from different sources and structures into a processable format, integrating agricultural information, breaking data silos, and achieving comprehensive sharing.

In summary, the convergence of these three technologies is beneficial for data sharing. Big data analytics can collect and preprocess multi-source and heterogeneous agricultural data. On this basis, artificial intelligence further processes and analyzes the data using machine learning algorithms to uncover valuable information. Blockchain, with its distributed ledger technology, ensures the secure sharing and credible transmission of data among all participants, maintaining data consistency and integrity. This convergence also supports decision-making. Big data analysis provides a basis for precision agriculture by analyzing data on soil, meteorology, and crop growth. Artificial intelligence constructs predictive models and decision support systems based on these data and analysis results, offering precise decision-making recommendations for agricultural production. Blockchain records and traces various data and decisions in the agricultural production process, ensuring transparency and traceability. Furthermore, it is advantageous for protecting the privacy of farmers. Blockchain's encryption technology provides security for agricultural data, ensuring privacy and integrity, preventing data tampering and leakage. Artificial intelligence analyzes and processes encrypted data, and big data analytics, under the premise of data security, mines and analyzes massive data to provide decision-making basis for agricultural production and management. Only by fully unleashing the potential of these three technologies and achieving effective technological integration can we better promote the transformation and development of the rural economic structure in Southwest China.

4.2 Suggestions and Prospects for Policy Makers

In order to promote the vigorous development of rural economy in southwest China, policymakers should be forward-looking and take multiple measures at the same time. The primary task is to build a sound technical standard system, enhance the adaptability and interoperability of artificial intelligence, blockchain and big data technologies, and lay a solid foundation for rural digital transformation. At the same time, strengthen technical education and training, improve farmers' technology application ability and information literacy, so that advanced technology is truly integrated into agricultural production practice, and release the huge potential of science and technology to rejuvenate agriculture.

In order to stimulate innovation, special funds and incentive mechanisms should be set up to attract scientific research institutions and enterprises to actively participate in the research and development and application of rural science and technology, and form a good ecology of deep integration of production, university and research. In addition, improve the system of laws and regulations, strict data supervision, to ensure that data security and privacy are effectively protected in the process of technology application, and escort the healthy development of rural economy. Through these comprehensive policies, the southwest rural economy will be inserted into the wings of science and technology to achieve leap-forward development [16-19].

5 CONCLUSION AND DISCUSSION

This paper deeply studies the far-reaching impact of the combination of artificial intelligence, blockchain and big data on the rural economy of southwest China, and clearly points out the application potential and challenges of these three technologies in the rural economy. Through a detailed analysis of specific application scenarios, such as the role of artificial intelligence in agricultural production, the practice of blockchain in agricultural product traceability, and the role of big data in targeted poverty alleviation, we see how these three technologies are changing and driving the development of rural economies, especially in southwest China. However, we also see that the popularity and application of these three technologies has also brought some challenges and problems, such as the formulation of technical standards, adaptability and security issues, which have caused certain challenges for policy makers in guiding and managing the development direction of science and technology, promoting rural economic development, and ensuring the smooth transition of rural society. Therefore, this requires us to study and think more deeply, how to guide and manage the development of these three technologies scientifically and reasonably according to the actual situation of the rural economy, grasp the opportunities and challenges, in order to better serve the development of the rural economy. At the same time, it is also expected that more research can go into the countryside to understand the actual needs and conditions of the countryside, so as to put forward more scientific suggestions and opinions to promote the scientific and technological innovation and transformation of the rural economy. In addition, we also look forward to more policies to support the application and popularization of these three technologies in rural areas, such as strengthening infrastructure construction, improving the scientific and technological quality of farmers, and establishing a sound technical service system, so as to promote the high-quality development of the rural economy driven by science and technology.

COMPETING INTERESTS

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

REFERENCES

[1] Liu Yunshuo, Liu Yuanyuan, Zhang Fan, et al. Threat or Challenge: The double-edged sword effect of artificial intelligence use on employee innovation performance. Business review, 2024, (9) : 91-102.
[2] Zhu Han, Wu Sheng. Block chain across chain technology and its security review. Computer application research, 2024: 1-12.
[3] Zhang Xiaoxue, Sun Yingguang. Ai fu can cast on the community consciousness of the Chinese nation logic approach. Academic exploration, 2024: 1-8.
[4] Ding Jianxun, Wang Yunyao, Wu Jiayu, et al. Machine Substitutions: AI applications or factor relative price Changes?. Soft science, 2024: 1-15.
[5] Yang Yongchun, Jian Yuting. Changes and challenges in the development of artificial intelligence era city geography. Journal of geographical, 2024: 1-17. http://kns.cnki.net/kcms/detail/11.1856.p.20240904.0909.002.html.
[6] Wu Jiaying, Yuan Lingyun, Chen Meihong, et al. The block dynamic fragmentation chain model based on node credibility. Computer application research, 2024: 1-10.
[7] Yan Chi. On the construction of artificial intelligence standard and law collaborative governance system. Journal of Beijing institute of technology (social science edition), 2025, 1-15.
[8] Liu Satai, Liu Pengfei, Li Fei. Agricultural science and technology innovation ability and the level of rural economic development of the coupling coordination study. Journal of statistics and decision, 2024, 40(16): 151-155.
[9] Lu Fuying, Yu Xiaoting. The development of rural democratic supervision to. Journal of zhejiang, 2024(5): 219-227.
[10] Feng Zhangwei, Du Bizheng, Yu Zhiyong, et al. Research on investment strategy of new energy vehicle power battery recycling and traceability technology driven by blockchain. Management science in China, 2024: 1-14.
[11] Wang Yiping, Jiang Shiyin. Study on Improving organic composition of agricultural Capital and Promoting high-quality Development of Rural Economy in New Era. Rural Economy, 2024(07): 135-144.
[12] Zhu Weiquan, Feng Xishuo, Shan Hongbo, et al. Research on the development strategy of rural collective economy in the process of rural revitalization. Journal of Agricultural Economics, 2024(07): 48-50.
[13] Gao Peng, Nie Jiajia, Zhu Binxin, et al. Online platform blockchain adoption and distribution model selection strategy considering green product competition. System engineering theory and practice, 2024: 1-25.
[14] Xie Dengke, Zhou Hongfei. Block chain electronic delivery of practical difficulties and deal with. Journal of seeking truth, 2024(03): 115-125.
[15] Hu Xiangpei, Du Mu, Kong Xiangwei, et al. Agricultural products supply chain based on the block chain traceability research review. Journal of management science, 2024, 27(5) : 1-12.
[16] He Y. Research on Public security application and legal regulation of blockchain electronic forensics technology. The rule of law research, 2024(3): 57-71.
[17] Li Jinwei. An analysis of rural economic development in Wuling Mountain Area in Ming and Qing Dynasties -- taking Northeast Guizhou as the center. Agricultural Archaeology, 2024(01): 95-102.

[18] Chang J. Research on the impact of e-commerce sinking on rural economy based on the background of rural revitalization. Agricultural Economics, 2024(02): 127-130.
[19] Yang Lian-Na, Zhang Xin-Yu. Does agricultural trade promote green agricultural development in China? - based on green agricultural total factor productivity perspective. Journal of finance and trade studies, 2024, 35(02): 31-41.

Trends in Social Sciences and Humanities Research
ISSN: 2959-9938
DOI: https://doi.org/10.61784/tsshr3131

CONVERTIBLE BOND PRICING BASED ON MONTE CARLO SIMULATION

YiHang Xie*, Quan Zhou, ZhanZhao Zhang
School of Mathematics Statistics and Mechanics, Beijing University of Technology, Beijing, 100124, China.
Corresponding Author: YiHang Xie, Email: xyh20030719@emails.bjut.edu.cn

Abstract: Convertible bonds, as a novel financing instrument, possess dual characteristics of both conventional bonds and options due to the inclusion of clauses with American option-like features such as conversion, redemption, putback, and conversion price adjustment. Therefore, the pricing of convertible bonds is of considerable importance. This study has gathered a substantial amount of relevant industry data. For accuracy considerations, this paper employs the Random Forest algorithm and LightGBM algorithm to predict the probability and price of triggering downward adjustment clauses, achieving a classification accuracy of 60.162% and a regression goodness of fit of 0.757. Subsequently, Monte Carlo simulation was utilized for convertible bond pricing prediction, resulting in the calculation of MAPE values for two convertible bonds of 5.15% and 9.6%, respectively, indicating the model's high accuracy. Finally, a financial analysis of the results was conducted to provide investment recommendations. Leveraging this research outcome, convertible bonds can be better applied and promoted, and the development of the convertible bond market can increase the proportion of debt financing in the capital market, enabling enterprises to flexibly adjust their capital structure. Its development also provides investors with more investment options.
Keywords: Convertible bonds; Random Forest; LightGBM; Monte Carlo simulation

1 INTRODUCTION

Convertible bonds are bonds that allow the holder to convert the bond into the company's common stock at a price agreed upon at the time of issuance. The interest rate on these bonds is generally lower than that of ordinary corporate bonds, and issuing convertible bonds can reduce the financing costs for companies. Holders of convertible bonds also have the right to sell the bonds back to the issuer under certain conditions, and the issuer has the right to compulsorily redeem the bonds under certain conditions. The Monte Carlo method is a numerical calculation method based on probability and statistical theory. It solves deterministic problems by performing a large number of random simulations to obtain numerical solutions. The Monte Carlo pricing method estimates the price of convertible bonds by simulating random variables. It generates a series of random paths to simulate the changes in convertible bond prices and calculates the bond price on each path. Today, the Monte Carlo method has become an effective method for bond valuation.

Xiao Jie[1] used the pricing method of the binary tree model to conduct empirical analysis on the theoretical value of the bond under various terms. Wang Pu[2] established a convertible bond pricing model with Hull-White stochastic volatility under the sub-fractional jump-diffusion process, and obtained the model parameters using the maximum likelihood function method. Jiao Dian[3] first used the present value of future cash flows method to price the bond value of convertible bonds, then used the traditional B-S model to price the option value of convertible bonds issued from 2015 to 2020 that meet the assumptions of the B-S pricing model, and finally used the extended B-S model with additional terms to conduct a secondary pricing of the convertible bond sample data. Hu Miao[4] used the sliding window method to estimate the upper and lower variances, simulated the underlying asset price using the relevant theories and definitions of G-Brownian motion, combined with the Monte Carlo method to simulate the price of the embedded call option of the convertible bond, and further priced the convertible bond. Du Dongxu[5] derived and constructed a convertible bond valuation model based on multiple linear regression and polynomial characteristics for convertible bond pricing. Li Zaiqiao[6] studied the pricing of convertible bonds based on the Black-Sholes model. Liu Sicheng[7] used the Ada Boost algorithm to price convertible bonds. Wang Yintian[8] adopted the convertible bond pricing model proposed by Tsiveriotis and Fernandes, rigorously incorporating the downward modification clause, as well as the redemption, put, and conversion clauses. She analyzed the impact of the downward modification clause on the pricing of convertible bonds.

Currently, scholars seldom employ the Monte Carlo method for the valuation of domestic convertible bonds, and there are scant studies that provide corresponding recommendations to investors based on the results.

Therefore, This study innovatively introduces downside clauses through the application of machine learning, compares various machine learning models, employs Monte Carlo simulation to price convertible bonds, and offers investment recommendations tailored to specific companies. Consequently, this study possesses certain practical value in the field of convertible bond pricing and investment in China.

2 PREDICTION OF DOWNWARD-ADJUSTMENT CLAUSES

To enhance the innovativeness of the model, data on downward revisions was collected. This study queried the Shanghai Stock Exchange and Shenzhen Stock Exchange for downward revision information of listed companies over

the past decade, encompassing issuance size, GICS primary industry codes, and convertible bond rating codes. The specific datasets for this article is sourced from www.sse.com.cn and www.szce.cn. Since the objective is to predict the conversion price following the triggering of downward revision clauses, cases that underwent downward revisions were selected from the datasets. Furthermore, the features "GICS primary industry" and "convertible bond rating" were encoded, with the coding scheme being "1, 2, 3, 4, 5, 6, 7, 8, 9" for "Industrial, Raw Materials, Consumer Goods, Information Technology, Healthcare, Telecommunications, Non-Consumer Goods, Utilities, Finance," respectively. The codes for "CC, B-, A, A+, AA-, AA, AA+, AAA" were sequentially assigned as "1, 2, 3, 4, 5, 6, 7, 8," and the downward revision passing flag was set to 1, while the failing flag was set to 0.

The prediction of conversion prices essentially involves a regression task, where the features include the pre-revision price, issuance size, GICS, and convertible bond rating. Considering accuracy, multiple machine learning models were established: linear regression, support vector machine regression, random forest regression, XGBoost regression, and LightGBM regression. The optimal model was selected based on the evaluation metrics mean squared error (MSE) and R-squared (R2) goodness of fit. After experimentation, the LightGBM model was ultimately chosen for the regression task, with an MSE of 44.616 and an R-squared of 0.757. The model demonstrated strong applicability with only four features. The regression curve for the test set is plotted as shown in Figure 1.

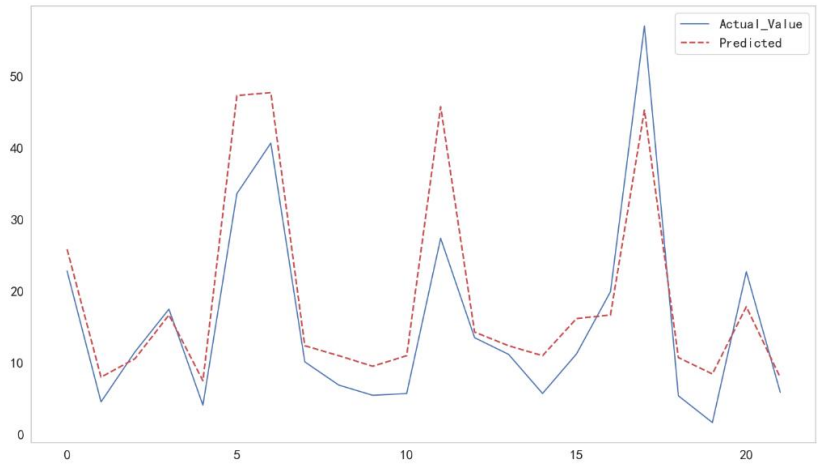

Figure 1 Results of the Regression Curve

Subsequently, a feature importance analysis was conducted. The result graph from the interpretable machine learning SHAP module reveals that the importance ranking is as follows: pre-revision price, issuance size, GICS, and convertible bond rating [9]. Furthermore, the mechanism of specific effects can be discerned. Taking the issuance size as an example, when its value is smaller, the corresponding model output is also smaller. Conversely, as its value increases, the model output also increases. The SHAP results are illustrated in Figure 2.

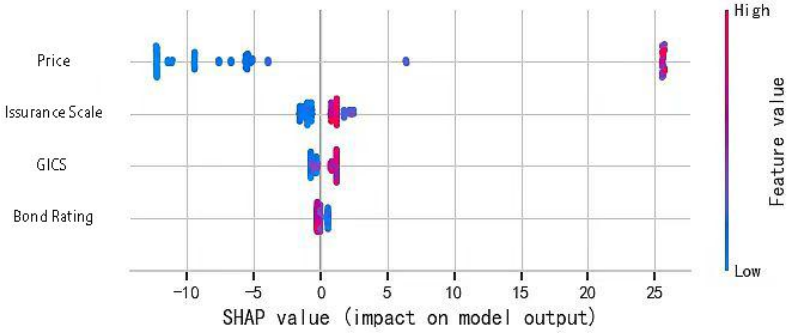

Figure 2 Result of the SHAP

The prediction of whether a downward revision will be approved is essentially a binary classification task, where category 1 represents approval of the downward revision and category 0 represents disapproval. The features remain the pre-revision price, issuance size, GICS, and convertible bond rating. A random forest model is established for classification, which is an ensemble model integrating multiple decision trees [10]. By solving and outputting the number of instances classified into two categories each time, the probability of whether the lower bound adjustment is successful can be calculated. The calculation method is as follows:

$$P = \frac{\sum_{i=1}^{n} kind = 1}{\sum_{i=1}^{n} kind = 0 + \sum_{i=1}^{n} kind = 1} \tag{1}$$

This study employed a 10-fold cross-validation method, deriving the final probability of downward revision equal to 0.27 by calculating the average. The model accuracy stood at 60.162%, which is visualized through the confusion matrix depicted in Figure 3.

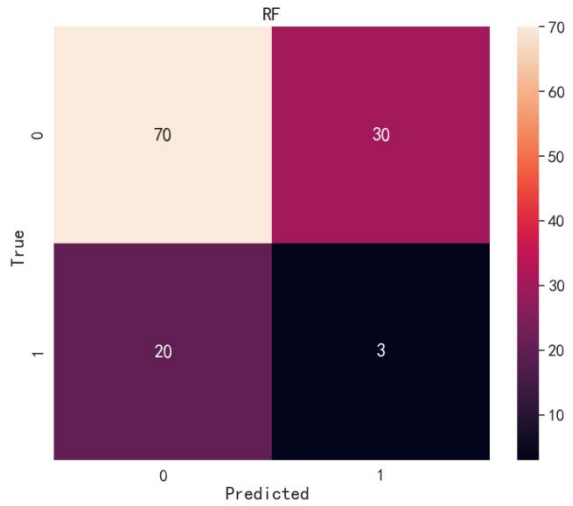

Figure 3 Confusion Matrix

3 MONTE CARLO-BASED PRICING OF BONDS

This article conducts valuation for each bond in China on every trading day. It simultaneously considers the conversion clauses, redemption clauses, putback clauses, and downward revision clauses of each convertible bond, performs 5,000 Monte Carlo simulations, calculates the expected returns under various simulation paths, and ultimately derives the model pricing of the convertible bond for the current day through discounted averaging. Through a large number of simulation paths, the model is able to capture multiple possible trends in stock prices, enhancing the accuracy of pricing. The basic information of the convertible bond is inputted, including the maturity date, conversion start date, coupon rate, redemption price, redemption trigger price, putback trigger price, conversion price, etc. The geometric Brownian motion model is used to simulate the stock price path. Where Z is a standard normal distribution random variable, St represents the asset price at time t, S0 represents the asset price at the valuation time, and σ represents the volatility of the asset price at time t. The stock price itself follows a lognormal distribution.

$$S_t = S_0 * \exp\left((r - \frac{1}{2}\sigma^2)t + \sigma\sqrt{t} \cdot Z\right) \tag{2}$$

Utilizing Python to develop a program, a simulated path is created using a random number generator. The mathematical formula for the pricing of convertible bonds is as follows, from which the predictive price of convertible bonds can be derived. Some of the results are presented in Table 1.

$$PredictPrice = \frac{\sum_{i=0}^{5000} price_i}{5000} \tag{3}$$

Table 1 Monte Carlo Pricing Results for Convertible Bonds

Date	Bond_Name	Prediction	Actual
2024-01-26	123087	112.93	115.22
2024-01-25	123087	114.02	115.04
2024-01-24	123087	123.85	112.42
2024-01-23	123087	112.41	112.81
2024-01-22	123087	111.93	114.10
2024-01-19	123087	113.07	115.78
2024-01-18	123087	109.14	115.60
2024-01-17	123087	111.06	116.05

The pricing results of the two convertible bonds are visualized in Figures 4 and 5. To verify the accuracy of the model, this paper adopts the Mean Absolute Percentage Error (MAPE) as an evaluation metric. The calculation formula is as follows: where N represents the data volume, yi denotes the actual value at the i-th observation point, and represents the model's predicted value at the i-th point. A MAPE value of 0% indicates a perfect model, while a MAPE value greater than 100% indicates a poor model. Upon calculation, the MAPE values for the two convertible bonds, "Mingdian Convertible Bond" and "Shengtang Convertible Bond", are 5.15% and 9.6%, respectively, demonstrating the high accuracy of the model.

$$MAPE = \frac{100\%}{N}\sum_{i=1}^{n}\left|\frac{\hat{y}_i - y_i}{y_i}\right| \tag{4}$$

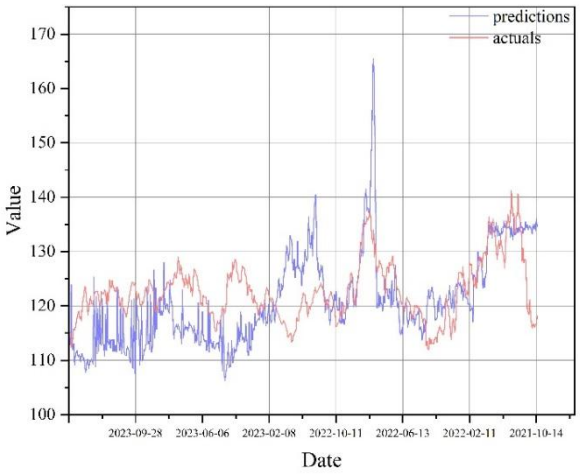

Figure 4 Comparison of Predicted and Actual Values for Mingdian Convertible Bonds

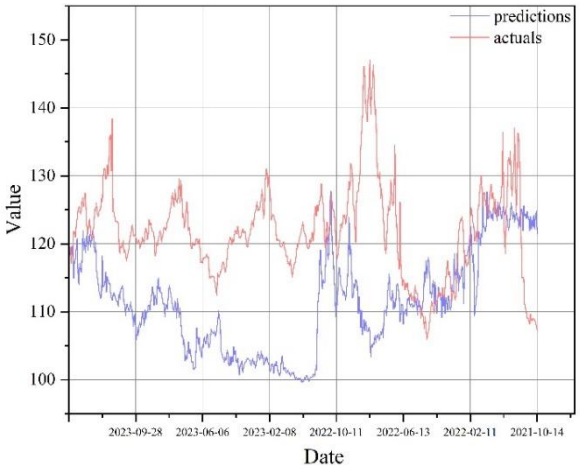

Figure 5 Comparison of Predicted and Actual Values for Shengtang Convertible Bonds

4 FINANCIAL ANALYSIS AND INVESTMENT ADVICE

After utilizing Monte Carlo simulation for the pricing of convertible bonds, this study selected a specific company for further financial analysis. Recent trading data reveals a certain degree of volatility in the price of Mingdian Convertible Bonds. From August 2023 to late January 2024, its price fluctuated between 119 yuan and 125 yuan, followed by a significant decline in February, with the lowest price falling below 113 yuan. Under the influence of fluctuations in the overall economic environment and policy changes, the stock prices of many technology companies have experienced ups and downs, and Mingdian is no exception. Although it maintained stability in the early stages, it has recently shown a clear downward trend, with indicators such as trading volume and turnover rate indicating market unease. The stock market itself is highly volatile, especially during periods when large institutional investors adjust their positions and liquidity is tight, which can lead to rapid price fluctuations. Specifically regarding information development, its stock price is influenced by various factors. For example, recent industry news, the performance of the company's financial

reports, and external economic data may all impact investors' psychology. The stock market itself is highly volatile, especially during periods when large institutional investors adjust their positions and liquidity is tight, which can lead to rapid price fluctuations. Specifically regarding information development, its stock price is influenced by various factors. For example, recent industry news, the performance of the company's financial reports, and external economic data may all impact investors' psychology.

Investors can utilize this model to predict the trend of company stock prices, select appropriate arbitrage methods, and subsequently profit. Investors may prioritize the GICS primary sectors, as companies in these sectors often possess a relatively stable business model and strong profitability, which reduces the risk of corporate default, thereby rendering the convertible bonds issued by them safer. Furthermore, certain categories within the primary sectors, such as consumer staples and healthcare, exhibit a certain degree of resilience against economic cyclicality. Even during economic downturns, the performance of these sectors remains relatively stable, thus bolstering the value of convertible bonds. Additionally, investors may endeavor to select companies with high ratings, as a high rating signifies a lower likelihood of corporate default. Consequently, investors can hold these convertible bonds with greater peace of mind, without fearing that the company may be unable to repay the debt or interest, leading to a more stable stock price and, consequently, more accurate model predictions.

5 CONCLUSIONS

This article addresses the pricing issue of convertible bonds, employing Monte Carlo simulation based on the least squares method for pricing prediction. It simultaneously considers the downward adjustment clause, as well as the redemption, putback, and conversion clauses. Furthermore, it utilizes random forest and LightGBM algorithms for predicting the downward adjustment price and probability. The accuracy of regression and classification tests has been found to be high. Monte Carlo simulations were conducted for related industries, and the MAPE values for the two tested convertible bonds were 5.15% and 9.6%, respectively. This demonstrates the strong practicality of the Monte Carlo method adopted in this article for pricing convertible bonds. For investors, they can choose appropriate arbitrage methods based on the predicted pricing of convertible bonds. In future research, further consideration could be given to incorporating credit risk, adjusting the model structure, and enhancing model accuracy, thereby enabling better decision-making for both companies and investors.

COMPETING INTERESTS

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

REFERENCES

[1] Xiao Jie, Zhao Hui, Ding Sheng. Research on the pricing of convertible bonds in the 5G industry chain based on the binary tree model - Taking Fenghuo Convertible Bond (110062) as an example. Operation and Management, 2023(12): 14-22. DOI: 10.16517/j.cnki.cn12-1034/f.2023.12.006

[2] Wang Pu, Xue Hong, Zhang Juan. Pricing Convertible Bonds with Random Volatility under Fractional Brownian Motion-Diffusion. Modern Marketing (Late Edition), 2023(03): 36-38. DOI: 10.19932/j.cnki.22-1256/F.2023.03.036.

[3] Jiao Dian. Research on the Pricing of Convertible Bonds Based on the B-S Model. The Economist, 2023, (01): 45-47+50

[4] Hu Miao, Xue Hong, Liu Xin. Pricing and Empirical Analysis of Convertible Bonds in a G-Brownian Motion Environment. Journal of Xi'an University of Technology, 2020, 34(05): 121-127. DOI: 10.13338/j.issn.1674-649x.2020.05.019.

[5] Du Dongxu, Yan Haibo. Application of Machine Learning in Convertible Bond Pricing. Science and Technology Economic Market, 2023, (04): 95-97.

[6] Li Zaiqiao. Pricing and Trading Strategies of Convertible Bonds Based on the Black-Scholes Option Model. Business Accounting, 2023, (06): 32-38.

[7] Liu Sicheng. Empirical Study on Convertible Bond Pricing. Southwest University of Finance and Economics, 2022. DOI: 10.27412/d.cnki.gxncu.2022.002272.

[8] Wang Yintian, Wen Zhiying. The Impact of Downward Revision Clauses on the Pricing of Convertible Bonds in China. Journal of Tsinghua University (Natural Science Edition), 2018, 58(01): 108-112. DOI: 10.16511/j.cnki.qhdxxb.2018.22.014.

[9] Fu M ,Liu Y ,Hou Z, et al.Interpretable prediction of acute ischemic stroke after hip fracture in patients 65 years and older based on machine learning and SHAP.Archives of Gerontology and Geriatrics, 2025, 129105641-105641.

[10] Xu H ,Li P ,Wang J , et al.A study on black screen fault detection of single-phase smart energy meter based on random forest binary classifier.Measurement,2025, 242(PE): 116245-116245.

Trends in Social Sciences and Humanities Research
ISSN: 2959-9938
DOI: https://doi.org/10.61784/tsshr3132

THE PROBLEM OF BENCH DRAGON ENTERING AND EXITING THE SPIRAL MOTION WITH CONSTANT DISTANCE

YiHeng Zhang
School of Mathematics and Statistics, Beijing Jiaotong University, Beijing 100044, China.
Corresponding Email: 22271080@bjtu.edu.cn

Abstract: With the acceleration of China's socialist modernization process, the protection and innovation of traditional folk culture have become the focus of societal attention. This paper focuses on the unique folk activity of the Bench Dragon, which is found in regions such as Zhejiang and Fujian. It conducts an in-depth study of the problem of the Bench Dragon entering and exiting the spiral motion with constant distance, aiming to provide theoretical support for the inheritance and development of this traditional folk custom. Through the analysis of the Bench Dragon's motion trajectory, speed variation, collision conditions, and turning areas, this paper establishes a mathematical model for the Bench Dragon's equidistant spiral motion. The model utilizes recursive formulas, geometric relationships, trigonometric theorems, and the simulated annealing algorithm to thoroughly explore the motion laws during the entering and exiting process. The study finds that there are collision risks during the entering and exiting process, calculates the time point of the first collision, and determines the minimum pitch that satisfies the turning conditions. Additionally, the paper analyzes the impact of the dragon head's speed variation on the dragon body's speed and derives the limiting speed of the dragon head. The research results show that the model and methods established in this paper can effectively guide the arrangement and safety of Bench Dragon performances, which is of significant importance for promoting the inheritance and innovation of traditional folk culture.
Keywords: Equidistant spiral motion; Simulated annealing algorithm; Bench dragon

1 INTRODUCTION

With the gradual advancement of Chinese-style modernization, the country has increasingly emphasized the integration of excellent traditional Chinese culture with modern technology, promoting the innovation and development of traditional folk culture. In particular, traditional local folk activities in regions like Zhejiang and Fujian continue to maintain vibrant vitality. The "Bench Dragon," as one of the region's unique folk cultural activities, has become an important festive event for local people due to its distinctive form of expression. The dragon dance involves connecting multiple segments of benches with the dragon's head leading, and the entire dragon team performs smooth movements along specific trajectories through continuous entering and exiting, showcasing strong local characteristics and the charm of folk art. This paper, addressing research issues related to this traditional folk activity, will establish a mathematical model based on equidistant spiral motion, focusing on the dynamic process of 1 dragon head and 223 dragon body segments during the entering and exiting process.

Currently, scholars both domestically and internationally have conducted research on equidistant spiral motion. Zhoulin Ding and Yongji Yu derived the Archimedean spiral equation describing the spiral intensity pattern by analyzing the propagation dynamics of AS beams and demonstrated that the intensity distribution of AS beams follows an equidistant spiral [1]. Weishuai Cui and others developed a collision detection model based on spiral geometric properties and used particle swarm optimization (PSO) and feedforward neural networks to determine the minimum pitch angle [2]. David Eppstein proved that every star-shaped or spiral-shaped domain in three-dimensional Euclidean space is unlockable and can be unfolded into a planar embedding through a continuous motion [3]. Lei Yang and others used discrete element methods and physical experiments to simulate and test the mass flow, material density [4], and dust concentration of equidistant spiral and non-axial (variable pitch) spiral conveying environments, obtaining a maximum dust elevation of 37.88%. Jhon Jasper D. Apan and others used computational fluid dynamics (CFD) to determine how the matching angle influences the hemodynamics of spiral flow-induced plant designs [5]. Shuangqing Yu and others established a kinematic model for equiangular spiral folding patterns based on the kinematic equivalence of rigid origami and spherical linkages [6]. Wenjian CAO and others proved the trajectory of the cathode tool center satisfies the Archimedes spiral equation, and the feed depth in adjacent cycles is a constant [7]. Greco C and others proposed a scalable automated manufacturing system for the efficient production of twisted spiral artificial muscles (TSAM) [8], reducing manufacturing time by 75% and achieving high automation of servo motors. Hai Zhu and others achieved low disturbance on the cutting surface of hydrate samples by studying the Archimedean spiral [9], providing precise control over the process. Peterman DJ and others studied the fluid statics and fluid dynamics of spiral-shaped corn cones through virtual modeling [10], computational fluid dynamics simulation, and water chamber experiments, using Cenomanian (Cretaceous) turrilitid Mariella-brazoensis (Roemer, 1852) as a test case. Ping Liu and others analyzed the characteristics of the Archimedean spiral equation [11], calculated interpolation points using the angle as a variable and the equiangular straight-line approximation algorithm. Katherine Longardner and others proposed a new algorithm to measure the amplitude of tremor movement using digital equidistant spiral diagrams and established its reliability and clinical practicality through the V3 framework (sensor validation, analysis validation, and clinical validation) [12].

2 THE BASIC FUNAMENTAL OF BP NEURAL NETWORK

2.1 Description of the Bench Dragon Motion Model

2.1.1 Equidistant spiral motion curve

In the polar coordinate system, any segment of the dragon dance team entering the spiral motion satisfies the equation of the equidistant spiral curve, which can be expressed as:

$$r(\theta) = r_0 + \frac{p}{2\pi}\theta \tag{1}$$

In this context, r(θ) represents the radial distance corresponding to the angle θ; r0 is the initial radial distance at the starting point, which in this scenario is set to 0, corresponding to an angle of 32π; p is the pitch, which is set as a constant value of 0.55 meters in the equidistant spiral motion; θ(t) is the angular position, which gradually decreases over time.

2.1.2 Motion path of the dragon head

During the spiral motion, this paper define the linear velocity of the dragon head as a constant v=1 m/s, and the infinitesimal line element ds along the spiral can be expressed as:

$$ds = \sqrt{dr^2 + (rd\theta)^2} \tag{2}$$

Based on the spiral equation in equation (1), this paper take the differential of both sides, resulting in $dr = \frac{p}{2\pi}d\theta$. Therefore, equation (2) can be simplified as:

$$ds = \sqrt{(\frac{p}{2\pi}d\theta)^2 + \left((r_0 + \frac{p}{2\pi}\theta)d\theta\right)^2} \tag{3}$$

Thus, this paper have initially established the differential equation expression with respect to θ\thetaθ. Next, this paper will simplify it further based on the given conditions.

2.1.3 The relationship between velocity and the angular change

Since the linear velocity of the dragon head is constant at v=1 m/s, this paper can substitute this into (3). Combining this with the above equation, this paper obtain the differential equation expression for the front handle of the dragon head at any given moment. To simplify further, this paper can proceed as follows:

$$\frac{d\theta}{dt} = \frac{1}{\sqrt{(\frac{p}{2\pi})^2 + \left(r_0 + \frac{p}{2\pi}\theta\right)^2}} \tag{4}$$

This equation indicates that the rate of change of the polar angle θ is related to the radius r(θ) and the pitch p. To obtain the expression for θ(t), this paper can integrate the above equation:

$$t = \int_0^{\theta(t)} -\frac{d\theta}{\sqrt{(\frac{p}{2\pi})^2 + \left(r_0 + \frac{p}{2\pi}\theta\right)^2}} \tag{5}$$

2.1.4 Further determination of the position of the front handle of bench dragon

It is not difficult to deduce that when the position of the front handle of the dragon head is determined at a fixed moment, the positions of the remaining body and tail segments are also determined. For any two adjacent segments, this paper can derive a recursive formula similar to the one in the lemma by following the same relationship.

$$d^2 = r_{i-1}(t)^2 + r_i(t)^2 - 2r_0(t)r_i(t)\cos\left(\theta_{i-1}(t) - \theta_i(t)\right), i = 1, 2...223 \tag{6}$$

$$r_i(t) = r_{i-1}(t) + \frac{p}{2\pi}(\theta_i - \theta_{i-1}), i = 1, 2...223 \tag{7}$$

For the nonlinear system, this paper need the maximum non-unique solutions. This paper set the initial guess by slightly increasing the radial distance of the last point plus bench length to ensure the solution matches the next point's front handle in the spiral-in.

After obtaining the position coordinates of the front handles of each segment and the rear handle of the dragon's tail in the polar coordinate system for the time interval from 0 to 300 seconds, this paper convert the polar coordinates to Cartesian coordinates by following the same steps as before, yielding the position coordinates in the Cartesian coordinate system as follows:

$$x = r\cos\theta \tag{8}$$

$$y = r\sin\theta \tag{9}$$

2.2 Analysis of Collision Conditions in the Bench Dragon Movement

As the Bench Dragon spirals inward, the distance between benches decreases, risking collision. This paper must identify the first collision point and handle positions. Using the law of sines, the dragon head, with its longer side, will be the first to collide due to its leading position and decreasing radial distance. As the spiral tightens, the head reaches a smaller radius first and, with constant velocity, quickly runs out of space, stopping the movement before the body and tail, which still have room to maneuver. As a result, the dragon head is the first to experience a collision due to lack of space. The specific collision constraints are as follows:

(1) Velocity condition: The velocity after the collision is zero.

(2) Overlap condition: The benches can overlap at the edges, but the benches and handles must not overlap or collide. Normally, the line connecting the center of the front handle and the outermost point of the front side of the bench is not collinear with the radial distance of the front handle. However, this paper considers the extreme case where the outermost point on the front side of the bench coincides with the outer spiral. In this case, a collision may occur. As shown in the diagram below, when the bottom right vertex E of the dragon head touches the handle on the outer spiral, the radial distance OB and the pitch BE are aligned, and the points OA, AE, and OE form a triangle. In this case, the collision condition is:

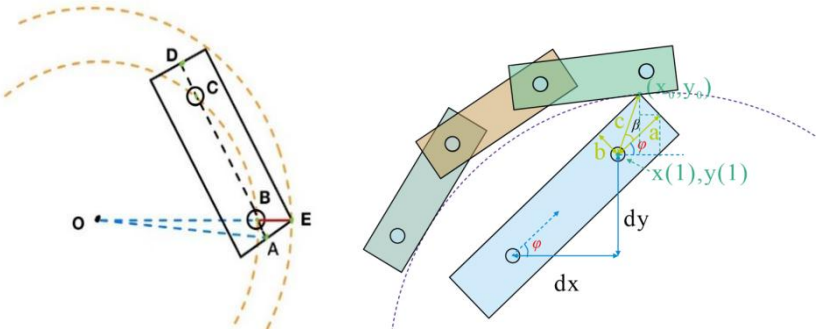

Figure 1 Collision Local Analysis Diagram

Assuming the coordinates of the front and rear handles of the dragon head are (x1,y1) and (x2,y2), this paper now derive the vertex where the dragon head collides in the extreme case, based on the geometric relationships and trigonometric equations, such as the Cartesian coordinates (x0,y0) of the top-right endpoint of the dragon head, as shown in Figure 1.

$$dx = x_2 - x_1 \tag{10}$$

$$dz = \sqrt{(dx)^2 + (y_2 - y_1)^2} \tag{11}$$

$$\varphi = \arccos\frac{dx}{dz} \tag{12}$$

Using the right-angle relationship shown in Figure 1, this paper can derive:

$$\beta = \arccos\frac{a}{\sqrt{a^2 + b^2}} \tag{13}$$

$$x_0 = x_1 + c \cdot \cos(\varphi + \beta) \tag{14}$$

$$y_0 = y_1 + c \cdot \sin(\varphi + \beta) \tag{15}$$

The distance z0 from the collision point to the center can be calculated in the extreme case:

$$z_0 = \sqrt{x_0^2 + y_0^2} \tag{16}$$

Based on the geometric relationships in the extreme case, this paper can derive:

$$z \approx \rho_1 + 55 - 30 \tag{17}$$

$$0 < \rho_1 + 55 - 30 < 0.01 \tag{18}$$

At this point, the dragon head continuously approaches, causing the pitch of the outer spiral to converge with the radial distance of the vertex.

2.3 Analysis of the Bench Dragon Turnaround Area

In the case where the pitch is uncertain and the velocity of the dragon head's front handle is 1 m/s, after the Bench Dragon has moved into a certain position along the spiral, a turnaround is required. This paper define the turnaround area as a circle with a diameter of 9 meters, and based on this, this paper calculate the minimum pitch at which the Bench Dragon can reach the boundary of the turnaround space.

Similar to the analysis in section 2.2, the risk of collision increases as the Bench Dragon moves gradually towards the center of the spiral, and this risk also increases as the pitch decreases. Therefore, this paper must ensure that no collision occurs before the front handle reaches the turnaround area. That is, this paper need to find the pitch at which the collision occurs exactly at the boundary of the turnaround area. This pitch is the minimum pitch that satisfies the required conditions. From the above analysis, this paper can see that the constraint conditions have changed. The new constraints are as follows:

(1) The velocity of the dragon head's front handle is constant at 1 m/s.

(2) The bench is a rigid body, and the distance between adjacent handles is fixed.

(3) The front handle of the dragon head must be able to move along the corresponding spiral path to reach the boundary of the turnaround area with a diameter of 9 meters.

Using the conclusions derived in section 2.2, this paper need to find the smallest pitch d that satisfies the above three constraints. To determine the minimum pitch under the most extreme conditions, this paper strengthen constraint 3 to "The dragon head must exactly collide when it reaches the boundary of the 9-meter diameter turnaround area (the dragon dance team can no longer continue moving inwards)." At this point, the pitch takes its boundary value, and the resulting pitch is the minimum pitch.

To avoid collisions between the benches outside the turnaround area, this paper must ensure that the pitch is greater than a minimum value, with no upper limit. The minimum pitch that satisfies the conditions is the final result that the algorithm aims to obtain. To improve algorithm efficiency, this paper have pre-defined the range of possible values for the minimum pitch based on multiple experimental and computational results.

2.4 Bench Dragon Turnaround Path Analysis

This paper adjust the pitch to 1.7m and maintain the dragon head’s front handle velocity at 1 m/s. The Bench Dragon’s turnaround path within a defined area consists of two S-shaped, tangent semicircles with the first arc twice the radius of the second. This paper design the shortest circular arc path tangent to the inward and outward spirals. A motion model for the “inward → turnaround → outward” sequence is created, solving for handle positions and velocities. The turnaround arcs are tangent to both spirals, making the outward spiral a 180° rotation of the inward spiral. The pitch at the arc boundaries is consistent, and the outward spiral lies between inward spiral arms. With a pitch of 1.7m and each bench covering a max of 32.32cm, no collisions occur between inward and outward spiral benches.

Based on the above analysis and section 2.3 settings, this paper calculate the position and velocity of the dragon head during the turnaround process using the method outlined in section 2.1. Using the recursive formula, this paper further calculate the positions and velocities of the dragon body during the turnaround process and record the results. Since the angles of the two arc sections are unknown, this paper set the angle of the longer arc as a variable. To solve for the shortest curve, this paper convert this into an optimization problem and solve it using an improved simulated annealing algorithm.

Simulated Annealing (SA) is a stochastic optimization algorithm mainly used to find approximate global optimum solutions, especially in large-scale and complex search spaces. Its principle is based on the physical phenomenon of metal annealing, where a solid is gradually cooled to reduce defects, finding the optimal solution. The process involves heuristic search to compute acceptance probabilities, and by gradually lowering the "temperature," it reduces the probability of accepting larger curve lengths. The high-temperature phase allows for a broad search, while the low-temperature phase converges to the shortest curve length. The steps for controlling the temperature include initialization, iteration, and termination condition determination.

For this problem, this paper determine that if the objective function value changes less than a preset value ($\left|E_{\text{best}} - E_{current}\right| < \varepsilon$) within a certain number of iterations, this paper can consider the algorithm to have converged and stop. Here, ε is a very small positive number representing the precision requirement (1e-5). Additionally, this paper set the temperature threshold to be the radius of the turnaround area plus a very small disturbance value to prevent possible collisions or extreme conditions during the algorithm's execution.

2.5 Bench Dragon Turnaround Path Analysis

Building on section 2.4, this paper further explore the impact of speed adjustment on the normal inward movement of the Bench Dragon. Here, this paper change the speed of the dragon head's front handle under the condition that the speed is fixed and does not exceed 2 m/s, and calculate how the speed change affects the maximum speed of other handles. This paper then solve for the limit of the dragon head's front handle speed under extreme conditions. Under the path setup of section 2.4, no new dragon dance team motion mathematical model needs to be established, and this paper proceed along this path. The dragon head’s speed remains constant, but this paper adjust and test different speeds, recording the speed states of the handle groups in the dragon body after each adjustment and determining if the maximum speed remains below the 2 m/s limit.

3 RESULTS

3.1 Analysis of Experimental Results

Based on the established differential equations, this paper obtained the positional coordinates and velocity magnitudes of the dragon head, the 1st , 51st, 101st, 151st segment at the initial moment, 1s, 50s, 101s, 151s, 201s, and 300s, respectively. Figure 2 illustrate the motion trajectory of the dragon team at the initial time, 1s, 60s, 120s, 180s, 240s, and 300s. As can be seen, even at 300s, all 223 sections of the dragon body have not fully entered the equidistant spiral, and thus, this paper will further explore the termination conditions for the dragon team's continued motion.

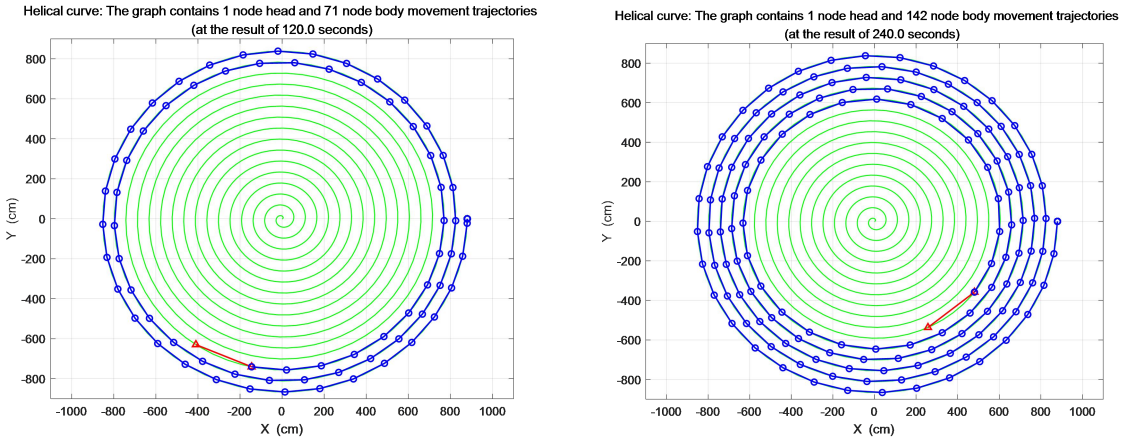

Figure 2 Results of Differential Equation and Recursion-Based Solution

The motion process is simulated with a 0.01s time step, ending at 390.92s, and with a 0.001s step, ending at 391.63s, as per Figure 3 Simulation errors stem from: (1) Time step size, with smaller steps yielding less error due to closer approximation of continuous motion, while larger steps may overlook nuances. (2) Limit condition approximations, where as the spiral's end is reached, error accumulation becomes more pronounced, potentially causing an earlier stopping condition detection with larger time steps. Smaller steps (0.001s) yield more accuracy, while larger steps (0.01s) result in earlier termination due to error build-up.

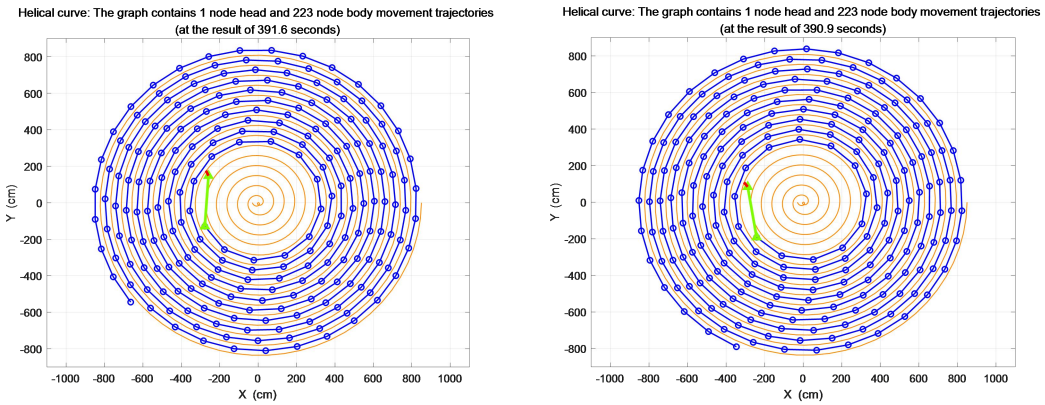

Figure 3 The Final Motion State with a Time Precision of 0.001s (Left Figure) and the Final Motion State with a Time Precision of 0.01s (Right Figure)

The final positions and velocities of the front handles of the 1st, 51st, 101st, 151st, and 201st dragon sections, as well as the rear handles of the dragon's tail, are as follows in Table 1:

Table.1. Position Coordinates of the Bench Dragon

	1st	51st	101st	151st	201st	tail
v(m/s)	0.953593	0.984499	0.990695	0.993352	0.994829	0.995289
x (m)	2.72196	-4.45227	6.008145	7.036571	0.954032	-8.376886
y (m)	-0.313555	-1.517427	0.80352	1.35954	-8.066584	1.496593

Based on the above analysis, it is easy to determine that the minimum pitch satisfying the turning condition lies between 50 cm and 60 cm. Therefore, this paper iterate over the pitch within this range, with a step size of 0.005 cm for each

iteration. The resulting graph of the judgment value (flag) and the time of obstruction termination as a function of pitch size is shown in Figure 4.

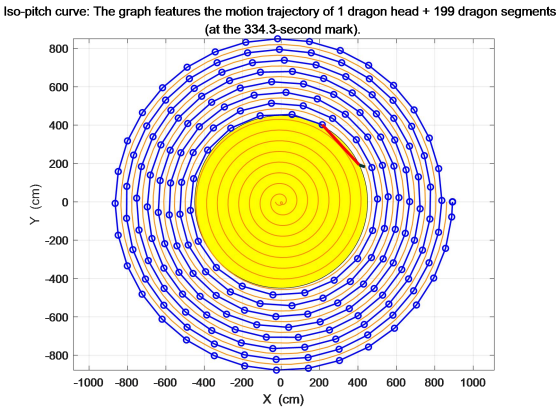

Figure 4 2.3 Experimental Results

In section 2.3, the minimum pitch is 55.758 cm with an obstruction time of 334.34 s. The graph shows the time to encounter obstacles increases slowly from 50cm to 60cm, with a sharp acceleration at 52.8cm, then a gradual decrease to no change. From section 2.2, the pitch value for the dragon head's exact arrival matches where the rate of increase in Figure 4 levels off. For segments other than the head, the front handle's trajectory retraces the bench's path, making the motion of the 223 segments equivalent if time is ignored. If the probability of encountering obstacles is equal for all benches past a certain time, the head has entered the turn-around area, indicating arrival. Thus, the pitch value at the arrival condition change is approximately where the obstacle encounter time rate of increase stops.

In 2.4, the final obtained angle of the longer arc is 3 radians, and the angle of the shorter arc is 2π - 3. Figure 5 shows the turning diagram of the dragon dance team under the optimal solution. Using the method from Section 2.1, the position and velocity changes of each dragon segment from -100s to 100s are calculated. Table.2 and Table.3 are the position and velocity results of the dragon dance team at certain times, along with the corresponding relative positions at the turning points.

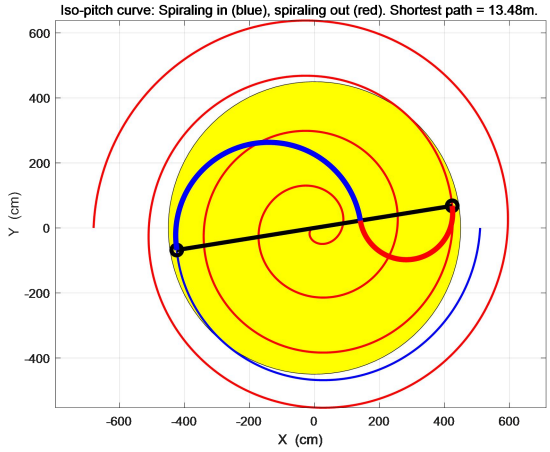

Figure 5 Schematic Diagram of the Entering and Exiting Trajectories

Table 2 Position Results of the Bench Dragon from -100s to 100s.

	-100	-50	0	50	100
head x(m)	8.503941	6.553096	-4.248714	4.076716	0.006748
head y(m)	0.348817	-1.562022	-0.590324	4.644781	8.074771
1st x(m)	7.989437	6.725194	-3.17611	5.628465	2.826317
1st y(m)	3.190113	1.312998	-3.131987	2.223662	7.459531
51st x(m)	10.2	-5.820768	-0.232925	-4.29776	4.235754
51st y(m)	0	-7.632433	-8.063824	-4.421895	0.710841
101st x(m)	10.2	10.2	10.2	-6.064715	-6.324483
101st y(m)	0	0	0	6.813674	4.025013

Table 3 Velosity Results of the Bench Dragon from -100s to 100s

	-100	-50	0	50	100
head (m/s)	1.00000	1.000000	1.000000	1.000000	1.000000
1st (m/s)	0.995391	0.992725	0.982747	0.990664	0.994638
51st (m/s)	0	0.9963	0.994757	0.99101	0.981378
101st (m/s)	0	0	0	0.995902	0.993926
151st (m/s)	0	0	0	0	0.996638

Figure 6 is the result of section 2.5.

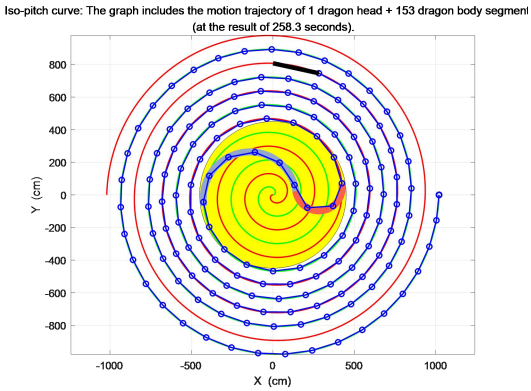

Figure 6 Schematic Diagram of the Entering and Exiting Trajectories

4 CONCLUSIONS

This paper takes the unique folk activity "Bench Dragon" from Zhejiang, Fujian, and other regions as the research subject, exploring its in-and-out motion along an equidistant spiral curve. By establishing a mathematical model, analyzing collision conditions and the turning area, and using the simulated annealing algorithm to solve for the minimum pitch and optimal turning path, the paper ultimately determines the position coordinates, velocity magnitudes, and collision time points at various stages of the Bench Dragon's motion. This paper can obtain these main conclusions: (1) The Bench Dragon is at risk of collision during the entry and exit spiral motion. Due to its leading position and smallest radius, the dragon head is the first to collide. The article calculates the time point of the first collision and determines the minimum pitch required for turning to be 55.758 centimeters; (2) The turning path of the Bench Dragon consists of two S-shaped, tangent semicircles, with one arc having twice the radius of the other. By using an improved simulated annealing algorithm, the article finds the shortest turning path and calculates the position and velocity changes of the dragon head and body during the turning process; (3) The speed variation of the dragon head affects the speed of the dragon body and has a limiting speed. Under the condition that the speed is constant and does not exceed 2 m/s, the article analyzes the impact of speed changes on the maximum speed of other handles and determines the limiting speed of the dragon head. The results of this research provides theoretical support for the study of equidistant spiral motion and contributes to the inheritance and development of traditional folk culture.

COMPETING INTERESTS

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

REFERENCES

[1] Ding Z, Yu Y. Archimedes spiral beam: composite of a helical-axicon generated Bessel beam and a Gaussian beam. JOSA A, 2024, 41(5): 874-880.
[2] Cui W, Deng X, Dong P. Research on Spiral Motion Analysis Based on Optimisation Algorithm and Neural Networks. Academic Journal of Science and Technology, 2024, 13(1): 83-88.
[3] Eppstein D. Locked and unlocked smooth embeddings of surfaces. arxiv preprint arxiv: 2206.12989, 2022.
[4] Yang L, Li Y, Wang Z, et al. Numerical simulation and experimental study on ultrafine powder spiral transportation degassing. Engineering Research Express, 2024, 6(2): 025412.
[5] Apan J J D, Honra J P, Tayo L L. Evaluation of the Effects of Anastomosis Angle on the Performance of an Optimized Spiral Flow-Inducing Graft Design using CFD. CFD Letters, 2023, 15(11): 118-130.
[6] Shuangqing Y U, Guo L I U, Pengyuan Z, et al. A flat-foldable equiangular spiral folding pattern inspired by sunflowers for deployable structures. Chinese Journal of Aeronautics, 2024, 37(6): 425-438.
[7] Wenjian C A O, Dengyong W, Zhiyuan R E N, et al. Evolution of convex structure during counter-rotating electrochemical machining based on kinematic modeling. Chinese Journal of Aeronautics, 2021, 34(3): 39-49.

[8] Greco C, Kotak P, Gallegos J K, et al. Scalable manufacturing system for bionspired twisted spiral artificial muscles (TSAMs). Manufacturing Letters, 2020, 26: 6-11.
[9] Zhu H, Chen J, Ren Z, et al. A new technique for high-fidelity cutting technology for hydrate samples. Journal of Zhejiang University-SCIENCE A, 2022, 23(1): 40-54.
[10] Peterman D J, Hebdon N, Ritterbush K A. Twirling torticones: hydrostatics and hydrodynamics of helically-coiled ammonoids. The American Association of Petroleum Geologists bulletin, 2021.
[11] Liu P, Wu M, Lin G. Optimization Design and Research on Macro Program of Archimedes Spiral Machining//Mechatronics and Automation Technology. IOS Press, 2022: 92-99.
[12] Longardner K, Shen Q, Tang B, et al. An Algorithm for Automated Measurement of Kinetic Tremor Magnitude Using Digital Spiral Drawings. Digital Biomarkers, 2024, 8(1): 140-148.

Trends in Social Sciences and Humanities Research
ISSN: 2959-9938
DOI: https://doi.org/10.61784/tsshr3106

TRANSFORMATIVE CURRICULUM DESIGN FOR ADVANCED CRITICAL THINKING AND COMPLEX PROBLEM-SOLVING: THEORETICAL MODELS AND PRACTICAL APPLICATIONS

Stephen Kelvin Sata
ICOF Global University, Lusaka, Zambia.
Corresponding Email: stephensata@gmail.com

Abstract: Concerning this issue, the present study aims to investigate transformational curriculum development as the key enabler of enhancing learners' critical thinking and problem-solving skills. These include research into curriculum theories and experiences that connect frameworks to the functioning of the 21st-century knowledge economy. This work seeks to critically analyse constructivist, experiential and inquiry learning theories as frameworks for creating a curriculum which fosters higher-order cognition. It also assesses how content area disciplines work in cohesion, taught with collaboration and communication implemented equally within the classroom, and various forms of technology to produce interactive and innovative learning.
This research reports a literature and case study analysis of progressive approaches for integrating critical thinking and problem-solving competency within various learning environments. Therefore, the study supports the learning goals, delivery models, and evaluation paradigms underpinning radical change. Implications for classroom practice, system improvement, and curriculum design are considered, focusing on the context and applicability of the ideas described at the classroom, school, district, and state levels. This research's findings help fill the literature gap on curriculum creation and application by providing best practices to enhance practice-based applied theoretical educational approaches for learners who are expected to solve multifaceted issues in the current work environment.
Keywords: Transformative curriculum design; Critical thinking; Complex problem-solving; Theoretical models

1 INTRODUCTION

New requirements of the knowledge-based global economy of the twenty-first century have significantly altered the roles expected from world education systems. At the same time, continuous technological progress and globalization and increased understanding of and concern for society add to the general demand for sophisticated learning activities that enhance the acquisition of critical thinking and complex problem-solving skills [1]. All these competencies are crucial to address the complex and fluctuating demands of the globalized and technological context, where people are facilitated to identify problems, think creatively and move in contexts which might change constantly. Still, the conventional curriculum models, in which learners work through the study material and the type of knowledge, memorizing it in some way, need to meet these demands since they cannot adapt to learning situations and similarly employ knowledge. Such a model does not foster the depth required to think critically, be creative, and look for ways to make a business work well in today's environment.
On the other hand, transformative curriculum design provides a concept that can be referred to as progressive by hurrying education to catch up with contemporary world trends [2]. This approach, therefore, involves flexibility, the combination of different fields of study, and participation in order to create a learning model that extends the understanding of the acquisition of knowledge to involve the use of knowledge in solving real-life problems. Inclusive and effective curricula adopt a variety of approaches and learning styles when working with learners to meet their learning processes' needs. So, by focusing on augmenting higher-order learning skills, these curricula equip learners not only to be solution-finders but also to advance the frontier of knowledge in their field of discipline.
This paper will discuss the transformation curriculum design for enhancing higher-order thinking skills and problem-solving in detail. This work outlines the evident values based on the following theoretical frameworks: constructivism, experiential learning, and the inquiry-based model. Heterodox theories of constructionism stress the meaningful organization of knowledge through meaningful experiences, and interpretivism and pragmatism are positioned as foundations for constructivist approaches. Experiential and inquiry-based learning integrate students' engagement with existing and new problems and encourage them to develop solutions together. These theoretical models are the foundation for redesigning curriculum to call for the skills essential in the 21st century.
Further, the increased use of digital support and connection with practice contributes to the outstanding role in the relevance and effectiveness of transformative curricula. ICT tools, including AI, VR, and collaborative environments, give innovations a context for individualized and engaging learning by doing and doing with understanding [3]. Real-world activities, case

problems, and interdisciplinary projects strengthen the relationship between course material covered and problems faced in practice to equip the learners to respond to diverse issues as they are solved in practice.
This paper explores the rationale and applied characteristics of an emancipatory approach to curriculum construction and offers insights into how and why curricula might be reconstructed to develop empowered learners [4]. The use of case studies, theory into practice and trends in curriculum development incorporated in this research propose practical solutions for educators, policymakers and institutions. The results should enrich the existing curriculum development literature focusing on fostering critical thinkers, team workers, and problem-solving individuals. In this way, this study highlights the constructive role of education in preparing learners to face the demands and opportunities of the increasingly globalised world.

2 LITERATURE REVIEW

Curriculum innovations across disciplines have made it essential for students to develop more critical thinking and problem-solving skills. For this reason, applying a transformation curriculum that centres on higher-order thinking skills analysis, evaluation synthesis, and problem-solving is critical in enabling students to face the ultimate challenges of the 21st century. The literature review will discuss different theoretical frameworks and possibilities for implementing the transformative curriculum, focusing on developing a post-conventional level of critical thinking and problem-solving abilities.

2.1 Theoretical Foundations of Transformative Curriculum Design

Transformative curriculum design is a notion that is based on several effective notions of learning that stress comprehensive understanding notions and the thinking abilities needed for higher-order learning. One of the most foundational models of cognition is Bloom's Taxonomy and it sorts the cognitive processes in a taxonomy. The Bloom taxonomy has been a basic assist for curriculum developers in mapping learning outcomes from simple levels of knowledge, comprehension, application to the relatively higher levels of analysis, synthesis, and evaluation. The synthesis and analysis levels in Bloom taxonomy are used in the design of curruculum that intend to develop in students problem solving skills [5].
Besides Bloom's Taxonomy, the Constructivist Theory of learning advanced by such theorists as Piaget & Vygotsky has a central role to play in transformative curriculum. Several approaches associated with constructivism include; active learning by which the learners acquire knowledge through the interactions with the surroundings and or other learners [1]. This theory provides backing to such notions as the application of problem-solving exercises to real life problems as well as the acquisition of superior critical analysis and problem-solving capabilities by students. From Vygotsky, curriculum design is informed again by his Zone of Proximal Development (ZPD) which postulates that students are capable of achieving higher cognitive planes when prompted by one with better knowledge as a peer or a teacher.
Another theory that can be linked to the present study is Mezirow's Transformative Learning Theory (1991) which asserts that learning consists of the appreciation of, as well as reflection on points of divergence from prior ways of processing information. Within this framework, transformative curriculum is defined as the learning experiences that enable students to reflect on the assumptions they have, in an effort to foster progression in critical thinking processes. Mezirow's concerns refer to perspective transformation which means that critical thinking and problem-solving domains because students are expected to challenge, redefine and solve intricate problems [4].

2.2 Approaches to Curriculum Design for Advanced Critical Thinking

This paper will explore several strategic approaches to designing curricula to enhance critical thinking and develop problem-solving skills. One such method is now known as inquiry-based learning (IBL), which has been adopted to encourage solving complex problems. Students are helped to use their resources to find solutions independently, ask questions, and work on real-life issues, hence sharpening their critical thinking skills established that IBL enhances higher-order thinking since students develop a more profound understanding of the material [6].
Another is the problem-solving approach, the PBL approach, in which students face real-life problems that challenge their ability to solve. PBL also enables students to work out and arrive at sound judgments for information they find in their research. It allows learners to solve real-life problems, which has made them improve on the theoretical knowledge they gained. This research shows that PBL enhances higher-order thinking abilities by presenting the learners with complex, real-life problems requiring design and improvisation solutions [7].
Design thinking is also evaluated as the innovative paradigm for curriculum making and, in particular, for the development of critical thinking and problem-solving competencies' development. Starting with empathy, continuing with ideation and ending with iteration, design thinking engages students in a problem-identification, solution-generating, and validation process. This approach not only fosters out-of-the-box solution generation but also fosters problem-solving tenacity in complex problems. For more extensive references on the benefits of design thinking integration into curriculum design [3].

2.3 Practical Applications and Case Studies

Specifically, transformative curriculum design for critical thinking and complex problem solving has been implemented at different levels, from a primary focus on K-12 schools, a secondary focus on higher education, and a tertiary focus on professionalism. For example, curriculum integration across content areas is often employed to enhance critical thinking as a result of cross-referential thinking. Since students are trained to approach problems from multiple disciplinary angles, they can solve problems from a more diverse perspective. Interdisciplinary learning has effectively developed students' problem-solving skills through multiple tools or concepts a student can apply to a complex problem [8].

However, one of the most apparent examples of applying new approaches to curriculum transformation is the global education model, which aims to teach students how to think globally. It proposes an integration of authentic, problematic contexts such as climate change, social justice, or economic inequality for students [9]. These complications force them to reason and even solve them using different perceptions and working together to find sustainable solutions to the problems. Using this model has been determined to enhance students' problem-solving habits since they face global needs requiring them to think critically.

One good example can be observed in the reforms in STEM: curriculum developers have incorporated critical thinking and problem-solving within scientific, technological, engineering, and mathematical knowledge. Incorporating communications through inquiry-based labs, design challenges, and collaborative projects makes STEM curricula enable students to use their theoretical knowledge in unique ways. The curricula based on STEM stress cognitive integration and problem-solving support deeper learning and bring out learning relevant to solving real-life problems.

A review of the literature on transformative curriculum design also points out that theoretical and practical frameworks need to be incorporated into the learning process in order to enhance the development of more sophisticated critical thinking and problem-solving skills. Curriculum frameworks, including Bloom's Taxonomy, Constructivism, and Transformative Learning Theory, are all well-grounded theories that help define how curricula can be developed to achieve higher-order thinking skills. Other theories, such as problem learning, design thinking, and inquiry-based learning, build on these theories by providing a practical manner in which students can be helped solve problems. As institutions of learning wrestle with the challenge of preparing learners to meet the global dynamics in the future, the need for curriculum transformation to prepare learners for future challenges cannot be underestimated.

Transformative curriculum design, based on theoretical frameworks such as Bloom's Taxonomy, Kolb's Experiential Learning Cycle, and Mezirow's Transformative Learning Theory, has shown significant effectiveness in fostering advanced and practical problem-solving skills, particularly in low-income settings. By shifting the emphasis from rote memorization to experiential, reflective, and applied learning, this approach equips students with the skills to address complex challenges both immediately and in the long term. In a longitudinal case study in rural Uganda, a transformative curriculum focused on community projects enabled students to apply critical thinking skills to address local challenges such as water scarcity and agricultural inefficiency. Students worked collaboratively to design low-cost irrigation systems and improve crop yields. Five years after graduation, many alumni had become leaders in community development initiatives, using the skills they learned during their studies to drive economic and social progress. Interviews with these individuals revealed that the program's focus on solving real-world problems had a lasting impact on their ability to analyze problems and implement sustainable solutions. In India, an experimental program incorporating Kolb's learning cycle was implemented in low-income urban schools. Students were tasked with solving waste management problems in their neighborhoods through field research, reflective discussions, and experimental projects. Over the course of a decade, follow-up studies showed that many alumni had established small-scale recycling businesses, which not only provided economic opportunities but also contributed to cleaner urban environments. Educators reported that these students demonstrated superior critical thinking and entrepreneurial skills compared to their peers in traditional programs. Community interviews demonstrated how these initiatives created a culture of environmental awareness and problem-solving among local residents.

A transformative curriculum implemented in low-income areas of Bangladesh focused on gender equality through Mezirow's transformative learning principles. Girls were encouraged to think critically about social norms, which led to greater self-confidence and advocacy. Ten years later, qualitative data from focus groups showed that these women were more likely to pursue higher education, delay child marriage, and assume leadership roles in their communities. Their critical thinking skills translated into tangible outcomes, including policy advocacy for girls' education and community initiatives to combat gender-based violence . Comparative studies in sub-Saharan Africa provide further evidence of the long-term impact of transformative curriculum design. Schools that have adopted curricula that incorporate real-world problem-solving strategies have consistently produced graduates who excel in civic engagement and leadership roles. For example, in Kenya, students who participated in agricultural innovation projects during their studies have later become key contributors to national food security programs. Educators have noted that the program's emphasis on critical thinking and interdisciplinary learning has enabled students to approach complex problems with creativity and resilience, leading to lasting social contributions.

Collectively, these case studies highlight the significant short- and long-term benefits of transformative curriculum design in low-income settings. By prioritizing critical thinking, experiential learning, and reflective practices, these programs not only improve immediate academic outcomes but also foster lasting problem-solving skills.

2.4 Content and Training Methods for Integrating Information Technology into Traditional Education

The integration of information technology (IT) into traditional teaching methods is a complex but necessary process in modern education. As technology increasingly shapes the learning environment, educators face challenges in adapting to tools that complement traditional pedagogies. Training programs designed to address this integration aim to equip teachers with the skills and strategies needed to use IT effectively without compromising the benefits of conventional teaching methods.

2.4.1 Content of IT Integration Training

The content of training programs generally covers three main areas: technological mastery, pedagogical strategies, and alignment with educational objectives.

1) Technological skills: Teachers should have a basic understanding of computer tools such as interactive whiteboards, online learning management systems, and subject-specific software. Studies highlight the importance of practical training that allows teachers to use these technologies with confidence. For example, training sessions often include practical tasks, such as creating virtual classrooms or creating multimedia presentations to help teachers acquire technical expertise.

2) Instructional strategies: Effective training programs address the pedagogical implications of the integration of information technology. The Technology Pedagogy Knowledge Framework (TPACK) has been widely cited in this regard, emphasizing the interplay between technology, pedagogy, and subject content. Teachers learn to use technology to enhance traditional teaching methods, such as integrating simulations into science lessons or using digital storytelling tools in language arts.

3) Practical application and course design: Programs emphasize course design that balances traditional and technological approaches. For example, training often includes case studies on combining face-to-face instruction with online tools for collaborative learning, ensuring that digital components enhance rather than replace the traditional classroom experience.

2.4.2 Training Methods for Information Technology Integration

The methods used in teacher training programs are essential for successful technology integration. The literature identifies several effective approaches:

1) Workshops and Seminars: Workshops provide immersive experiences where teachers engage directly with IT tools. These sessions often include peer collaboration and immediate feedback, allowing teachers to problem-solve and improve their skills in real time.

2) Blended learning models: Training that combines online modules with in-person workshops is gaining popularity. Teachers benefit from the flexibility of self-paced online learning, complemented by face-to-face sessions that allow for collaboration and practice.

3) Mentoring and coaching: Pairing teachers with experienced mentors provides personalized support during the onboarding process. Mentors help teachers adapt IT tools to their specific teaching contexts, addressing challenges such as curriculum alignment and classroom management.

4) Professional Learning Communities (PLCs): Collaborative learning environments encourage teachers to share best practices and solve problems collectively. Research shows that CAPs create a support network that supports IT integration efforts beyond initial training.

5) Simulation and microteaching: Simulation-based training and microteaching sessions allow teachers to experiment with IT integration in a controlled environment. Feedback from trainers and peers helps refine their approach before implementing it in real classrooms.

2.4.3 Addressing the Challenges of Integrating Information Technology

Despite its benefits, integrating information technology into traditional teaching methods presents challenges, such as resistance to change, limited infrastructure, and lack of time for professional development. Effective training programs include strategies to mitigate these issues:

1) Gradual Integration: The gradual introduction of technology allows teachers to adapt without feeling overwhelmed. For example, starting with simple tools such as digital attendance systems can build confidence before moving on to more complex applications such as virtual reality.

2) Context-specific training: Tailoring training to the resources and needs of specific schools ensures its relevance. In resource-limited settings, programs can focus on low-cost or offline technologies that are appropriate for the local context.

3) Emphasizing educational value: Training programs emphasize the use of technology to enhance rather than replace traditional teaching methods. For example, digital tools have been created as complements to collaborative learning or interactive assessments, thus preserving the main advantages of face-to-face teaching.

2.4Future Directions

Emerging technologies such as artificial intelligence (AI), gamification, and virtual reality (VR) offer new opportunities for training and integration in the classroom. Future research should explore how these innovations can help teachers integrate IT with traditional methods. In addition, longitudinal studies are needed to assess the long-term impact of training programs on teaching effectiveness and student outcomes.

2.5 Conclusion

Training programs designed to help teachers integrate IT into traditional teaching must strike a balance between technological mastery and pedagogical aspiration. With an emphasis on practical application, collaborative learning, and ongoing support, these programs address the complexities of IT integration. When implemented effectively, such training improves teaching practices, enriches students' learning experiences, and bridges the gap between traditional and modern educational paradigms.

3 METHODOLOGY

This study evaluates the transformative curriculum design in enhancing students' high-order thinking skills. In order to achieve this, the study utilizes a composite theoretical and empirical method in its execution. Conducted in synergy with the theoretical research design and the practical inquiry, the methodology guarantees a rigorous approach to discussing the topic by examining its theoretical and practical considerations. The following sub-section describes the research design, participant selection, data collection and study analysis.

3.1 Research Design

The study utilizes an exploratory mixed-method design, which translates theoretical concepts into actual research outcomes. This approach is appropriate for designing a transformative curriculum as it addresses the subject's discipline density and interdisciplinarity [10].

3.2 Theoretical Component

The thinking and problem-solving theoretical part provides a critical analysis of the existing models and frameworks as well as the existing literature on curriculum design, critical thinking, and problem-solving. This review looks at theories in formative education, such as Bloom’s Taxonomy, Constructivist Learning Theory, and Transformative Learning Theory, with a view to escaping the key principles of transformative curriculum practices. Also, it includes theoretical substantiation based on educational psychology, cognitive science, and instructional design disciplines to strengthen the review’s general perspective [1].

3.3 Practical Component

The practical part is based on the use of work methods of collecting research data under the analysis of the application of viewpoints of theoretical models in an educational environment. These are case studies, semi-structured interviews, focus groups, and course observations. This research strategy enables a deeper understanding of how educators and learners engage with and regard curriculum design strategies for transformative education, as well as the context and experience-based findings that drive them.

3.4 Rationale for a Mixed-Methods Approach

The mixed-methods approach is chosen for its ability to integrate diverse data sources and perspectives, enabling a holistic analysis of the research problem [6]. Theoretical analysis provides a foundation for understanding curriculum design principles, while empirical inquiry validates these principles by examining their practical impact. This dual perspective ensures that the study not only identifies best practices but also evaluates their effectiveness in real-world educational settings.

4 DISCUSSION

As such, this study’s findings contribute to the understanding of how and when transformative curriculum design enhances higher-order critical thinking and reasonable problem-solving skills. The focus always transitions from the discussion of theoretical frameworks and their applications to learning experiences and risks, possibilities, and effects on learners, students, and curriculum designers.

4.1 Alignment of Theoretical Models with Practical Applications

The study shows that curricula development to enhance higher-order thinking skills is very useful due to Bloom’s Taxonomy, Constructivist Learning Theory, and Transformative Learning Theory. However, it calls for efficient and appropriate implementations for the theories to apply to practice seamlessly. For instance, although Bloom’s Taxonomy provides sequential categories of learning objectives, using it requires a little tweaking depending on the learning needs and background of the recipients. Consequently, constructivism encourages students’ activities and focuses on inquiries, which

can be a challenging approach to adopt in a more traditional classroom setting that needs substantial adaptations and professional development for teachers [11].

Incorporating these theories is best realized by using techniques such as problem-based learning (PBL) and design thinking that allow the student actually to solve problems [2]. These methods are highly receptive to the principles of transformative curriculum design since the work of critical analysis, creativity, and collaborative problem-solving. The study establishes that barriers to implementing these strategies are lack of institutional support, refers, and teacher training and development, though there was evidence of implementation of the proposed strategies in some instances.

Bloom, B. S. (1956). Taxonomy of Educational Objectives: The Classification of Educational Goals. Handbook I: Cognitive Domain. New York: David McKay Company.

4.2 Enhancing Critical Thinking Through Curriculum Design

The findings underscore the importance of creating learning environments that challenge students to think critically and independently. Transformative curriculum designs that integrate authentic, real-world problems into the learning process provide students with opportunities to practice and refine their critical thinking skills. For example, inquiry-based and interdisciplinary curricula encourage students to make connections across domains, fostering a deeper understanding of complex issues [11].

However, the study also identifies barriers to achieving these outcomes, such as rigid assessment systems and traditional teaching practices that prioritize content delivery over skill development. To overcome these challenges, educators must adopt formative assessment strategies that emphasize reflection, feedback, and iterative learning processes. Additionally, incorporating technology into the curriculum, such as simulation tools and collaborative platforms, can enhance the development of critical thinking by providing students with dynamic, interactive learning experiences.

4.3 Promoting Complex Problem-Solving Skills

The study highlights the effectiveness of experiential learning approaches, such as case studies and project-based learning, in developing complex problem-solving skills. These methods immerse students in real-world scenarios that require them to analyze information, evaluate alternatives, and devise creative solutions. The iterative nature of these activities mirrors the complexity of real-world problem-solving, equipping students with transferable skills applicable across disciplines and careers [1].

Despite these benefits, the study reveals that fostering complex problem-solving skills often requires a shift in traditional classroom dynamics. Educators must move from being content transmitters to facilitators of learning, guiding students through the problem-solving process while allowing them the autonomy to experiment and learn from failure. Furthermore, integrating interdisciplinary perspectives into the curriculum is crucial for addressing multifaceted problems that span various fields of knowledge.

4.4 Challenges and Implications

While the transformative curriculum designs examined in this study have shown promising results, several challenges persist. One major issue is the resistance to change within educational institutions, where entrenched practices and standardized testing often limit the adoption of innovative teaching methods. Additionally, the time and resources required to implement transformative curricula can be significant, particularly in under-resourced settings.

To address these challenges, the study suggests the following strategies:

1) Professional Development: Providing ongoing training for educators to equip them with the skills and knowledge needed to implement transformative curriculum strategies effectively.
2) Policy Reform: Advocating for policy changes that prioritize skill development and support flexible, student-centered learning approaches.
3) Resource Allocation: Ensuring that institutions have access to the necessary resources, including technology, instructional materials, and support staff.

4.5 Broader Implications for Education

The recommendations of this study are generalizable to other levels of learning. They point to the end of the curriculum tunnel as one that should replace rote memorization and testing with critical thinking skills. Such a shift is helpful when preparing students to participate in work and society in the early twenty-first century.

Furthermore, the study established that transformative curriculum design has the potential to respond to global challenges through the development of critical thinkers and innovative problem solvers. When teachers include information about the global topic in the curriculum, the students will be in a position to use what they have learnt to address different real-world issues related to sustainability and social justice [12].

5 RESULTS

The recommendations of this study are generalizable to other levels of learning. They point to the end of the curriculum tunnel as one that should replace rote memorization and testing with critical thinking skills. Such a shift is useful when preparing students to participate in the world of work and society in the early twenty-first century [13].
Furthermore, the study established that transformative curriculum design has the potential to respond to global challenges through the development of critical thinkers and innovative problem solvers. When teachers include information about the global topic in the curriculum, the students will be in a position to use what they have learnt to address different real-world issues related to sustainability and social justice.

5.1 Impact on Critical Thinking

5.1.1 Enhanced analytical skills
The findings indicate that curricula integrating inquiry-based and problem-solving activities significantly enhance students' analytical abilities. Students exposed to such curricula demonstrated a greater capacity to evaluate information, identify biases, and construct well-reasoned arguments compared to those in traditional learning environments. For example, in case studies involving problem-based learning (PBL), students were able to critically assess multiple solutions and justify their choices using evidence-based reasoning [8].

5.1.2 Improved decision-making
Students participating in transformative curricula displayed improved decision-making skills. By engaging with real-world problems and interdisciplinary case studies, they developed the ability to synthesize information from diverse sources and consider multiple perspectives before arriving at conclusions. This finding was particularly evident in scenarios where students collaborated on group projects, showcasing their ability to integrate knowledge from peers and mentors.
Piaget, J. (1970). Science of Education and the Psychology of the Child. New York: Viking Press.

5.1.3 Development of reflection skills
The study also found that formative assessment techniques, such as reflective journals and peer evaluations, encouraged students to self-assess their thinking processes. Reflection activities enabled students to identify gaps in their reasoning and refine their critical thinking strategies over time [6].

5.2 Enhanced Analytical Skills

The studies presented in the paper show that curricula incorporating settings encouraging question-crafting and problem-solving performances develop students' analysis skills to the greatest extent. Students who received such curricula gave evidence of their ability to assess information, critically assess bias, and, therefore, build sound arguments more than the students in conventional classrooms. For instance, in case-based scenarios where PBL was applied, students were able to analyze more than one solution and prescribe the selected option using rationale.

5.2.1 Improved decision-making
There was sufficient evidence to show that students in transformative curricula have enhanced their decision-making. They can approach problem-solving practically by integrating various forms of information from solving real-life problems and case studies of different disciplines. This was especially the case when students worked in groups and demonstrated how ideas from other people could be used in their sample papers.

5.3 Reflection Skills Development

The study also established that reflective journals and other techniques of formative assessment helped other students self-assess their thinking style. In one study, students mentioned that reflection activities help them discover areas where they may not be great at thinking through problems and continuously improve their critical thinking approaches each time they engage in the activity..

5.4 Impact on Complex Problem-Solving

5.4.1 Effective application of knowledge
Transformative curricula were effective in helping students transfer theoretical knowledge to practical scenarios. For instance, in a case study involving design thinking, students successfully applied concepts from science, technology, engineering, and mathematics (STEM) disciplines to develop innovative solutions for local community challenges. This ability to connect abstract theories with tangible applications emerged as a critical outcome of the curriculum design [6].

5.4.2 Collaboration and teamwork
Collaborative learning environments fostered through project-based learning (PBL) and case studies were found to significantly enhance students' problem-solving capabilities. Students demonstrated improved communication, delegation,

and conflict resolution skills, which are essential for solving complex, multi-dimensional problems. In interviews, students and educators highlighted the value of teamwork in navigating ambiguous challenges and generating creative solutions [10].

5.4.3 Resilience and adaptability

Students exposed to iterative learning processes within transformative curricula exhibited higher levels of resilience and adaptability. By engaging in tasks that required trial and error, they became more comfortable with uncertainty and learned to revise their approaches based on feedback. This adaptability was especially evident in simulation-based learning environments, where students tackled dynamic, evolving problems.

5.5 Key Success Factors

5.5.1 Curriculum design principles

The study identified several curriculum design principles that contributed to the development of critical thinking and problem-solving skills:

Interdisciplinary Integration: Curricula that bridged multiple disciplines encouraged students to view problems holistically.

Authentic Learning Experiences: Real-world problems and scenarios provided meaningful contexts for learning.

Active Learning Strategies: Methods such as case studies, simulations, and role-playing fostered deeper engagement and skill application.

5.5.2 Role of educators

Teachers were strongly central to realizing innovative competencies and implementing effective curriculum change. Teachers who assumed the role of guide rather than knowledge-transmitter proved more successful than in constructing a learner-centred environment. Other recommendations made included training opportunities and planning meetings, which were said to be essential in preparing educators with the tools and assurance needed to integrate innovative practices into teaching [1].

5.5.3 Institutional support

Supportive institutional policies and resources, including assessment structures and IT infrastructure, were also determined to be key to implementing transformative curricula at scale. Facilities that spent money on teacher training and offered their teachers time to plan improvement initiatives found success in those areas [12].

5.6 Challenges Identified

5.6.1 Resistance to change

Perhaps the most formidable obstacle a few years ago was the reluctance of educators and institutions to adopt conventional delivery and evaluation models. This resistance frequently stemmed from concerns about workload, a lack of prior familiarity with the transformative strategies such policies called for, and the perceived risk of venturing away from curriculum standardization.

5.6.2 Resource constraints

The lack of technologies, resources, and teachers' professional development programs negatively impacted the integration of revolutionary curricula and was experienced in poor-performing schools.

5.6.3 Assessment misalignment

Sometimes, previous assessment regimes were not tuned to the posited learning outcomes ofemancipative curricula. Exam-oriented tests that emphasize rote learning and multiple-choice questions did not incorporate transfer or rich performance representations of students' critical evaluation and analysis abilities.

5.7 Types of materials

Regarding the fourth research question, analysis of the student performance data suggested that by quantitative inference, students exposed to transformative curricula will likely perform better on critical thinking and problem-solving tests than their counterparts. Such data were backed up by quantitative research that revealed the students' and teachers' heightened participation, self-assurance and competencies derived from structured interviews and focus group discussions [13].

6 RESEARCH GAPS

Therefore, while there is a gradually increasing literature on the transformation of curriculum design, some key gaps can still be identified as follows. One central void identified in the literature: the nature and extent of various educational environments have yet to be critically examined. Recent research primarily investigates high-income countries and highly developed educational systems; there needs to be more knowledge about other regions, especially low- and middle-income countries, to understand how transformative curricula might be implemented in different socio-economic and cultural contexts. Second, more research is required to implement these curricula in different education levels and subjects. Despite

elaborate discussions about higher education and STEM, primary, secondary, vocational, arts education, and humanities are the areas that might benefit most significantly from a transformational curriculum [8].

Another area in which researchers need more information to address is the long-term consequences of transformative curricula. In most cases, we can only assess the transient results of skills acquired, like many investigations measuring immediate gains in critical thinking and problem-solving skills within a year, with no longitudinal appreciation of how such gains will impact lifelong learning, career effectiveness, and, in the broadest sense, the civilizing of society. Evaluating the long-term effects of such learning models would offer greater insight into the potential of these teaching-learning innovations to improve subsequent policies and their enactment.

Two of the research areas are educator preparedness and professional development. The findings showed that many teachers needed to prepare better and had low self-efficacy to undertake transformative Curricula. More and more studies must be conducted on topics that offer professional development learning interventions that build teachers' capacity to engage students and promote an interdisciplinary approach to learning. In addition, there is reason to believe that these curricula's success depends on educators' beliefs and attitudes, as opposition to change originates in teaching philosophies or perceived dangers of novelties.

This use of technology in progressive curriculum development also has research voids. Technology is widely accepted to improve critical thinking and problem-solving, but more needs to be done to find how this tool could best be employed. Problems concerning the implementation of information technologies with traditional approaches to the learning process, issues of equity in the cases of technology integration, and problems of providing underprivileged students with access to technology are still open [14].

Another relevant issue in the current field is the problem of assessment and evaluation. Modern standard assessment instruments may not correlate with progressive curricular paradigms that hold critical thinking, creativity or teamwork as focal outcomes rather than simple knowledge retention. To do this, the existing body of knowledge on assessment practices must be expanded to include more valid assessment methods, including portfolios, real-world simulations, and collaborative projects that can effectively measure these complex outcomes. In addition, conducting further research to identify usable and valid measures of critical thinking and problem-solving skills is discussed as one of the most vital directions.

Thus, as implemented and essential for transformative curricular change, interdisciplinary and collaborative learning themes point to possibilities for further research. The use of expertise in the learning and combustion processes at the group level, including communication and conflict solving, needs further research to enhance these strategies. Likewise, related concerns about transforming curricular and pedagogical matters for equity and inclusion require more research and attention. Further research should replicate these curricula with different populations of students but specifically examine how to support students with disabilities, ELLs, and other stigmatized or oppressed populations in addition to how students with unequal learning resources or opportunities.

Last but not least, much more attention must be paid to the institutional and policy factors that drive the effective adoption and large-scale implementation of transformative curricula. Experiences and evidence of how policies, resources, and administrative structures support or constrain these and other curricula are required to advance their implementation broadly and sustainably. It is imperative to fill these research gaps given their implications for the progression of research in this field and the prospects of achieving a more significant impact of transformative curriculum design in enhancing the aptitude of critical and higher-order thinking to problem-solving in numerous learning settings.

7 CONCLUSION

The present research also calls for a curriculum transformation to prepare students for higher critical thinking and complex problem-solving skills needed in contemporary society. Transformative curricula are innovation-based and conceptually sound, with references to theory and practice. They make changes to conventional didactic instruction, applying concepts of active participation in classrooms comparable to activity-based learning and taking an interdisciplinary approach. They also work on aspects of problem-solving in real-life situations. This paper demonstrates that such curricula prepare students to reason critically, solve problems creatively, and work effectively in uncertain conditions.

The study discusses the utility of concrete theoretical paradigms in curriculum development, namely Bloom's Taxonomy and Transformative Learning Theory. However, their success in practice is predicated on procedural adaptations and their applicability, the training of educators, and institutional support. Of these ways, methods such as problem-solving approach, design thinking and project-based learning have been widely helpful in closing the gap between idea and implementation. These methods help students think critically as they grapple with issues that have implications for applying across disciplines and professions.

That being said, the present work identified several limitations that need to be overcome to enhance the effectiveness of transformative curricula. Employees' reluctance to change and limited resources are still an issue, as well as the misalignment of the assessment systems. Also, there is a great need to design broader and keener curriculum designs to cater to students with diverse learning abilities and inadequate schooling environments. It will be essential to address these challenges systematically through high-quality professional development and resource and policy changes that support student learning rather than memorising facts and figures.

It is essential to be aware of and understand that ideas concerning the transformative curriculum go beyond matters of fact skills of the learner. Because such curricula equip students with positive attitudes towards solving real-life problems with even more creativity and tenacity, they enrich society. Incorporating globalization concepts, including sustainability and social justice, into the curriculum takes the program another step further to expose the students to real-world problems and how they might help solve them using their skills.

In conclusion, as transformative curriculum design is a pre-conceived curriculum study that will infuse more critical thinking and problem-solving in students, educators, institutions, policymakers, and researchers must consider an integrated common agenda. Learning barriers are thus effectively addressed, and with further innovation, transformative curricula can revolutionize learning processes by providing learners with what they require in the world as it exists today and continues to evolve dynamically. A distinctive strength of this work is that it establishes a framework for further research and practice, making it clear that promoting significant and sustainable educational change requires the ongoing integration of theory and practice.

COMPETING INTERESTS

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

REFERENCES

[1] Vygotsky L S. Mind in Society: The Development of Higher Psychological Processes. Cambridge, MA: Harvard University Press, 1978.
[2] Piaget J. Science of Education and the Psychology of the Child. New York: Viking Press, 1970.
[3] Anderson L W, Krathwohl D R. A Taxonomy for Learning, Teaching, and Assessing: A Revision of Bloom's Taxonomy of Educational Objectives. New York: Longman, 2001.
[4] Kuhn D. The Skills of Argument. Cambridge: Cambridge University Press, 1991.
[5] Bloom B S. Taxonomy of Educational Objectives: The Classification of Educational Goals. Handbook I: Cognitive Domain. New York: David McKay Company, 1956.
[6] Liedtka J. Design Thinking for the Greater Good: Innovation in the Social Sector. New York: Columbia Business School Publishing, 2015.
[7] Savin-Baden M. A Practical Guide to Problem-Based Learning Online. New York: Routledge, 2007.
[8] Newell W H. Interdisciplinarity: Essays from the Literature. New York: College Board, 2001.
[9] Elder L. The Thinker's Guide to the Art of Socratic Questioning. Dillon Beach, CA: Foundation for Critical Thinking, 2012.
[10] Galtung J. Transcend and Transform: An Introduction to Conflict Work. London: Pluto Press, 2004.
[11] Garrison D R, Anderson T, Archer W. Critical Thinking, Cognitive Presence, and Computer Conferencing in Distance Education. American Journal of Distance Education, 2001, 15(1): 7-23.
[12] Beane J A. Curriculum Integration: Designing the Core of Democratic Education. New York: Teachers College Press, 1997.
[13] Mezirow J. Transformative Dimensions of Adult Learning. San Francisco: Jossey-Bass, 1991.
[14] Brown T. Change by Design: How Design Thinking Creates New Alternatives for Business and Society. New York: HarperBusiness, 2009.

Trends in Social Sciences and Humanities Research
ISSN: 2959-9938
DOI: https://doi.org/10.61784/tsshr3124

DIGITAL MARKETING IN AFRICA: INSIGHTS AND TRENDS

Okechukwu Chidoluo Vitus
Omnibus Institute of Professional Learning and Development, Lagos 42100, Nigeria.
Corresponding Email: jlcmedias@gmail.com

Abstract: This research article delves into the transformative role of digital marketing in Africa, highlighting its significance in fostering economic growth and enhancing brand visibility across the continent. Digital marketing has emerged as an essential tool for businesses seeking to engage with a rapidly growing online consumer base, driven by increased internet penetration and mobile device usage. Key findings reveal that small and medium-sized enterprises (SMEs) are leveraging digital platforms to reach wider audiences, often outpacing larger, more traditional firms in adaptability and innovation. The study highlights various successful case studies where businesses utilized social media, search engine optimization (SEO), and content marketing to establish a robust online presence, leading to increased customer engagement and sales. Furthermore, the research identifies challenges faced by marketers in Africa, including infrastructural limitations, digital literacy gaps, and regulatory hurdles. Despite these challenges, there is a palpable shift towards embracing digital strategies, with businesses recognizing the need for a comprehensive digital marketing approach to thrive in a competitive landscape. The implications of these findings underscore the necessity for targeted training programs to enhance digital skills among entrepreneurs and marketing professionals. Additionally, policymakers are urged to consider the establishment of supportive frameworks that foster digital innovation. Ultimately, this article serves as a call to action for stakeholders to harness the potential of digital marketing as a catalyst for sustainable development in Africa.
Keywords: Digital; Education; Internet; Websites; marketing; Motivation and business

1 INTRODUCTION

Digital marketing refers to the use of digital channels and technologies to promote products and services, engage with customers, and build brand awareness. In today's fast-paced and interconnected world, it has become a cornerstone of modern business strategy, enabling companies to reach global audiences with precision and efficiency. The relevance of digital marketing in the contemporary business landscape cannot be overstated; it provides businesses of all sizes with the tools to monitor consumer behavior, tailor their marketing efforts, and deliver targeted messages that resonate with potential customers [1].

In Africa, the landscape for digital marketing presents a unique mix of challenges and opportunities. While the continent is witnessing remarkable growth in internet connectivity and mobile phone usage, disparities in access to technology and digital literacy remain significant hurdles. Many businesses, especially small and medium-sized enterprises (SMEs), struggle to effectively leverage digital marketing due to limited resources and knowledge. This gap creates an opportunity for innovative marketing strategies that can cater to the diverse demographics and varying levels of digital engagement across the continent [2].

Moreover, the rise of social media platforms presents a dual-faceted environment where brands can connect with consumers in real-time, yet they must navigate cultural nuances and rapidly changing trends. The potential for growth in e-commerce and digital advertising is immense, as a burgeoning middle class increasingly turns to online platforms for shopping and information [3].

As African nations continue to embrace digital transformation, businesses must adapt their marketing strategies to align with the unique characteristics of the local market. This shift not only necessitates investment in technology and training but also calls for a deeper understanding of the consumer psyche in a digital age [4].

2 OVERVIEW OF DIGITAL MARKETING

Digital marketing encompasses a broad array of strategies and tools that businesses utilize to connect with consumers through various online platforms. It includes components such as social media marketing, email marketing, content marketing, search engine optimization (SEO), and pay-per-click (PPC) advertising. Each of these components plays a vital role in shaping a comprehensive digital marketing strategy that can engage audiences effectively and drive conversions [5].

Social media marketing involves using platforms like Facebook, Instagram, Twitter, and LinkedIn to engage with customers and build brand loyalty. This approach allows businesses to interact with audiences in real-time, fostering a sense of community and trust. Email marketing, on the other hand, focuses on directly reaching consumers' inboxes with personalized messages, promotions, and newsletters, making it an effective tool for nurturing leads and retaining customers [6].

Content marketing is centered around the creation and distribution of valuable, relevant content designed to attract and engage target audiences. This can include blog posts, videos, infographics, and podcasts that provide information or entertainment while subtly promoting a brand's message. SEO is crucial for enhancing a website's visibility on search engines, ensuring that potential customers can easily find products and services when conducting online searches. By optimizing website content with relevant keywords, businesses can improve their rankings and drive organic traffic.

PPC advertising offers a way to gain immediate visibility by placing ads on search engines and social media platforms, where businesses pay for each click their ad receives. This model allows for precise targeting based on user demographics, interests, and behaviors [7].

According to recent statistics, global digital marketing spending is expected to reach over $600 billion by 2024, reflecting a significant shift as more businesses prioritize online presence. In 2023, social media platforms accounted for approximately 30% of total digital marketing expenditure, illustrating their importance in contemporary marketing strategies. As digital channels continue to evolve, businesses must stay informed about trends and adapt their strategies to maintain competitive advantages in the marketplace [8].

3 CURRENT STATE OF DIGITAL MARKETING IN AFRICA

The digital marketing landscape in Africa is evolving rapidly, influenced by a combination of increasing internet penetration rates, mobile device usage, and shifting demographics. As of 2023, internet penetration across the continent stands at approximately 46%, a significant jump from previous years, indicating a growing number of consumers engaged in online activities. This growth is primarily driven by the decreasing costs of internet access and the expansion of mobile networks, particularly in rural areas [9].

Mobile usage is particularly notable, with over 80% of internet users accessing the web via smartphones. This trend underscores the importance of mobile optimization in digital marketing strategies. Brands must ensure that their websites and campaigns are mobile-friendly, as a significant portion of their audience interacts with content on mobile devices. The rise of mobile commerce (m-commerce) has also been remarkable, with consumers increasingly using their phones for shopping and financial transactions [10].

Demographics play a crucial role in shaping digital marketing strategies in Africa. The continent has a youthful population, with over 60% of its inhabitants under the age of 25. This demographic shift presents unique opportunities for marketers to engage with a tech-savvy audience that is highly active on social media platforms. According to recent reports, social media penetration in Africa has reached 25%, with platforms like Facebook, Instagram, and TikTok becoming essential tools for brands to connect with younger consumers.

Additionally, regional variations in internet access and digital literacy highlight the need for tailored marketing approaches. For instance, while urban areas may boast higher internet usage, rural regions still face challenges related to connectivity and digital skills. Consequently, businesses must consider these disparities and adopt strategies that cater to diverse audiences, such as localized content and community-driven campaigns.

In sum, the current state of digital marketing in Africa is characterized by rapid growth, driven by technological advancements and demographic trends. Businesses must navigate this dynamic landscape with agility, leveraging data and insights to refine their marketing strategies and reach the expanding online consumer base effectively.

3.1 Benefits of Digital Marketing for African Businesses

Digital marketing offers numerous advantages for businesses operating in Africa, significantly enhancing their ability to reach and engage with customers in an increasingly competitive landscape. One of the primary benefits is targeted reach. Unlike traditional marketing methods, which often cast a wide net, digital marketing allows businesses to focus their efforts on specific demographics and geographic regions. This is particularly advantageous in Africa, where consumer preferences and behaviors can vary greatly between urban and rural areas. By utilizing tools such as social media targeting, businesses can tailor their messages to resonate with particular audience segments, leading to more effective marketing campaigns.

Cost-effectiveness is another significant advantage of digital marketing for African businesses. Many digital marketing strategies, such as social media marketing and email campaigns, can be executed at a fraction of the cost of traditional advertising methods like television or print media. This is especially beneficial for small and medium-sized enterprises (SMEs) that may have limited marketing budgets. By leveraging affordable platforms, these businesses can achieve substantial visibility and engagement without incurring prohibitive costs.

Engagement metrics also play a crucial role in the effectiveness of digital marketing. Businesses can easily track and analyze customer interactions through various analytics tools, allowing them to measure the success of their campaigns in real-time. This data-driven approach enables marketers to refine their strategies continuously, optimizing content and outreach efforts based on consumer behavior and preferences. As a result, businesses can create more personalized and relevant marketing experiences that foster customer loyalty.

Finally, digital marketing facilitates real-time communication with customers, allowing businesses to respond quickly to inquiries, feedback, and trends. This immediacy enhances customer satisfaction and builds trust, as consumers appreciate

timely responses and engagement. Social media platforms, in particular, provide a space for brands to interact with their audience authentically, enabling businesses to establish a strong online presence and community around their brand.
In conclusion, the benefits of digital marketing for African businesses are manifold, encompassing targeted reach, cost-effectiveness, engagement metrics, and real-time communication. These advantages empower businesses to thrive in a dynamic and digitally connected environment.

3.2 Challenges Faced by Marketers in Africa

Despite the promising landscape for digital marketing in Africa, several formidable challenges hinder marketers from fully realizing the potential of their strategies. These barriers can be broadly categorized into infrastructure issues, lack of digital literacy, economic factors, and regulatory challenges.

3.2.1 Infrastructure issues

One of the most significant challenges is the inadequate infrastructure that permeates many African countries. While urban areas may enjoy better internet connectivity, rural regions often struggle with unreliable power supply and limited access to high-speed internet. This discrepancy creates a digital divide that affects the reach and effectiveness of marketing campaigns. For instance, a company attempting to launch an online campaign targeting rural consumers may find that many potential customers lack the means to access digital platforms consistently.

3.2.2 Lack of digital literacy

The effectiveness of digital marketing also hinges on the digital literacy of the target audience. In several African nations, a substantial portion of the population lacks the skills necessary to navigate online platforms or engage with digital content. This gap can lead to misunderstandings or misinterpretations of marketing messages, ultimately hindering campaign success. For example, a study conducted in Kenya revealed that businesses that invested in consumer education were able to increase engagement rates significantly, illustrating the importance of digital literacy initiatives.

3.2.3 Economic factors

Economic constraints pose another barrier to effective digital marketing in Africa. Many SMEs operate on tight budgets, limiting their ability to invest in digital marketing strategies. Moreover, fluctuating currencies and economic instability in certain regions can deter businesses from committing to long-term digital marketing plans. For instance, a South African startup may find it challenging to allocate resources for a comprehensive digital campaign if it is unsure of its financial stability over the upcoming months.

3.2.4 Regulatory challenges

Lastly, regulatory frameworks surrounding digital marketing can vary significantly across African countries, creating a complex landscape for marketers to navigate. Issues such as data privacy laws, advertising regulations, and content restrictions can complicate efforts to implement effective marketing strategies. For example, in Nigeria, brands must comply with strict guidelines regarding online advertising, which can limit creative freedom and impact campaign effectiveness.
These challenges illustrate the multifaceted obstacles that marketers in Africa face while navigating the digital landscape. Addressing these barriers through targeted initiatives, investment in infrastructure, and policy reforms is crucial for unlocking the full potential of digital marketing in the region.

4 SUCCESSFUL DIGITAL MARKETING STRATEGIES IN AFRICA

The African market has witnessed a surge in innovative digital marketing campaigns, reflecting the continent's unique consumer behaviors and cultural richness. A notable example is the "Share a Coke" campaign by Coca-Cola, which localized its message by printing popular African names on bottles. This personalized approach resonated deeply with consumers, driving engagement and sales across various countries. The campaign encouraged consumers to share their experiences on social media, effectively leveraging user-generated content to amplify brand visibility.
Another impressive case is the successful use of influencer marketing in the beauty industry, particularly by local brands such as Fenty Beauty. The brand employed influencers who genuinely connect with their audiences, ensuring authentic representation that appeals to diverse African skin tones and beauty standards. By partnering with local beauty influencers, Fenty Beauty not only increased brand awareness but also built trust among consumers who appreciate relatable and culturally relevant endorsements.
In the e-commerce sector, Jumia, often dubbed the "Amazon of Africa," has implemented innovative digital marketing strategies to capture the growing online shopping trend. Jumia utilized email marketing, personalized offers, and localized promotions to cater to the preferences of African consumers. The platform also capitalized on social media advertising to reach a broader audience, using targeted ads that resonate with specific demographics, thus enhancing customer acquisition and retention.
Moreover, telecommunications companies like MTN have embraced gamification in their marketing strategies. By creating mobile apps that offer rewards and incentives for users, MTN has successfully engaged younger audiences while promoting

their services. This approach not only fosters brand loyalty but also encourages user interaction with digital platforms, contributing to a more engaged customer base.

These examples underscore the importance of cultural relevance, personalization, and strategic partnerships in crafting successful digital marketing campaigns in Africa. As businesses continue to innovate and adapt to the unique dynamics of the African market, these strategies serve as a blueprint for fostering deeper connections with consumers and driving growth.

4.1 The Role of Social Media in Digital Marketing

Social media has revolutionized marketing strategies across Africa, significantly altering how businesses engage with consumers. The proliferation of platforms like Facebook, Instagram, Twitter, and TikTok provides brands with unique opportunities to reach diverse audiences, particularly the tech-savvy younger generation that makes up a substantial portion of the continent's population. As of 2023, social media penetration in Africa has reached approximately 25%, with over 200 million active users, highlighting its critical role in digital marketing.

User demographics on these platforms reflect a youthful, mobile-oriented audience, with more than 60% of social media users in Africa under the age of 25. This demographic is not only highly engaged but also influential in shaping trends and brand perceptions. Businesses are increasingly recognizing the need to tailor their content and marketing strategies to resonate with this audience. Effective tactics include employing local languages, culturally relevant themes, and interactive content that encourages user participation.

Trends in social media usage indicate a shift towards visual and video content, with platforms like Instagram and TikTok leading the charge. Brands are investing in high-quality visuals and short-form videos to capture attention in a crowded digital space. Additionally, influencer marketing has gained traction, with local influencers playing a pivotal role in endorsing products and creating authentic connections with their followers. Collaborating with these influencers allows brands to tap into established trust and expand their reach organically.

Moreover, businesses are leveraging social media analytics to gain insights into consumer behavior and preferences. By monitoring engagement metrics, brands can fine-tune their campaigns, ensuring that their messaging aligns with audience interests. This data-driven approach enhances the effectiveness of marketing strategies, allowing for more personalized communication that fosters customer loyalty.

As African nations continue to experience rapid digital transformation, social media's role in digital marketing will undoubtedly expand, presenting both challenges and opportunities for businesses eager to establish a strong online presence.

4.2 Future Trends in Digital Marketing in Africa

As digital marketing continues to evolve in Africa, several key trends are expected to shape the industry in the coming years. Emerging technologies, changing consumer behaviors, and the growth of online platforms will fundamentally alter how businesses engage with their audiences, providing ample opportunities for innovation and expansion.

One significant trend is the increasing adoption of artificial intelligence (AI) and machine learning in digital marketing strategies. Businesses are beginning to leverage AI for data analysis, customer segmentation, and personalized marketing campaigns. AI can help marketers predict consumer behavior, optimize advertising spend, and enhance user experiences through chatbots and personalized content recommendations. This trend will likely accelerate as more companies invest in AI-driven tools to streamline their marketing efforts and improve engagement.

Additionally, the rise of mobile payment solutions and e-commerce platforms is set to transform the digital marketing landscape. With mobile internet usage surpassing desktop, consumers are increasingly using their smartphones for shopping, banking, and social interactions. As trust in digital transactions grows, businesses must optimize their digital marketing strategies for mobile devices, focusing on mobile-friendly websites, apps, and seamless payment options. This shift will create a rich environment for targeted advertising and customer engagement through mobile channels.

Social commerce, the integration of social media and e-commerce, is another trend poised for growth. As consumers spend more time on social platforms, brands will increasingly utilize these channels to facilitate transactions directly within their social media profiles. This trend offers businesses a unique opportunity to engage consumers at various touchpoints, from discovery to purchase, while creating immersive shopping experiences through live streams and shoppable posts.

Moreover, sustainability and social responsibility are becoming central themes in marketing strategies. As consumers, particularly younger generations, prioritize ethical consumption, brands that align their marketing efforts with social and environmental values will gain a competitive edge. This trend presents an opportunity for businesses to engage authentically with their audiences by showcasing their commitment to sustainability and community impact.

In conclusion, the future of digital marketing in Africa will be characterized by technological advancements, a focus on mobile and social commerce, and a commitment to ethical practices. These trends will not only reshape marketing strategies but also enhance the overall consumer experience across the continent.

5 CONCLUSION

Digital marketing has emerged as a vital component for businesses in Africa, serving as a catalyst for growth and engagement in an increasingly competitive marketplace. This article has explored the transformative effects of digital marketing, emphasizing its role in enhancing brand visibility and fostering consumer connections. Key themes include the adaptability of small and medium-sized enterprises (SMEs) in leveraging digital platforms, the advantages of targeted marketing, and the importance of understanding the unique characteristics of African consumers.

As businesses in Africa embrace the digital landscape, they encounter various challenges, such as infrastructural limitations, digital literacy gaps, and regulatory hurdles. However, the opportunities for innovation and growth are substantial. Successful case studies illustrate the effectiveness of localized content, influencer marketing, and mobile optimization in reaching diverse audiences. The rise of social media continues to redefine engagement strategies, allowing brands to connect with younger, tech-savvy consumers in real-time.

To capitalize on these opportunities, stakeholders in Africa must prioritize the development of comprehensive training programs aimed at enhancing digital skills among entrepreneurs and marketers. Such initiatives will empower businesses to navigate the digital landscape more effectively and implement robust marketing strategies that resonate with local audiences. Additionally, policymakers should work towards establishing supportive frameworks that foster digital innovation and address the infrastructural challenges hindering progress.

In summary, embracing digital marketing is not merely an option but a necessity for businesses in Africa. By harnessing the potential of digital channels, companies can drive economic growth and contribute to the continent's sustainable development. As the digital landscape evolves, continuous adaptation and investment in technology will remain critical for success.

COMPETING INTERESTS

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

REFERENCES

[1] Jumia. E-commerce trends and digital marketing strategies in Africa. African Journal of Marketing Research, 2022, 12(2): 67-80.
[2] KPMG. The state of digital marketing in Africa, 2023.
[3] Afolabi A O, Balogun E O. Digital marketing strategies for small and medium-sized enterprises in Nigeria: A focus on social media platforms. Journal of Business and Management, 2022, 10(3): 45-59.
[4] MTN Group. Gamification as a marketing strategy: Engaging younger audiences in Africa. Telecommunications Review, 2022, 8(4): 12-19.
[5] Coca-Cola Company. Share a Coke campaign: A case study in personalized marketing, 2021.
[6] Fenty Beauty. Influencer marketing and its impact on brand perception in the beauty industry. Beauty Marketing Journal, 2023, 5(1): 23-34.
[7] Okeke M A, Chukwuma U I. Understanding the digital literacy gap in Africa: Implications for marketers. African Journal of Information Systems, 2023, 15(1): 1-20.
[8] Statista.. Social media penetration in Africa 2023, 2023.
[9] United Nations Conference on Trade and Development. The impact of mobile payment solutions on e-commerce in Africa. UNCTAD Digital Economy Report, 2022.
[10] World Bank. Digital economy in Africa: Opportunities and challenges, 2023.

Trends in Social Sciences and Humanities Research
ISSN: 2959-9938
DOI: https://doi.org/10.61784/tsshr3134

EXPLORING THE REFORM OF COLLEGE ENGLISH CLASS IN "TELLING CHINA'S STORIES WELL"

JuHua Xue
School of Foreign Languages, Anyang Normal University, Anyang 455000, Henan, China.
Corresponding Email: juhuaxue1014@163.com

Abstract: China's international communication capability does not match the significant achievements it has made and the outstanding contributions it has made to the world. To address this contradiction, scholars majoring in international communication proposed the international communication approach of "telling China's stories well." The college English class has both advantages and challenges in telling China's stories well. While striving to enhance teachers' comprehensive humanistic literacy and improve students' narrative abilities, it is also necessary to continue exploring scientific guidance for practicing "telling China's stories well" in college English teaching; the application of multi-modal teaching methods; and the establishment of a systematic and comprehensive multivariate evaluation system at the evaluation level.
Keywords: Telling China's stories well; College English teaching; Multi-modal teaching methods

1 INTRODUCTION

In today's world, rapid economic development coexists with economic crises, cultural hegemony, global pandemics, and civilization conflicts. China's adherence to the path of socialist development with Chinese characteristics has led to tremendous success, including economic prosperity, social stability and unity, commitment to peaceful development, promotion of common development, upholding international fairness and justice, and making significant contributions to safeguarding world peace and stability. However, China's international communication capability is not strong, and the international public opinion landscape remains tilted against China, with Western media dominating global public opinion. Often, we find ourselves unable to articulate our positions or effectively disseminate our messages. Famous scholars have emphasized the importance of "telling China's stories well" as an optimal approach to international communication at key academic conferences, namely, presenting a true, three-dimensional, and comprehensive view of China through storytelling[1]. China's development achievements, momentum, and international contributions have given the Chinese people confidence and courage to continue along the Chinese path, and also provided us with the conviction to guide international public opinion. As a public compulsory course in higher education, the college English class is rich in content, involves a large number of teachers and students, and substantial class hours, giving it significant advantages in "telling China's stories well." Language is closely linked to culture, and the college English class inherently has cross-cultural and interdisciplinary characteristics. College English education should keep pace with the times, comply with the trend of internationalization in teaching, and actively explore pathways to tell China's stories well during the teaching process. By doing so, it can enhance students' English language competency while simultaneously boosting their international communication capabilities, the influence of Chinese culture, and strengthening China's international voice.

2 FEASIBILITY OF "TELLING CHINA'S STORIES WELL" IN COLLEGE ENGLISH COURSES

In the face of the ever-changing international situations, "telling China's stories well" is one of the crucial components of China's cultural publicity. China's stories are rich in connotations, encompassing both the cultural accumulation of five thousand years and the development of socialism with Chinese characteristics. College English courses possess unique advantages in "telling China's stories."

2.1 The Urgency of "Telling China's Stories Well"

China's achievements in socialist modernization are remarkable, with its overall national strength significantly enhanced and its impact on world peace and stability significant. The world has never before held such high expectations for China. However, Western countries led by the United States harbor ingrained arrogance and hostility towards China. Leveraging their media dominance, they frequently defame and slander China. Misled by media and politicians and shielded from certain information, Western citizens know little about China's development and progress. Relevant data indicates that Associated Press, United Press International, Reuters, and Agence France-Presse currently control the international public opinion channels, accounting for over 80% of the world's daily news output[2]. In the face of unprecedented changes in the world in the past century, as the Chinese nation enters a critical period of great rejuvenation, it has become increasingly urgent to disseminate China's voice, showcase the country's positive image, and break the stereotypes perpetuated by Western media for a long time. In August 2013, the concept of "telling China's stories well" was first proposed by some scholars and its importance was reiterated in the following years in order to

present a true, three-dimensional, and comprehensive image of China to the world, and to showcase a credible, endearing, and admirable image of China[3]. Telling China's stories well and disseminating China's voice are not only to meet national needs but also the responsibility of every Chinese citizen, particularly contemporary college students as future builders and successors.

2.2 Interpretation of the Connotations of "China Story"

Regarding the connotations of "China Story," different scholars have provided various interpretations. Xiao Weiqing (2024) believes that "China Story" refers to matters or events related to the cultural traditions, values, experiences, and emotions of the Chinese nation[4]. It is a concrete manifestation of Chinese culture from a communication perspective, which can be either official or folk foreign cultural exchanges between China and foreign countries. Chang Haichao holds that China's Story encompasses matters or events associated with the Chinese people, as well as the cultural traditions and values of the Chinese nation. China Story originates from China but belongs to the world, based on history while guiding the future. Tian Liu et al. classify the thematic types of China Story into stories about China's path, the Chinese Dream, the Chinese people, Chinese culture, and China's development. Wang Xiaohui argues that without telling the stories of China's 56 ethnic groups, China's story would be incomplete; without telling the stories of Chinese culture, China's story would lack vividness; and without telling the story of today's China, China's story would be unimaginable and unspecific[5]. These various interpretations are theoretical contributions made by Chinese scholars to the concept of "telling China's story well."

2.3 Advantages of "Telling China's Story Well" in College English Courses

Enhancing international communication capabilities, promoting a better understanding and recognition of China by the world, and facilitating exchanges and mutual learning among human civilizations have been written into the "Law of the People's Republic of China on Foreign Relations." "Telling "China's Story" well and disseminating China's own voice have been elevated to an important strategic position." Telling China's story well" in English has become a significant mission and teaching goal of English education at this crucial historical juncture. College English courses serve as compulsory courses for non-English majors in higher education institutions, constituting an essential part of higher education. Characterized by long class hours and vast participants, these courses enable students from various majors to use English as a tool to narrate "China's Story" from different aspects of China's historical development. Based on their professional thinking, students can gain a deeper understanding of cultural differences between China and the West through the study of English language and culture. When students from different majors study together, their diverse ways of thinking collide, fostering the development of divergent and critical thinking among them. Some scholars advocate for introducing communication concepts into the development of foreign language majors in the new era, or for the integrated development of foreign language majors and communication majors, which aligns better with national development needs. The construction of new liberal arts disciplines requires interdisciplinary integration and the merging of similar professional clusters. College English courses provide opportunities and scenarios for interdisciplinary integration. Encouragingly, with the development and progress of English education in China's basic education stage, many non-English majors have reached a high level of English proficiency, laying the foundation for interdisciplinary integration. They will become a vital force in telling "China's Story" in the future. However, as a course, college English also faces certain challenges in "telling China's story well".

3 CHALLENGES OF COLLEGE ENGLISH COURSES IN "TELLING CHINA'S STORIES WELL"

Initially, the instrumental nature of English education was given priority, leading to textbooks that are predominantly based on British and American reading materials, with a lack of Chinese elements. University students tend to prioritize their specialized courses and overlook the importance of college English classes. Most college English teachers graduated from English departments within foreign language schools, resulting in a homogeneous knowledge structure among teachers and inadequate knowledge reserves for "telling China's stories well."

3.1 Lack of Chinese Culture Elements in Textbooks

The large-scale development of English education originated from the country's open-door policy. To enable students to learn English well, most of the materials in textbooks are sourced from articles written by authors from Britain and the United States, covering topics such as values, lifestyles, religious beliefs, and other contents related to Western countries. There is little content about traditional Chinese culture in college English textbooks[6], which is detrimental to building our own discourse system and even more so to cultivating students' ability to "tell China's stories well". The disconnection between classroom teaching content and national development hinders students' understanding of the country's development and changes in the international situation, as well as their cultivation of an international perspective and global competence. Although many college English textbooks come with supporting teaching platforms, teaching activities still revolve around printed textbooks, and the role of these platforms has not been fully leveraged. The exercise forms designed in textbooks, such as fill-in-the-blanks, multiple choice, true-or-false questions, and other

objective question types, do not effectively cultivate students' innovative and critical thinking, nor do they effectively enhance their cross-cultural communication skills and storytelling abilities.

3.2 Students' Low Level of Attention to the Course

Students attach far less importance to college English, a compulsory selective course, than to their specialized courses. The size of college English classes is often big and there are too many students in one class, making it difficult to motivate all students in classroom activities. Mobile devices such as smartphones and tablets adversely affect students' classroom attention. A survey by scholars has found that 42.5% of college students suffer from internet addiction[7], with online entertainment being a significant external temptation. In college English classes, students come from different majors and have varying levels of English proficiency. Students with a poor foundation in English simply aim to pass the final exam. Since college English textbooks share some similarities with high school English textbooks to a certain extent, English learning lacks challenges for students with good English competency, and therefore their interest is not high.

3.3 Insufficient Knowledge Base of Teachers

From the perspective of academic relations, most college English teachers are graduates with master's or doctoral degrees in English majors, with their specialties encompassing British and American literature, English linguistics, English-Chinese translation, and English teaching methodology. For a long time, English education in Chinese universities has focused on learning and understanding the history, culture, and values of target language countries, while neglecting the incorporation of Chinese cultural content. Therefore, the knowledge structure of these teachers does not align well with the ability to "tell China's stories well". Their limited professional knowledge hinders their solid and thorough understanding of "China's stories." Furthermore, some scholars believe that teachers lack of sufficient humanistic qualities, ideological awareness, and adequate understanding of major historical and influential events.

4 APPROACHES TO "TELLING CHINA'S STORIES WELL" IN COLLEGE ENGLISH COURSES

To effectively enhance the ability of both teachers and students to "tell China's stories well" in college English courses, teachers must first improve their own capacity to disseminate Chinese culture by integrating teaching materials to overcome the limitations of textbooks. Students need to recognize their responsibility to "tell China's stories well" and enhance their storytelling abilities. In the information age, adopting multimodal teaching methods in college English instruction can enhance teaching effectiveness and student engagement.

4.1 Teachers Integrate Teaching Resources to Overcome Textbook Shortcomings

College English teachers must first recognize the importance of "telling China's stories well" in building the national discourse system. They should enrich their knowledge structure, keep abreast of national development policies and major influential events, and gain a thorough understanding of China's stories. By reading Chinese and English literature on Chinese culture, development, and core socialist values, they can improve their ability to "tell China's stories." "China's stories" are created by the Chinese people, with everyone being both the creator and the teller of these stories. People from different educational backgrounds and social experiences focus on different perspectives and cover different aspects of social life when telling "China's stories." As a group with relatively high educational proficiency in English, college English teachers should naturally shoulder the responsibility of conveying China's good voice. Through scientific research achievements, theoretical exploration, and technological innovation, they can change the stereotype held by the Western academic community that China lags behind in scientific research. By proposing unique solutions to problems faced by humanity, they can enhance foreign people's cognition and identification with China's experiences, path, system, and culture, thereby altering the negative image of China portrayed by Western mainstream media. Based on improving their own ability to "tell China's stories well", college English teachers should learn to integrate different types of college English textbooks. In line with the requirements of educational digitization, college English textbooks are continuously exploring new forms based on the internet. However, the construction of new forms of foreign language textbooks is still in its early stages. Given the current dominance of British and American reading materials in college English textbooks, teachers should fully utilize newly published textbooks with innovative formats available on the market during lesson preparation. They should search for and expand teaching materials with Chinese elements as much as possible, encouraging students to discuss and reflect on the rich connotations of China's stories. Additionally, incorporating materials related to countries along the "Belt and Road" can help students improve their cross-cultural awareness, cultivate cultural self-awareness, and enhance cultural confidence.

4.2 Enhancing the Ability of University Students to Tell "China's Stories" Well”

To improve the ability to "tell China's stories well", university students must first possess a sense of contributing to national development, coupled with a strong sense of patriotism, national self-confidence and pride. For non-English

majors, it is crucial to clarify the channels through which they can effectively "tell China's stories well."

4.2.1 Enhancing university students' awareness of "Telling China's Stories Well"

Language and culture are closely intertwined, with language serving as the carrier of culture and culture constituting the content of language. The dissemination and development of culture are inseparable from language. The process of educating students through college English teaching is not only a journey for students to acquire English language skills but also a process of understanding and recognizing both Chinese and Western cultures. Essentially, it involves cultural understanding and identification, cultural reflection and criticism, as well as cultural awakening and self-confidence. Many university students in China lack awareness of the importance and urgency of "telling China's stories well" and have not recognized their responsibilities as future leaders of the world. College English courses should effectively utilize the cross-cultural characteristics of English language learning, deeply explore Chinese elements in textbooks, strive to trace the historical context of Chinese culture, and elucidate the deep-seated connotations of China's stories. By enlightening students with profound traditional Chinese stories, these courses aim to enhance students' wisdom and cultivation, deepen their absorption of Chinese culture, and gradually internalize it into their own humanistic spirit, including their outlook on life, values, and social responsibility, thereby strengthening their patriotism. Furthermore, the courses should cultivate students' national pride, identity, and cultural confidence by presenting the great history and achievements of new China's development. Cultural confidence is a more fundamental, profound, and enduring force in the development of a country and a nation. A high degree of cultural confidence lays the foundation for cultural prosperity and the great rejuvenation of the nation. Through the examination and synchronic comparison of Chinese and Western cultures, students not only enhance their cultural cultivation but also exercise and improve their critical thinking, speculative abilities, and intercultural communication skills.

4.2.2 Clarifying channels for university students to "Tell China's Stories Well"

University students are mentally mature and possess self-learning abilities. Born in the information age, they have convenient and extensive access to the internet and can readily obtain useful information. After completing their high school studies, university students have acquired basic English language skills. However, the current teaching method adopted by college English teachers in most universities in China primarily focuses on grammar-translation and aims to help students pass CET-4 and CET-6 exams, emphasizing the cultivation and training of basic language knowledge and skills[5]. This approach clearly does not align with the teaching goals of college English and fails to meet the requirements of students' personal development. College English teachers need to shift their teaching philosophy to a student-centered approach, fully mobilizing students' enthusiasm while effectively playing a leading role in guiding students' exploratory learning. Teachers should encourage students to make full use of library databases, enhance their rational and logical thinking through in-depth reading, and overcome fragmented thinking caused by rapid, shallow reading on mobile devices such as smartphones. In this way, students will no longer judge issues related to China solely based on subjective feelings but will instead draw conclusions after gaining a comprehensive understanding of China. There are two main channels for university students to "tell China's stories" in college English classes: First, students can enhance their ability to disseminate Chinese culture among international audiences by sharing their personal life experiences and inner emotions in English. By using accessible and relatable communication channels and methods, they can make the dissemination of Chinese culture more accessible and inspiring, providing powerful evidence for official publicity. By utilizing multimedia channels such as images, animations, and short videos from a first-person perspective, university students can share the real-life experiences and subjective feelings of contemporary Chinese college students, creating authentic life scenarios. These vivid stories about individuals, hometowns, cities, and the country will be more appealing and popular among international audiences[8]. Second, by reading English literature related to their majors, students can understand and grasp the international academic frontier of their fields, using English as a tool to improve their scientific research awareness and skills. By writing papers in the academic discourse of their disciplines, students can lay the foundation for future participation in international academic exchanges and cooperation.

4.3 Application of Multimodal Teaching Methods

Technological advancements have facilitated reforms in college English teaching. The student-centered teaching philosophy dictates that English instruction should consider students' needs, concerns, and difficulties, and provide them with high-quality learning resources. Students' needs, learning backgrounds, interests, language proficiency, and learning abilities can be quickly identified through online surveys or relevant testing tools, laying a solid foundation for differentiated instruction. Different teaching goals and learning tasks are set for students of varying proficiency levels. Teaching methods are no longer confined to textual representations; online courses and video explanations free students from the constraints of time and space. Virtual reality and augmented reality technologies enable student participation and create vivid learning scenarios for them. With the development of digital intelligence, multimodal teaching has garnered attention among university teachers. Multimodal teaching refers to integrating multimodal elements such as language, images, sounds, and movements into the most effective means of meaning expression and communication under the guidance of multimodal discourse analysis theory, and guiding students to construct meaning through multimodal means[7]. The introduction of multimodal teaching methods can make the telling of China's stories more vivid and diverse, thereby stimulating students' enthusiasm for learning and sharing China's stories.

5 CONCLUSION

Cultivating English talents with an international perspective who can tell China's stories to the international community is one of the teaching objectives of college English courses. On the one hand, students in college English classes can tell personal stories to foreign people through multimedia; on the other hand, they can combine their majors with English to express their academic views to the international academic community. Teachers and students of college English courses have a positive attitude and evaluation towards the goal of "telling China's stories well," but they lack scientific guidance at the operational level and a comprehensive evaluation system at the assessment level. The ability of college students to personally disseminate Chinese culture and tell stories is not a simple addition of English skills and other abilities; it requires systematic training. The topic of non-English majors telling China's stories in English to enhance the dissemination of Chinese culture needs further exploration by interested scholars.

COMPETING INTERESTS

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

FUNDING

This paper is the phased finding of the General Project of Higher Education Teaching Reform Research and Practice in Henan Province (project number 2024SJGLX0438).

REFERENCES

[1] FENGRONG J. Promoting the International Dissemination of Chinese Culture Through International Chinese Language Education: A Case Study of Chinese-English Idiomatic Equivalence. Contemporary Social Sciences, 2023, 8(6): 119-140.
[2] XIONG B. Tell China’s Story Well? International Journal of Interactive Communication Systems and Technologies, 2015, 5(1): 26-40.
[3] HUANG Z A, WANG R. Building a network to “tell China stories well”: Chinese diplomatic communication strategies on Twitter. International Journal of Communication, 2019, 13: 2984-3007.
[4] XIONG B. Tell China’s Story Well?: Cultural Framing and Online Contestation. International Journal of Interactive Communication Systems & Technologies, 2015, 5(1): 26-40.
[5] PEI L. To Tell China’s Stories in an International Way——A Retrospection of China’s Cause of International Communication. Journal of Guangdong University of Foreign Studies, 2008.
[6] DIRESTA R, MILLER C, MOLTER V. Telling China’s story: the Chinese campaign to shape global narratives. Stanford Internet Observatory Stanford, CA, 2020.
[7] GUO-QING F, RUN W, HONG-BIN L. Wushu: To Tell China’ s Stories in an International Way——a theoretical framework on the country’s image. Zhejiang Sport Science, 2011.
[8] XU W. Learning to ‘tell China’s story well’: higher education policy and public diplomacy in Chinese international education. Journal of Higher Education Policy and Management, 2024, 46(2): 166-181.

Trends in Social Sciences and Humanities Research
ISSN: 2959-9938
DOI: https://doi.org/10.61784/tsshr3133

EXPLORING THE EFFECT OF CODE-MIXING AND CODE-SWITCHING ON ACADEMIC ACHIEVEMENT IN MATHEMATICS AMONG SECONDARY SCHOOL STUDENTS IN OYO METROPOLIS, OYO STATE, NIGERIA

Gift Chioma Okeke[1*], Babatunde Ojo Badmus[1], Adewumi Modinat Adeleke[1], Temitope Dasola Alabi[1], Kamoru Abiodun Sabitu[2]
[1]*Department of Language and Communication Education, School of General Studies Education, Federal College of Education (Special), Oyo, Nigeria.*
[2]*Department of Science Education, School of General Studies Education, Federal College of Education (Special), Oyo, Oyo State, Nigeria.*
Corresponding Author: Gift Chioma Okeke, Email:okeke.gift2192@fcesoyo.edu.ng

Abstract: The study investigated the effect of code-mixing and code-switching on academic achievement in mathematics among secondary school students. This study employed a quasi-experimental design. The population for the study comprises all secondary school students in the thirty-three (33) public secondary schools in Oyo metropolis. Thirty (30) JS 2 Students were selected from each school to have ninety (90) respondents as a sample. The instrument used was a Mathematics Achievement Test (MAT) which was validated by experts. Three research questions and one hypothesis guided the study. The instrument was tested for reliability using Croabach alpha and a reliability coefficient of 0.89 was obtained. The data collected were analysed using Pearson Product Moment Co-efficient (PPMC) and Analysis of Variance (ANOVA). The finding revealed that there is a mild relationship between the academic achievement of students taught mathematics with English language only and those taught using code-switching; that there is a strong relationship between the academic achievement of students taught mathematics with English language only and those taught using code-mixing; that there is a relationship between the academic achievement of students taught mathematics with code-mixing and those taught using code-switching and that there is a significant relationship between the achievement of students taught with English language only, code mixing and code-switching. Based on the findings, it was recommended among others that Mathematics teachers should strategically and 'gradually' introduce students to the use of code-mixing and code-switching to enhance their understanding of mathematical concepts.
Keywords: Code-mixing; Code-switching; Academic achievement; Mathematics

1 INTRODUCTION

The dismal performance of students in public mathematics examinations in recent decades has necessitated a re-evaluation of the current teaching methods, given its significance as a basis for national growth. It is a fundamental course spanning from basic education to the highest levels of academia worldwide. In a nation with around four hundred languages, Akindele and Adegbite [1] assert that the English language is crucial to the socio-economic, political, and cultural spheres of the populace. It serves as a lingua franca for Nigerians and a unifying language for the roughly two hundred and fifty ethnic groupings in the nation. A minimum level of conversational ability in the English language is therefore anticipated for an average educated Nigerian. Despite fewer than twenty-five percent of Nigerians being proficient in English, there exists a collective aspiration among citizens to acquire the language to integrate into the nation's political and socioeconomic framework [2]. Bilingualism is a prevalent communication phenomenon in Nigeria; so, a commendable Nigerian is fundamentally a bi-multilingual individual who primarily speaks their mother tongue and secondarily the English language. Language is essential in mathematics education for understanding mathematical concepts, problem-solving, and communication [3]. Research has demonstrated that students' language competence can influence their mathematics achievement, with language-minority pupils often encountering difficulty in acquiring mathematical knowledge [4]. Language is essential in mathematics education, functioning as the principal medium for conveying mathematical concepts, ideas, and problem-solving techniques. However, among multilingual pupils, the usage of many languages in the classroom might be a common event. Code-mixing and code-switching are linguistic activities wherein pupils interchange two or more languages within a single discussion or even within a single sentence. Moreover, Mathematics can be referred to be both the gate and key of Science; while every topic is taught through language. Hence, the a necessity to analyze the relationship between the extremely important topic in the light of the first language of the learner in a Nigerian setting where the majority of school children come from households where English is not used at all in communication [5].

Code-switching is defined as a communicative phenomenon of frequently switching between two languages in a bilingual's speech repertoire. Akindele & Adegbite describe Code-switching as a way of communication which entails a speaker shifting between one language and another in communicative events. Moschkovich [4] views the concept as a code switch when an individual who is bilingual shifts between two languages during his or her speech engagement with another bilingual while Essien Okon [6] describes it as an alternate transfer from one language to another. All these definitions suggest that the speaker in a code-switching situation must have communicative competency in two languages for them to be able to switch from one language to another; it may be the mother tongue (MT) and a second language (L2), in the same discourse. In regular discourse between two bilinguals, code-switching consists of eighty-four percent single-word switches, ten percent phrase switches and one percent clause switching [7]. Code-switching executes many roles in its naturally occurring context. Speakers code switch to manage influence or define situations as they like, and to transmit nuances of meaning and personal intention [8].

Code mixing in the context of teaching and language use, refers to the practice of switching between two or more languages or language varieties within a single discourse, sentence or phrase. This occurs in numerous educational settings including classes, seminars and conversations. Code mixing can be intra-sentential code-mixing that is, switching languages within a sentence or inter-sentential, that is, switching language between sentences. Muysken [9] characterizes code-mixing as instances in which lexical elements and grammatical attributes from two languages coexist within a single phrase. According to Bhatia and Ritchie [10], code-mixing denotes the amalgamation of diverse linguistic elements (morphemes, words, modifiers, phrases, clauses, and sentences) predominantly from two concurrent grammatical systems within a sentence. Code-mixing is specifically intrasentential and governed by grammatical concepts. Social psychological variables may also drive it. Notwithstanding these definitions, some individuals may struggle with the terminology, as various scholars employ differing terms for code-mixing. Pfaff [11] utilizes "mixing" as a neutral umbrella term encompassing code-mixing and borrowing. Some individuals struggle to differentiate between code-switching and code-mixing. Code-mixing incorporates features from several linguistic levels and units, from individual lexical items to entire sentences, making it challenging to differentiate between code-switching and code-mixing [12]. Code-mixing incorporates features from several linguistic levels and units, from individual lexical items to entire sentences, making it challenging to differentiate between code-switching and code-mixing [12].

Code-mixing and code-switching are widespread linguistic practices among multilingual individuals when they alternate between two or more languages in the same discussion or even within a sentence. In educational settings, these language patterns can have both beneficial and bad consequences on students' academic progress. Reasons for code-mixing and code-switching in education include clarity, accessibility, cultural relevance and teacher’s language competency. Research in linguistics and education has acknowledged code-mixing and code-switching as common language patterns among multilingual individuals [13,14]. These linguistic activities might be motivated by numerous circumstances, including the urge to clarify complex concepts, fill lexical gaps, or develop social interactions [15]. Studies have also explored the impact of code-mixing and code-switching on language learning outcomes, with conflicting results. Some research suggests that code-mixing and code-switching can promote language learning by providing learners with opportunities to negotiate meaning and build linguistic awareness [16]. However, other research indicates that excessive code-mixing and code-switching can impair language learning by causing cognitive overload and distorting linguistic structures [17].

Despite the relevance of language in mathematics education, there is a scarcity of studies studying the impact of code-mixing and code-switching on mathematics achievement. The present work has mostly focused on language learning outcomes, with scant emphasis on mathematics instruction. This study attempts to solve this research gap by studying the impact of code-mixing and code-switching on academic attainment in mathematics among multilingual students. This study will contribute to our understanding of the intricate link between language and mathematical learning. It will also provide insights into the impact of code-mixing and code-switching on mathematical achievement, which can inform teaching techniques and language policies.

1.1 Statement of the Problem

The frequent practice of code-mixing and code-switching among multilingual students in mathematics classrooms has generated concerns about its effect on academic attainment. Despite the prevalence of these language practices, there is a paucity of research exploring their effects on mathematics learning as most of the studies were based on language education. As a result, stakeholders in education lack a clear understanding of how code-mixing and code-switching affect mathematics achievement, making it challenging to develop effective strategies to support multilingual students' learning. This study aims to address this knowledge gap by investigating the impact of code-mixing and code-switching on academic achievement in mathematics among secondary school students in Oyo metropolis, Oyo state, Nigeria.

1.2 Purpose of the Study

The main purpose of this study is to explore the effect of code-mixing and code-switching on academic achievement in mathematics among secondary school students. Specifically, the study sought to determine the;

1. relationship between the academic achievement of students taught mathematics with English language only and code-mixing.
2. relationship between the academic achievement of students taught mathematics with English language only and code-switching.
3. relationship between the academic achievement of students taught mathematics with code-switching and code-mixing.
4. relationship between the achievement of students taught with English language only, code-mixing and code-switching.

1.3 Research Questions

The following questions guided the study;
1. What is the relationship between the academic achievement of students taught mathematics with English language only and code-mixing?
2. What is the relationship between the academic achievement of students taught mathematics with English language only and code-switching?
3. What is the relationship between the academic achievement of students taught mathematics with code switching and code mixing?

1.4 Hypothesis

H_0: There is a significant relationship between the achievement of students taught with English language only, code-mixing and code-switching.

2 Methodology

This study employed a quasi-experimental design. The population for the study comprises all secondary school students in the thirty-three (33) public secondary schools in Oyo metropolis. Oyo Metropolis comprises of Atiba, Oyo East and Oyo East local government Areas. A school was randomly selected from each of the local government areas. Thirty (30) JS 2 Students were selected from each school to have ninety (90) respondents as a sample. The school in Atiba local government area was chosen to be the control group, the school selected in Oyo East local government area was tagged as Experimental Group 1 and the school from Oyo West local government area was tagged as Experimental group 2. The control group was taught using the English language only as an official language in Nigeria. Experimental group 1 was taught using code-mixing while experimental group 2 was taught using code-switching. The instrument used was a Mathematic Achievement Test (MAT) which was validated by experts in the field of test and measurement. Lesson note was developed for uniformity in teaching. The instrument was tested for reliability using Croabach alpha and a reliability coefficient of 0.89 was obtained. The permission of school heads was sought before the exercise was carried out in the various schools. Extensive teaching was carried out in the schools for six weeks with the assistance of research assistants after which the achievement test was administered. The data collected were analysed using Pearson Product Moment Co-efficient (PPMC) and Analysis of Variance (ANOVA).

3 Results

The results are as follows;
Research Question 1: What is the relationship between the academic achievement of students taught mathematics with English language only and Code-Switching?

Table 1 Correlations

		English language	Code-Switching
English language	Pearson Correlation	1	.331**
	Sig. (2-tailed)		.000
	N	30	30
Code-Switching	Pearson Correlation	.331**	1
	Sig. (2-tailed)	.000	
	N	30	30

Table 1 above reveals that there is a mild relationship (0.331) between the academic achievement of students taught mathematics with English language only and those taught using Code-Switching.
Research Question 2: What is the relationship between the academic achievement of students taught mathematics with English language only and code-switching?

Table 2 Correlations

		English language	Code-mixing
English language	Pearson Correlation	1	.893**
	Sig. (2-tailed)		.000
	N	30	30
Code-mixing	Pearson Correlation	.893**	1
	Sig. (2-tailed)	.000	
	N	30	30

The table 2 above shows that there is a strong relationship (0.893) between the academic achievement of students taught mathematics with English language only and those taught using code mixing.

Research Question 3: What is the relationship between the academic achievements of students taught mathematics with code-switching and code-mixing?

Table 3 Correlations

		Code-mixing	Code-switching
Code-mixing	Pearson Correlation	1	.573**
	Sig. (2-tailed)		.000
	N	30	30
Code-switching	Pearson Correlation	.573**	1
	Sig. (2-tailed)	.000	
	N	30	30

Table 3 shows that there is a strong relationship (0.573) between the academic achievement of students taught mathematics with English language only and those taught using code-switching.

Hypothesis Testing

H_{01}: There is no significant relationship between the achievement of students taught with English language only, code mixing and code-switching.

Table 4 ANOVA[a]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	12.102	1	12.102	43.532	.000[b]
	Residual	26.488	88	.278		
	Total	38.590	89			

In the ANOVA table 4 above, it was revealed that the significant value of 0.000 is less than the p-value of 0.05. Therefore, we reject the null hypothesis and accept the alternative hypothesis that there is a significant relationship between the achievement of students taught with English language only, code-mixing and code-switching.

4 DISCUSSION OF FINDINGS

Table 1 revealed that there is a mild relationship between the academic achievement of students taught mathematics with English language only and those taught using code-switching. The finding suspected that the students in secondary schools in Oyo metropolis appreciate teaching not done purely with the English language. The mild relationship was a result of the switches. It was also suspected that the aspect taught while switching was the aspect understood by the students more, that is, their mother tongue. The finding is corroborated by the study of Sert [8] that teaching mathematics in the mother tongue contributes to students' achievement in mathematics.

Furthermore, table 2 shows that there is a strong relationship between the academic achievement of students taught mathematics with English language only and those taught using code mixing. The relationship is stronger than that of code-mixing. This is a sign that the students are with the teacher from the beginning of the class to the end unlike using code-switching. The finding is in support of the report of Atolagbe & Sabitu [5] that when the mother tongue is mixed with the English language during teaching, the students tend to learn more and achieve better. Moreover, the finding revealed that there is a relationship between the academic achievement of students taught mathematics with code-mixing and those taught using code-switching.

In conclusion, it was revealed that there is a significant relationship between the achievement of students taught with English language only, code mixing and code-switching. Comparing the outcome of their achievement tests, it was deduced that there is a relationship between their academic achievements in mathematics. This indicates that if mathematics teachers can make use of the methods of code mixing and code switching together during teaching and learning, the students will benefit much and the teaching-learning process will be more effective. This assertion is in line with the study of Atolagbe & Sabitu [5]; Moschkovich [4] and Cook [16].

5 CONCLUSION

The findings of this study reveal a significant relationship between the language of instruction and academic achievement in mathematics. Specifically, the results suggest that students taught mathematics using a combination of code-mixing and code-switching (in addition to English) tend to perform differently compared to those taught using the English language only. This study's outcomes are important for mathematics education, particularly in multilingual settings. The results imply that incorporating students' mother tongue into mathematics instruction through strategic code-mixing and code-switching can be a viable teaching approach. This approach may facilitate deeper understanding, improve academic achievement, and enhance learning experiences for linguistically diverse students. The study's conclusions underscore the need for educators and policymakers to reconsider the role of language in mathematics education. Rather than adhering to a strict English-only approach, teachers can explore innovative, linguistically responsive methods to support students' mathematical development.

6 RECOMMENDATIONS

Based on the findings, the following recommendations were made;

- Teachers of mathematics should be encouraged to use code mixing during the class. They should desist from speaking English language from the beginning of the class to the end
- Mathematics teachers should strategically and 'gradually' introduce students to the use of code-mixing and code-switching to enhance their understanding of mathematical concepts.
- Mathematics teachers need to offer additional language support for struggling English learners, including bilingual materials, language tutors or multilingual teaching assistants.
- Professional development should be provided by the government to teachers to enable them to be informed about effective approaches to teaching mathematics to linguistically diverse students.

COMPETING INTERESTS

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

REFERENCES

[1] Akindele F, Adegbite W. The Sociology and Politics of English in Nigeria: An Introduction. Obafemi Awolowo University Press Ltd, 2009.
[2] Adegbite W. Towards an Efficient Bilingual Programme for Teaching Language Skills in Nigeria Primary Schools. Literary and Reading in Nigeria, 2023, 6: 337-351.
[3] Morgan C. Language and mathematics education. In A. J. Baroody & A. Dowker (Eds.), The Oxford handbook of numerical cognition. Oxford University Press, 2014: 943-958.
[4] Moschkovich J. Mathematics education and language. In M. A. Clements & N. H. Ellerton (Eds.), Mathematics education and language: A review of the literature. Springer, 2013: 1-20.
[5] Atolagbe A A, Sabitu K A. The impact of mother tongues on the achievement of children in Mathematics in Nigeria: An experimental approach. African Journal of Education Research, 2023, 28: 49-53. https://africanjournalofeducationalresearch.com.ng/.
[6] Bangbose A F. Using the first language in the classroom. The Canadian Modern Language Review/La revue canadienne des langues vivantes, 2015, 57(3): 402-423.
[7] Skiba R. Code Switching as a Countenance of Language Interference. The Internet TESL Journal, 1997, III(10): 78-81. http://iteslj.org/.
[8] Sert Olcay. The Functions of Code Switching in ELT Classroom: The Internet TESL Journal, 2005, XI(8):55-61 http://iteslj.org/.
[9] Muysken P. Bilingual speech: A typology of code-mixing. Cambridge: Cambridge University Press, 2000.
[10] Bhatia T K, Ritchie W C. Social and Psychological Factors in Language Mixing. In W. C. Ritchie and T. K. Bhatia (eds.), Handbook of Bilingualism . Blackwell Publishing, 2004: 336-352.
[11] Pfaff C. Constraints on language mixing: intrasentential code-switching and borrowing in Spanish/English. Language, 1979, 55: 291-318
[12] Grosjean F. Life with two language. An introduction to bilingualism. Cambridge, MA: Harvard University Press, 2002.
[13] Bhatia T K, Ritchie W C. The handbook of bilingualism and multilingualism. John Wiley & Sons, 2013.
[14] Myers-Scotton C. Multiple voices: An introduction to bilingualism. Blackwell, 2006.
[15] Grosjean F. Bilingualism and multilingualism. In T. K. Bhatia & W. C. Ritchie (Eds.), The handbook of bilingualism and multilingualism . John Wiley & Sons, 2013: 1-20.
[16] Cook V. Second language learning and language teaching. Routledge, 2013.
[17] Kachru B B. The Oxford handbook of world English. Oxford University Press, 2017.

Trends in Social Sciences and Humanities Research
ISSN: 2959-9938
DOI: https://doi.org/10.61784/tsshr3135

ARTIFICIAL INTELLIGENCE-ENHANCED BLENDED LEARNING FOR ECONOMIC LAW: A NEW APPROACH FOR ECONOMICS AND MANAGEMENT EDUCATION IN CHINA

Jing Yu
School of Economics and Management, Guangdong University of Petrochemical Technology, Maoming 525000, Guangdong, China.
Corresponding Email: yujing@gdupt.edu.cn

Abstract: Economic Law education in Chinese universities, particularly for economics and management students, faces unique challenges, including complex legal content, limited classroom hours, and low student engagement. Traditional teaching methods often fail to connect theoretical knowledge with practical applications, leading to reduced interest and participation. This study explores an Artificial Intelligence (AI)-enhanced blended learning model tailored to the needs of economics and management students. By integrating AI technologies such as intelligent tutoring systems, adaptive learning platforms, and real-time analytics, the model personalizes learning experiences, improves feedback efficiency, and fosters student-teacher interaction. The approach combines digital resources with interactive online and offline activities to enhance student engagement and facilitate the practical application of legal knowledge. Preliminary results demonstrate significant improvements in student comprehension, participation, and problem-solving abilities. This AI-driven blended learning model provides a scalable framework for modernizing Economic Law education, aligning it with the evolving demands of interdisciplinary education in China.
Keywords: Artificial intelligence in education; Blended learning model; Economic law education; Personalized learning

1 INTRODUCTION

In Chinese universities, Economic Law serves as a critical foundational course for students in economics and management studies. Unlike the Economic Law courses tailored for law majors, which emphasize in-depth legal theory and rigorous case analysis, this course for economics and management students focuses on the practical application of legal principles in economic activities. However, traditional classroom-based teaching methods face significant challenges in engaging these students, who often perceive the subject as abstract and disconnected from their future careers.

The complexity of legal content, combined with limited classroom hours, makes it difficult for educators to fully cover both theoretical and practical aspects. Students in economics and management programs, accustomed to applied and interactive learning environments, frequently struggle with the memorization of legal terms and regulations, leading to low engagement and motivation. Moreover, the lack of practical problem-solving exercises further alienates students, reinforcing the perception that Economic Law is irrelevant to their professional goals.

To address these challenges, this study explores an Artificial Intelligence (AI)-enhanced blended learning model designed specifically for Economic Law courses in economics and management studies. This approach integrates intelligent tutoring systems, personalized learning paths, and interactive digital tools to align the course with the learning preferences of these students. By focusing on real-world applications, such as case-based exercises and scenario simulations, the model aims to make the subject more accessible and relevant.

This reform reflects broader trends in educational modernization and digital transformation in China. With the increasing adoption of AI technologies, there is a growing opportunity to transform traditional teaching methods into dynamic and engaging learning experiences. AI-driven tools not only provide real-time feedback but also enable instructors to design interactive, student-centered activities that bridge theoretical knowledge and practical skills.

By tailoring the Economic Law curriculum to the needs of economics and management students, this research seeks to enhance their interest and engagement in the subject. The AI-enhanced blended learning model emphasizes problem-solving, critical thinking, and collaboration, equipping students with the legal acumen necessary to navigate complex economic environments. This study contributes to the evolution of higher education in China, offering a scalable framework for integrating technology and pedagogy in similar interdisciplinary courses.

2 LITERATURE REVIEW

Economic Law education plays a vital role in the curriculum of economics and management studies in China, aiming to provide students with practical legal knowledge applicable to economic activities. However, the teaching of Economic Law for these students differs significantly from that for law majors. While the latter emphasizes in-depth legal theory and case analysis, the former focuses on applying legal principles to real-world business scenarios. Despite this distinction, traditional teaching methods have often failed to capture the interest of students in economics and

management, who perceive the subject as overly theoretical and disconnected from their professional needs [1-2].
Research has highlighted several challenges in the traditional teaching of Economic Law. The complexity of legal content, combined with limited classroom hours, often overwhelms students. Additionally, traditional lecture-based methods prioritize knowledge transmission over student engagement, leading to low participation rates and limited practical understanding [3-4]. These challenges have prompted calls for innovative teaching models that cater specifically to the needs of students in economics and management studies.
Blended learning has emerged as a promising approach to address these issues. By integrating online and offline teaching methods, blended learning offers greater flexibility and interactivity, enabling students to engage with the subject matter more effectively. Studies have shown that blended learning enhances student performance in business-related courses such as marketing and financial management by combining theoretical knowledge with practical applications [5-6]. However, its application in Economic Law education remains underexplored, particularly in the context of Chinese economics and management programs [7].
The integration of Artificial Intelligence (AI) into blended learning models has further transformed educational practices. AI technologies, such as intelligent tutoring systems, adaptive learning platforms, and data analytics tools, have demonstrated their ability to personalize learning experiences, provide real-time feedback, and improve overall teaching effectiveness [8-9]. In the context of economics and management education, AI has been applied to tailor learning content to individual needs, helping students better understand complex topics and engage more deeply with the material. Despite these advancements, the use of AI in Economic Law education for economics and management students is still in its infancy [10].
Existing literature on Economic Law education and AI-enhanced blended learning highlights several gaps. Most studies focus on generic blended learning models or the application of AI in STEM fields, leaving the specific needs of students in economics and management studies insufficiently addressed [1, 5]. Furthermore, there is limited research on how AI can be leveraged to design interactive, application-oriented learning activities that bridge the gap between theoretical knowledge and practical skills [4, 8].
This study seeks to address these gaps by proposing an AI-enhanced blended learning model tailored specifically to Economic Law education in Chinese economics and management studies. By combining AI technologies with interactive teaching strategies, this model aims to enhance student engagement, improve learning outcomes, and equip students with the legal knowledge and skills necessary for their careers. In doing so, the study contributes to the ongoing modernization of higher education and demonstrates the potential of AI to transform traditional teaching methods in interdisciplinary courses [2, 10].

3 RESEARCH METHODOLOGY

This section introduces the research methods used to design and implement the AI-enhanced blended learning model for the Economic Law course. It includes the teaching philosophy, the integration of AI technologies, and the practical steps for course implementation.

3.1 Teaching Philosophy

The teaching philosophy adopted in this study is rooted in the goal-problem-oriented approach, which restructures course content around clear objectives and problem-solving tasks. This approach emphasizes setting specific learning goals that align with the students' academic and professional needs. For the Economic Law course, these goals include mastering key legal concepts, applying legal principles to business scenarios, and fostering critical thinking skills.
The course design integrates problem-based learning (PBL) principles by introducing practical, real-world legal problems. Each module begins with a clearly defined objective, followed by a series of guided questions and tasks designed to facilitate active learning. This method encourages students to engage critically with the material, promoting a deeper understanding of the subject while addressing the challenges of traditional rote memorization.

3.2 AI-Supported Blended Learning Approach

The blended learning model integrates AI technologies with traditional teaching methods to enhance student engagement and learning outcomes. AI tools were used to align learning objectives with the content and individual student profiles. Personalized study plans were developed using intelligent platforms, while resources such as video lectures, interactive question banks, and case libraries were prepared to support the learning process. AI tutors facilitated real-time Q&A and provided tailored guidance, helping students address challenges in understanding complex legal topics.
Interaction within this model occurred both online and offline. Online, students engaged with tasks, discussions, and assessments on AI-driven platforms, which provided real-time feedback and progress tracking. Offline sessions, informed by AI-generated insights, focused on targeted group discussions and case analyses, encouraging collaboration and practical problem-solving. Dynamic feedback mechanisms ensured continuous improvement, with AI tools generating individualized reports for students and instructors to identify learning gaps and adjust strategies accordingly.

3.3 Course Implementation

The AI-enhanced blended learning model was implemented for second-year undergraduate students in accounting and business management programs. These students require a practical understanding of legal concepts to navigate business environments effectively. The course design balanced online and offline activities to integrate theoretical and practical knowledge. Online sessions delivered lectures, interactive exercises, and progress tracking, while offline activities such as case studies and group discussions reinforced the application of legal principles.

Assessment methods combined formative and summative approaches, including AI-adaptive quizzes, problem-solving tasks, and traditional written tests. Real-time feedback provided students with actionable insights into their progress, while instructors utilized the data to refine their teaching strategies. This comprehensive approach ensured that the course addressed the specific needs of economics and management students, improving engagement and preparing them for practical applications in their professional careers.

4 KEY FINDINGS AND CHALLENGES

This section explores the differences observed before and after implementing the AI-enhanced blended learning model, highlights existing weaknesses and challenges, and discusses the integration of commonly used AI-assisted teaching tools in China. It also reflects on the specific requirements of teaching Economic Law to economics and management students.

4.1 Differences Before and After AI-Enhanced Teaching

Prior to the integration of AI, the teaching of Economic Law for economics and management students in China faced significant challenges. Traditional lecture-based methods relied heavily on the transmission of dense legal theory, which often alienated students. Engagement levels were low, as students perceived the subject as irrelevant to their career goals. Assessments primarily focused on memorization, offering little opportunity for critical thinking or problem-solving.

After incorporating AI, notable improvements were observed:

(1) Enhanced Engagement: AI tools such as intelligent tutoring systems and adaptive learning platforms personalized the learning experience, making content more relatable and engaging.

(2) Improved Feedback Mechanisms: Real-time feedback allowed students to identify and address their weaknesses promptly, while instructors could adjust teaching strategies based on data-driven insights.

(3) Increased Practical Applications: Case-based scenarios and interactive exercises, supported by AI, bridged the gap between theoretical content and practical business applications.

(4) Flexible Learning Paths: Students could progress at their own pace, ensuring a better understanding of complex legal concepts.

4.2 Weaknesses and Challenges

Despite the benefits, several weaknesses and challenges remain in the AI-enhanced teaching model:

(1) Technical Barriers: Not all students were familiar with AI tools, requiring additional training and support.

(2) Resource Limitations: Developing high-quality digital resources, such as videos and interactive case studies, demanded significant time and investment.

(3) Over-Reliance on AI: Some students relied excessively on AI tools, which reduced their initiative to engage critically with the material.

(4) Assessment Complexity: Balancing formative and summative evaluations while incorporating AI feedback required careful planning and execution.

4.3 Integration of Common AI Teaching Tools in China

This study leveraged five AI tools commonly used in Chinese higher education to address these challenges:

(1) Wisdom Tree: Used for delivering video lectures and monitoring student progress.

(2) Rain Classroom: Integrated for interactive online quizzes, real-time feedback, and classroom interaction.

(3) XuetangX: Provided a platform for MOOCs, enabling students to access supplementary resources.

(4) iFlytek Learning Assistant: Assisted with personalized learning plans and real-time Q&A.

(5) Intelligent Question Bank Systems: Enabled adaptive testing and automated grading.

4.4 Teaching Economic Law to Economics and Management Students

Economic Law courses for economics and management students in China emphasize the practical application of legal principles to business contexts. Core content includes topics such as contract law, corporate governance, competition law, and financial regulations. Unlike law majors, these students require an applied understanding of how these laws influence business decisions.

The AI-enhanced teaching model addressed this need by restructuring the course to focus on:

(1) Real-World Scenarios: Students analysed case studies involving common business disputes and regulatory compliance.

(2) Interactive Problem-Solving: AI tools facilitated group discussions on legal dilemmas, encouraging collaboration and critical thinking.
(3) Customized Learning Pathways: Adaptive systems ensured that students with varying levels of prior knowledge could engage meaningfully with the material.
By aligning the course content with the professional needs of economics and management students, the study successfully enhanced their interest and engagement in Economic Law while addressing key teaching challenges.

5 RESEARCH FINDINGS AND DISCUSSION

This section presents the key findings from the implementation of the AI-enhanced blended learning model, focusing on its impact on learning outcomes, personalized learning experiences, teacher-student interaction, and the challenges encountered during the process. These findings provide valuable insights into the effectiveness of this innovative teaching approach and its implications for improving Economic Law education.

5.1 Differences Before and After AI-Enhanced Teaching

The implementation of the AI-enhanced blended learning model resulted in significant improvements in student learning outcomes. Participation rates in online and offline activities increased markedly, with task completion rates exceeding 90% in most modules. Classroom discussions became more dynamic, as students demonstrated greater engagement with legal concepts and actively contributed to problem-solving exercises. This increased interaction fostered a deeper understanding of Economic Law and its practical applications, particularly in business contexts relevant to economics and management students.

5.2 Personalized Learning Experiences

AI technologies played a pivotal role in creating tailored learning experiences for students. Intelligent tutoring systems and adaptive platforms identified individual weaknesses and recommended targeted resources to address them. For example, a group of students struggling with corporate governance concepts received additional case-based exercises through the AI system, enabling them to focus on their specific learning gaps. As a result, these students achieved an average improvement of 20% in their assessment scores compared to their initial performance. This level of personalization not only improved comprehension but also increased students' confidence in tackling complex legal topics.

5.3 Enhanced Teacher-Student Interaction

The integration of real-time data and AI-generated insights significantly enhanced teacher-student interaction. AI systems provided instructors with detailed analytics on student progress, including task completion rates, participation levels, and areas of difficulty. This allowed teachers to dynamically adjust lesson plans, introduce targeted discussions, and provide timely interventions. For instance, during a module on competition law, instructors used AI insights to identify students who were struggling with key concepts and organized additional offline sessions to address their questions. This proactive approach strengthened the teacher-student relationship and created a more supportive learning environment.

5.4 Challenges and Solutions

While the AI-enhanced blended learning model demonstrated clear benefits, several challenges were encountered during its implementation:
(1) Technical Training for Teachers: Many instructors initially lacked familiarity with AI tools, which hindered their ability to fully utilize the technology. To address this, workshops and training sessions were conducted, focusing on the operation of AI platforms and data interpretation.
(2) Student Adaptation: Some students faced difficulties adapting to the AI-supported environment, particularly those less comfortable with technology. To mitigate this, onboarding sessions were organized to familiarize students with the platform's features and functionality.
(3) Resource Development: Creating high-quality digital resources, such as video lectures and interactive case studies, required significant time and effort. Collaboration with instructional designers and subject matter experts helped streamline this process.
(4) Over-Reliance on AI: A minority of students exhibited over-dependence on AI tools, potentially reducing their critical thinking skills. This was addressed by incorporating offline activities and encouraging students to engage in collaborative problem-solving without AI assistance.
Despite these challenges, the study demonstrated that a carefully designed AI-enhanced blended learning model can effectively address the traditional limitations of Economic Law education. By balancing technology with human-centred teaching strategies, this approach not only improved learning outcomes but also provided valuable insights for future applications in similar educational contexts.

6 CONCLUSIONS

The findings of this study demonstrate that the AI-enhanced blended learning model can significantly improve the teaching effectiveness of complex courses like Economic Law. By leveraging AI technologies, this model personalized learning experiences, increased student engagement, and strengthened teacher-student interaction, addressing many challenges inherent in traditional teaching methods. The integration of digital tools and adaptive learning strategies proved particularly effective for economics and management students, making legal education more relevant and accessible.

Looking forward, this innovative teaching approach has the potential to be extended to other disciplines, particularly those requiring the combination of theoretical knowledge and practical application. Additionally, its scalability and flexibility suggest that it could be implemented across the university to modernize education and improve learning outcomes in diverse academic fields. Future research should explore the long-term impact of such models and refine their application to ensure continued effectiveness in evolving educational environments.

COMPETING INTERESTS

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

FUNDING

This study is supported by the project Research on Innovative Practices of the Blended Teaching Model for Economic Law Under the Goal-Problem-Oriented Approach, funded by the 2023 Guangdong Education Science Planning Program (Higher Education Special Project) (Ref. No. 2023GXJK394), and the 2024 Guangdong University of Petrochemical Technology Smart Course Project (AI+Course Initiative).

REFERENCES

[1] Castan M, Hyams R. Blended Learning in the Law Classroom: Design, Implementation and Evaluation of an Intervention in the First Year Curriculum. Legal Education Review, 2017, 27(1).
[2] Park Y, Doo M Y. Role of AI in Blended Learning: A Systematic Literature Review. International Review of Research in Open and Distributed Learning, 2024, 25(1): 164–181.
[3] Chen X. Exploration on the Application of Blending Teaching in the Teaching Process of Economic Law. International Journal of New Developments in Education, 2024, 6(7): 116–121.
[4] De Vries B. Blended Learning in Legal Education. Law and Method, 2020.
[5] Castan M, Hyams R. Blended Learning in the Law Classroom: Design, Implementation and Evaluation of an Intervention in the First Year Curriculum Design. Legal Education Review, 2017, 27(1).
[6] Zhang X, Wang J. A Systemic Review of AI for Interdisciplinary Learning: Application Contexts, Roles, and Influences. Education and Information Technologies, 2024.
[7] Song T. Practice of Integrating Blended Teaching of Tax Law (CPA Perspective) into Course Ideological and Political Education Under OBE Concept//Advances in Artificial Systems for Logistics Engineering IV. Springer, 2024: 448–459.
[8] Li H. AI-Enabled Blended Collaborative Education//Advances in Artificial Systems for Logistics Engineering IV. Springer, 2024: 320–331.
[9] Moskal P, Dziuban C, Hartman J. Blended Learning: The New Normal and Emerging Technologies. International Journal of Educational Technology in Higher Education, 2018, 15(3).
[10] Zhang W, Li S. Integrating Generative AI and Blended Learning: Enhancing Learning and Teaching in Higher Education. International Journal of Information and Education Technology, 2024, 14(8): 345–352.