

The Relationship between Academic Digital Literacy and Innovation Competences among Students at Zhengzhou Technology and Business University, China

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Abstract: This study aims to investigate the current status of academic digital literacy and innovation competences among undergraduate students at Zhengzhou Technology and Business University, analyzing the differences and correlations between the two under various demographic background variables. The academic digital literacy scale and innovation competences scale were employed as survey instruments in a questionnaire administered to 380 undergraduate students at the institution.

Quantitative methods including descriptive statistical analysis, independent samples t-tests, one-way ANOVA, and correlation analysis were utilized to systematically examine the current status, variations, and correlations between students' academic digital literacy and innovation competences. Findings indicate that students at Zhengzhou Technology and Business University demonstrate overall high levels of academic digital literacy and innovation competences.

The highest scores were observed in the socio-emotional and networking dimensions, indicating students' performance in academic integrity awareness, teamwork, and interpersonal communication. Significant differences in academic digital literacy and innovation competences were found across different grade levels, majors, and departments, while no significant gender differences were identified. A significant positive correlation exists between academic digital literacy and innovation competences: higher academic digital literacy correlates with stronger creativity, critical thinking, initiative, teamwork, and networking skills.

Keywords: Zhengzhou Technology and Business University, Academic Digital Literacy of Students, Innovation Competences

1. INTRODUCTION

Against the backdrop of rapid global digitalization and intelligent development, higher education learning and research activities are undergoing profound transformation. The widespread application of artificial intelligence, big data, cloud computing, and open science environments has made university students increasingly dependent on digital technologies for academic learning, research training, and innovation competences (Liu & Zhang, 2021). Academic digital literacy refers to students' ability to effectively engage in academic learning and research activities through cognitive understanding, technological application, and socio-emotional responsibility. Compared with general digital literacy, academic digital literacy emphasizes its role in academic problem

construction, research participation, and knowledge innovation, making it an important foundation for cultivating students' innovation competences. International organizations such as UNESCO and the OECD recognize digital literacy as a key competency for future participation in knowledge innovation and sustainable development. The European Union's Digital Education Action Plan (2021–2027) further highlights the importance of strengthening students' digital capabilities to enhance innovation competences, while universities in Europe and North America have integrated digital literacy cultivation with research training, data literacy, and project-based learning to improve students' critical thinking and innovation competences (Ferrari & Punie, 2023).

In China, the rapid development of the digital economy and the national strategy of

educational digitization have accelerated the integration of digital technologies into higher education teaching, learning, and research. The Chinese government has emphasized improving talent cultivation quality and innovation competences through educational digitalization (Zhou et al., 2023). Chinese universities have related to the coordinated development of academic digital literacy and innovation competences through curriculum reform, research training, and innovation competences, while studies indicate that digital literacy can enhance students' innovation behaviors by improving learning engagement and academic self-efficacy (Zhou et al., 2023). However, disparities remain in students' advanced academic digital competencies and innovative digital practices (Li et al., 2022). In Zhengzhou, under the development frameworks of "Digital Zhengzhou" and innovation-driven strategies, universities increasingly emphasize academic digital literacy as a key indicator of talent cultivation quality and innovation competences. Taking Zhengzhou Technology and Business University as an example, students frequently use digital platforms and academic tools in coursework and innovation activities, yet challenges persist in academic information retrieval, data analysis, citation practices, and digital expression. These limitations affect students' innovative thinking and creative outputs, highlighting the practical significance of examining the relationship between academic digital literacy and innovation competences within the context of local applied universities.

College students widely use digital technologies, but their academic digital literacy remains at a basic level, particularly in information retrieval, data analysis, literature screening, and academic writing, which limits the development of their innovation competence. Meanwhile, universities lack systematic training and effective evaluation mechanisms, and existing research pays limited attention to the relationship between academic digital literacy and innovation competence, especially in local applied universities. Therefore, this study focuses on Zhengzhou Technology and Business University to examine the current situation and relationship between academic digital literacy and innovation

competence, providing support for talent cultivation and educational reform.

RESEARCH OBJECTIVES

- 1) To understand the current state of academic digital literacy among students at Zhengzhou Technology and Business University.
- 2) To understand the current state of innovation competences among students at Zhengzhou Technology and Business University.
- 3) To analyze the differences in academic digital literacy among students at Zhengzhou Technology and Business University across various demographic background variables (including gender, Grade level, major, and department).
- 4) To analyze the differences in innovation competences among students at Zhengzhou Technology and Business University across various demographic background variables (including gender, Grade level, major, and department).
- 5) To determine the existence of a positive correlation between academic digital literacy and innovation competences among students at Zhengzhou Technology and Business University.

2. LITERATURE REVIEW

Constructivist Learning Theory

Constructivist learning theory emphasizes that learners actively construct knowledge through interactions with their environment, social participation, and prior experiences within authentic contexts, rather than passively receiving information. Contemporary research has expanded constructivism from a cognitive-oriented theory into a comprehensive framework integrating cognitive, social, and contextual dimensions (Doolittle & Hicks, 2020; Kirschner & Hendrick, 2021). Scholars argue that learning involves continuous cognitive restructuring through assimilation, accommodation, dialogue, and reflection, particularly within collaborative and inquiry-based learning environments that related to critical thinking, problem-solving, and innovation competences (Loyens et al., 2023). In digital and online learning contexts, constructivist theory has gained renewed significance as technologies support scenario creation, resource

and practice-oriented learning environments can strengthen students' problem-solving, critical thinking, teamwork, and innovation performance, while digital learning environments provide opportunities for collaboration and information integration but may also create challenges related to information overload and cognitive distraction (Bond et al., 2021). Current research increasingly adopts multidimensional and contextualized approaches to measuring innovation competences, incorporating dimensions such as creativity, critical thinking, initiative, teamwork, networking, problem identification, and solution implementation (Zhou et al., 2025). However, scholars note that existing studies still lack unified measurement standards and often rely heavily on self-reported data, limiting the ability to fully capture the dynamic and process-oriented nature of students' innovation competences development.

Relationship Between Students' Academic Digital Literacy and Innovation Competences

Existing research widely confirms a significant positive relationship between students' academic digital literacy and innovation competences, particularly within digital and academic learning environments. Studies indicate that academic digital literacy, especially competencies related to information retrieval, information evaluation, digital content creation, critical thinking, and academic problem-solving, provides essential cognitive and technological support for innovation activities (Tang et al., 2022; Park & Kim, 2023). Research further shows that students with higher academic digital literacy are better able to integrate multi-source information, engage in reflective judgment, and develop innovative solutions in complex learning tasks (Hatlevik et al., 2022). Academic digital literacy also indirectly enhances innovation competences by improving self-directed learning, problem-solving ability, and sustained engagement in innovative activities (Almerich et al., 2020; Sailer et al., 2021). Within the Chinese and Henan higher education contexts, scholars have found that academic digital literacy significantly influences students' innovation performance, although many local university students still demonstrate imbalances between technical operational skills

and higher-level competencies such as critical evaluation, academic ethics, and innovative application (Li & Yu, 2022; Wang et al., 2023). Studies focusing on central China and Henan Province further emphasize that instructional support, curriculum design, and faculty guidance play important roles in transforming academic digital literacy into innovation competences outcomes (Zhang et al., 2024). However, current research still lacks systematic quantitative investigations specifically examining the relationship between academic digital literacy and innovation competences among students in local undergraduate universities in Henan Province, highlighting the practical and theoretical significance of conducting empirical studies within the context of Zhengzhou Technology and Business University.

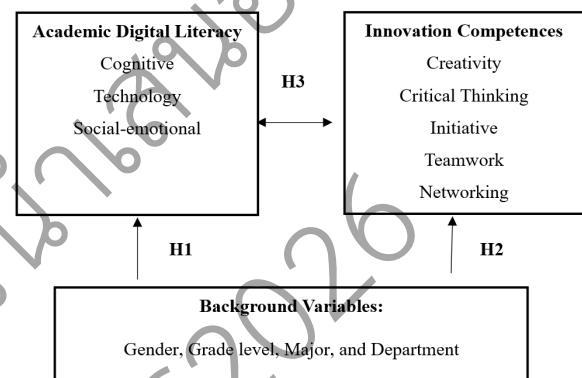


Figure 1 Research Framework

3. MATERIALS AND METHODS

This study employed a quantitative research design using a questionnaire survey method to investigate the relationship between academic digital literacy and innovation competences among students at Zhengzhou Technology and Business University. Sampling was adopted to ensure representative participation across the university's eight colleges, with a total student population of 32,049. Based on Krejcie and Morgan's (1970) sampling standard, 380 questionnaires were distributed and all 380 were validly returned. The questionnaire consisted of three sections, including demographic information, the academic digital literacy scale adapted from Anwar et al. (2023), and the innovation competence scale developed by Keinänen and Kairisto-Mertanen (2019). Academic digital

literacy was measured through three dimensions, namely technology, cognitive, and social-emotional, while innovation competences included creativity, critical thinking, initiative, teamwork, and networking. All items employed a five-point Likert scale ranging from strongly disagree to strongly agree.

This study adopted a questionnaire survey method to investigate college students' academic digital literacy and innovation competences at Zhengzhou Technology and Business University. To ensure the smooth progress of the survey, stratified sampling was employed in the formal investigation stage. With the assistance of university counselors, questionnaires were distributed to students. The researcher explained in detail the specific rules and precautions for completing the questionnaires, and required students to finish and submit them on time. The survey was conducted in the form of electronic questionnaires, and students completed the survey by clicking the link provided. A total of 380 questionnaires were distributed and 380 were retrieved, achieving a response rate of 100%.

The reliability analysis showed strong internal consistency for all dimensions. The overall Cronbach's alpha coefficient for academic digital literacy was 0.87, including technology (0.83), cognitive (0.77), and social-emotional (0.86). The overall Cronbach's alpha coefficient for innovation competences was 0.93, including creativity (0.92), critical thinking (0.84), initiative (0.83), teamwork (0.75), and networking (0.82). The pilot test involving 50 students also demonstrated good reliability, with Cronbach's alpha values of 0.890 for academic digital literacy and 0.921 for innovation competences. Validity analysis further confirmed acceptable model fit and convergent validity. The academic digital literacy scale achieved an AVE value of 0.74, RMSEA = 0.07, SRMR = 0.04, CFI = 0.95, and TLI = 0.93, while the Innovation competences Scale showed CFI = 0.90, TLI = 0.89, RMSEA = 0.06, and SRMR = 0.06. Data analysis methods included descriptive statistics, independent samples t-tests, one-way ANOVA, and Pearson correlation analysis to examine demographic differences and the relationship between students' academic digital literacy and innovation

competences.

4. RESULTS AND DISCUSSION

4.1 DEMOGRAPHIC ANALYSIS

This study surveyed 380 undergraduate students from Zhengzhou Technology and Business University. Among the participants, 210 were male (55.3%) and 170 were female (44.7%). Sophomore students accounted for the largest proportion (39.7%), followed by junior students (32.1%) and senior students (28.2%). Most participants were from science and engineering majors (58.9%), while humanities and social sciences students accounted for 27.1%, and students from other majors accounted for 13.9%. Participants were drawn from different departments, with the School of Business representing the largest group (19.5%). The relatively balanced distribution across gender, grade levels, majors, and departments indicates that the sample had good representativeness and provided a reliable basis for analyzing the relationship between academic digital literacy and students' innovation competences.

Table. 1: Demographic Information of Participants

Variable	Item	N	%
Gender	Male	210	55.3
	Female	170	44.7
Grade Level	Sophomore	151	39.7
	Junior	122	32.1
	Senior	107	28.2
Major	Humanities and Social Sciences	103	27.1
	Science and Engineering	224	58.9
	Other	53	13.9
Department	School of Engineering	51	13.4
	School of Information Engineering	46	12.1
	School of Business	74	19.5
	School of Finance and Taxation	38	10.0
	School of Humanities and Law	55	14.5
	School of Arts	47	12.4
	School of Physical Education	21	5.5
	Lankao College	48	12.6
	Total	380	100.0

4.2 HYPOTHESIS TESTING

1) The findings showed that students at Zhengzhou Technology and Business University demonstrated a high level of academic digital literacy overall ($M = 3.51$, $SD = 0.841$). Among

the dimensions, the socio-emotional dimension recorded the highest mean score ($M = 3.61$, $SD = 0.900$), followed by the cognitive dimension ($M = 3.56$, $SD = 0.937$), while the technical dimension showed a slightly lower but still high level ($M = 3.41$, $SD = 0.868$). Students also demonstrated a high level of innovation competences overall ($M = 3.66$, $SD = 0.810$). Among the innovation dimensions, networking recorded the highest score ($M = 3.78$, $SD = 0.900$), followed by teamwork ($M = 3.73$, $SD = 0.890$), critical thinking ($M = 3.62$, $SD = 0.853$), creativity ($M = 3.60$, $SD = 0.819$), and initiative ($M = 3.60$, $SD = 0.833$).

2) The analysis of demographic variables revealed no significant gender differences in either academic digital literacy or innovation competences. Specifically, no significant gender differences were found in overall academic digital literacy ($t = -0.171$, $p = 0.864$) or innovation competences ($t = -0.814$, $p = 0.416$), although female students reported slightly higher innovation competence scores ($M = 3.70$) than male students ($M = 3.63$). Significant grade-level differences were identified in academic digital literacy ($F = 3.840$, $p = 0.022$) and innovation competences ($F = 4.288$, $p = 0.014$), with sophomores ($M = 3.59$; $M = 3.76$) and seniors ($M = 3.60$; $M = 3.72$) demonstrating relatively higher levels than juniors. No statistically significant differences were observed across majors for academic digital literacy ($F = 1.005$, $p = 0.367$), while significant differences were found for innovation competences ($F = 3.052$, $p = 0.048$), with humanities and social sciences students performing better than science and engineering students. Departmental differences were also statistically significant for academic digital literacy ($F = 2.290$, $p = 0.027$) and innovation competences ($F = 3.348$, $p = 0.002$), with students from the School of Finance and Taxation, Lankao College, and the School of Humanities and Law generally reporting higher scores than students from several other departments. These results indicate that grade level, major, and department exerted measurable effects on students' academic digital literacy and innovation competences.

Table 2 Correlation Analysis

	TE	CO	SE	AD	CR	CT	IN	TEA	NE	IC
T	1									
E		1								
C	.805									
O	**	1								
S	.780	.867								
E	**	**	1							
A	.935	.943	.931							
D	**	**	**	1						
C	.812	.843	.835	.885						
R	**	**	**	**	1					
C	.764	.827	.819	.854	.909					
T	**	**	**	**	**	1				
IN	.749	.796	.791	.828	.874	.901				
	**	**	**	**	**	**	1			
T	.689	.780	.771	.792	.841	.870	.887			
E	**	**	**	**	**	**	**	1		
A	.667	.747	.773	.772	.828	.836	.852	.900		
N	**	**	**	**	**	**	**	**	1	
E	.782	.847	.846	.877	.948	.954	.951	.947	.931	
IC	**	**	**	**	**	**	**	**	**	1

* $p < 0.05$ ** $p < 0.01$, Technology: TE, Cognitive: CO, Social-Emotional: SE, Academic Digital Literacy: AD, Creativity: CR, Critical Thinking: CT, Initiative: IN, Teamwork: TEA, Networking: NE, Innovation Competences: IC

3) The results revealed a significant positive relationship between academic digital literacy and innovation competences among students at Zhengzhou Technology and Business University. The technical dimension showed a positive correlation with innovation competences ($r = 0.782$, $p < 0.01$), while the cognitive dimension ($r = 0.847$, $p < 0.01$) and socio-emotional dimension ($r = 0.846$, $p < 0.01$) also demonstrated positive correlations with innovation competences. The correlation coefficient between academic digital literacy and innovation competences reached 0.877 ($p < 0.01$). Among the innovation dimensions, teamwork ($r = 0.947$) and networking ($r = 0.931$) exhibited positive relationships with academic digital literacy.

To assess this issue, Harman's single-factor test was conducted. The results showed that the first unrotated factor explained 38.6% of the total variance, which is below the commonly accepted threshold of 40%, indicating that common method bias was not a serious concern in this study. Therefore, although the correlations were relatively high, they remain within an acceptable range for interpretation.

development of academic digital literacy and innovation competences. Most importantly, the study confirmed a strong positive and synergistic relationship between academic digital literacy and innovation competences, suggesting that students with higher academic digital literacy also tended to report higher levels of creativity, critical thinking, initiative, teamwork, and networking.

6. RECOMMENDATIONS

1) Universities Should Establish a Systematic Academic Digital Literacy Development System

Universities should incorporate academic digital literacy into undergraduate education and provide systematic training for students at different levels. Foundational training should focus on information retrieval, data analysis, academic writing, and digital tool use, while advanced training should emphasize academic ethics, critical thinking, and innovation practice. Through online courses, workshops, and practical activities, universities can help students progressively transform digital skills into innovation competences.

2) Universities Should Closely Integrate Digital Literacy with Innovation Practice

Universities should connect academic digital literacy with practical innovation activities in teaching and research. Through project-based learning, teamwork, and interdisciplinary practice, students can apply digital tools to solve academic problems, strengthen critical thinking, and develop creative problem-solving abilities, thereby effectively transforming digital literacy into innovation competences.

3) Departments Should Tailor Instruction to Individual Needs

Departments should design targeted training strategies according to students' grade levels and disciplinary backgrounds. Students with weaker digital foundations should receive additional technical support, while discipline-specific projects should be provided to meet different academic needs. This targeted approach can reduce competency gaps and improve students' overall academic digital literacy and innovation competences.

4) Establish a Joint Evaluation Mechanism for Dynamic Cultivation

Universities should establish a comprehensive evaluation system that assesses both academic digital literacy and innovation competences. Indicators such as information processing, academic expression, creativity, and teamwork should be included, with evaluation results linked to academic credits, scholarships, and practice opportunities. This can motivate students and provide data support for improving teaching strategies.

5) Optimizing Resource Allocation and Supportive Environments

Universities should improve digital learning resources and innovation practice platforms by providing literature databases, data analysis tools, virtual laboratories, and collaborative spaces. At the same time, academic lectures, mentoring, innovation competitions, and incentive mechanisms should be strengthened to create a supportive environment that encourages students' active participation in academic research and innovation practice.

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