

Determining the influencing factors affecting the digital competencies of colleges students in blended teaching

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Abstract

Understanding the current state of information and communication technology (ICT) use in teaching situations will help schools better develop students' 21st-century skills to meet the digital age's challenges and opportunities. The purpose of this paper is to provide reference for colleges and universities to formulate the framework and implementation strategies of digital literacy education, by analysing the key factors that influence the digital literacy education of college students. Firstly, based on literature research and activity theory, this paper integrates and refines the influencing factors of digital literacy education of college students from five dimensions, and analyses the key factors affecting digital literacy education. Then, experts were invited to fill in the questionnaire to obtain sample data, and the interaction between the factors was analysed by using the decision-making trial and evaluation laboratory method to identify the key influencing factors. The results show that university policy, cultural environment, ICT infrastructure, teaching management and evaluation system are the five key influencing factors.

Keywords: ICT, digital literacy education, university students, activity theory, DEMATEL.

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1. Introduction

With the full penetration of information and communication technology (ICT) in all walks of life, understanding the current state of ICT use in teaching situations will help schools better develop students' 21st-century skills to meet the digital age's challenges and opportunities. ICT is the product of integrating information technology and communication technology, generally referring to hardware, software, networks, communication tools and related service applications, with digitalisation, processing and transmission functions (Markauskaite, 2006).

At present, a new round of scientific and technological revolution is being staged, and digital technologies, such as 5G technology, big data, the Internet of Things and artificial intelligence, have developed rapidly. Digital resources have become an essential factor of production for citizens in the information age. Digital literacy is an important foundation for developing the digital economy. To improve citizens' digital literacy, the European Union, American New Media Alliance, UNESCO and other institutions have proposed various digital literacy frameworks. Digital literacy, as the main force of technological innovation, has become their indispensable core competitiveness. Since 2000, the International Student Assessment Programme has been investigating students' access to and using ICT in and out of school, emphasising on computer and Internet access, and few surveys on digital learning resources. In 2019, in response to increasingly complex requirements for measuring ICT literacy, the Organisation for Economic Co-operation and Development released the ICT Framework 2021 of the International Student Assessment Programme (from now on referred to as the Framework), which is the first evaluation framework of the International Student Assessment Programme in the field of ICT and provides an evaluation strategy for investigating students' participation in ICT practices and related environmental factors. Simultaneously, the Framework also clarifies that the development of ICT literacy is an essential part of Programme for International Student Assessment's future evaluation field, laying the foundation for participating countries and regions to formulate their ICT literacy evaluation framework (Wu & Li, 2019). In 2018, China's National Development and Reform Commission issued the 'Guiding Opinions on Developing Digital Economy Stability and Expanding Employment', clearly pointing out that higher education should strengthen the education of digital knowledge and skills (NDRC, 2018). The cultivation of college students' digital literacy is in line with the needs of the development of the information society era, and it is also an inevitable requirement of future education. The education of digital literacy of college students has gradually become a hot topic in higher education, and its significant development can improve the learning and scientific research efficiency of college students in the environment of generalisation and wisdom network, which is the need for the development of information society and the embodiment of national competitiveness.

In recent years, researchers have carried out many studies on the connotation of digital literacy, the framework of digital literacy, the practice of civic digital literacy education and the library services based on digital literacy, but relatively few studies have been made on digital literacy education and ICT literacy in colleges and universities. Kulthida and Mega (2017) probed into the current situation and influenced digital literacy in higher education in Thailand through questionnaires. Mark (2015) put forward a form of digital literacy education for college students based on digital game development projects. Zhengqiang (2020), a domestic scholar, analysed the current situation, problems and educational paths of college students in China. Qingjie and Ting (2020) combed the development status and evolution of digital literacy education in domestic colleges and universities based on

qualitative analysis. Zhang and Hui (2016) analysed digital literacy's educational practice in foreign universities through network investigation methods and summarised the enlightenment of digital literacy education for Chinese college students. Throughout China and other countries, most of the relevant research is based on literature review, network survey, the current situation, path and educational form of digital literacy education in colleges and universities to explore the impact factors of digital literacy education based on quantitative analysis methods is very few.

The purpose of this paper is to integrate and extract the influencing factors of college students' digital literacy education from five dimensions: university policy, cultural environment, ICT infrastructure, teaching management and evaluation system, and analyse the key factors affecting digital literacy education, aiming at providing a reference for universities to formulate digital literacy education framework and implementation strategies.

1.1. Conceptual framework

1.1.1. Digital literacy education for college students

At present, there is no uniform definition of digital literacy in academia. In the book *Digital Literacy* published in 1997, Gilster (1997) describes digital literacy as the ability to use and understand all kinds of digital resources and information displayed by computers. The European Union defines digital culture as people's ability to critically and innovatively use information technology in their study, work, entertainment and social participation (Ferrari, Brecko & Punie, 2014). The American Library Association defines people's ability to use ICT to retrieve, understand, evaluate, create and digitally exchange information (Ahmed & Rasheed, 2020). Later, some scholars began to extend and deepen the definition of digital literacy. Ng (2012) believes that digital literacy is embodied in three levels: technical ability, cognitive ability, social and emotional ability, ICT operation skills, information search, evaluation and creation ability, compliance with network norms, information security protection and information identification ability. Wang, Yang, Hu and Wang (2013) believe that digital literacy's foundation and core component are computer literacy and network literacy.

On the contrary, information literacy and media literacy are skills in the digital environment, which overlap with digital literacy's main aspects. Digital literacy is the most widespread concept. From the above definition, it can be seen that digital literacy is a comprehensive concept, a critical application of digital technology and a comprehensive ability to acquire, understand, communicate, integrate and create digital resources (Hua, 2018).

Digital literacy education for college students refers to students' digital technical literacy and ability through formal and informal education in colleges and universities. At present, some colleges and universities in developed countries have formed a better digital literacy education system for college students, guided by national policies and jointly carried out the educational practice by universities, libraries and trade associations. Some universities have developed digital literacy frameworks within which various digital literacy projects have been launched, such as the digital literacy education resources website, which was set up by Cardiff University with funding from the Joint Information Systems Committee of the United Kingdom to think digital training website. Multi-form education, including general digital literacy education, digital literacy education embedded in subjects and online

education (e.g., digital literacy online learning portals such as digital literacy.gov in the United States and Dig in Australia).

Soviet psychologist Viko in the 1920s first proposed the theory of activity. Activity theory is not a methodology but an interdisciplinary framework for studying the evolving social practice, the core idea of which is that human consciousness or knowledge and skills are formed in the interaction between man and the objective world. The initial model of activity theory established by Viko consists of three elements: subject, object and the intermediary (tool), emphasising on intermediary regulation (Weijiao, 2007). Using the 'activity' itself as an analytical unit, the activity's initiator serves the object through the tools at the material or spiritual level, thus achieving the activity's objectives. Later, after Leontev and Notum's addition, a complete theoretical model of activity, which is now widely used, was formed, as shown in Figure 1.

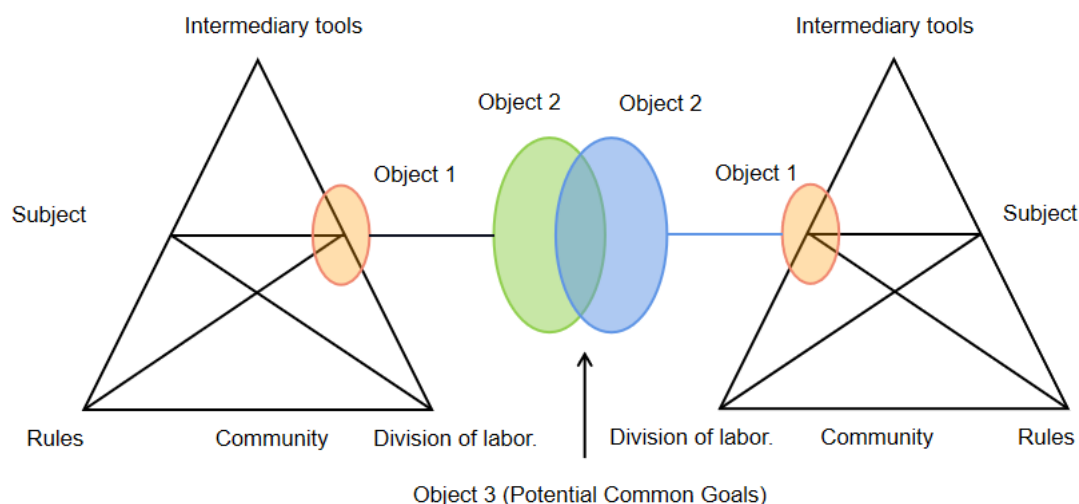


Figure 1. Engeström's theoretical model of activity

The model adds three secondary components to the initial model: rules, community and division of labour. The community is the participant in the activity. The rules are the system, regulation and cultural customs that coordinate the primary object relationship and guarantee the activity. The main idea is the principle of contradiction, which creates contradictions and conflicts between the elements in which activities are linked, creating structural tensions and stimulating innovation and development of activities (Wenbo, 2020).

At present, the activity theory is widely used in education, psychology, economic management and other fields, and also provides a new research idea and conceptual framework for the subject of library and information, such as information literacy education based on activity theory, information service, information behaviour and other aspects of research. As for the subject of digital literacy education for college students, from the perspective of activity theory, the research object is no longer a subject, but 'educational teaching activities' as an analysis unit, which investigates the

process of continuous interaction between the main body, object, intermediary, rules and other elements in order to achieve the goal of digital literacy education. The researchers can understand some environmental factors affecting activities and their relationship with each other from the six dimensions of the activity theory model.

1.1.2. Blended teaching

With the penetration of information technology into the education, traditional classrooms are evolving into ‘traditional classroom and digital classrooms’ or even pure digital classrooms. At present, the traditional classroom teaching behaviours coexist with blended teaching behaviours supported by information technology. Among them, the blended teaching behaviour is both online teaching behaviour and offline teaching behaviour. The two are interrelated and intertwined with each other. In order to improve college students' digital literacy, this paper attempts to construct a blended teaching behaviour model and apply it to the teaching practice of ‘digital literacy education’ course of college students. After the course, the collected teaching behaviour data were extracted for data mining and analysis, and the key influencing factors that affected college students' digital literacy education and cultivation based on blended teaching behaviours were discovered (Wei & Haiying, 2019).

2. Materials and methods

2.1. Data collection tool

Through the questionnaire survey, the teaching practice data of influencing factors of improving college students' digital literacy in the mixed teaching environment were obtained. Taking ‘digital literacy education for college students’ on the platform of ‘Yin Xue Online’ as the survey object, 382 questionnaires were distributed and 355 valid questionnaires were obtained after eliminating invalid questionnaires, such as inconsistent options, with an effective rate of 92.9%, which met the requirements of educational research samples.

2.2. Participants

The analysis of the basic situation of the respondents is as follows: 71 men, accounting for 20%, and 284 women, accounting for 80%. In terms of majors, there were 146 students of science and engineering, accounting for 41.13%; 156 students of cultural history, accounting for 43.94%; 39 students of music, sports and art, accounting for 10.99%; and 14 students of other kinds, accounting for 3.94%.

2.3. Data collection procedure and analysis

Based on the literature research and activity theory, this paper integrates and refines the influencing factors of college students' digital literacy education from five dimensions and analyses the interactive relationship among the factors by using the decision-making trial and evaluation laboratory (DEMATEL) method and finds out the key factors. Through literature investigation, this paper analyses the influencing factors of college students' digital literacy education activities from the dimensions of subject, object, tool/intermediary, community, division of labour and rules, and understands the

conflicts and related relationships among the factors, so as to promote the innovative development of digital literacy education.

3. Results and discussion

3.1. Critical factors of digital literacy education for college students determined

3.1.1. Principal dimension

The main activities of digital literacy education for college students include universities and teachers. The overall planning and teaching implementation of universities are the key factors affecting the quality of education. Some studies have shown that one of the leading factors in transforming information literacy into students' meta-skills and integrating it into the general education curriculum is policymaking, including system policy, teacher allocation, capital investment and publicity. Tuamsuk and Subramaniam (2017) believe that the implementation of academic management under the guidance of school policy, such as integrating digital literacy development into all curriculum development goals, is an effective measure to improve students' digital literacy. Ling believes that in order to promote the development of students' digital literacy, teachers must improve their level because as implementers of digital literacy education, they have their own technical ability, problem-solving thinking ability, teaching ability and digital service penetration ability, which will influence and guide students' understanding and internalisation of knowledge and skills imperceptibly. Based on this, this paper summarises the main dimension of the influence factors for university policy (M1), teaching management (M2) and teacher literacy (M3).

3.1.2. Object dimension

The goal of digital literacy education in universities is to improve students' digital literacy, which is the object of activities. From the perspective of the object of action, the factors affecting the achievement of the goal can be analysed from the level of personal traits. Studies show that students' awareness of the value of information technology, sensitivity to information and application attitude are the key factors that affect their own level of information literacy (Roma & Wang, 2018). Yunxiang et al. (2014) believe that college students' personal needs, interests and cognitive level will encourage them to use information technology such as network, virtual reality and artificial intelligence to study. Research by Luo and Wei (2018) shows that college students' perception and trust on the Internet can have a positive impact on their understanding and use of technology. One of the important characteristics of college students in the information age is digital originality. That is to say, students who grow up in the Internet environment have long-term contact with various technologies and tools, thus possessing certain digital skills, but they also have shortcomings such as low evaluation of the network and poor information recognition (Alexandra, 2019). Based on the above research, this paper summarises the influence factors of the object dimension: digital consciousness (M4) and digital natives (M5).

3.1.3. Tool/mediation dimension

The tool/intermediary in the activity theory refers to the medium, internal and external environment, platform, means and methods used in activities. The digital literacy education of college

students can be understood as a teaching environment, which includes not only material conditions, such as platform and equipment, but also soft conditions, such as campus culture and network ecology. From the perspective of a hard environment, Ma Teng and others believe that the premise of carrying out data literacy education is the construction of data infrastructure, ensuring students' access to various software and hardware, which can promote the development of data literacy. Some scholars believe that the cultivation of students' information retrieval, utilisation and innovation is related to the allocation of digital resources in colleges and universities, such as electronic documents, databases, online open courses and interactive teaching platforms. From the perspective of the soft environment, Zhang (2014) believes that the virtuality of social networks will have a negative impact on college students' moral awareness and judgment ability. The campus cultural environment corresponding to the network environment, such as school spirit and educational philosophy, is an important factor in guiding the formation of students' values and awareness of network security. Based on the above research, this paper summarises the influencing factors of tool dimension: ICT infrastructure (M6), digital resources (M7) and cultural environment (M8).

3.1.4. Community and the dimension of the division of labour

Digital literacy education for college students is a huge project, which is difficult to complete by relying solely on the strength of universities or teachers themselves. Most foreign universities will receive financial support from educational management institutions or trade associations, and at the same time, they will unite with many departments in the university. For example, Cornell University's digital literacy education participants include the library, information technology centre and professors, who are responsible for teaching information retrieval, digital technology application and digital humanistic literacy. Deepening the division of labour and developing diversified education models are successful practices of digital literacy education in foreign universities. For example, universities and enterprises cooperate in developing digital literacy education portals and launching online education models; subject librarians cooperate with teachers, participate in curriculum development teams of various majors and provide embedded digital literacy teaching; Library, employment guidance centre and information centre jointly carry out personalised digital literacy education on employment and entrepreneurship, content creation, network security and other topics. Therefore, the effective development of digital literacy education for college students cannot be separated from multi-party participation and rich educational models. Based on the above research, this paper puts forward the impact indicators of community and division of labour: institutional cooperation (M9) and diversified education (M10).

3.1.5. Rule dimension

In the digital literacy education and teaching activities of college students, the rule is a constraint. It coordinates the subject–object relationship and ensures the orderly development of digital literacy education. Many scholars' researches indicated that the university has a set of regular system monitoring mechanisms and has an important influence on student digital accomplishment development. Han Yudong and others believe that time control, online operation monitoring and other mandatory regulatory measures help to improve the learning effect of undergraduate online courses. This shows that the supervision of digital literacy education projects and the monitoring of students' network behaviour are the important factors that affect the effect of education. The measurement of the effectiveness of digital literacy education needs an objective evaluation system.

Because digital literacy is difficult to define, college students lack a clear understanding of their own digital needs. The scientific evaluation system based on the needs of students plays a guiding role in digital literacy education planning, teaching management and teaching practice. Based on this, the impact index of the rule dimension is put forward: monitoring mechanism (M11) and evaluation mechanism (M12).

Through the above analysis, the index system of influencing factors of digital literacy education for college students is constructed, as shown in Table 1.

Table 1. Index system of influencing factors of digital literacy education for college students

Relationship dimension	Number	Influencing factors
Principal dimension	M1	University policy
	M2	Teaching management
	M3	Teacher literacy
Object dimension	M4	Digital consciousness
	M5	Number of first nations
	M6	ICT infrastructure
Tool (mediation) dimension	M7	Digital resources
	M8	Cultural environment
Community and division of labour dimension	M9	Institutional cooperation
	M10	Multiple education
Rule dimension	M11	Oversight mechanisms
	M12	Evaluation system

3.2. Identification of the key influence factors in digital literacy education for college students

The DEMATEL method, or decision laboratory analysis, was proposed by scholars in American Battelle Laboratory in 1971. This method mainly uses matrix and graph theory to analyse the system elements to solve complex social problems. The DEMATEL method needs to determine the influence of the relationship between each factor in the system and its position in the system based on the expert's knowledge and experience judgment, and then identify the main influencing factors of the target problem and put forward the corresponding improvement measures. At present, the method is widely used in sociology, economics, management and other disciplines.

The specific implementation steps of the DEMATEL method are as follows: ① analyse the research problem and determine the influencing factors; ② according to expert judgment, quantify the mutual influence relationship between various factors and construct the direct influence matrix, which is expressed by the following formula: $M = (a_{ij})_{n \times n}$, where a_{ij} refers to the degree of influence of factor i on j and n refers to the number of influencing factors; ③ through normalisation, the normalised direct influence relationship matrix is obtained; ④ the comprehensive influence matrix T is calculated; and ⑤ each influence factor is calculated according to the comprehensive influence matrix: the degree of influence, the degree of centrality and the degree of cause. The influence degree is the sum of the row values of T and the influence degree is the sum of the column values of T . The centrality is equal to the influence degree plus the influence degree, which reflects the influence of a

factor in the system. The cause degree is the influence degree. The difference between the degree of influence and the degree of influence is used to distinguish the cause factor (cause degree >0) and the resulting factor (cause degree <0). This article obtained sample data by inviting experts to fill out a questionnaire. The survey objects include scientific research and teaching personnel, teaching management personnel, development planning administrators, student representatives etc. related to digital literacy education, with a relatively large proportion of middle and senior titles to ensure the validity and accuracy of the data. According to the above conditions, more than 30 experts and staff were invited to score the mutual influence relationship between various factors. The scoring standards are as follows: 4 points (very high impact), 3 points (high impact), 2 points (general impact), 1 points (low impact) and 0 points (no impact). First, comprehensively for all the scoring results, according to the degree of direct correlation between every two elements, select the score with the highest frequency to construct the direct influence matrix of the influencing factors of college students' digital literacy education, as shown in Table 2.

Table 2. Direct influence matrix of influencing factors of digital literacy education for college students

No.	M1	M2	M3	M4	M5	M6	M7	M8	M9	M10	M11	M12
M1	0	5	4	4	2	5	5	4	4	4	4	4
M2	3	0	4	4	2	3	3	4	4	4	3	4
M3	0	3	0	4	1	2	1	1	3	4	2	3
M4	2	3	0	0	4	1	1	4	1	1	0	1
M5	2	3	1	4	0	2	3	4	1	3	1	1
M6	3	4	4	5	5	0	5	3	3	4	3	2
M7	3	4	4	4	4	2	0	3	3	4	1	1
M8	5	4	5	5	4	2	3	0	4	3	3	4
M9	3	3	3	2	2	3	4	2	0	4	3	2
M10	1	1	3	4	2	3	3	3	3	0	2	3
M11	3	4	4	4	2	3	3	3	3	4	0	3
M12	4	4	4	4	1	3	3	2	3	5	4	0

After constructing the direct impact matrix, MATLAB is used to transform it into normalised impact matrix N , and the comprehensive influence matrix T is further seq. Normalising the impact matrix is directly affecting the matrix M row elements to take the maximum value, and then the direct impact of the elements in the matrix divided by the value. The comprehensive impact matrix is based on the following formula:

$$T = (N + N^2 + N^3 + \dots + N^k) = \sum_{K=1}^{\infty} N^k \rightarrow T = N(I - N)^{-1}$$

Calculate the comprehensive influence matrix of the influencing factors of college students' digital literacy education, as shown in Table 3.

Table 3. Comprehensive influencing matrix of influencing factors of digital literacy education for college students

No.	M1	M2	M3	M4	M5	M6	M7	M8	M9	M10	M11	M12
M1	0.1964	0.3538	0.3234	0.3762	0.2453	0.2971	0.3273	0.3077	0.3008	0.3474	0.2573	0.2747
M2	0.2269	0.2115	0.2835	0.3287	0.2111	0.2268	0.2511	0.2710	0.2653	0.3044	0.2099	0.2446
M3	0.1026	0.1901	0.1216	0.2339	0.1262	0.1428	0.1374	0.1399	0.1741	0.2187	0.1321	0.1618
M4	0.1294	0.1707	0.1034	0.1267	0.1711	0.1050	0.1195	0.1830	0.1146	0.1331	0.0760	0.1050
M5	0.1546	0.2044	0.1564	0.2496	0.1180	0.1510	0.1887	0.2136	0.1448	0.2082	0.1182	0.1308
M6	0.2324	0.3029	0.2887	0.3605	0.2813	0.1700	0.2980	0.2643	0.2513	0.3125	0.2114	0.2093
M7	0.1993	0.2602	0.2497	0.2922	0.2269	0.1815	0.1594	0.2263	0.2168	0.2689	0.1448	0.1602
M8	0.2791	0.3135	0.3180	0.3693	0.2637	0.2225	0.2673	0.2077	0.2803	0.3042	0.2222	0.2587
M9	0.1978	0.2383	0.2313	0.2489	0.1835	0.2004	0.2410	0.2011	0.1531	0.2683	0.1845	0.1774
M10	0.1430	0.1778	0.2076	0.2628	0.1686	0.1802	0.1992	0.2006	0.1942	0.1613	0.1477	0.1781
M11	0.2167	0.2818	0.2722	0.3159	0.2023	0.2180	0.2406	0.2425	0.2359	0.2922	0.1386	0.2164
M12	0.2401	0.2879	0.2790	0.3229	0.1864	0.2247	0.2471	0.2285	0.2423	0.3190	0.2262	0.1598

Finally, according to the calculation formula of the DEMATEL model, the relationship between the factors is quantified, as shown in Table 4, and the causality diagram is drawn with the centre degree as the horizontal coordinate and the cause degree as the vertical coordinate, as shown in Figure 2.

Table 4. Calculation of the interrelation between influencing factors of digital literacy education for college students

	Degree influence (Di)	Affected degree (Ci)	Centrality degree (Mi)	Cause degree (Ri)
College policy (M1)	3.6073	2.3181	5.9254	1.2892
Education management (M2)	3.0348	2.9929	6.0277	0.0419
Teacher literacy (M3)	1.8811	2.8347	4.7158	-0.9536
Digital awareness (M4)	1.5373	3.4875	5.0248	-1.9503
Digital first nations (M5)	2.0383	2.3843	4.4226	-0.3460
ICT infrastructure (M6)	3.1827	2.3198	5.5025	0.8629
Digital resources (M7)	2.5860	2.6766	5.2626	-0.0906
Cultural environment (M8)	3.3063	2.6862	5.9925	0.6202
Institutional cooperation (M9)	2.5257	2.5735	5.0992	-0.0478
Diversified education (M10)	2.2211	3.1382	5.3594	-0.9171
Oversight mechanisms (M11)	2.8731	2.0690	4.9421	0.8041
Evaluation system (M12)	2.9639	2.2767	5.2405	0.6872

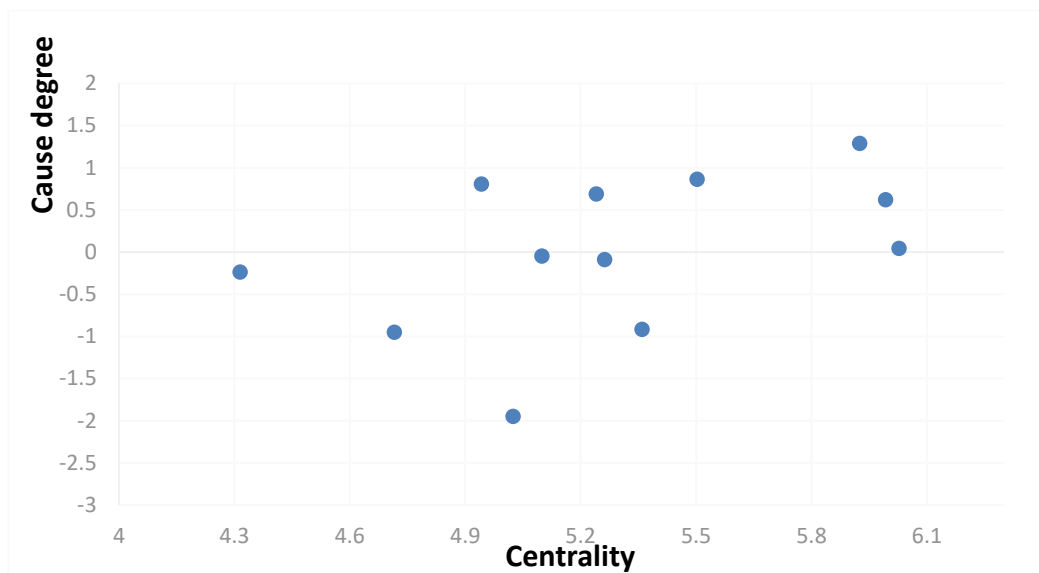


Figure 2. Centric degree – reason for Cartesian coordinates

3.3. Analysis of the key influencing factors of digital literacy education for college students

3.3.1. Analysis of the causal factors

The causing factor is the factor whose cause degree is greater than 0; the degree of reason depends on the degree of influence and the size of the degree of influence; the greater the degree of influence of a factor, the smaller the degree of influence, the greater the degree of reason. As can be seen from Table 4, the causes are university policy (1.2892), ICT infrastructure (0.8629), supervision mechanism (0.8041), evaluation system (0.6872), cultural environment (0.6202) and teaching management (0.0419), indicating that these factors have a more significant impact on other factors, especially the first three indicators. The reason is that, as a product of the Internet's big data age, the digital literacy education of college students is still in the exploration stage, which needs policy guidance, goal orientation, system constraint and infrastructure construction as the origin and prerequisite of digital literacy education.

3.3.2. Analysis of the resulting factors

The resulting factors, i.e., elements with a cause degree less than 0, are generally influenced by other factors. According to the results, there are six factors, in order of reason from small to large: digital awareness (-1.9503), teacher literacy (-0.9536), multi-education (-0.9171), digital first nations (-0.3460), digital resources (-0.0906) and institutional cooperation (-0.0478). From the perspective of educational practice, this conclusion has a specific reference. On the one hand, students' digital consciousness and digital native characteristics are formed naturally in the information environment. On the other hand, they are trained and cultivated under the guidance of educational policy; the improvement of a teacher's literacy also comes from self-strengthening and the external drive of teaching tasks and supervision mechanism; diversified education is guided by curriculum planning and depends on teachers' teaching strategy, and innovation is realised in institutional cooperation. At the same time, digital resources are passed on to students under complete infrastructure construction. Compared with the reason factors, these factors have a more direct impact on college students' digital literacy education.

3.3.3. Identification of the crucial influencer factors

The DEMATEL model is used to calculate the centre and cause of each factor and to map the distribution (Figure 2). The centrality of a factor reflects its importance in a complex system, while the causal relationship demonstrates its contribution to the system. Centrality is an essential principle for judging the core elements. Centrality is an important principle to evaluate the core elements. As can be seen from Figure 2, some aspects have a high degree of centrality and motivation, such as M1 (university policy), M8 (cultural environment), M6 (ICT infrastructure), M2 (teaching management) and M12 (evaluation system); these factors play a driving role in the digital literacy education in colleges and universities; these factors are the most critical. University policy is an indispensable system designed for digital literacy education activities, and it plays a leading and coordinating role. Environmental education is a subtle suggestion of growth. ICT infrastructure construction, digital literacy teaching planning and management and evaluation system are the basis of digital literacy education, which are used to guide specific teaching practice.

In addition to the key factors, M10 (multi-education) is highly central and vital but vulnerable to other factors. The centre and reason of M9 (institutional cooperation) and M7 (digital resources) are in a moderate position and can play a regulating role because digital literacy, as an integrated capability requires the addition of multi-channel educational resources and strength. Factors with low centrality and a high degree of reason, such as M11 (a supervisory mechanism), play a secondary role, and M3 (teacher literacy), M5 (digital natives) and M4 (digital consciousness), which are both low values, are relatively independent elements in the system.

4. Discussion

Based on the activity theory, this paper analyses the influence factors of college students' digital literacy education from five dimensions and identifies the key influence factors, cause factors and outcome factors by the DEMATEL method. It is found that the college policy, cultural environment, ICT infrastructure, teaching management and evaluation system play the most crucial role. This paper puts forward the strategy of improving the digital literacy education of college students.

Relevant policies must guide digital literacy education in colleges and universities. First of all, we can learn from the practices of foreign universities; set up a working group on digital literacy, which is composed of the principal in charge and the leaders of academic affairs office, library and secondary colleges; formulate a framework for digital literacy education; clarify the educational objectives, contents forms and conditions based on the framework; study the development of digital literacy education courses and projects; and provide unique guidance documents for curriculum setting, so as to make the cultivation and education of digital literacy of college students systematic and standardised (Wu & Li, 2019). Secondly, colleges and universities should strengthen capital investment and publicity in digital literacy education, invest special funds for theoretical research and practical projects of digital literacy, strengthen cooperation with external institutions such as industry associations and enterprises and provide guidance for related research and project implementation while receiving support and funding. The importance of digital literacy education is publicised by the official website and micro-media, which attracts the attention of leaders, teachers and students of various departments, and integrates digital awareness and concepts into teaching and learning. Besides, colleges and universities should establish a long-term mechanism for developing teachers' digital literacy, strengthen teachers' strengths and promote the deep integration of digital technology, education and teaching.

Creating an excellent digital cultural environment is based on digital quality education, including environmental space, digital resources and campus culture construction. In physical space construction, colleges and universities can equip classrooms, libraries and laboratories with intelligent devices and interactive tools to build smart campuses (Wu & Li, 2019). For example, establish a producer space in the library; introduce emerging technologies such as visualisation and GIS; and equip intelligent robots, 3D printing equipment, digital preservation and management tools so that students can stimulate their creative potential in the digital environment. In virtual space construction, a learning management system, virtual laboratory and learning community are introduced to create a clean network environment through standardised management. In terms of resource allocation, we should give full attention to libraries' advantages; build a rich digital resource system; strengthen the integration, co-construction and sharing of electronic resources; and provide online courses on digital literacy, digital content creation training platform and so on. Besides, in the construction of campus culture, the most important thing is to rectify the school spirit and discipline, promote quality education, standardise students' network behaviour, cultivate students' information moral awareness and discrimination ability and strengthen safety promotion awareness and digital literacy (Frydenberg, 2015; List, 2019).

ICT infrastructure construction is the technical support for digital teaching. First, there must be full campus coverage of wireless networks to ensure that students have quick and easy access to digital resources (Zheng, 2014). Secondly, in the construction of hardware, colleges and universities should be equipped with modern hardware and tools, such as classroom multimedia equipment, library self-service equipment, touch screen all-in-one machine, electronic whiteboard, intelligent guide, audio and video equipment, laboratory 3D stereoscopic display, data gloves and other virtual simulation experimental equipment. In software configuration, you need to develop or purchase tools or applications that support digital resource management, such as data storage, classification, switching, communication applications and software that promotes creative learning and work, such as mind maps and programme development. Digital devices and software can support students' many digital practices, and virtual reality, artificial intelligence and other technologies can provide students with an immersive learning experience. ICT infrastructure construction is an essential part of building a smart campus, and the new learning culture created by modern educational technology will have a subtle impact on college students' digital technology skills and digital media skills.

5. Conclusion

Teaching, planning and management directly affect the effectiveness of students' digital literacy education. Training management personnel must give full attention to the functions of planning, organisation and coordination to ensure the orderly and efficient operation of all links. Colleges and universities should formulate undergraduate curriculum goals and plans based on the digital literacy framework and teach at different levels, types and stages. On the one hand, the digital literacy general education curriculum runs through college students' entire learning stage. On the other hand, integrate digital literacy education into the talent training programmes of various disciplines; explore the integrated education model of digital literacy and professional courses; and cultivate students' ability to creatively use digital technology to solve practical problems in different situations. Secondly, other content teachings can be carried out in different grades. For example, the lower levels offer digital awareness, information retrieval and utilisation courses, focusing on cultivating students' basic necessary manipulation skills; the upper grades can offer more challenging topics such as digital content creation, digital security, critical thinking and social responsibility. The content enhances

students' thinking and creativity. It is also necessary to actively explore new training models, such as launching innovation competitions with the digital economy's theme or big data applications.

The evaluation system is an essential factor in guiding the practice and management of digital literacy teaching, which includes evaluating the effect of education and evaluating the form and condition of education. As far as evaluating the teaching effect is concerned, there is no unified digital literacy education framework in colleges and universities. As the main body of activities, colleges and universities should clarify digital literacy training for different student groups. First, is the design of detailed digital literacy evaluation indicators for college students, and in various forms of regular evaluation of college students' digital literacy, such as the design of online assessment tools, information skills competition, systematic development project practice, monitoring students' online behaviour and creation of digital security test questions. The proportion of class hours in special contests and other links is evaluated. An authoritative evaluation system can promote the popularisation of digital literacy education and improve teachers' quality.

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