Strategies for Improving University Students' Digital Competence in Intelligent Learning Environment

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Abstract: The deep combination of intelligent learning environment and university students' digital competence has greatly accelerated the development speed of university students' digital competence. However, there are some barriers on improving digital competence of university students. Many factors affect the digital competence of university students, including problem solving, data security, content creation, communication, information, digital technology and tools. The aim of this study is to investigate development level of digital competence among university students in intelligent learning environment and promote improvement strategies. A questionnaire survey was administered to 603 university students from different universities in China. The potential relation and whether there are differences in gender and teaching year among the six dimensions were also studied.

1. Introduction

Digital competence has become the necessary element for people in the digital era[1]. Digital competence refers to the various cognitive thinking strategies used by users of digital information [2]. Many factors affect the digital competence of university students, including problem solving, data security, content creation, communication, information, digital technology and tools (see Figure 1). As the most important group in a country, the level of digital competence of university students directly affects the pace of a country's digital development. However, digital competence of university students has been still in the developing stage, and there are some barriers such as unclear educational paths and uneven educational resources. Therefore, it is crucial to improve the digital competence of university students. Intelligent learning environment is uses digital technology and innovative educational theory to enable students to engage in efficient, intelligent and personalized learning [3]. In order to deeply integrate digital technology with higher education, it is necessary to integrate the development of digital competence into the training program of university students. It can enable the rich and high-quality digital intelligent technology resources in intelligent learning environments to be fully utilized to help enhance the digital competence of university students.

Currently, research on digital competence of university students are focused on the concepts of digital competence connotations in China, digital competence and libraries, evaluation of digital competence and improvement of digital competence.

For example, governments have carried out a number of activities to develop critical thinking skills of information technology of university students in Hispanic countries [4]. However, research on digital competence of university students in intelligent learning environment were not enough.

Therefore, this study investigated the level of development of digital competence among university students in intelligent learning environment using a questionnaire and proposed development strategies. The main questions have been stated as follows:

(1) What is the level of digital competence of university students in intelligent learning environment?

(2) What are the strategies to improve digital competence of university students?

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Figure 1 Six dimensions of digital competence.

2. Methods

This study determined that intelligent learning environment had influence on digital competence of university students through viewing the relevant literature.

First, this study adopts the validated questionnaire for measuring the level of university students' digital competence. The university students with learning experiences in intelligent learning environments are the research object. Second, the questionnaire was distributed and recovery through network. The invalid questionnaire was deleted. The data were analyzed with SPSS software. Finally, based on the findings, strategies were put forward to provide references for improving digital competence of university students in intelligent learning environment.

2.1. Instrument

The "Questionnaire on the Development Level of University Students' Digital Competence in Intelligent Learning Environment" [1] was adopt in this study. It has been validated and adopt in different research. There are 32 items in the questionnaire included 2 items of digital technology and tools, 3 items of information, 4 items of communication, 3 items of content creation, 5 items of problem solving and 5 items of data security. The questions adopt 5-point Likert scale, it is easy to understand the complete list of scale descriptors ('1 equals strongly disagree, 2 equals disagree, 3equals neither disagree nor agree, 4 equals agree, 5 equals strongly agree') [5]. Then, our group was testing and discussing about all the items. Finally, reliability and validity of the questionnaire were tested. And results show that questionnaire items could reflect variables to be studied. SPSS29.0 was used to data analysis.

2.2. Participants

In total, 603 university students with learning experiences in intelligent learning environments were contacted. They are from different universities in China. After removing incomplete and meaningless questionnaires, 463 valid questionnaires were collected. The specific statistics are shown in Table 1.

Table 1 Specific statistics of participants.

Measured features	Eigenvalue	Numbers	Percentage (%)
Gender	Male	219	47.30
	Female	244	52.70
Age	18-21 years	238	51.40
	22-25 years	133	28.73
	26-29 years	68	14.69

	More than 30 years	24	5.18
Degree	Undergraduate	358	77.32
	Postgraduate	75	16.20
	Doctor	25	5.40
	Others	5	1.08
Grade	Freshman or sophomore	235	50.76
	Junior or Senior	128	27.65
	Postgraduate students	76	16.41
	Ph.D. candidate	24	5.18
Time spent on digital devices	Very low	25	5.40
	low	59	12.74
	General	120	25.92
	High	177	38.23
	Very high	82	17.71
Digital skills in demand	The demand is strong	294	63.50
	The demand is not high	169	36.50
Self-directed learning of digital skills	Studied relevant courses	360	77.75
	No studies have been conducted	103	22.25
Whether there is a need to improve the digital competence of university students	Not at all	19	4.10
	Compare not to match	50	10.80
	General	123	26.57
	More compliant	207	44.71
	Exactly	64	13.82

2.3. Date analysis

The data analysis part of this study is divided into three steps.

First, the data collection. The questionnaire was distributed and recovery through network. The invalid questionnaire was deleted.

Second, data coding. The corresponding scores are recorded into an Excel according to the answer.

Third, data analysis. Import the data in the Excel file into SPSS29.0 for data analysis based on the research questione.

3. Results

3.1. The level of all dimensions

Overall average digital competence score for university students 3.4736. The average score of four dimensions was shown at Figure 2. The mean scores for the three dimensions of Digital Information Security Knowledge, Digital Tools Communication Knowledge, and Digital Competence Security Knowledge were all above 3.473, indicating a relatively high level of proficiency. The highest mean score of 3.508 was found in the communication. The problem solving, content creation, and digital technology and tools had relatively low average scores of 3.455, 3.448, and 3.454, respectively. This suggests that students get themselves into some trouble when they encounter technical problems in operating and using the digital environment, when they are unable to create and edit digital content or disseminate digital information using digital devices, and when they are unable to recognize, understand, or operate hardware, software tools, and technology. Moreover, they do not trust themselves to be able to use technology independently and better without guidance, leading to a reluctance to learn and use technology. Therefore, the digital competence of university students should be improved in three areas: problem solving, content creation, and digital technology and tools.

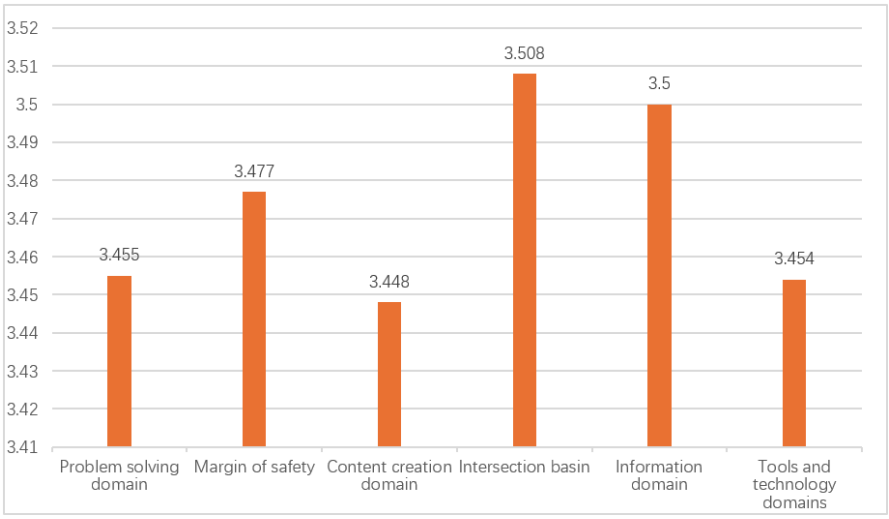

Figure 2 The average score of the six dimensions.

3.2. The correlations between the six dimensions

As shown in Figure 3, there had a positive significant correlation between any two of the six dimensions. For example, dimension of problem solving has a positive significant correlation with other five dimensions. And the correlation coefficients were 0.841, 0.819, 0.814, 0.812 and 0.747, respectively. Therefore, it is necessary to train university students on problem solving to improve the other five dimensions level of digital competence of university students in intelligent learning environment.

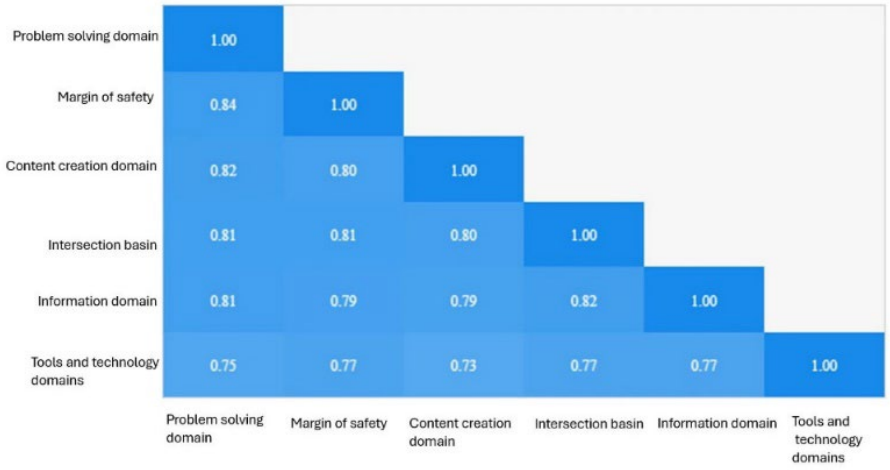

Figure 3 Correlations between any two of the six dimensions.

3.3. The influence of demographic variables on digital competence

A t-test and analysis of variance (ANOVA) were conducted to investigate whether gender, age, and subject were related to six dimensions of university students in intelligent learning environment. Results showed that gender, age, and subject have no impact on the six dimensions of university students in intelligent learning environment.

3.4. Improvement strategies and suggestions

The knowledge and skills learning in intelligent learning environments are an important for university students' digital competence. They are mainly derived from training, educational experiences and so on. Knowledge in the dimensions of data security, the communication, and the information can be learnt through training and other learning activities easily. However, the improvement of problem-solving, content creation, and digital technology and tools are not easy.

The results of this study showed that university students have high levels of data security, communication and information. The level of problem-solving digital technology and tools was

relatively low. The level of the content creation is the lowest. In addition, the findings of this study show that gender, age and subject have no significant influence on digital competence. There is a strong positive correlation between the six dimensions of university students' digital competence in intelligent learning environment. Based on these findings, three recommendations for the development of digital competence among university students in intelligent learning environments are proposed.

3.5. Optimizing intelligent learning environments

Improving the digital competence of university students is a critical task in the field of education. Optimizing the intelligent learning environment is a key strategy to achieve this goal. First, accessibility and diversity of learning resources should be ensured. Provide students with a rich learning experience by integrating multimedia content and interactive tools. Second, the intelligent learning platform should have personalized recommendation function. Push customized learning content according to students' learning habits and preferences so as to improve digital competence. Third, strengthening cybersecurity education and cultivating students' ability to recognize and prevent cyber risks is an important part of improving digital competence. Finally, university students are encouraged to participate in online collaborations and projects to promote their technical application skills and teamwork spirit through practice. In addition, universities should regularly evaluate and update their intelligent learning environments to ensure that they meet the needs of university students.

3.6. Improving problem-solving skills in practice

This can effectively improve their problem-solving skills in practice by encouraging university students to participate in digital projects or experiments, such as the school's scientific research projects, social and practice. Students are encouraged to put forward new ideas for solving the problems using digital technology and utilize to digital tools to solve complex problems. In addition, the feedback and multiple solution learning received through participation in practice activities are important for the development of students' problem-solving skills. It can effectively improve students' problem-solving skills by integrating the development of problem-solving skills into the educational programs of university students in intelligent learning environments through rational instructional design.

3.7. Training university students on content creation using digital technology

Training university students on the use of digital technologies for content creation is an important part of modern education. The improvement of digital competence of university students involves the ability to search for and integrate information using various search engines and databases. It is essential to encourage university students to utilize data analysis tools for content creation. For example, it could teach university students in the use of Python or R for data manipulation and analysis. In addition, to make the content more engaging and persuasive, students are instructed to use visual tools in intelligent learning environments to represent data in the form of graphs or animations. In addition, training should be provided on methods of creating multimedia content, including video editing, audio production, etc., so that students understand how to integrate multimedia elements into content to make it more engaging. Universities should also provide students with the courses they need to learning digital technologies. It could not only improve students' digital competence, but also prepare for the challenges they will face in the digital world.

3.8. Developing online learning platform for university students' technology knowledge

Basic courses on digital technology in online learning platform are offered to enable students to learn the basic principles and fundamentals of digital technology such as Introduction to Computer Science, Programming Fundamentals Database Principles and so on. And professional-related digital technology courses are offered to meet the needs of different majors. University students are guided to make full use of online learning platforms to learn digital technology. The platforms provide rich course resources and personalized learning paths. It provides students with access to the latest technological tools and software. Students are encouraged to participate in technology community

activities and communicate with peers. It facilitates students in staying current with the most recent advancements and prevailing trends in technology, as well as in demonstrating their competencies and achievements. Therefore, online learning platforms can effectively support university students' learning of technological knowledge.

4. Conclusion

This study investigated development level of digital competence among university students in intelligent learning environment and promote improvement strategies from four aspects. First, the study presents the developmental level of university students' digital competence in intelligent learning environment. The results showed that the overall level of university students' digital competence in intelligent learning environment is relatively high. The level of the Crossing domain is the highest. The levels of problem-solving, digital technology and tools were relatively low. And the level of content creation was the lowest. Second, the correlation between the six dimensions of digital competence in intelligent learning environment was investigated. The results show that there had a positive significant correlation between any two of the six dimensions. Third, the effect of demographic variables such as gender and age on digital competence was examined. Fourth, based on these findings, suggestions for the university students in intelligent learning environment were put forward to improve digital competence.

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