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A Study on the Impact of Digital Literacy on Research Ability of Graduate Students

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Abstract: In the digital age, this paper discusses the impact of graduate students' digital literacy on scientific research ability, aiming at cultivating research talents with digital literacy, and improving the quality and efficiency of graduate students' scientific research ability. This study investigates the current situation of digital literacy of graduate students through a questionnaire survey, and constructs a structural equation model of the impact of digital literacy of graduate students on scientific research ability. SPSS and AMOS 28.0 are used for empirical analysis, the research results show that digital literacy has a certain positive impact on scientific research ability, which is mainly manifested in three aspects: digital thinking, digital learning and digital ethics awareness. It is proposed that universities should adjust and optimize the cultivation mode of digital literacy university libraries, build rich and complete colleague digital literacy, and strengthen the guidance of graduate students to form the bottom line of digital ethics awareness and other countermeasures.

Keywords: Graduate Student; Digital Literacy; Scientific Research Ability

Introduction

With the innovation and iteration of digital technology, the wide application of Internet, big data and artificial intelligence, and the integration of digital society and education field, the digital transformation and upgrading of education has become the general trend. Digital resources have become an important factor of production in the information age, and citizens' digital literacy is regarded as an important basis for economic development [1]. Digital literacy is a digital ability system that includes knowledge, skills, traits, attitudes, ethics and other elements. In today's increasingly digital social environment, digital literacy has become an indispensable quality for citizens to survive and develop in the information digital society. In order to improve citizens' digital literacy, there are numerous digital literacy frameworks proposed by international organizations such as the European Union and UNESCO. China also attaches great importance to the cultivation of digital literacy, and has successively promulgated documents such as the "Education Informatization 2.0 Action Plan" and the "Action Program to Improve Digital Literacy and Skills of the whole People", aiming to explore the cultivation and improvement of learners' digital literacy. In recent years, digital literacy of graduate students has gradually become a hot topic in higher education. As the new force of scientific and technological innovation in the new era and the innovation source of a new round of scientific and technological revolution, digital literacy has become their competitive advantage. Cultivating graduate talents with digital literacy can not only improve the quality and efficiency of scientific research, but also is the core of digital transformation and upgrading of education.

1. Literature review

1.1 Concept definition

The concept of "literacy" first appeared in research reports by the OECD and the Council of the European Union, where the OECD defined literacy as "the ability to use and mobilize psychosocial resources (including skills and attitudes) to meet complex needs in a given context." Digital literacy was first proposed by Israeli scholar Alkailaiy in 1994, and five elements of the conceptual framework of digital literacy were proposed: image elements, re-creation elements, branch elements, information elements and emotional elements [2]. Since then, research and discussion on digital literacy have been carried out. Since the 21st century, scholars in different fields, countries and international organizations have different understandings of the concept of "digital literacy". The EU has identified five key components of digital literacy, including 1) information and data literacy; 2) Communication and collaboration; 3) Digital content creation; 4) Safety; 5) Solve problems. The EU Digital Competence Framework was developed to identify the digital competence of EU citizens and to serve as a tool for improving and supporting digital competence [3]. The U.S. Department of State defines digital literacy as having computer skills and the ability to use computers and other technologies to improve learning, productivity, and performance. [4] UNESCO describes "digital literacy" as "the basic skills

needed to use digital media, information processing and retrieval, to enable people to participate in social networks and to create and share knowledge." Li Zheng Feng believes that in the digital age, digital literacy and skills not only refer to relevant knowledge and skills, but also include values, ethics and other qualities integrated in the digital age [5]. Wang You Mei pointed out that digital literacy is a comprehensive and evolving concept that covers media skills, computer skills, information processing ability and network application ability [6]. The Program of Action to Enhance Digital Literacy and Skills for All People, released by China in 2021, defines digital literacy as the collection of a series of qualities and abilities that citizens possess in digital society, such as digital acquisition, production, use, evaluation, interaction, sharing, innovation, security and ethics [7]. Digital literacy is more than just word skills; it is a comprehensive, dynamic, and open concept that also includes attitudes, emotions, and other aspects of meaning.

Domestic scholars' definition of scientific research ability can be divided into output theory, activity theory and synthesis theory. The output theory holds that scientific research ability is an individual's ability to produce creative knowledge results [8], and uses scientific research output such as published papers to measure individual scientific research ability. Activity theory holds that scientific research ability is the ability and skill shown by an individual in the process of scientific research [9], so the ability of literature review, research design, data processing, paper writing and other scientific research activities are used to measure an individual's scientific research ability. In general, it is believed that scientific research ability is the physical and mental condition required for an individual to complete scientific research activities. Scholars who hold this view believe that scientific research ability includes not only scientific research activity ability, but also more general ability (such as logical reasoning ability and language expression ability) [10]. The definition and measurement of scientific research ability in foreign countries are not good, and researchers usually adopt similar concepts such as research self-efficacy [11] and research competence [12] to study similar issues. This paper defines scientific research ability as three dimensions, including the publication of scientific research results, scientific research practice ability, and scientific research innovative thinking.

1.2 Research on the relationship between digital literacy and scientific research ability

Scientific research ability is one of the essential abilities of postgraduate students, and the cultivation of scientific research ability is also the key link and core content of postgraduate education. On the relationship between the two, scholar Yazon identified the relationship between digital literacy, digital ability and research productivity of educators, and the results showed that digital literacy and scientific research ability of faculty members were significantly correlated. This means that an increase in the use of digital technologies to understand, discover, use, and create information is positively correlated with faculty members' ability to conduct, complete, present, and publish research articles [13]. Some scholars used Digcomp2.1, the framework of citizen digital competence, to conduct a scale test on 1, 416 undergraduate students from four countries, and the research results showed that digital competence supports research competence and may even support inclusiveness [14]. Other scholars believe that digital technologies, especially digital open systems, play an important role in cultivating the information and research capabilities of postgraduates and doctors, and their use helps to improve and expand research opportunities, research results display, and the image of researchers and institutions [15]. Higher education must provide quality education, not only among teachers and researchers, but also among the students who will be the researchers of the future.

Generally speaking, the research directions of domestic and foreign scholars mainly focus on the connotation definition of digital literacy, the formulation and interpretation of digital framework, and the education and practice of digital literacy. There are several problems in the current research: In terms of research objects, the research pays more attention to undergraduates and lacks research on postgraduates; In terms of research methods, they are more inclined to qualitative research such as literature analysis, and few studies use rigorous empirical methods to collect and analyze data, so that the research is not convincing enough. In the process of research, the influence weight of each influencing factor on scientific research ability was not calculated, and it was impossible to put forward specific suggestions for subsequent improvement strategies.

2. Research design

2.1 Research objects

The data of this study come from the Questionnaire on the Learning Experience and Experience of Postgraduate students, which was initiated by the research group on the learning experience and experience of postgraduate students in universities and colleges in Fujian Province, aiming to understand the learning experience and school experience of postgraduate students in Fujian Province. The survey followed the principle of voluntary answering, and finally, the postgraduate students from 14 universities in Fujian Province participated in the survey. In this survey, a total of 3301 questionnaires were collected, 251 invalid questionnaires with less than 300s filling time and abnormal parental background were excluded, and 3050 valid questionnaires remained, with an effective rate of 92.40%.

The data distribution of the questionnaire survey is as follows: From the perspective of gender, there were 1, 936 female respondents,

accounting for 63.48%, and 1, 114 male respondents, accounting for 36.52%. From the grade point of view, the number of people who filled in the first study was 1671, accounting for 54.8%, the number of people who filled in the second study was 854, accounting for 28.0%, the number of people who filled in the third study was 515, accounting for 16.9%, and the other cases accounted for 3%. From the perspective of learning type, the number of academic master's students was 1, 211, accounting for 39.7%, and the number of professional master's students was 1, 839, accounting for 60.3%. From the perspective of the type of colleges and universities, normal colleges and universities account for the largest proportion, accounting for 53.19%, comprehensive colleges and universities account for a relatively large proportion, accounting for 20.32%, science and technology colleges and universities account for 11.03%, and other colleges and universities account for 15.46%. From the perspective of the subject types of the majors, humanities and social sciences accounted for 52.1%, science, agriculture and medicine accounted for 46.70%, and interdisciplinary subjects accounted for 1.2%.

2.2 Variables and reliability and validity test

2.2.1 Reliability test

In this study, Cronbach's Alpha was used to test the reliability of the three latent variables, and the results were all greater than 0.6 (as shown in Table 1), which indicates that the scale has strong internal consistency and stability, and the reliability of latent variables is good.

Table 1. Reliability test

Latent Variables	Cronbach's Alpha	Measure number of questions
Digital thinking	0.942	4
Digital learning	0.922	4
Digital ethical awareness	0.926	4

2.2.2 Validity test

In this study, the validity analysis of the questionnaire was further carried out, and the results showed that the KMO value was 0.968, while the P-value of Bartlett test was less than 0.01, indicating that there was a strong correlation between the data and factor analysis could be carried out. In this study, the principal component analysis method was adopted, the number of factors to be extracted was set to 3, and 12 items including three variables, such as digital thinking, digital learning and digital ethical awareness, were extracted. The factor load was all above 0.4, which had strong explanatory power, indicating that the validity of the questionnaire was good.

3. Empirical analysis of the impact of digital literacy on research ability of graduate students

3.1 Descriptive statistics and correlation analysis

Descriptive statistical results as shown in Table 2 below. In addition, it can be seen that digital thinking has a significant correlation with the publication of scientific research results, scientific research practice ability and scientific research innovation thinking ($P<0.01$), and the Pearson correlation coefficients are 0.43, 0.549 and 0.562, respectively, with a moderate correlation. There is also a significant correlation between digital learning and scientific research practical ability and scientific research innovative thinking, and the Pearson correlation coefficient is 0.561 and 0.578, respectively, which has a moderate correlation. There is a significant correlation between digital ethics awareness and scientific research practice ability and scientific research innovative thinking, and the Pearson correlation coefficients are 0.425 and 0.484, respectively. Therefore, we can proceed to the next step of model building.

Table 2. Describes variables for statistical and correlation analysis

Variables	M	SD	Digital thinking	Digital learning	Digital ethical awareness	Publication of scientific research results	Scientific research practice ability
Digital thinking	3.076	0.565					
Digital learning	2.971	0.617	.787**				
Digital ethical awareness	3.24	0.585	.678**	.600**			
Publication of scientific research results	0.634	0.802	.043*	0.012	0.01		
Scientific research practice ability	2.804	0.662	.549**	.561**	.425**	.039*	
Innovative thinking in scientific research	2.858	0.639	.562**	.578**	.484**	0.01	.864**

***. Representative P<0.01*

**. Representative P<0.05*

3.2 Model construction

3.2.1 Influence model construction

In order to explore whether digital literacy of graduate students has an impact on scientific research ability, this study makes the follow-

ing three hypotheses according to the three latent variables obtained by factor analysis:

H1: Graduate students' digital thinking has a positive impact on research ability

H2: Digital learning of graduate students has a positive impact on research ability

H3: Digital ethics awareness of graduate students has a positive impact on scientific research ability

3.2.2 Modification of structural equation model

In the initial model path, digital thinking, digital learning and digital ethical consciousness belong to exogenous potential variables, and scientific research ability belongs to endogenous potential variables. To ensure that the verification process of the model can be established, a total of 22 residual variables from e1 to e32 are equipped. According to the suggestion of the modified index, taking into account the path graph and modified index of the initial structural equation model, in general, among the commonly used fitting indexes, the absolute fitting index RMSEA<0.05, the Chi-square freedom ratio CMIN/DF<5, and CFI (comparative fitting index) >0.9. In the common fitting index of the initial structural equation model, CMIN/DF was >5, which was not up to the standard, so it was necessary to modify the initial structural equation model to some extent. After adding the covariant relationship between the residual terms e5 and e6, and e31 and e32, the model was re-run in the software AMOS28.0, and the model parameters were greatly improved. However, due to the large sample size, the Chi-square degree of freedom ratio still does not meet the reference adaptation standard, but it is still greatly improved compared with before, so it is used as the final structural equation model.

Table 3. Results of path analysis and hypothesis testing

Path			Standardized path coefficient	S.E.	C.R.	P value
Publication of scientific research results	<---	Digital thinking	0.018	0.01	1.85	0.064
Innovative thinking in scientific research	<---	Digital thinking	0.143	0.04	3.585	***
Scientific research practice ability	<---	Digital thinking	0.227	0.042	5.431	***
Publication of scientific research results	<---	Digital learning	-0.011	0.009	-1.336	0.182
Innovative thinking in scientific research	<---	Digital learning	0.466	0.035	13.229	***
Scientific research practice ability	<---	Digital learning	0.452	0.037	12.28	***
Publication of scientific research results	<---	Digital ethical awareness	-0.001	0.006	-0.204	0.838
Innovative thinking in scientific research	<---	Digital ethical awareness	0.143	0.024	5.854	***
Scientific research practice ability	<---	Digital ethical awareness	0.04	0.026	1.577	0.115

The results of path analysis and hypothesis testing of the final revised model (as shown in Table 3). In the path of the influence of digital thinking on scientific research innovation thinking and scientific research practice ability, the path coefficients are 0.143 and 0.277, respectively, and pass the significance test at 0.001 level (P=0.000), This reflects that graduate students with digital thinking can also play a positive guiding role in scientific research innovative thinking and practical ability, so hypothesis 1 is valid. In terms of the influence path of digital learning on innovative thinking and practical ability of scientific research, the path coefficients are 0.466 and 0.452 respectively, and pass the significance test at the level of 0.001 (P=0.000), indicating that digital learning, as an important internal factor, affects the formation of innovative thinking of graduate students in scientific research, so hypothesis 2 is valid. The path coefficient of the influence of digital ethical awareness on scientific research practice ability is 0.143, which passes the significance test, indicating that digital ethical awareness can further support scientific research practice.

4. Conclusions and Recommendations

4.1 Research conclusions

Based on the above analysis, the hypothesis part has been verified. According to the empirical results, the following conclusions can be drawn in this study:

First, digital thinking is a prerequisite for guiding the improvement of scientific research ability. The path coefficients of influence of digital thinking on innovative thinking and practical ability of scientific research are 0.143 and 0.277, respectively. It shows that digital thinking has a significant positive impact on innovative thinking and practical ability of scientific research. Hypothesis 1 is valid. If graduate students can develop good digital thinking, before solving scientific research problems, they can not only think of using paper media such as book resources, but also have a high sensitivity to numbers, can find digital resources valuable to research, not limited to traditional methods and models, dare to use digital innovation, and actively look for the possibility of digital technology to solve problems. Then the ability to think and create will be significantly improved.

Second, digital learning is the core and key to improve the quality and efficiency of scientific research capabilities. The path coefficients of influence of digital learning on innovative thinking and practical ability of scientific research are respectively 0.466 and 0.452, which are the highest among the three latent variables of digital literacy. It can be seen that digital learning has a significant positive impact on innovative thinking and practical ability of scientific research. Hypothesis 2 is valid. Digital learning is an important part of digital literacy education, including the retrieval and utilization of digital resources, the basic knowledge and application of digital technology, and the attitude and ability to integrate digital information into the digital society. In the process of practice, graduate students not only need to learn to use various methods to collect and obtain information, but also to process, analyze and apply the miscellaneous information. If the skills and attitudes learned digitally can be transformed into the understanding, analysis, integration and creation of numbers, the traditional learning mode can be changed, and the digital resources with features such as hypertext and real-time interaction can be recreated according to the needs of researchers, it will eventually become an important means to promote the improvement of research ability of graduate students.

Digital ethics consciousness is the bottom line and guarantee of scientific research ability. Digital ethical consciousness has a positive influence on innovative thinking in scientific research, and the influence path coefficient is 0.143, indicating that it can support the formation and development of innovative thinking in scientific research of graduate students. Hypothesis 3 is valid. In the research and creation process of graduate students, understanding the risk of information leakage, clarifying the key points of writing norms, and realizing the importance of digital security are the bottom line of forming innovative thinking in scientific research. Adhering to digital security is also conducive to optimizing the academic environment and atmosphere, maintaining a benign relationship between scientific research creators and scientific research academic achievements through the restriction of rules, and facilitating the output of scientific research achievements.

4.2 Research suggestions

Based on the above research conclusions, it is concluded that the digital literacy of graduate students has an impact on the improvement and development of their scientific research ability. This study puts forward suggestions from the following three aspects, in order to eliminate the gap in the use of digital resources for graduate students in the digital era, strengthen digital learning to promote the cultivation of digital literacy for graduate students, and improve the quality and efficiency of graduate research work.

4.2.1 Adjust and optimize the digital literacy cultivation mode of university libraries

In terms of computer network and other infrastructure construction, university libraries, as the main position of digital resources acquisition, should first ensure the full coverage of the network and reduce the situation that the network is stuck or even unable to connect due to the large number of online people. Secondly, increase the investment in hardware and software, hardware including the purchase of touch screen all-in-one, intelligent audio and video equipment, virtual simulation experiment equipment, etc., to facilitate the use of students; In terms of software, it is necessary to purchase rich data resource libraries and digital resource management tools, so that students can have a good digital experience. It is particularly noteworthy that although university libraries are aware of the importance of digital literacy, the content and mode of cultivation are biased in the process of cultivation, which is manifested in paying too much attention to information retrieval ability. In fact, in the process of carrying out scientific research, information retrieval is only the first step, and graduate students are lacking in digital communication, content creation, analysis and integration. This requires university libraries not only to carry out information retrieval lectures with limited content, but also to open digital sharing and communication channels, so that more graduate students can understand how to transform digital resources into valuable research problems, guide graduate students to create digital content, and burst out the vitality of scientific research and innovation.

4.2.2 Build a rich and complete college digital literacy curriculum

Digital literacy courses in colleges and universities have some problems, such as few courses, short class hours, narrow coverage and few application opportunities. To do a good job in the course planning and management of digital learning is the key link to improve the research ability of postgraduates. On the one hand, it is necessary to take the digital literacy course as the general education course to run through the whole graduate study career in stages and layers. At the beginning of the graduate school, while learning theories, create an atmosphere of digital learning and integrate digital consciousness into learning. And gradually set up such as information retrieval courses, digital content analysis and processing courses, digital ethics and security courses and other related courses, imperceptibly influence the digital thinking of graduate students. On the other hand, to change the positioning of digital literacy courses in professional training programs, we should not only learn theoretical knowledge, but also change the training mode. We can create digital practice bases and carry out digital innovation competitions, so that postgraduates can explore the meaning of numbers in practice and learn to handle applied data in practice.

4.2.3 Strengthen guidance to form the bottom line of digital ethics awareness

The awareness of digital security and digital ethics is a kind of academic constraint in the process of research work of graduate students.

However, due to the pressure of postgraduate study and heavy scientific research tasks, some postgraduate students will commit data fraud, academic misconduct and other behaviors, which will undoubtedly destroy the academic environment and order, causing bad winds. Universities should strengthen the awareness of digital ethics of graduate students, adhere to the bottom line of academic norms, pay attention to digital security, avoid privacy disclosure, and clean up the academic environment, so that researchers have full confidence in scientific research and innovation, and bloom everywhere on the road of scientific research.

5. Conclusion

The highest level of higher education is graduate students, whose purpose is to cultivate high-quality innovative talents for socialist construction. Scientific research ability is an important dimension to measure graduate students' level. In the digital age, the cultivation of digital literacy is closely related to the research ability of graduate students. From the perspective of the research on the impact of graduate students' digital literacy on scientific research ability, this paper constructs a structural equation model and finds that digital thinking, digital learning and digital ethics consciousness all have positive effects on graduate students' scientific research ability. It also puts forward some suggestions on adjusting and optimizing the cultivation mode of digital literacy in university libraries, constructing rich and complete courses of digital literacy in universities, and strengthening guidance to form the bottom line of digital ethical consciousness, in an attempt to provide ideas for universities to train scientific research reserve army with digital literacy.

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