Support of Data Literacy for Cultivation of Graduate Students' Innovative Ability: a Study Based on Empirical data

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Abstract: In view of the problems of unclear supporting mechanism of different dimensions of data literacy for the cultivation of graduate students' innovation ability in existing studies, which leads to an untargeted graduate students' data literacy training practice, this paper analyzes the supporting role of data literacy for the cultivation of graduate students' innovation ability based on empirical data. This paper conducts analytical modeling of data literacy from four dimensions: data attitude, data awareness, data knowledge and data skills, and designs a data literacy cultivation questionnaire. Based on the cultivation results of science and engineering graduate students in a university, the Apriori algorithm is used to conduct association analysis on literacy dimension items and innovation ability scores, and extract effective strong association rules with the thresholds of support, confidence and lift set to 0.1, 0.7 and 1 respectively. The results show that the supporting effect of data awareness on the cultivation of innovation ability is significantly higher than that of other dimensions, followed by data skills. Data knowledge and skills have a promoting effect on the enhancement of data awareness, and data awareness also significantly related to the cultivation of data attitude. Therefore, in the practice of graduate training, it is necessary to improve the data literacy cultivation strategy in combination with the training stage and content. To be specific, grasp the key initial stage of the course learning to enhance the data awareness, strengthen the multi-dimensional data literacy cultivation and use the interaction of various dimensions in all stages to promote the comprehensive generation of innovation ability.

Keywords: data literacy; innovation ability; supporting mechanism; graduate training; empirical data

1 Introduction

Postgraduate training is an important work related to the development and progress of the country and society, shouldering the mission of cultivating innovative talents[1]. At present, science and engineering postgraduates are one of the main forces to promote scientific and technological innovation[2-3]. Their innovative ability is defined as the comprehensive ability to play innovative thinking, discover and raise problems and solve problems in the process of scientific research practice or learning, and the ability to put forward or produce original and practical results. Innovation ability is an important goal for the cultivation of science and engineering postgraduates, and the discussion and analysis of its targeted training mode has been

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highly concerned in the field. Data literacy refers to the ability to have data awareness and data sensitivity, to effectively and appropriately acquire, analyze, process, utilize and present data, and to think critically about data. Today, with the rise of data-intensive scientific research, data literacy has become a necessary factor and core competitiveness for researchers to enhance their ability of scientific research and innovation [4-6], which is of great significance and has become a broad consensus for science and engineering postgraduates to find and solve problems innovatively. But at the same time, the existing research on the mechanism of data literacy supporting the cultivation of graduate students' innovative ability is not clear, the importance of graduate students' data literacy is not recognized enough, and the orientation of training practice guidelines is not accurate, which leads to the lack of pertinence of data literacy cultivation under the guidance of innovative ability, data literacy and mathematical knowledge, and even mathematics. The main reason is that the relevant research lacks quantitative theoretical evidence to support, and the relationship between data literacy dimension and graduate students' innovative ability needs to be deepened.

Based on the empirical data, this paper quantitatively analyzes the correlation between the data literacy dimension and the formation of innovation ability in the process of postgraduate cultivation through questionnaire survey[7] and correlation analysis[8], in order to construct a data literacy cultivation path for science and engineering postgraduates oriented to the cultivation of innovation ability, and to provide research ideas and methods with strong generalization for different cultivation objects.

2 Cultivation of Graduate Students' Innovative Ability and Data Literacy

2.1 Innovation ability of postgraduates

The study of innovation capability began in social psychology. Amabile (1988) [9], combined with the study of organizational innovation, proposed that innovation capability is a process in which individuals generate innovative ideas and use their knowledge and capabilities to promote valuable innovative output. With the advancement of field research, the concept of innovation capability has been developing. For example, the core of innovation capability is considered to be the ability to raise innovative problems and solve them, and innovation capability needs representative innovative achievements to prove.

Facing the overall strategy and development plan of national innovative talents training, the Ministry of Education, the National Development and Reform Commission and the Ministry of Finance's Opinions on Accelerating the Reform and Development of Postgraduate Education in the New Era (Teaching and Research [2020]) put forward that "we should adhere to innovation leadership, enhance the sense of mission and responsibility of postgraduates, and comprehensively enhance their knowledge innovation and practical innovation ability." The innovative ability of graduate students is defined as the comprehensive ability of graduate students to exert innovative thinking, discover and raise problems and solve problems in the process of scientific research practice or learning, and is the ability to propose or produce innovative and practical results (Ye et al., 2008; Liao et al., 2011; Zhang et al, 2014) [10-12]. The cultivation of innovation ability has always been the focus of research in the field. For example, Liu et al. (2022) [13]

analyzed the influence mechanism of the combination type of supervisors and stage guidance on the innovation ability of science and engineering doctoral students, and Tu et al. (2022) [14] constructed and practiced the "1 + 6" training mode of science and engineering postgraduates oriented to the cultivation of innovation ability. Generally speaking, the cultivation of graduate students' innovative ability has been widely concerned in the field, and the research mainly focuses on the discussion and analysis of the cultivation mode.

2.2 Data literacy cultivation

Data literacy is proposed in the context of the increasing popularity of computers and networks, the relative relaxation of platform and method constraints, and the increasingly critical role of data as the basic unit of information resources. With the development of information technology, the research on data literacy in foreign countries started earlier than that in China. In 2004, Schield [15] first defined data literacy as "the ability to acquire, manipulate and summarize data from different data sources according to scientific research needs, and to infer conclusions from them". Calzada et al. (2013) [16] further expanded the concept of data literacy, believing that data literacy includes not only the acquisition, understanding, critical evaluation and management of data, but also the ability to comply with the ethics of data use. In the process of cultivating data literacy in foreign universities, some research results have been obtained. In 2015, Dalhousie University in Canada published the Comprehensive Report on Strategies and Best Practice Knowledge of Data Literacy Education [17], which identified the core competence elements of data literacy education and new ways of data literacy education, and proposed phased and differentiated data literacy cultivation strategies. In terms of specific measures, many foreign universities have carried out data literacy courses for graduate students. For example, the University of Minnesota in the United States offers online training in data management for new graduate students. At the same time, Europe and the United States and other countries have already carried out a large number of data literacy research, such as the RDMRose project funded by the Joint Information Systems Committee (JISC) of the United Kingdom [18]. Hao et al. (2016) [4] put forward that data literacy has become an essential factor and core competitiveness to enhance the ability of scientific research and innovation, which can be divided into five basic elements: data attitude, data awareness, data knowledge, data skills and data ethics. The mechanism construction and development strategy of data cultivation are analyzed and discussed.

Generally speaking, with the wider attention paid to the importance of data, the cultivation of graduate students' data literacy has gradually been highly valued by the educational circles at home and abroad, but the research purpose of the cultivation path of data literacy is not strong, and it is often carried out under the default background of general quality cultivation, and most of them are only from the qualitative point of view. There is no internal correlation mechanism between cultivation quality and cultivation path based on quantitative analysis of data.

2.3 Cultivation of data literacy oriented by the cultivation of innovation ability

This paper holds that the innovation of scientific research practice is the core of the training process of science and engineering postgraduates, and its innovation of scientific research practice is highly dependent on data literacy, especially the construction of methods and concepts for discovering and raising problems, which requires the scientific and flexible use of data means and tools under the guidance of data awareness and sensitivity. Effectively and appro-

priately apply data technology methods to "change and innovate" solutions and verify and promote them in engineering practice. Therefore, the cultivation of data literacy of science and engineering postgraduates should mainly serve the formation of their innovative ability, and the related cultivation path research should also be carried out under the guidance of the cultivation of innovative ability.

At present, the research on the cultivation of graduate students' innovative ability and data literacy is often separated. The cultivation of data literacy under the guidance of this kind of research has some problems, such as simplifying the cultivation of literacy into skills training, and the guiding role of scientific research practice is not strong, which can not focus on the core quality of graduate students' innovative ability. Du et al. (2018) [19] studied the model construction of data capability for the overall knowledge innovation capability of scientific research teams through literature research, theoretically demonstrated the role of data capability in promoting scientific research innovation, and believed that it could enhance knowledge innovation capability from five aspects of knowledge discovery, management, integration, sharing and evaluation. Wang (2021) [20] establishes the structural equation model hypothesis from the four dimensions of data awareness, data acquisition, data processing and analysis, and data utilization, measures the dimensions of data ability of college students through questionnaires, and investigates social practice, paper publication, large-scale projects, curriculum design and competition awards. Through fitness test and correction, it is concluded that all dimensions of data capability are positively correlated with knowledge innovation capability, and the interaction between data awareness and data acquisition capability is obvious. This study can achieve quantitative analysis, but the unified questionnaire survey of junior and senior students ignores the differences between majors and the training situation of senior students.

Based on the existing research, we can find that data literacy is a multi-dimensional concept, involving various aspects such as thinking and practical ability, but the supporting role of different dimensions of data literacy for graduate students' innovative ability is not clear in the existing research, and data literacy is only treated as a whole concept. The above problems directly lead to the lack of targeted and operable guidelines for the practice of data literacy cultivation of postgraduates, and the effect of data literacy supporting the cultivation of postgraduates' innovative ability is uneven and inefficient.

Based on this, this paper analyzes the supporting role of data literacy in the cultivation of graduate students' innovative ability based on empirical data, which has significant theoretical innovation and practical value, and quantitatively analyzes the correlation between data literacy dimensions and training content and the formation of innovative ability in the process of graduate students' cultivation. In order to provide research ideas and methods that can be popularized for the cultivation path research of different training objects.

3 Research Methods

3.1 Objects and data collection

Considering the reality of data literacy cultivation of graduate students in different disciplines, this paper takes science and engineering graduate students as the research object, and collects data from January to February 2023 for science and engineering graduate students in a univer-

sity through data statistics and questionnaire survey. Inclusion criteria: 1) Full-time science and engineering postgraduates who have obtained degree certificates and diplomas from 2017 to 2022; 2) Voluntary participation in this study. Exclusion criteria: 1) Extend the planned length of schooling due to tasks, illness, suspension and other reasons during the school period; 2) Participate in joint training, scientific research practice and other programs without completing the whole course of study and research in the school; 3) Change majors and tutors. Within the scope of the above survey objects, a total of 150 samples were randomly selected, and electronic and paper questionnaires were distributed through the internal network, on-site survey and other forms. 139 questionnaires were collected, with a response rate of 92.67%. After eliminating the incomplete and random invalid questionnaires, 135 valid questionnaires were left, and the effective response rate was 90%.

3.2 Evaluation of the innovation ability of postgraduates

In order to evaluate the innovative ability of science and engineering postgraduates, the data statistics of graduates' cultivation effect should closely focus on the relevant achievements that can reflect their innovative ability in scientific research practice. It mainly includes the academic papers published by the first and second authors of graduate students, utility model patents, software copyrights, scientific research and practical innovation projects hosted and participated by graduate students, awards in academic competitions, and the use of professional knowledge to participate in special tasks inside and outside the university to solve practical problems. Based on the comprehensive evaluation criteria for the graduates of the university, the evaluation criteria for the innovation ability of the science and engineering postgraduates of the university are formulated by experts and employers in close connection with the scientific research practice needs of scientific research institutes for the graduates. The evaluation criteria are shown in Table 1.

Table 1. Evaluation Criteria for Innovation Ability of Science and Engineering Postgraduates

Assess the project	Content		Score
Academic papers (The conference papers correspond to the actual disciplines)	SCI (District 1)		10
	SCI (District 2)		7
	SCI (District 3)		5
	SCI (District 4)		4
	EI		3
	Chinese core journals		1.5
	Other publications		0.5
Patent	Authorized invention patent		4
	Utility model patent		2
Works	Monograph		7
	Translation		4
	Computer software works		2
Fund	National Natural Science Foundation		10
	Provincial Natural Science Foundation		8
Scientific research awards	National level	First prize	7
		Second prize	4
		Third prize	2

	Provincial and ministerial level	First prize	5
		Second prize	3
		Third prize	1
Subject competition and scientific and technological innovation activities	National level	First prize	5
		Second prize	4
		Third prize	3
	Provincial and ministerial level	First prize	3
		Second prize	2
		Third prize	1.5
Practical activities inside and outside the school (Related to the field of expertise)	Participate in in-school practice projects	Backbone members	5
		Ordinary participation	3
	Participate in off-campus practical activities	Backbone members	5
		Ordinary participation	3

In this study, the purpose of evaluating the innovation ability of postgraduates is not to analyze the current situation of the cultivation of innovation ability of postgraduates, but to explore the relationship between the generation of innovation ability and the cultivation of data literacy, so it is necessary to carry out follow-up data analysis based on the relative evaluation results of graduates' innovation ability. For this reason, according to the ability score, the innovation ability of graduates is assessed as five relative grades, so that the number of students in each grade is equal. For the convenience of expression, 1-5 is used in the following text to indicate that the innovation ability is evaluated as "poor" to "good". The evaluation criteria of innovation ability are not the focus of this paper, because there are significant differences according to the different evaluation objects, this paper is based on the case analysis of the cultivation data of science and engineering postgraduates in a university, which has certain particularity. Using this relative and qualitative evaluation method to study the path of data literacy cultivation oriented by innovation ability cultivation has the advantage of high accuracy and inclusiveness of innovation ability evaluation, and can adapt to different evaluation objects, so that the research method of this paper has a strong generalization.

3.3 Questionnaire on data literacy cultivation

Based on the research at home and abroad, this paper holds that the data literacy of science and engineering postgraduates is the ability to discover, raise and solve problems by using data means and tools scientifically, flexibly and in accordance with the constraints of legal and moral norms under the guidance of data sensitivity according to the needs of scientific research practice and innovation. As shown in Table 2, it can be analytically modeled from the four dimensions of data attitude, data awareness, data knowledge and data skills [1]. Among them, data attitude mainly refers to the ability to correctly understand the role of data and to standardize and rationally use data, which can be summarized as data values, data ethics and data ethics; Data awareness mainly refers to the ability to find problems through data and solve problems by using data sensitively and consciously. The core includes subjective awareness (subjective initiative to use data to serve people), maintenance awareness (including the ability to actively acquire, update, store and share data resources to make sustainable use of them) and security

awareness; Data knowledge mainly refers to the knowledge reserve for data mining, such as the basic concepts, representation forms, storage formats and transmission rules of data; data skills refer to the practical ability to acquire, store, process, analyze, apply and display data by using various tools and means, such as using programming means to crawl and using artificial intelligence algorithms to analyze data.

Table 2. Dimensions and Connotations of Data Literacy Model for Science and Engineering Graduate Students

Model	Dimension	Connotation of each dimension
Data literacy	Data attitude	Values
		Morality
		Ethics
	Data awareness	Subject consciousness
		Maintenance awareness
		Safety awareness
	Data knowledge	Knowledge Storage of Data Mining
	Data skills	Practical ability to use tools and means

Based on the data literacy model of science and engineering graduate students, this paper designs and develops a questionnaire on the cultivation of data literacy, excavates the potential association rules between the dimensions of data literacy and the level of innovative ability of graduates, and further discusses the construction of the cultivation path of data literacy by analyzing and explaining the causal relationship between the dimensions of literacy and the generation of innovative ability. The questionnaire is a 5-point (1-5) Likert scale, in the form of "XXX (literacy dimension) has been improved during the postgraduate period", and the alternative answers are "very disagree, disagree, general, agree, very agree". For the convenience of expression, 1-5 correspondences are used in the following text to indicate that the degree of improvement of literacy dimension items is from small to large. Among them, the literacy dimensions are the four dimensions of the literacy model.

3.4 Analytical methods and tools

In order to quantitatively analyze the correlation between the data literacy dimension and the cultivation content and the formation of innovative ability in the process of postgraduate cultivation based on the data of the cultivation effect of science and engineering postgraduates in a university in the past five years and the questionnaire survey data, this paper first makes a correlation analysis between the promotion of each dimension of data literacy during the period of postgraduate cultivation and the evaluation of graduates' innovative ability. That is to say, the hidden links between items (scores of each grade) are analyzed, including frequent patterns, causality and correlation. The classic Apriori algorithm is widely used to find association rules between different things [21-22]. An association rule is an implication of the form "$X \rightarrow Y$", where X is called the antecedent and Y is called the consequent. The most basic attributes of association rules include support and confidence. Support reflects the frequency of occurrence of item sets, and the minimum support threshold is used to control the association rules to have statis-

tical significance to a certain extent; confidence reflects the probability of Y occurrence in the case of X occurrence, which can reflect the reliability of association rules. However, in the process of using the classical algorithm, if the support and confidence are too small, it will produce invalid redundant rules, and if they are too large, it will miss effective rules, which can be improved by introducing lift [23-24]. The correlation between X and Y can be reflected by the promotion degree, and the ratio of confidence degree to consequent support is generally used. When the promotion degree is greater than 1, the antecedent and consequent are positively correlated, and the larger the value is, the more it indicates that the association rule has non-accidental importance.

In this paper, WEKI 3.7.3 is used to carry out association analysis. The specific steps are as follows: all association rules composed of literacy dimension items and innovation ability scores are screened with support degree greater than 0.1; The support degree, confidence degree and promotion degree of the qualified rules are calculated, and the effective strong association rules whose confidence degree is higher than 0. 7 and promotion degree is higher than 1 are adopted, and the association rules whose consequent contains innovation ability are explained to further carry out the theoretical analysis of innovation ability cultivation orientation. The setting of the three thresholds refers to the common practices in current research, and makes experimental adjustments to the five-level rating method and specific data in this paper. Then, by analyzing the role of each dimension of data literacy in cultivating the innovative ability of science and engineering postgraduates, this paper further puts forward the improvement measures of data literacy cultivation process and constructs the training path.

4 Results and Discussion

The relationship between the five evaluation results of graduates' innovation ability and the four elements is analyzed. Table 3 lists the effective strong association rules that meet the threshold condition of support and take innovation ability as the consequent, and gives the corresponding confidence and promotion degree, which are arranged in descending order of confidence.

Table 3. Analysis results of effective strong association rules of each dimension of innovation ability and data literacy of postgraduates in a university

Serial number	Rule antecedent	Rule consequent	Support	Confidence level	Lifting degree
1	Data Awareness = 4, Data Skills = 3	Innovation capacity = 4	0.16	0.96	4.78
2	Data Awareness = 5, Data Skills = 5	Innovation capacity = 5	0.13	0.94	4.72
3	Data Awareness = 5, Data Attitude = 4	Innovation capacity = 5	0.16	0.91	4.57
4	Data Awareness = 2, Data Skills = 3	Innovation capacity = 3	0.13	0.90	4.50
5	Data Awareness = 5, Data Knowledge = 5	Innovation capacity = 5	0.12	0.89	4.44

6	Data Awareness = 4	Innovation capacity = 4	0.17	0.88	4.42
7	Data Attitude = 4, Data Skills = 5	Innovation capacity = 5	0.11	0.88	4.41
8	Data Attitude = 4, Data Knowledge = 5	Innovation capacity = 5	0.10	0.88	4.38
9	Data Skills = 5	Innovation capacity = 5	0.14	0.86	4.32
10	Data Awareness = 4	Innovation = 4, Data Skills = 3	0.16	0.85	4.57
11	Data Awareness = 5	Innovation capacity = 5	0.19	0.83	4.17
12	Data Awareness = 1	Innovation capacity = 1	0.13	0.81	4.05
13	Data Awareness = 2, Data Skills = 2	Innovation capacity = 2	0.10	0.78	3.89
14	Data knowledge = 5	Innovation capacity = 5	0.13	0.77	3.86
15	Data Skills = 5	Innovation capability = 5, data awareness = 5	0.13	0.77	4.17
16	Data knowledge = 5	Innovation capability = 5, data awareness = 5	0.12	0.73	3.93
17	Data Skills = 1	Innovation capacity = 1	0.13	0.71	2.40
18	Data Awareness = 5	Innovation ability = 5, data attitude = 4	0.16	0.70	4.11

According to the content and promotion degree of the effective strong association rules, it can be explained that the four dimensions of data literacy are: when the promotion of the dimension item is good, the possibility of higher evaluation of the innovation ability of the trained postgraduates is higher, which shows that the ability of each dimension of data literacy plays an important role in the cultivation of the innovation ability of science and engineering postgraduates. Therefore, it is of great significance to carry out the research on the cultivation path of data literacy of science and engineering postgraduates oriented by the cultivation of innovative ability.

Among them, data awareness, data skills, data knowledge and data attitude appeared in the number of antecedents 11, 8, 4 and 3 respectively. When data awareness is improved well in the current case, the confidence rate of higher innovation capability evaluation level is significantly higher than that in other cases (such as Rule 1-6, and Rule 11 compared with Rule 14), especially when both data awareness and data skills are good. It has a great influence on the cultivation of innovation ability. (Rule 1, Rule 2). It can be explained that the supporting role of data literacy in scientific research practice innovation is mainly reflected in data awareness and data skills. Contrary to this, there is still a phenomenon of unconsciously falling into the technology-only theory in the current postgraduate education of science and engineering. For example, in the course learning stage, teachers often do not attach importance to correctly guiding students to establish good data awareness, but put data knowledge and skills in the central position of teaching. In the research stage, especially in the lower grades of science and engineering postgraduates, because the students' awareness of data subject is still at a weak level, the role of tutors as guides is particularly important, while some tutors do not pay enough attention to the lower grades of postgraduates, and do not strengthen guidance in the stage of "finding problems" for postgraduates. It is easy to lead to incomplete investigation and in-depth understanding of the research direction of related topics, which further leads to the phenomenon that

the research does not meet the application needs and does not conform to the actual application. But at the same time, the study found that the supporting role of data skills can be ranked second after data awareness, which also fully shows that the emphasis on data skills in the process of cultivating master students is scientific. As the main ability element of practice, data skills can directly affect the output of scientific research practice, and are also very important for the generation of master's innovation ability (Rule 15, Rule 17). In addition, from the perspective of Rule 15 and Rule 16, data knowledge and skills also play an important role in promoting students to form good data awareness, and data awareness is also closely related to the establishment of good data attitude (Rule 18). Therefore, the cultivation of the four dimensions of data literacy is a mutual blending relationship, which can not be treated separately.

The results indicate that data literacy is a multidimensional concept, and there are differences in the supporting effects of data awareness, data skills, data knowledge, and data attitude on the cultivation of graduate students' innovation ability. The supporting effect of data awareness on the cultivation of innovation ability is significantly higher than other dimensions, followed by data skills; Data knowledge and skills have a promoting effect on data awareness, and data awareness is significantly related to the cultivation of data attitudes. Compared to existing research, our study presents the supporting role of data literacy in cultivating graduate students' innovation ability through quantitative research methods, which are evidences for graduate education.

5 Conclusions

The training of science and engineering postgraduates is usually divided into course learning stage and subject research stage. This paper argues that the cultivation of data literacy of science and engineering postgraduates oriented by innovative ability training should be combined with the specific training stages and contents of postgraduates, and the improvement strategies of data literacy cultivation in each stage should be put forward around the four dimensions of data attitude, data awareness, data knowledge and data skills.

Data awareness cultivation into the classroom and group meetings. Based on the above data analysis, the importance of data awareness needs to be highly concerned. The course learning stage is the key initial stage for science and engineering postgraduates to cultivate data literacy, which requires teachers, especially teachers of applied courses, to first enhance their personal understanding, abandon the idea of technology-only theory, and change from task-oriented knowledge teaching to innovative ability-oriented course teaching. Specifically, it is necessary to mobilize and cultivate the subjective initiative of students to use data for scientific research practice, and combine the core knowledge and skills of the course to teach, interspersed with the education of maintenance awareness and safety awareness. In the research stage, the research team in charge of the tutor is required to provide a good environment for cultivating data awareness for postgraduates of science and engineering, and to strengthen guidance and help for junior students through academic exchanges and discussions in the form of group meetings, so that postgraduates of science and engineering can realize the transformation from undergraduate thinking to postgraduates' thinking as soon as possible, and learn to base themselves on data. Avoid the phenomenon of detours caused by the laissez-faire training mode.

Multi-dimensional cultivation promotes the comprehensive generation of innovation capability. According to the results of association analysis, each dimension of data literacy has a positive correlation with the generation of innovation capability, and each dimension has a mutually reinforcing effect. This requires that the cultivation of data attitude, data awareness, data knowledge and data skills should not be simply separated in the training process of science and engineering postgraduates, and such problems occur in both the course learning stage and the subject research stage. For example, the ideological and political courses for postgraduates of science and engineering are expected to achieve good scientific research values, morality and ethics from the beginning of personnel training, but as a large course that does not distinguish between majors, it is difficult to link up with specific scientific research practice, resulting in a gap between data attitude training and other dimensions of training. Mathematics courses play an important role in laying a theoretical foundation for science and engineering research, but there is also a fragmentation centered on data knowledge. In view of this kind of problem, we can carry out small-class and more personalized teaching in different professional fields, or we can adopt the method of case teaching and discussion to cultivate students' data literacy in different disciplines, so as to make data attitude education more vivid and pleasant, and integrate data knowledge education into practical application. The cultivation of science and engineering postgraduates depends on the tutor's guidance in the whole stage, so the tutor's personal style has a significant impact on the cultivation of students' innovative ability. This puts forward higher requirements for the personal quality of tutors, which needs to strengthen students' data awareness and attitude from the macro level in the process of guidance, and can not be laissez-faire to students in specific research practice, and needs to be properly checked and guided in key technologies, so as to achieve the overall quality improvement of students. In terms of specific measures, we should actively advocate the establishment of scientific research teams by tutors, and strengthen academic guidance and guidance by holding academic seminars and jointly participating in research and project work. In addition, schools and colleges should also provide a wide range of digital information resources platform for postgraduates, and strongly support tutors and students to participate in academic exchanges, seminars and scientific research practice activities outside the school, so as to provide learning and exercise opportunities for improving data literacy.

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References

[1] Lindsay R, Breen R, Jenkins A. Academic research and teaching quality: The views of undergraduate and postgraduate students. Studies in Higher Education, 2002, 27(3): 309-327. https://doi.org/10.1080/03075070220000699.

[2] Wu N, Liu Z K. Higher education development, technological innovation and industrial structure upgrade. Technological Forecasting and Social Change, 2021, 162: 120400. https://doi.org/10.1016/j.techfore.2020.120400.

[3] Xiao H, Mao J. Effects of postgraduate education on technological innovation: a study based on the spatial Durbin model. Asia Pacific Education Review, 2021, 22: 89-99.

[4] Hao yuanling, Shen Tingting. Data literacy and its cultivation mechanism construction and strategic thinking. Intelligence Theory and Practice, 2016, 39 (1): 58-63. DOI:10.16353/j.cnki.1000-7490.2016.01.010.
[5] Poce A. Information and data literacy skills development in creative industries adult education: the digiculture project. Pedagogia Oggi, 2019, 17(2): 184-201.
[6] Leon-Urrutia M, Taibi D, Pospelova V, et al. Data literacy: an essential skill for the industry//Proceedings on 18th International Conference on Industrial Systems–IS'20: Industrial Innovation in Digital Age. Cham: Springer International Publishing, 2022: 326-331.
[7] Boparai J K, Singh S, Kathuria P. How to design and validate a questionnaire: a guide[J]. Current clinical pharmacology, 2018, 13(4): 210-215.
[8] Senthilnathan S. Usefulness of correlation analysis[J]. Available at SSRN 3416918, 2019. https://dx.doi.org/10.2139/ssrn.3416918.
[9] AMABILE TM. A model of creativity and innovation in organizations. Research in Organizational Behavior,1988, 10(1):123-167.
[10] Ye Haizhi, Ding Nan. Tactics of cultivating postgraduates' innovative ability based on tacit knowledge theory. China Higher Education Research, 2008 (1): 25-26. DOI:10.16298/j.cnki.1004-3667.2008.01.005.
[11] Liao Heping, Gao Wenhua, Wang Kexi. Examination and reflection on the cultivation of innovative ability of postgraduates in colleges and universities. Academic Degrees and Graduate Education, 2011 (9): 33-37. DOI:10.16750/j.adge.2011.09.009.
[12] Zhang Yanbing, Liu Hefu, Gu Jibao. Research on the influence of graduate students' initiative and social capital on the cultivation of innovation ability. Academic Degree and Graduate Education, 2014 (5): 47-52. DOI:10.16750/j.adge.2014.05.014.
[13] Liu Ji'an, Qi Jia, Sun Chiyao, et al. Tutorial combination type, staged guidance and the development of innovation ability of science and engineering doctoral students. Academic Degrees and Graduate Education, 2022 (7): 63-70. DOI:10.16750/j.adge.2022.07.010.
[14] Tu Zongcai, Xiao Ziliang, Wang Hui, et al. Construction and practice of "1 + 6" training mode for science and engineering postgraduates oriented by cultivating innovative ability. Academic Degrees and Graduate Education, 2022 (3): 40-44. DOI:10.16750/j.adge.2022.03.006.
[15]Schield M. Information literacy statistical literacy and data literacy. Iassist Quarterly, 2004, 28(2): 7-14.
[16] Prado J C, Marzal M. Á incorporating data literacy into information literacy programs: Core competencies and contents. Libri, 2013, 63(2):123-134. https://doi.org/10.1515/libri-2013-0010
[17] Chen yuanyuan, Wang yuanying. Practice and enlightenment of data literacy education in Canada: Taking dalhousie university as an example. Intelligence Theory and Practice, 2019 (6): 166-171.
[18] Cox A M, Verbaan E,Sen B. A spider, an octopus, or an animal just coming into existence? Designing a curriculum for librarians to support research data management. Journal of eScience librarianship,2014,3(1):15-30. https://doi.org/10.7191/jeslib.2014.1055.
[19] Du Xingye, Li He, Li Zhuozhuo. Research on data capability model of scientific research team for knowledge innovation. Library and Information Work, 2018, 62 (04): 28-36. DOI:10.13266/j.issn.0252-3116.2018.04.004.
[20] Wang Jiping. Research on the construction of college students' data capability model for knowledge innovation. Industry and Technology Forum, 2021, 20 (21): 49-51.
[21] Xie Jialiang, Chen Yanling, Zhu Rongkun, et al. Linear algebra test paper analysis based on improved apriori algorithm. Journal of Changchun Normal University, 2022, 41 (12): 48-54.

[22] Zhang Fenfen, Xu Xinhua. Application of apriori algorithm in university course data mining. Information. Technology and Informatization, 2020 (11): 179-182.
[23] Xu S. An Apriori Algorithm to Improve Teaching Effectiveness[J]. International Journal of Performability Engineering, 2020, 16(5).
[24] Chen Weiyu and JiaNan, "Teaching analysis based on association rule mining," IEEE Conference Anthology, China, 2013, pp. 1-3, doi: 10.1109/ANTHOLOGY.2013.6784997.