Research on the Cognitive Degree of Pre-service High School Mathematics Teachers on the Implementation for Data Analysis Literacy

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Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

Original Research Article

ABSTRACT

Currently, data analysis literacy has attracted more and more attention from all walks of life. Many relevant problems about it have been studied except the cognitive degree of pre-service high school mathematics teachers on the implementation for data analysis literacy. In order to better implement the data analysis literacy in the process of middle school education, this study investigates the understanding of pre-service high school mathematics teachers on the implementation of data analysis literacy. This research design adopts the combination of quantitative and qualitative methods. 51 pre-service high school mathematics teachers from a university are selected through cluster sampling. Their cognition of implementing data analysis literacy is investigated through interview, and then the data are classified and coded by list method. It is found that: 1. The scope of cognition of the current pre-service high school mathematics teachers on the implementing for data analysis literacy is not wide, and more than half of the content on the implementing for data analysis literacy previously proposed has not been realized by many pre-service teachers yet; 2. The understanding focuses on that students should experience the whole process of data analysis; 3. The cognition of many pre-service teachers is not reasonable and lacks feasibility or effectiveness, which needs to be further explored and thought. Therefore, it is suggested that: 1. Experts and teachers responsible for training work should provide more teaching practice opportunities for pre-service teachers; 2. Pre-service

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teachers should pay attention to observing students' learning status in the process of practice, reflect on whether their cultivation strategies are reasonable, and then make further adjustments according to the actual situation of the school and classroom.

Keywords: High school; mathematics; pre-service teacher; data analysis; literacy.

1. INTRODUCTION

Data analysis refers to the acquisition of data from the research object, the use of mathematical methods to sort, analyze and infer the data, and form the literacy of the knowledge about the research object. The development of multimedia and network technology not only brings us convenience, but also requires us to have a certain ability to screen information and analyze data. It is very necessary to cultivate students' data analysis consciousness and data processing ability in middle school mathematics education. Therefore, teachers should put the cultivation of students' data analysis literacy in an important position. However, through questionnaires, interviews and other methods, predecessors investigated the data analysis literacy of senior high school students in different regions and grades, and found that the current data analysis literacy of senior high school students is generally not high. Is it possible that teachers do not have a comprehensive understanding of how to implement data analysis literacy? There is no research on this issue, so in order to better implement data analysis literacy at the secondary level, this study investigates pre-service high school mathematics teachers' awareness of implementing data analysis literacy. This study intends to investigate two dimensions of teaching in general and specific teaching, and use the interview method to understand the awareness of pre-service high school mathematics teachers, mainly to find out the scope of their awareness, the focus of their awareness and the rationality of their awareness. Based on the results of the study, the author proposes recommendations for use by the two types of subjects, experts and teachers responsible for the development work and the pre-service teacher groups.

2. LITERATURE REVIEW

There have been many studies on the data analysis literacy of senior high school students.

2.1 Cognitive Status of Data Analysis Literacy of Senior High School Students

He studied the second-year students of a high school in Jiangsu Province from three dimensions of obtaining data, processing data and interpreting data. He found that most students' score levels in these three dimensions correspond to high, average and low respectively. At the same time, he found that most students still have some problems in interpreting the data [1]. Cai divided the data analysis literacy into four dimensions, and he investigated the third-year students of a high school in Hubei Province. It was found that 46% of the students reached Level 0, 39% of the students reached Level 1, only 15% of the students reached Level 2, and no one reached Level 3 [2]. Liu concluded through questionnaire survey and conversation survey that senior high school students have strong ability to collect and use data, and weak ability to sort and analyze data [3]. By analyzing the questionnaire and test paper, Hu found that the data analysis literacy of senior high school students is generally not high, only reaching the level of multiple structure and being able to do mechanical calculation, but they didn't realize the importance of data analysis and didn't know what content to include [4]. In the survey of data analysis literacy of senior high school students in Qingdao, Sun found that their average level is about Level 2, that is, students can make relevant questions, but they can't apply them to real life [5]. Zhao interviewed 196 high school students in Henan Province. The overall level of data analysis literacy of the interviewed high school students was low, only 30.6% [6]. By testing the explicit data ability, Zhang found that high school students' ability to obtain, process and interpret data is not high [7].

2.2 Influencing Factors of Data Analysis Literacy of Senior High School Students

Shen et al. analyzed and summarized that teachers' professional literacy has a significant impact on cultivating students' data awareness.

In order to improve students' data literacy, teachers must have high data professional literacy, so the key is to improve teachers' data literacy [8]. Jiang found that some teachers lack professional knowledge related to data analysis and ignore the mining and training of students' data analysis ability, resulting in students' fear of data analysis [9]. Wu et al. analyzed that there are problems in the development of students' data analysis literacy due to teachers' lack of understanding in probability and statistics teaching [10]. Zhang, et al. found that students' performance in collecting and searching data is not satisfactory. One of the important reasons is that teachers do not pay enough attention to how to collect and find data in a problem and how to extract useful information [11].

2.3 Cultivation Strategy of Data Analysis Literacy of Senior High School Students

Yu studied the cultivation of mathematics core literacy from the perspective of knowledge classification. He believed that to implement data analysis literacy, students need to develop their ability to read, summarize and analyze problems. Therefore, he put forward that students should strengthen reading training, improve quantitative thinking and provide exploration situations for them in the teaching process [12]. Wu et al. proposed that teachers should first grasp the teaching objectives of statistics as a whole, and the teaching method is mainly case teaching. Secondly, teachers should teach students different data analysis methods and let students experience complete statistical investigation activities [13]. Zhang, et al. proposed that in order to develop students' core mathematical literacy and realize the modernization, internationalization and big data of probability and statistics teaching, teachers must change their educational concepts, practice their basic teaching skills, and unremittingly carry out the reform and innovation in mathematics education and teaching [14]. Cheng et al. proposed that in the process of problem solving, teachers should cultivate students' data analysis literacy and teach students to look at local statistical methods from the whole of statistics; In the process of teaching, teachers should pay attention to the connection between junior and senior high school contents and make rational use of information technology [15]. Wu et al. give experience enlightenment from four dimensions: pay attention to situation setting in problem introduction, case teaching in the process of new knowledge learning, solve real-life problems in application, and pay attention to diversified evaluation in the evaluation system [10]. Qiu believes that first of all, teachers should create a good learning atmosphere for students and stimulate students' thirst for knowledge and interest in learning in teaching methods. Secondly, teachers should improve students' practical ability and strengthen their sensitivity to data [16].

2.4 Evaluation Method of Data Analysis Literacy of Senior High School Students

Yu believes that the evaluation of students' mathematics core literacy should be based on three forms of knowledge learning, namely knowledge understanding, knowledge transfer and knowledge innovation. Based on this, he constructs an evaluation framework with three forms corresponding to three levels [17]. Li analyzed the current situation of data analysis literacy. Based on the curriculum standard and PISA evaluation theory, she took the content, process, situation and emotional attitude values as the four dimensions of data analysis literacy evaluation. Based on SOLO classification theory, she formulated the content dimension level division standard. Therefore, a data analysis literacy evaluation system for senior high school students is established [18].

It can be seen from the above studies that predecessors have conducted various studies on senior high school students' data analysis literacy, and some studies have been relatively rich, such as the research on training strategies, scholars have given a variety of programs. However, it is also clear from this that there are some areas that have not been addressed, such as the lack of in-depth research on the understanding of pre-service high school mathematics teachers on the implementation of data analysis literacy, and it would undoubtedly be meaningful to research this aspect. It is clear from previous studies that pre-service teachers in the previous education model learn from some previous experiences, but educational theories need to be constantly supplemented and improved, and pre-service teachers need to summarize the laws and experiences by themselves. So do they know how to implement data analysis literacy? Are their teaching suggestions practical? Therefore, this paper intends to study the pre-service high

school mathematics teachers' understanding of the implementation of data analysis literacy from two dimensions, mainly to find out their understanding of the implementation of data analysis literacy in general teaching and specific teaching.

The degree of cognition generally includes the scope of cognition, the focus of cognition, and the rationality of cognition. Cognitive scope indicates the points that pre-service high school mathematics teachers can recognize with respect to the teaching suggestions made by their predecessors; cognitive focus indicates which points most pre-service high school mathematics teachers can recognize; and cognitive rationality indicates whether the teaching suggestions made by pre-service high school mathematics teachers are feasible and effective.

Therefore, the main problems studied in this paper are:

1. How widespread is the current awareness of pre-service high school mathematics teachers regarding the implementation of data analysis literacy?
2. In what areas do current pre-service high school mathematics teachers' awareness of implementing data analysis literacy focus?
3. Is the current awareness of pre-service high school mathematics teachers about implementing data analysis literacy reasonable?

Several studies have been conducted to show that the current level of data analysis literacy among high school students is not high, and that teachers' awareness of implementing data analysis literacy is an important factor affecting students' data analysis literacy. Thus, the hypotheses of this study are:

Hypothesis 1: Current pre-service high school mathematics teachers do not have a broad awareness of data analysis literacy;

Hypothesis 2: Current pre-service high school mathematics teachers' perceptions of data analysis literacy focus on how students do it;

Hypothesis 3: Current pre-service high school mathematics teachers' perceptions of data analysis literacy are not very reasonable.

3. METHODS

3.1 Design

This study uses a combination of quantitative and qualitative methods to investigate pre-service high school mathematics teachers' awareness of implementing data analysis literacy, mainly to figure out the scope of their awareness, the focus of their awareness, and the rationality of their awareness.

3.2 Sample

In order to investigate the pre-service high school mathematics teachers' understanding of the implementation of data analysis literacy, this study selects 51 students with 2021 master of education from the school of mathematics and statistics of Shandong Normal University for research. The method of cluster sampling is used for investigation, which saves time and is easy to organize. However, there is a gap between clusters, and the error caused by cluster sampling is often greater than that caused by simple random sampling. The 51 masters of education are all located in Jinan. Their ages are between 21 and 26, of which 94.12% are girls and 5.88% are boys. The reason why they are selected as the research object is that they have high school teacher qualification certificate and have obvious intention to teach in high school.

3.3 Instrument

This study adopts the method of interview. Through open-ended interview, the author investigates the master of education's cognition of implementing data analysis literacy, and records the whole process with a recording pen. According to the research objectives and the suggestions of experts, two interview questions are set: 1 How do you think data analysis literacy should be implemented in middle school? 2. How do you think to implement data analysis literacy in class? The reason why these two questions are used as the interview content is to investigate whether they know how to implement data analysis literacy in senior high school and whether their understanding is reasonable. At the same time, data collection with the help of interview method can obtain direct and reliable information, which is not limited by written language and is easy to conduct in-depth investigation.

3.4 Data Collection

In this study, 51 masters of education are interviewed one by one through open-ended interview, and the interview content is recorded after soliciting the consent of them.

3.5 Data Processing

The collected recordings are converted into text and sorted out. In the process of sorting out, in order to retain the original intention of the respondents, no change is made, only modal particles such as uh ah are removed. With the help of list method, the data are classified according to two dimensions and three implementation subjects, and then the cognition of master of education is comprehensively processed and counted by coding method.

4. RESULTS

4.1 Cognitive Scope

The statements of master of education are summarized as 37 points. There are 20 points on how to implement them in middle school and 17 points on how to implement them in class. This study arranges the training strategies of data analysis literacy put forward by predecessors, and a total of 56 points are sorted out. See Table 1 for details.

Pre-service teachers can recognize 17 points, accounting for 30.36%. Among the training strategies proposed by predecessors, 36 points relate to how to implement them in middle school, pre-service teachers can recognize 10 points, accounting for 27.78%, and 20 points relate to how to implement them in class, pre-service teachers can recognize 7 points, accounting for 35.00%.

In the dimension of "how to implement it in middle school", there are 6 implementation strategies for schools. They recognize 0 of them, accounting for 0.00%; There are 18 implementation strategies for teachers, and they recognize 6 of them, accounting for 33.33%; There are 12 implementation strategies for students, and they recognize 4 of them, accounting for 33.33%.

In the dimension of "how to implement it in class", there are 15 implementation strategies for teachers, and they recognize 5 of them, accounting for 33.3%; There are 5

implementation strategies for students. They recognize 2 of them, accounting for 40.00%.

It can be seen that pre-service high school mathematics teachers do not have a wide range of understanding of the implementation of data analysis literacy, and they have not realized more than half of the training strategies put forward by predecessors. Whether from the two dimensions or from the implementation subject of each dimension, their understanding has not reached half, and when the implementation subject is the school, although they put forward their own opinions, the training strategies put forward by predecessors do not involve relevant contents, and the feasibility needs to be further explored. See Table 2 for details.

4.2 Cognitive Focus

In the dimension of "how to implement it in middle school", their understanding mainly focuses on "students should experience the whole process of data analysis", accounting for 47.06% of the total number. For the point that "students should observe problems in real life and collect real data", the number of people recognized accounts for 21.57% of the total number. Relatively speaking, these two points are the two points with a large number of people in this dimension. The implementation subjects are students, and the number of people who recognize these two points accounts for 68.63% of the total number. It can be seen that pre-service teachers can recognize that students are the main body of learning, if they want to better implement data analysis literacy, students must give full play to their autonomy and initiative. At the same time, they can realize that data analysis should be connected with practice. Only by experiencing the whole process can students better master relevant knowledge, deepen their understanding of data analysis and realize the importance of data analysis.

In the dimension of "how to implement it in class", their understanding mainly focuses on "teachers should explain the role of mean, median, mode variance and so on in data analysis". The number of people recognized accounts for 27.45% of the total number. For the point that "teachers should create a situation conducive to students' data analysis", the number of people recognized accounts for 23.53% of the total number. The implementation subjects of these two points are teachers, and the number of people who recognize these two points accounts

Table 1. Coding of training strategies proposed by predecessors

Primary index	Secondary index	Symbol	Viewpoint
How to implement it in middle school	A School	A1	Increase investment in education and provide perfect hardware and software facilities for the implementation of students' data analysis literacy as far as possible
		A2	Actively develop and utilize social education resources and implement data analysis literacy
		A3	Carry out inter school exchanges
		A4	Provide opportunities for statistical practice activities and promote the implementation of students' data analysis literacy
		A5	Provide opportunities for teachers to exchange and learn
		A6	Reduce the burden on students appropriately
	B Teacher	B1	Strengthen the research and interpretation of the new curriculum standard
		B2	Actively participate in the new curriculum reform, strive to improve theoretical research level, and explore and practice the new teaching mode
		B3	Improve the awareness of data analysis and pay more attention to data analysis literacy
		B4	Promote the integration of data literacy education and disciplines
		B5	Make full use of mathematical modeling activities and strengthen the connection with other literacy
		B6	Pay attention to the connection between junior high school and senior high school
		B7	Constructing hierarchical data literacy teaching system
		B8	Innovate data literacy teaching model
		B9	Develop data literacy evaluation tools
		B10	Teach students to look at local statistical methods from the whole of statistics
		B11	Cultivate students' data analysis literacy in the process of problem solving
		B12	Infiltrate the cultivation of data analysis literacy into daily teaching
		B13	Pay attention to the teaching of probability and statistics module and give full play to the training value of the advantageous content of the textbook
		B14	Pay attention to the formation process of students' data processing ability
		B15	Pay attention to the cultivation of students' data processing ability
		B16	Pay attention to the differences between students
		B17	Let students go through the whole process of data analysis
		B18	Create statistical practice activities
	C Student	C1	Raise awareness and perception of data
		C2	Learn to look at problems with statistical thinking
		C3	Experience the thought and method of Statistics

		C4	Strengthen the study of statistical concepts
		C5	Go through the whole process of data analysis
		C6	Actively participate in practical activities
		C7	Avoid blindly brushing questions and pay attention to the summary of ideas and methods
		C8	Strengthen the selection and application of methods
		C9	Deepen the understanding of randomness
		C10	Cultivate good learning attitude
		C11	Strengthen reading training
		C12	Improve quantitative thinking
How to implement it in class	**D** **Teacher**	D1	Pay equal attention to diversity in pre class teaching design
		D2	Closely follow the teaching materials and learning conditions, and establish the teaching objectives conducive to students' development
		D3	Grasp the teaching objectives of statistics as a whole, and take case teaching as the main teaching method
		D4	Explore appropriate and appropriate life topics and create reasonable problem situations
		D5	Avoid lengthy and complicated operation process and pay attention to the understanding of the concept of probability and statistics
		D6	Strengthen the understanding of concepts and emphasize the essence of knowledge
		D7	Adopt spiral, diversified and dialogue teaching implementation approaches
		D8	Teach students different data analysis methods
		D9	Select appropriate examples and strengthen the guidance of problem situations
		D10	Expand and improve, and give full play to the promotion function of after-school exercises
		D11	Reasonably arrange the blank time in class
		D12	Using information technology to assist teaching
		D13	Stimulate students' thirst for knowledge and interest in learning
		D14	Create a good learning atmosphere
		D15	Correct evaluation after class
	E **Student**	E1	Actively integrate into classroom teaching activities
		E2	Tabulate the problems with scattered data information
		E3	Use images to represent and analyze the problem of clear correspondence between data information
		E4	Simplify data information with many characters by mathematical symbols
		E5	Transform and classify the data information in unfamiliar fields with familiar knowledge and mathematical models

Table 2. Cognitive scope

Primary index	Points	Total Points	Secondary index	Points	Total Points
How to implement it in middle school	10	36	**A School**	0	6
			B Teacher	6	18
			C Student	4	12
How to implement it in class	7	20	**D Teacher**	5	15
			E Student	2	5

Table 3. Pre-service high school mathematics teachers' understanding of training strategies

Primary index	Secondary index	Symbol	Viewpoint	Percentage (%)
How to implement it in middle school	**F School**	F1	Strengthen the design of relevant contents of data analysis	3.92
		F2	Set up courses related to data analysis software	7.84
		F3	Hold statistical analysis competitions and encourage all staff to participate	1.96
	G Teacher	G1	Be aware of data analysis and realize the importance of data analysis literacy	13.73
		G2	Provide lectures and training on data analysis topics	3.92
		G3	Build an evaluation index system related to data analysis literacy	3.92
		G4	Implement with the help of the course of probability and statistics	15.69
		G5	Cultivate students' awareness of data analysis	17.65
		G6	Cultivate students' Dialectical Thinking	3.92
		G7	Guide students to establish models and databases and solve problems of data analysis	3.92
		G8	Cultivate students' data analysis literacy in the process of problem solving	5.88
		G9	Set up comprehensive practical activities to encourage students to participate after class	13.73
	H Student	H1	Observe and find problems in real life and collect real data	21.57
		H2	The sources of explicit data are multiple and can be obtained in different forms	1.96
		H3	Enhance data sensitivity	3.92
		H4	Get interested data through the Internet	3.92
		H5	Extract useful information from numerous data	3.92
		H6	Strengthen the reading of books related to data analysis	1.96
		H7	Experience the whole process of data analysis	47.06
		H8	Take the initiative to participate in practical activities	7.84

Primary index	Secondary index	Symbol	Viewpoint	Percentage (%)
How to implement it in class	**I Teacher**	I1	Choose appropriate teaching methods and strategies	1.96
		I2	Infiltrate the idea of data analysis	7.84
		I3	Create contexts that facilitate students' data analysis	23.53
		I4	Implement data analysis literacy from three aspects: teaching objectives, teaching process and teaching evaluation	3.92
		I5	Stimulate students' interest in learning	7.84
		I6	Provide students with questions related to data, let students extract information and analyze the role of information	9.80
		I7	Teach students the complete process of data analysis	1.96
		I8	Teach students a variety of methods of data analysis	7.84
		I9	Data description in combination with practical problems	5.88
		I10	Explain the role of mean, median, mode variance in data analysis	27.45
		I11	Evaluate the data collected by students to make students know the effectiveness of the data	1.96
		I12	Grasp the relationship between in-class content and data analysis literacy	1.96
		I13	Pay attention to the assignments related to data collection	1.96
		I14	Rational use of information technology	11.76
	J Student	J1	Organize and analyze the data with graphs	9.80
		J2	Organize and analyze the data with tables	1.96
		J3	Work in groups to exchange the process and results of data analysis	15.69

Table 4. Cognitive rationality

Primary index	Secondary index	Symbol	Viewpoint	Percentage (%)
How to implement it in middle school	**A School**	A1	Increase investment in education and provide perfect hardware and software facilities for the implementation of students' data analysis literacy as far as possible	0.00
		A2	Actively develop and utilize social education resources and implement data analysis literacy	0.00
		A3	Carry out inter school exchanges	0.00
		A4	Provide opportunities for statistical practice activities and promote the implementation of students' data analysis literacy	0.00
		A5	Provide opportunities for teachers to exchange and learn	0.00
		A6	Reduce the burden on students appropriately	0.00
	B	B1	Strengthen the research and interpretation of the new curriculum standard	0.00

Primary index	Secondary index	Symbol	Viewpoint	Percentage (%)
	Teacher	B2	Actively participate in the new curriculum reform, strive to improve theoretical research level, and explore and practice the new teaching mode	0.00
		B3	Improve the awareness of data analysis and pay more attention to data analysis literacy	13.73
		B4	Promote the integration of data literacy education and disciplines	0.00
		B5	Make full use of mathematical modeling activities and strengthen the connection with other literacy	3.92
		B6	Pay attention to the connection between junior high school and senior high school	0.00
		B7	Constructing hierarchical data literacy teaching system	0.00
		B8	Innovate data literacy teaching model	0.00
		B9	Develop data literacy evaluation tools	3.92
		B10	Teach students to look at local statistical methods from the whole of statistics	0.00
		B11	Cultivate students' data analysis literacy in the process of problem solving	5.88
		B12	Infiltrate the cultivation of data analysis literacy into daily teaching	0.00
		B13	Pay attention to the teaching of probability and statistics module and give full play to the training value of the advantageous content of the textbook	15.69
		B14	Pay attention to the formation process of students' data processing ability	0.00
		B15	Pay attention to the cultivation of students' data processing ability	0.00
		B16	Pay attention to the differences between students	0.00
		B17	Let students go through the whole process of data analysis	0.00
		B18	Create statistical practice activities	13.73
	C	C1	Raise awareness and perception of data	3.92
	Student	C2	Learn to look at problems with statistical thinking	0.00
		C3	Experience the thought and method of Statistics	0.00
		C4	Strengthen the study of statistical concepts	0.00
		C5	Go through the whole process of data analysis	47.06
		C6	Actively participate in practical activities	7.84
		C7	Avoid blindly brushing questions and pay attention to the summary of ideas and methods	0.00
		C8	Strengthen the selection and application of methods	0.00
		C9	Deepen the understanding of randomness	0.00
		C10	Cultivate good learning attitude	0.00
		C11	Strengthen reading training	1.96
		C12	Improve quantitative thinking	0.00

Primary index	Secondary index	Symbol	Viewpoint	Percentage (%)
How to implement it in class	**D Teacher**	D1	Pay equal attention to diversity in pre class teaching design	0.00
		D2	Closely follow the teaching materials and learning conditions, and establish the teaching objectives conducive to students' development	0.00
		D3	Grasp the teaching objectives of statistics as a whole, and take case teaching as the main teaching method	0.00
		D4	Explore appropriate and appropriate life topics and create reasonable problem situations	23.53
		D5	Avoid lengthy and complicated operation process and pay attention to the understanding of the concept of probability and statistics	0.00
		D6	Strengthen the understanding of concepts and emphasize the essence of knowledge	0.00
		D7	Adopt spiral, diversified and dialogue teaching implementation approaches	0.00
		D8	Teach students different data analysis methods	7.84
		D9	Select appropriate examples and strengthen the guidance of problem situations	0.00
		D10	Expand and improve, and give full play to the promotion function of after-school exercises	0.00
		D11	Reasonably arrange the blank time in class	0.00
		D12	Using information technology to assist teaching	11.76
		D13	Stimulate students' thirst for knowledge and interest in learning	7.84
		D14	Create a good learning atmosphere	0.00
		D15	Correct evaluation after class	1.96
	E Student	E1	Actively integrate into classroom teaching activities	0.00
		E2	Tabulate the problems with scattered data information	1.96
		E3	Use images to represent and analyze the problem of clear correspondence between data information	9.80
		E4	Simplify data information with many characters by mathematical symbols	0.00
		E5	Transform and classify the data information in unfamiliar fields with familiar knowledge and mathematical models	0.00

for 50.98% of the total number. It can be seen that some pre-service high school mathematics teachers can think of these aspects when analyzing data. At the same time, they can also realize that teachers are guides and should create more opportunities for students to analyze data. See Table 3 for details.

4.3 Cognitive Rationality

The statements of master of education are summarized as 37 points, of which 17 points are similar to the previous suggestions, accounting for 45.95%. In the dimension of "how to implement in middle school", their expression is summarized as 20 points, of which 10 points are similar to the previous suggestions, accounting for 50.00%; In the dimension of "how to implement in class", their expression is summarized as 17 points, of which 7 points are similar to the previous suggestions, accounting for 41.18%.

In terms of specific contents, they have focused on the two points that "students should experience the whole process of data analysis" and "teachers should create a situation conducive to students' data analysis", which are similar to the previous teaching suggestions. However, "students should observe real-life problems and collect real data" and "teachers should explain the role of mean, median, mode variance and so on in data analysis". Although a large number of people have recognized, relevant contents have not been mentioned in previous teaching suggestions.

It can be seen that the pre-service high school mathematics teachers' understanding of the implementation of data analysis literacy is not very reasonable. Although they can put forward some suggestions according to the learned professional knowledge and existing professional skills, the suggestions are still one-sided, and some views lack feasibility or effectiveness, which needs to be further explored and considered. See Table 4 for details.

5. DISCUSSION

5.1 Cognitive Scope

From the above statistics, it can be seen that the current pre-service high school mathematics teachers' understanding of the implementation of data analysis literacy is not wide, and they have

not realized more than half of the training strategies put forward by predecessors. Whether from the two dimensions or from the implementation subject of each dimension, their understanding has not reached half, and when the implementation subject is the school, although they put forward their own opinions, the training strategies put forward by predecessors do not involve relevant contents, and the feasibility needs to be further explored. It can be seen that the current pre-service high school mathematics teachers' cognition of implementing data analysis literacy is not comprehensive. This is also consistent with some previous research results. Wu et al. and others analyzed that there are problems in the development of students' data analysis literacy due to teachers' insufficient understanding of data analysis in probability and statistics teaching [10]. Therefore, hypothesis 1 is confirmed.

5.2 Cognitive Focus

From the above statistics, it can be seen that the current pre-service high school mathematics teachers' awareness of implementing data analysis literacy mainly focuses on "students should experience the whole process of data analysis", and they can realize that students are the main body of learning, and students must play the autonomy and initiative in order to better implement data analysis literacy. It can be seen that current pre-service high school mathematics teachers can realize that data analysis should be related to the real world, and students can experience the whole process in order to better grasp the relevant knowledge, deepen their understanding of data analysis, and perceive the importance of data analysis. This is almost the same as the results of some previous studies. Wu et al. suggested that firstly, teachers should grasp the teaching objectives of statistics as a whole and teach in a case-based way; secondly, they should teach students different methods of data analysis and let them experience a complete statistical investigation activity [13]. Therefore, hypothesis 2 is confirmed.

5.3 Cognitive Rationality

From the above statistics, it can be seen that the current pre-service high school mathematics teachers' understanding of the implementation of data analysis literacy is not very reasonable. Although they can put forward some suggestions according to their learned professional knowledge and existing professional skills, the

suggestions still have some aspects, and some views are lack of feasibility or effectiveness, which needs to be further explored and considered. It can be seen that the current pre-service high school mathematics teachers' cognition of implementing data analysis literacy is not very reasonable. Some previous research results also involve this point of view. Zhang, et al. found that students' performance in collecting and searching data is not satisfactory, one of the important reasons is that teachers do not pay enough attention to how to collect the data in a problem and how to extract useful information [11]. Therefore, hypothesis 3 is confirmed.

6. CONCLUSION

This study investigates the cognition of pre-service high school mathematics teachers on the implementation of data analysis literacy. Through the investigation and analysis, It is found that: 1. The scope of cognition of the current pre-service high school mathematics teachers on the implementing for data analysis literacy is not wide, and more than half of the content on the implementing for data analysis literacy previously proposed has not been realized by many pre-service teachers yet; 2. The understanding focuses on that students should experience the whole process of data analysis; 3. The cognition of many pre-service teachers is not reasonable and lacks feasibility or effectiveness, which needs to be further explored and thought.

Therefore, we suggest that: 1. Train experts and teachers of pre-service high school mathematics teachers, provide them with more teaching practice opportunities, and hold group meetings to discuss how to implement data analysis literacy; 2. Pre-service high school mathematics teachers should seize the opportunity of teaching practice, pay attention to observing students' learning state in the process of practice, reflect on whether the training strategy proposed by the summary is reasonable, and then further adjust and explore according to the actual situation of the school and classroom.

Finally, this study selects 51 masters of mathematics education in the same grade in the same university and lacks other types of participants. Therefore, future research should expand the sample range and adopt a variety of research methods to further investigate the data analysis literacy of pre-service high school mathematics teachers, in order to find more detailed conclusions and suggestions.

CONSENT

As per international standard or university standard, respondents' written consent has been collected and preserved by the author(s).

ETHICAL APPROVAL

As per international standard or university standard written ethical approval has been collected and preserved by the author(s).

Competing interests

Authors have declared that no competing interests exist.

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