Original Research Article

The Cognition of Pre-service High School Mathematics Teachers on the Implementation of Logical Reasoning Literacy

ABSTRACT

Currently, logical reasoning literacy has attracted more and more attention from all walks of life, and its implementation has become a research hot point. This study takes 51 master students from a university in China as objects to interview their cognition of the implementation of logical reasoning literacy with two questions. It was found that 1. The cognition focus of them on the implementation of logical reasoning literacy is to make students master the form of logical reasoning and improve logical reasoning ability; 2. The cognition of the implementation of logical reasoning literacy is not comprehensive and not consistent with the implementation measures proposed by predecessors. Therefore, it is suggested that 1. The teachers and experts in charge of training should pay more attention to logical reasoning literacy and provide pre-service high school mathematics teachers with more opportunities for teaching practice; 2. Pre-service high school mathematics teachers should grasp the importance of teaching practice. In the process of practice, the teachers should pay attention to observing the students' learning status, take the initiative to study and research, and constantly reflect, adjust and improve.

Keywords: Logical reasoning; Literacy; Mathematics; Pre-service teachers; Cultivation

1. INTRODUCTION

The operability of logical reasoning is defined as the ability of analysis and reasoning shown by students when faced with a mathematical situation or mathematical problem. The thinking ability and reasoning art are shown in [1]. Only by mastering the form of logical reasoning and learning to think logically can students grasp the relationship between things in a more complex situation, grasp the context of the development of things, and finally form a quality of thinking that emphasizes conclusions that are organized, logical and rational[2]. Therefore, it is particularly important to clarify the connotation of logical reasoning and to explore the implementation of logical reasoning in "general teaching" and "classroom teaching". However, from the discussion and research of experts and scholars, the implementation of logical

reasoning literacy in classrooms and teaching is not optimistic. The lack of awareness of logical reasoning literacy training [3] and the limitation of the test-oriented education model [4] are important obstacles to the implementation of logical reasoning literacy at present. The level of logical reasoning literacy of high school students is generally not high [5], which is inseparable from the inability to accurately implement logical reasoning literacy. The predecessors have also put forward many training strategies such as "cultivating students' awareness and habits of autonomous learning" [6], "integrating knowledge content and encouraging students to carry out logical reasoning" [7], but with little effect. Most of the previous research focuses on theoretical research on the connotation and characteristics of logical reasoning literacy, and there is no unified statement on how to implement logical reasoning literacy. Therefore, it is of great significance to study the pre-service high school mathematics teachers' understanding of the implementation of logical reasoning literacy.

2. LITERATURE REVIEW

At present, there have been many studies on the implementation of logical reasoning literacy in mathematics teaching in senior high school.

2.1 the Connotation of Logical Reasoning Literacy

Jie believes that core literacy includes not only learning ability and cultural knowledge but also skills to adapt to society and life. Core literacy refers to the ability that students should have and be able to adapt to lifelong development and social development and it is an important part of literacy. With the progress of the times and the advancement of education reform, the definition of core literacy is slightly different. The generally defined core literacy includes two aspects: one's ability and one's ability to get along with society[8]. Zhou believes that reasoning is the thinking process from propositional judgment to propositional judgment. Logical reasoning ensures the rigor of mathematics, and the development of mathematics requires logical reasoning[9]. Li expressed the following opinions on logical reasoning under the core literacy: logical reasoning is based on the logical relationship of mathematical concepts. It points to the development of students' logical reasoning ability; The process of students' logical reasoning is the process of building a building of mathematical knowledge; The formation of logical reasoning literacy is not limited to mathematics learning. It can be transferred to all aspects. Therefore, cultivating students' logical reasoning literacy can not only improve learning efficiency but also enhance students' thinking ability [10].

2.2 Cognitive Situation of Students' Logical Reasoning Literacy

Yu conducted research on the overall cognition of high school students' core literacy by using questionnaires and establishing a three-dimensional model. The research

shows that the logical reasoning literacy of high school students is at a medium aspect in the overall literacy aspects and there are few strong logical reasoning abilities[11]. Dong used the test questions of the 2016 primary and secondary school students' academic quality monitoring in Jiangsu Province as a tool and used the method of questionnaire to study the core literacy cognition of more than 80,000 middle school students in Jiangsu Province. But there is severe polarization [12]. Zhu analyzed the cognition of core literacy among high school students in 16 cities and prefectures in Hubei Province by means of a questionnaire. It is concluded that there are obvious differences in the cognition of core literacy among high school students in different cities and states [13].

2.3 On the Influencing Factors of Students' Logical Reasoning Literacy

Wang investigated the influencing factors of students' logical reasoning ability in a middle school in Tianjin. The results show that among many influencing factors, mathematics learning strategies have the greatest impact on it and learning motivation factors have the least impact [14]. Li has studied the influencing factors of senior high school students' logical reasoning from different aspects. From the research results, teachers play a decisive role in the influence of students' logical reasoning literacy, among which teachers' logical language teaching and situational setting teaching have the most significant influence [15].

2.4 On the Cultivation Strategy of Students' Logical Reasoning Literacy

Ni believes that the key point for junior middle school mathematics teachers to improve teaching quality is to cultivate students' logical reasoning literacy. To implement logical reasoning literacy in teaching, teachers need to pay attention to the rationality and interest of mathematical problem design in daily teaching[16]. Taking the construction method as an example, Sun analyzed how to implement logical reasoning literacy in teaching. The analysis shows that: in the process of problem-solving, students are encouraged to explore independently and support students to seek differences; We should use the variation of the original question to cultivate students' creative thinking [17]. Taking the perpendicularity of straight lines and planes as an example, Xu discusses how to implement logical reasoning literacy in teaching from two aspects of the concept and practice of solid geometry. She believes that situations and problems should be set reasonably in teaching and deductive reasoning and reasonable reasoning should be made good use of [18]. Wu believes that cultivating students' logical reasoning literacy is significant. But at this stage, cultivating students' logical reasoning literacy faces many difficulties, such as the lightweight of cultivating students' logical reasoning. Finally, he put forward the methods of implementing logical reasoning literacy in teaching including creating exploration situations, setting exploration problems, and integrating life elements [19]. Ruan takes the multiplication formula(complete square) as an example to analyze how to implement logical reasoning literacy in the classroom. She believes that the

penetration of core literacy into the classroom is mainly through four stages, "creating situations and introducing new knowledge", "Using new knowledge to deepen cognition", "Practice, consolidate, expand and improve" and "summarize and sort out knowledge" [20]. Cui believes that it is necessary to build an efficient classroom in the context of core literacy that can meet the needs of the times and meet the requirements of educational reform. However, at present, classroom teaching has the disadvantages of unclear teaching objectives, single teaching methods, and an inactive classroom atmosphere. He believes that this disadvantage can be improved by setting up a teaching environment, carrying out practical activities, integrating information technology, group communication and learning [21]. He used the Pythagorean theorem to summarize that information technology is helpful to implement logical reasoning literacy in class [22]. Ma believes that under the new curriculum standard the implementation of logical reasoning literacy in the mathematics classroom is a great challenge to mathematics teachers. He believes that the implementation of logical reasoning literacy in mathematics classrooms needs to break through the limitations of the traditional mathematics classroom, enrich teaching methods, carry out novel and interesting practical activities, and make good use of Multimedia Teaching [23].

It can be seen from the above research that predecessors have carried out many studies on the logical reasoning literacy of high school students, and some researches are relatively mature, such as the research on the students' logical reasoning literacy level and the research on the influencing factors of students' logical reasoning literacy level. However, there are still deficiencies that need to be improved, such as pre-service high school mathematics teachers' understanding of the implementation of logical reasoning literacy. Therefore, it is meaningful to study this issue. It can be seen from previous studies that under the previous educational model, pre-service high school mathematics teachers learned from the experience summarized by predecessors, but educational theories need to be continuously supplemented and improved, and pre-service teachers also need to summarize rules and experiences themselves. Therefore, the research content of this paper is to clarify the pre-service high school mathematics teachers' awareness of the implementation of logical reasoning literacy from the two dimensions of "general teaching" and "classroom teaching".

At present, there is no unified standard on how to implement logical reasoning literacy. Therefore, the research on the understanding of pre-service high school mathematics teachers on implementing logical reasoning literacy should be compared with experts' suggestions on how to implement logical reasoning literacy. Based on the analysis of great quantity literature, combined with the development status of the implementation of logical reasoning literacy, this paper summarizes the experts' suggestions on the implementation of logical reasoning literacy and clarifies the focus and general scope of the experts' suggestions for implementing logical reasoning literacy. This study is based on this. Therefore, the main problems of this paper are:

1. What is the focus of pre-service high school mathematics teachers' cognition of the implementation of logical reasoning literacy?
2. Whether the current pre-service high school mathematics teachers have a comprehensive cognition of the implementation of logical reasoning literacy?
3. Is the current pre-service high school mathematics teachers' cognition of the implementation of logical reasoning literacy consistent with the previous suggestions?

3. RESEARCH METHOD

3.1 Participants

In order to ensure the authenticity and reliability of the data, this study takes 51 masters of education majoring in Mathematics in 2021 discipline of Shandong Normal University as the survey sample, including 3 boys and 48 girls, of which 33 have high school teacher qualification certificates and have the intention to go to high school for employment.

3.2 Instrument

The research methods used in this paper are unstructured interviews and literature analysis. Unstructured interviews have great flexibility and can fully mobilize the enthusiasm of the interviewees. The characteristics of the interviewers and the interviewees are similar to improve the validity of the interview results. The use of unstructured interviews for information collection is more authentic and reliable. The literature analysis method is used to sort out and summarize the literature related to logical reasoning literacy, which provides certain theoretical support for this research.

3.3 Data Collection

Teaching is a bilateral interactive activity between teachers' teaching and students' learning, aiming to promote the comprehensive development of students' morality, intelligence, physique, aesthetics, and labor, and classroom teaching is a method commonly used in school teaching. Therefore, in order to fully understand the pre-service high school mathematics teachers' understanding of the implementation of logical reasoning literacy, two questions were set up to implement logical reasoning literacy from the two dimensions of "general teaching" and "classroom teaching". Question 1: "How do you think the core competencies of mathematical abstraction are implemented in general teaching?" Question 2: "How do you think the core competencies of mathematical abstraction should be implemented in the mathematics classroom?". In order to avoid the confusion of the data, this study conducted interviews with the masters of education one by one. The interviews were retained by recording, and the recordings were later converted into text for sorting. In order to ensure the authenticity of the data, only unnecessary items were removed during the

process of converting into them text. Modal. The collected data is the M.Ed's answer to the questions "How do you think the core literacy of logical reasoning is implemented in general teaching" and "How do you think the core literacy of logical reasoning is implemented in the mathematics classroom specifically". Because many answers are too long and unorganized, they are simplified by extracting keywords. In the end, a total of 53 key points were collected for deeper analysis.

3.4 Data Analysis

The research data were descriptively analyzed by summarizing all the research data and presented in the form of percentages. All the research data were further analyzed according to the degree of semantic similarity. Finally， the research data was divided into 8 levels. Among them, the dimension of "implementation in general teaching" has four levels, which are divided into "creating a teaching situation and stimulating students' interest", "mastering the form of reasoning and rationally reasoning", "exercising logical thinking and building a knowledge system" and "teachers and students attach importance to logical reasoning literacy". The dimension of "implementation in the classroom" is also divided into 4 levels, which are divided into "creating a situation to stimulate students' interest", "focusing on cultivating logical reasoning thinking in the classroom", "guiding students to express problems in mathematical language" and "teachers and students attach importance to logical reasoning literacy".

4. RESUITS ANALYSIS

4.1 Cognitive Focus

From the perspective of "how to implement the core literacy of logical reasoning in general teaching", the pre-service high school mathematics teachers' cognition of implementing logical reasoning literacy mainly focuses on the aspect of "mastering the form of reasoning and reasoning reasonably" and the proportion of the people as high as 50.98%. As far as the specific content is concerned, the focus of pre-service high school mathematics teachers is "infiltrating logical reasoning ability into students in teaching", accounting for 9.804%; From the perspective of "specifically to how to implement logic in classroom teaching", pre-service teachers' awareness of implementing logical reasoning literacy mainly focuses on the aspect of "focusing on cultivating logical reasoning ability in the classroom" and the proportion of the people is as high as 49.02%. In terms of specific content, they focus of cognition is "Teachers should guide students correctly", accounting for 11.765%. See Table 1 for details. Therefore, the key point of pre-service high school mathematics teachers' cognition of implementing logical reasoning literacy in the two dimension of "classroom teaching" and "general teaching" is that teachers should focus on letting students master the form of logical reasoning and improve students' logical reasoning ability.

Table 1. Vocational education recognition statistics: statistics of pre-service teachers' cognition

Primary index	Secondary index	number	concrete content	percentages(%)	percentage(%)
General teaching	**A create teaching situation Stimulate students' interest**	A1	Stimulate students' interest, carry out logical reasoning activities, and standardize students' logic.	3.922	7.843
		A2	Lead out mathematical concepts through situations and guide ideas	3.922	
	B master the reasoning form and reason reasonably	B1	Exercise logical reasoning literacy through specific topics	1.961	50.980
		B2	Develop students' logical reasoning ability through independent thinking and hands-on practice	1.961	
		B3	Encourage students to actively find and ask questions	5.882	
		B4	Pay attention to logic and process in teaching	1.961	
		B4	Let students experience the formation and development of knowledge	1.961	
		B6	Students show a complete reasoning process	1.961	
		B7	Let them master the basic form of reasoning	1.961	
		B8	We should cultivate students' ability to find problems, put forward problems and solve problems.	1.961	
		B9	We should consciously guide students to carry out logical reasoning	1.961	
		B10	Students use deductive reasoning to verify the correctness of the conclusion	5.882	
		B11	Use existing knowledge to infer new knowledge.	7.843	
		B12	Design problems according to students' reality	1.961	
		B13	Let the students summarize the new knowledge through observation and	1.961	

		conjecture		
	B14	Pay attention to the generality of the law and arrange reasoning training step by step.	1.961	
	B15	The teacher should explain the logical reasoning process to the students clearly	1.961	
	B16	Ask students to clarify the logic.	7.843	
C exercise logical thinking and build knowledge system	C1	Let students explore the logical relationship between mathematical objects independently	3.922	31.373
	C2	Let students know the meaning of logical reasoning	3.922	
	C3	Infiltrate students' logical reasoning ability in Teaching	9.804	
	C4	Let students classify and summarize the logical thinking in specific problems.	3.922	
	C5	The teacher should explain the logical reasoning process to the students clearly	1.961	
	C6	Ask students to clarify the logic.	7.843	
D strengthen teachers' and students' attention to logical reasoning literacy	D1	Both teachers and students should pay more attention to the core literacy of logical reasoning	3.922	9.804
	D2	It should be implemented from three aspects: schools, teachers and students.	3.922	
	D3	We should deal with the relationship between teaching content and core literacy, and deal with the four basics and core literacy.	1.961	
a create situations and connect with life	a1	Combined with the actual situation of students, create a scenario	5.88	21.569
	a2	creating situations	9.804	
	a3	contact with real life	1.961	
	a4	improve students' interest	3.922	

		a5	formulate clear and feasible teaching objectives according to the actual situation of learning situation and teaching content	1.961	
classroom teaching		b1	Encourage students to find and ask questions and boldly put forward their own conjectures	1.961	
		b2	teachers should correctly guide students	11.765	
		b3	pay attention to the occurrence and development process of knowledge	3.922	
		b4	attach importance to the teaching of basic concepts	3.922	
		b5	students use logical reasoning thinking to reason and prove	5.882	
	b Pay attention to improving logical reasoning ability in class	b6	let students learn how to classify problems and cultivate reasonable reasoning and deductive reasoning	1.961	
		b7	combine some specific knowledge to cultivate	1.961	
		b8	understand the significance of mathematical knowledge	1.961	49.020
		b9	let students observe and think more in class	3.922	
		b10	establish corresponding index system to correctly evaluate students in class	1.961	
		b11	Pay attention to the process of exploring cooperation and students' independent participation.	1.961	
		b12	make rational use of counterexamples for teaching	1.961	
		b13	enlightening teaching focuses on enlightening students' thinking in class.	3.922	
		b14	after class, enough training should be carried out to train the students	1.961	
	c Guide students to use logical reasoning thinking	c1	Pay attention to the expression of language	1.961	
		c2	cultivate students' logical thinking ability	5.882	23.529
		c3	uses heuristic teaching to let students find some theorems and formulas through their own	7.843	

		conjectures.		
	c4	guide students to verify these conjectures	1.961	
	c5	students use logical reasoning thinking to reason and prove	5.882	
d Strengthen teachers' and students' attention to logical reasoning literacy	d1	Improve teachers' core literacy of logical reasoning	1.961	3.922
	d2	pay attention to the law of students' physical and mental development	1.961	

4.2 Cognitive Comprehensiveness

This study sorts out the implementation measures of logical reasoning literacy proposed by predecessors, and sorts out 22 aspects with a total of 98 points. Among them, there are 12 aspects and 56 points in the dimension of "how to implement logical reasoning literacy in general teaching". There are 10 aspects and 42 points in the dimension of "specifically how to implement logical reasoning literacy in classroom teaching". The details are shown on Table 2 [15-42]. Analysis from the dimension of "how to implement logical reasoning literacy in general teaching", the four aspects of pre-service high school mathematics teachers' cognition of implementing the logical reasoning literacy all are involved in the implementation measures of the logical reasoning literacy proposed by predecessors; Analysis from the dimension of"specifically how to implement the logical reasoning literacy in classroom teaching", pre-service high school math teachers have only three aspects of in their cognition of the implementation of logical reasoning literacy are involved in the implementation measures of the logical reasoning literacy proposed by predecessors. Pre-service high school math teachers only have 53 points in their cognition of the implementation of logical reasoning literacy, which is far less than the 98 points proposed by predecessors. The number of cognitive aspects in teaching and classrooms has not reached half of the number of implementation measures proposed by predecessors, and the details are shown in Table 3. Therefore, the current pre-service high school mathematics teachers have incomplete cognition of the implementation of logical reasoning literacy.

Table 2. Implementation measures proposed by predecessors

Primary index	**Symbol**	**Secondary index**	concrete content	Proportion of

				employees(%)
teaching	**E1**	**Create teaching situations and guide students to observe**	Create interesting teaching situations and guide students to observe Create problem situations to promote students' logical reasoning ability Set up teaching situations and cultivate students' mathematical operation ability Carefully create situations and combine teaching with audio-visual teaching Using situational teaching to promote students' multi angle analysis and exploration	16.071
	E2	**Contact with real life**	Situation creation Realistic situation creation Create problem situations and pay attention to knowledge transfer Connecting with real life and constructing problem situations Appropriate relevance to real life Connecting with life and cultivating intuitive imagination Integrate life elements and develop students' associative thinking ability Contact life case Through life examples, help students establish correct values Cultivating students' mathematical logical reasoning ability by skillfully using life materials	10.714
	E3	**Carefully design teaching links to spread students' thinking**	Carefully design teaching links to spread students' thinking Enrich teaching methods and optimize the training effect of core literacy	21.429

		Internalized knowledge development ability exchange sublimation The process of exploring new knowledge can be guessed and discovered through students' hands-on operation Cultivating the ability of data analysis in Statistics Teaching Create an inquiry mathematical scene and cultivate students' ability of abstract imagination Cultivate students' ability of independent observation and thinking, and lay the foundation for divergent thinking Innovate teaching methods and pay attention to cultivating students' logical reasoning ability logical reasoning Change teaching methods and stimulate creative ability Improve reading ability and tap hidden conditions Using mind map skillfully to optimize thinking logic Encourage reasonable reasoning and infiltrate logical reasoning rules Plausible reasoning can be applied in the introduction of curriculum Deductive reasoning verification, demonstration of logical reasoning process Model transformation logic reasoning generation rule Teachers should pay attention to the performance of students in the application of deductive reasoning Improving logical reasoning ability in formula reasoning	
E4	**Encourage reasonable reasoning and make good use of deductive reasoning**		10.714

		proof	
E5	**Build knowledge system and sort out logical relations**	Build knowledge system and sort out logical relations Great transfer of knowledge points to exercise thinking ability Carry out targeted training and develop thinking habits	5.357
E6	**Carry out practical activities to strengthen students' logical reasoning ability**	Carry out practical activities to strengthen students' logical reasoning ability Carry out novel and interesting practical activities to cultivate students' innovative ability Develop independent mathematical activities and cultivate students' ability of logical reasoning Developing math games Pay attention to the concept of "unity of knowledge and practice" and strengthen students' practical ability	8.929
E7	**Strengthen teachers' cognition of the concept of core literacy, and the teaching plan design runs through the core literacy of mathematics**	Strengthen teachers' cognition of the concept of core literacy, and the teaching plan design runs through the core literacy of mathematics Introduce the concept and content of core literacy Infiltrate the rigorous spirit of mathematics and promote the flexible transfer of knowledge Emphasize the guidance of mathematical thinking and refine the mathematical conditions of hidden dangers	7.143
E8	**Multimedia optimization teaching**	Optimize mathematics teaching with the help of multimedia and strengthen students' self-study ability Strengthen core literacy with the help of information technology Using information technology to	5.357

			simplify reasoning steps	
	E9	**Advocate reflective learning and extend students' logical thinking space**	Advocate reflective learning and extend students' logical thinking space Improving students' logical reasoning ability in reflection	3.571
	E10	**introduces mathematical experiment to enrich the training form of logical reasoning ability**	Introduce mathematical experiments to enrich the training forms of logical reasoning ability Cultivate core literacy through experiments	3.571
	E11	**take students as the main body and cultivate learning ability**	Cultivating students' learning ability with students as the main body Students' "Recent Development Zone" Actively carry out teacher-student dialogue and dynamically inspire students' thinking	5.357
	E12	**improve the teaching evaluation mechanism and promote the all-round development of students**	Improve the teaching evaluation mechanism and promote the all-round development of students	1.786
Classroom	**e1**	**creating classroom situations**	Focus on the problem situation and effectively create the starting point of logical reasoning Create exploration situations and stimulate students' thinking ability Exploring the source of history and stimulating the thinking of dynamic development Create problem situations and cultivate problem awareness Cultivate students' mathematical emotion through the history of	14.286

		Mathematics	
e2	**creating classroom situations**	Reproduce the scene and experience the reality Stimulate students' classroom interest and improve classroom teaching efficiency Using interesting logical reasoning method to carry out mathematics teaching Carry out interesting classes and cultivate students' logical reasoning literacy	7.143
e3	**design reasonable mathematical problems to stimulate students' conjecture**	Design reasonable mathematical problems to stimulate students' conjecture Set up exploration problems and cultivate students' cognitive ability in the whole process The selection of examples and exercises should be appropriate and reasonable, and fully reflect the core literacy of mathematics Teach students in accordance with their aptitude and improve students' mathematical literacy and ability Pay attention to students' personality and activate students' mathematical imagination Cultivating reverse thinking in problem solving Design diversified mathematical problems and cultivate students' ability of intuitive imagination Give full play to the role of the classroom and add an appropriate amount of exercises Improve the content of homework after class and consolidate the ability of logical reasoning Teachers need to carry out teaching from difficult to easy and seek typical examples.	23.810

e4	**pay attention to mathematical concepts and firmly establish the cornerstone of logical reasoning**	Pay attention to mathematical concepts and firmly establish the cornerstone of logical reasoning Data cognition, law operation, reasoning and formation of concepts Pay attention to the teaching of basic knowledge and guide students to think actively Exercise logical reasoning ability from mathematical concepts	9.524
e5	**encourage reasonable reasoning and make good use of deductive reasoning**	Encourage reasonable reasoning and infiltrate logical reasoning rules Plausible reasoning can be applied in the introduction of curriculum Deductive reasoning verification, demonstration of logical reasoning process Model transformation logic reasoning generation rule Teachers should pay attention to the performance of students in the application of deductive reasoning	11.905
e6	**fusion information technology**	Integrate information technology to enrich students' intuitive imagination Promoting the development of junior middle school mathematics core literacy under the environment of information technology Introducing Internet plus to cultivate logical reasoning quality in all directions	7.143
e7	**pay attention to the organizational function of group cooperative learning**	Pay attention to the organizational function of group cooperative learning Establish study groups to expand the depth and breadth of students' thinking	11.905

		Developing cooperative learning and strengthening students' logical reasoning ability Group cooperative learning to stimulate innovative thinking "Cooperative" group exploration to jointly cultivate logical reasoning literacy	
e8	**cultivate students' questioning ability and creative thinking**	Guide students to ask questions and cultivate students' questioning ability Guide students to debate and cultivate students' creative thinking	4.762
e9	**promote the innovation of teaching content**	Cultivate mathematical logic in class and promote the innovation of teaching content Using comparative analysis to cultivate students' logical reasoning ability	4.762
e10	**master logical reasoning methods**	Master logical reasoning methods and enhance logical reasoning literacy Strengthen students' cognition and mastery of basic concepts	4.762

Table 3. The comparison between the pre-service high school mathematics teachers' knowledge and the previous knowledge

Primary index	Number of implementation measures proposed by predecessors	Number of aspects of implementation measures proposed by pre-service high school mathematics teachers	Percentage(%)	Total points of implementation measures proposed by predecessors	Total points of implementation measures proposed by pre-service high school mathematics teachers
teaching	12	4	33.33	56	27
Classroom	10	3	30.0	42	26
total	22	7		98	53

4.3 Cognitive Consistency

From the previous analysis, it can be seen that logical reasoning literacy recognized by pre-service high school mathematics teachers is implemented in the four aspects of teaching. A B, C, and D correspond to the four aspects E1, E4, E5, and E7 mentioned in the literature respectively. From the perspective of "how to implement the core literacy of logical reasoning in general teaching", pre-service high school mathematics teachers' cognition of the implementation of logical reasoning literacy focuses on "mastering the form of reasoning and reasoning reasonably", while the literature on the implementation of logical reasoning literacy focuses on "well-designed teaching links, divergent thinking of students". The aspect of "mastering the form of reasoning and reasoning reasonably" recognized by pre-service high school mathematics teachers only accounts for 10.714% percent of the literature. No one mentioned the aspect of "well-designed teaching links and divergent thinking of students" that literature proposed. According to the above analysis, there are four levels of pre-service high school mathematics teachers' cognition of the implementation of the logical reasoning literacy in the classroom, of which the three levels of a, b and c correspond to e1, e5, and e10 in the literature respectively. From the perspective of "specifically how to implement logical reasoning literacy in classroom teaching", the focus of pre-service high school mathematics teachers' cognition of the implementation of logical reasoning literacy is "paying attention to cultivating logical reasoning ability in class". The focus of the literature on the implementation measures of logical reasoning literacy in the classroom is "designing reasonable mathematical problems to stimulate students' conjecture", The aspect of "paying attention to cultivating logical reasoning ability in the classroom" recognized by pre-service high school mathematics teachers accounts for only 11.905% percent in the literature. The aspect of "designing reasonable mathematical problems to stimulate students' conjecture" proposed in the literature is not mentioned by pre-service high school mathematics teachers. The detailed results are shown in Figure 1.

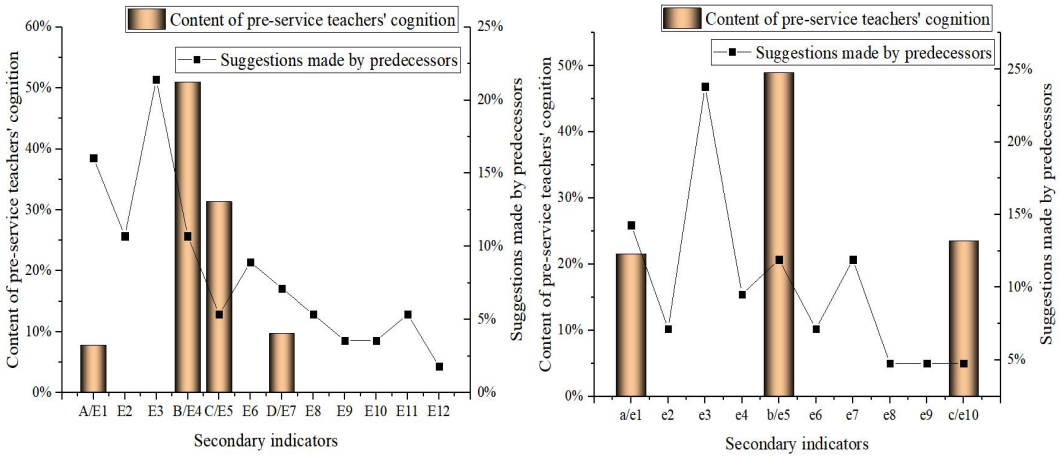

Fig. 1. Distribution of recognition points of pre-service teachers and points

of implementation measures in the literature

As far as the specific content is concerned, there are 53 points in the expressions of pre-service high school mathematics teachers, of which 22 points are similar to those suggested by predecessors, accounting for 41.05%. From the dimension of "how to implement logical reasoning literacy in general teaching", the pre-service high school mathematics teachers' expressions are summarized into 27 points, of which 9 points are similar to those suggested by predecessors, accounting for 33.33%, among which the two points that pre-service high school mathematics teachers have centrally recognized are "encouraging students to actively discover and ask questions" and "students use deductive reasoning to verify the correctness of conclusions" are relatively similar to previous teaching suggestions, while "using existing knowledge inference of new knowledge" and "requesting students to figure out the logic", although the number of people who have recognized them is relatively large, they have not been mentioned in the teaching suggestions of predecessors. From the dimension analysis of "how to implement logical reasoning literacy in classroom teaching", the pre-service high school mathematics teachers' expressions are summarized into 26 points, of which 13 points are similar to those suggested by predecessors, accounting for 50.00%, of which pre-service high school mathematics teachers have concentratedly recognized that "combining students' actuality and creating scenarios" is relatively similar to the teaching suggestions of predecessors. Although "teachers should guide students correctly" is recognized by a large number of people, it is not mentioned in the proposal. The detailed results are shown in Fig. 2(The point with result 0 is not drawn).

According to the data analysis, the measures proposed by pre-service high school mathematics teachers to implement logical reasoning literacy are inconsistent with those proposed by predecessors. The scope of the measures proposed by the two is different. There is a certain overlap but the overlap ratio is not high. It can be seen that the pre-service high school mathematics teachers' cognition of the implementation of logical reasoning literacy is inconsistent with the previous cognition of the implementation of core literacy. Although they can Some suggestions are put forward, the scope of the suggestions is narrow and needs to be further explored and considered.

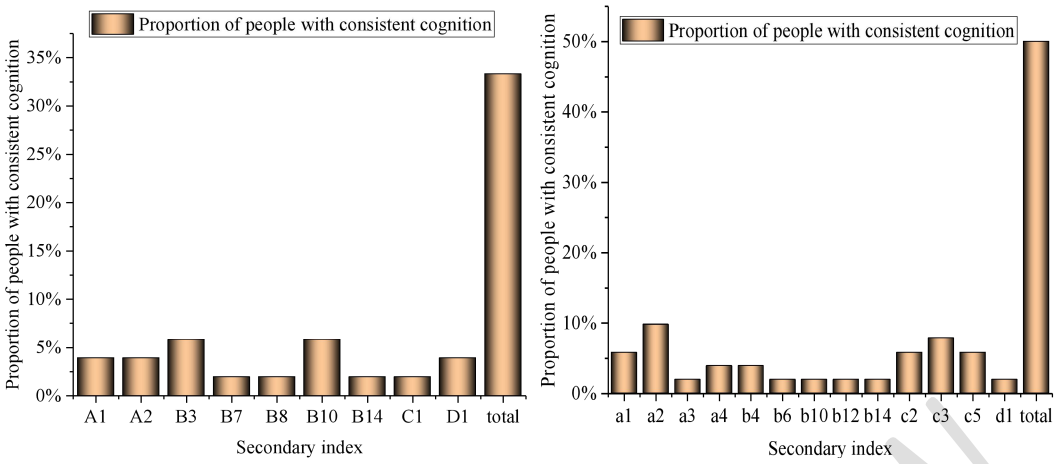

Fig. 2. Cognitive consistency analysis

5. DISCUSSION

5.1 On the Cognitive Focus

From the above data analysis, it can be seen that concerning the dimension of "Implementing logical reasoning literacy in general teaching ", pre-service high school mathematics teachers realize that in order to better implement logical reasoning literacy, students should master the form of logical reasoning and carry out reasonable Reasoning, and should pay attention to the use of creative situations in teaching to improve students' interest in learning; at the same time, teachers should pay more attention to the literacy of logical reasoning. Regarding the dimension of "Implementing logical reasoning literacy in classroom teaching", pre-service high school mathematics teachers realized that teachers should focus on improving students' logical reasoning ability, and should link real life in the process of classroom teaching, infiltrating core literacy throughout the teaching process. From this, we can see that the current pre-service high school mathematics teachers can realize the importance of cultivating students' logical reasoning thinking, and know how to let students master the method of logical reasoning and reasoning reasonably. This result is quite similar to the previous research results. Zhang believes that the focus of cultivating students' logical reasoning literacy is that teachers should cultivate students' logical thinking, improve students' ability to answer questions, and strengthen students' confidence in learning mathematics [43].

5.2 On the Cognitive Comprehensiveness

From the above data analysis, it can be seen that the pre-service high school mathematics teachers' cognition of the implementation of logical reasoning literacy is far less than the implementation measures proposed by predecessors, whether it is the dimension of "Implementing logical reasoning literacy in general teaching " or "specific to classroom teaching" , the number of cognitive aspects of pre-service high

school mathematics teachers on implementing logical reasoning literacy has not reached half the number of implementation measures proposed by predecessors. From this, we can see that the current pre-service high school mathematics teachers do not have a very comprehensive cognition of the implementation of logical reasoning literacy. This result is somewhat similar to previous research results. Deng believes that logical reasoning literacy cannot be well implemented in teaching because in the actual teaching process, many teachers have not yet mastered comprehensive core literacy training skills, and research on it is still in the Theoretical aspect [44].

5.3 On the Cognitive Consistency

From the above data analysis, it can be seen that the measures for implementing logical reasoning literacy proposed by pre-service high school mathematics teachers are significantly different from those proposed by predecessors, and the scope of the measures proposed by the two is also different, although there is a certain overlap. degree, but the overlap ratio is low. It can be seen that the pre-service high school mathematics teachers' understanding of the implementation of logical reasoning literacy is not very consistent with their predecessors' understanding of the implementation of logical reasoning literacy. Although they can make certain suggestions based on the professional knowledge and professional skills they have learned, However, the scope of the proposal is narrow and needs to be further explored and considered. Wang used the literature analysis method to carry out a quantitative analysis of logical reasoning literacy. The results show that the research on the implementation of logical reasoning literacy is still on the rise, and no targeted suggestions have been put forward [45]. This coincides with the findings of this study.

6. CONCLUSIONS AND RECOMMENDATIONS

Existing research has shown that teachers' cognition of implementing logical reasoning literacy directly affects the implementation effect of logical reasoning literacy. Therefore, the current implementation of logical reasoning literacy in middle school mathematics classrooms is not effective. Through investigation and analysis, it can be seen that the current pre-service high school mathematics teachers: 1. The focus of the implementation of logical reasoning literacy is to master the form of logical reasoning and improve the ability of logical reasoning; 2. The cognition of the implementation of logical reasoning literacy is not comprehensive, and from different dimensions， It can be seen that the number of aspects of their cognition of the implementation of logical reasoning literacy has not reached half of the number of implementation measures proposed by predecessors; 3. The cognition of the implementation of logical reasoning literacy is not very consistent with the implementation measures proposed by predecessors. There is a certain degree of overlap, but the overlap ratio is low, and the suggestions they put forward involve a narrow range, which needs to be further explored and considered.

Therefore, it is suggested that: 1. Relevant teachers and experts who cultivate pre-service high school mathematics teachers should pay more attention to the literacy of logical reasoning, strengthen the training of pre-service teachers in this area, and provide them with more opportunities for teaching practice; 2. Pre-service teachers High school mathematics teachers should seize the opportunity of teaching practice, pay attention to observe the students' learning status in the process of practice, take the initiative to study and research, and constantly reflect, adjust and improve.

The research object of this survey is 51 postgraduates of the same grade of education masters in the same institution. The sample size is small and the sample range is not wide, and other types of pre-service high school mathematics teachers are not involved. Therefore, it is necessary to expand the scope of research samples in the future, to conduct further in-depth research on the cognitive aspect of pre-service high school mathematics teachers on logical reasoning literacy, and to adopt a variety of research methods in order to find more detailed and comprehensive results.

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