Research on the Cognitive Degree of Pre-service School Mathematics Teachers for Operation Ability Literacy

Abstract:
Currently, the education of operation ability literacy has attracted wide attention from all walks of life. So far, many scholars have studied this aspect, but there is no research on the cognitive degree of pre-service junior high school mathematics teachers for operation ability literacy. In this study, 20 postgraduate students and undergraduate students majoring in mathematics at a university were investigated, and their cognition of operation ability literacy was investigated by interview. After that, through data analysis, it can be found that the current pre-service junior high school mathematics teachers' literacy of operation ability: 1. The cognitive scope is not wide, and less than half of the people can recognize more than half of the content; 2. The cognitive clarity of operation ability literacy is low, although all points of operation ability literacy can be recognized, the expression error rate is high. Therefore, it is suggested that pre-service junior high school mathematics teachers should pay more attention to the literacy of operation ability through training; Pre-service junior high school mathematics teachers should learn and study curriculum standards independently to improve their understanding of operation ability literacy.

Keywords: Pre-service Junior High School Mathematics Teachers, Mathematical Operation Ability Literacy, Cognitive degree

1. INTRODUCTION

Mathematical operation is an important component of the core literacy of junior high school mathematics. It is the basic literacy and ability of students to study mathematics. It is a process of integrating students' logical thinking and computing skills [1]. In 2022, the "Compulsory Education Mathematics Curriculum Standards (2022 Edition)" promulgated by the Ministry of Education of the People's Republic of China emphasizes that operation power mainly refers to the ability to perform correct operations according to laws and operational laws. Operation power helps to form the quality of standardized thinking and develop a meticulous, rigorous and realistic scientific attitude [2]. However, through the research of many scholars, we can find that junior high school students' mathematical operation ability literacy is not high. What is the reason for this? How should we improve the mathematical operation ability of junior high school students?

2. LITERATURE REVIEW

There are many studies on the literacy of junior high school students' mathematical operation ability. The existing research mainly focuses on the current situation, influencing factors and training strategies of junior high school students' mathematical operation ability literacy. Researchers often analyze the current situation and

influencing factors of junior high school students' mathematical operation ability literacy, and obtain the training strategies of junior high school students' mathematical operation ability literacy.

The previous training strategies for junior high school students' mathematical operation ability under the background of core literacy involve many categories of knowledge and skills. The predecessors mostly start from the basic knowledge and basic skills, and suggest that teachers should help students consolidate the foundation and guide students to master the operation skills to improve the mathematical operation ability of junior high school students. However, previous studies have involved fewer strategies in the process and thinking categories. Under the category of non-intellectual factors, there are more strategies involved in habits and interests, and fewer strategies involved in attitudes. Wang combines his own teaching experience, analyzes the requirements of cultivating students' core literacy in the process of junior high school mathematics teaching on students' operational ability and the factors affecting the improvement of junior high school students' mathematical operation ability, and obtains the measures to improve students' operational ability under the core literacy of junior high school mathematics [3]. Wei analyzes the requirements of junior high school students' mathematical operation ability under core literacy and the factors affecting junior high school students' mathematical operation ability, and obtains the methods to improve junior high school students' mathematical operation ability under core literacy [4]. Qiu analyzes the role of core literacy in junior high school students' mathematical operation learning and the current situation of junior high school students' mathematical operation ability, and draws measures to improve students' operational ability [5]. Yan analyzes the requirements of mathematical core literacy for cultivating junior high school students' mathematical operation ability and the reasons for the poor mathematical operation ability of junior high school students, and obtains the strategies for cultivating junior high school students' mathematical operation ability under core literacy [6]. Huang analyzes the requirements of the core literacy of mathematics on the operational ability and the factors of the poor mathematical operation ability of junior high school students, and draws three strategies to improve the mathematical operation ability of junior high school students under the core literacy [7].

From the above research, we can see that there are many studies on the literacy of junior high school students' mathematical operation ability. However, we can also see that few people have studied the mathematical operation ability literacy of pre-service teachers, and the research on the cognitive degree of pre-service teachers' mathematical operation ability literacy is blank. As a guide on the way of students learning, teachers' attitude towards mathematical operations and their own knowledge level and teaching skills will have a great impact on students' ability development [8]. It can be seen that teachers' cognition degree of mathematical operation ability literacy is the influencing factor that affects students' mathematical operation ability literacy. Therefore, the purpose of this paper is to understand the current pre-service junior high school mathematics teachers' cognition degree of mathematical operation ability literacy through investigation.

The main issues of this study are:

1. How wide is the cognitive degree of operation ability literacy of pre-service junior high school mathematics teachers?
2. Is the current pre-service junior high school mathematics teachers' cognition of operation ability literacy clear?

A number of current studies have shown that the current junior high school students' operation ability literacy is not high, and the teacher's cognitive degree of operation ability literacy is an important factor influencing students' operation ability literacy. Therefore, the hypotheses of this study are:

Hypothesis 1: The current pre-service junior high school mathematics teacher's cognitive degree of the operation ability literacy is not wide;

Hypothesis 3: The current pre-service junior high school mathematics teacher's cognitive degree of the operation ability literacy is not clear.

3. THEORETICAL BASIS

There have been many studies on what the connotation of mathematical operation ability literacy is and what it is mainly composed of.

Zhang points out that mathematical operation is an individual's deformation and deduction of a problem under the premise of accurately understanding the operation rules and operation formulas. It is a process that requires students to excavate the operation conditions according to the knowledge they have learned, and clarify the ideas and obtain the results according to the relevant rules [9]. Lin says that in the stage of compulsory education, operation ability mainly includes two meanings. One is the ability to calculate mathematical problems based on the mastered rules and formulas, and the other is the ability to master the arithmetic of operations. Based on careful examination of the questions, the known conditions are excavated, and the most convenient and effective operation methods are explored [10]. 'Mathematics Cihai' (Volume 6) points out: 'Operational ability refers to the operation and reasoning of knowledge to obtain the results of operation'. 'Standard (2017 Edition)' points out that mathematical operation literacy refers to the literacy of solving mathematical problems according to mathematical algorithms on the basis of clarifying mathematical operation objects. It mainly includes: understanding the operation object, mastering the algorithm, exploring the operation idea, selecting the operation method, designing the operation program, and obtaining the operation result [11]. The 'Compulsory Education Mathematics Curriculum Standard (2022 Edition)' points out that operation ability mainly refers to the ability to perform correct operations according to the rules and operation laws. It can clarify the object and significance of the operation, and understand the relationship between the algorithm and the algorithm. To understand the problem of operation, choose a reasonable and concise operation strategy to solve the problem; It can promote the development of mathematical reasoning ability through operation. The ability to operate helps to form the quality of standardized thinking and develop a meticulous, rigorous and realistic scientific attitude [2].

In order to ensure the objectivity of the research, this study uses the 'Compulsory Education Mathematics Curriculum Standards (2022 Edition)' to define the operational ability literacy, and studies the cognitive degree of pre-service junior high school mathematics teachers on the operational ability literacy.

4. RESEARCH METHODS

4.1. Participants

In order to accurately reflect the pre-service junior middle school mathematics teachers' cognition of mathematical operation ability, this study selected 15 education master's degree students majoring in subject teaching (mathematics) of grade 2022 in the School of Mathematics and Statistics of Shandong Normal University and undergraduates in the School of Mathematics and Statistics of Shandong Normal University as the survey objects. They all have the intention of going to junior high school for employment in the future.

4.2. Instrument

This study uses interviews to investigate, and the interview outline includes three questions: 1. What is operation ability literacy? Please talk in detail. 2. What are the requirements of compulsory education mathematics curriculum standards for operation ability literacy? (That is, what requirements should students meet in terms of operation ability literacy). 3. What is the significance of cultivating students' operation ability literacy to students' development? The reason why these three questions are selected is to understand the real cognition of pre-service junior high school mathematics teachers on mathematical operation ability literacy. The use of interviews is because it is fast and convenient, flexible, not limited by written language, easy to conduct an in-depth investigation, and access to the most direct information.

4.3. Data Collection

To ensure the reliability of the research, the interview method was used to interview 20 interviewees one by one, and the interview content was recorded in the whole process after seeking the consent of the other party.

4.4. Data Processing

Firstly, the content of mathematical operation ability literacy in 'Compulsory Education Mathematics Curriculum Standards (2022 Edition)' is divided and coded. A, B and C are used to represent the meaning of mathematical operation ability, the requirements that students can meet through junior high school mathematics curriculum learning, and the significance of mathematical operation ability literacy to students' development. A total of 7 items of A1-C2 are divided, and the specific content is shown in Table 1. Subsequently, the interview recording content was converted into text, and the modal particles such as um and ah were removed. The original words of the interview were strictly sorted out and compared with the encoded content one by one. If the meaning of the content is similar, it is considered that the respondents can recognize this point. In addition, the degree of cognition is determined according to the breadth and clarity of the expression of the respondents. Finally, the number of points mentioned by each survey object and the number of people mentioned in each content are counted, the corresponding percentage is calculated, and a statistical table is made.

Table 1: Content coding

Index	Label	Content

A Implication	**A1**	Operation ability mainly refers to the ability to perform correct operations according to rules and operation laws
B Requirement	**B1**	It can clarify the object and significance of the operation
	B2	Understand the relationship between algorithm and arithmetic
	B3	To understand the problem of operation, choose a reasonable and concise operation strategy to solve the problem
	B4	It can promote the development of mathematical reasoning ability through the operation
C Significance	**C1**	Operational ability helps to form the quality of standardized thinking problems
	C2	Operational ability helps to develop a meticulous, rigorous and realistic scientific attitude

5. RESULTS

5.1. Cognitive Breadth

The content of mathematical operation ability literacy in the 'Compulsory Education Mathematics Curriculum Standards (2022 Edition)' is divided into 7 items. The maximum number of cognitive points of the respondents is 5, only 3 people, accounting for 15 % of the total number. Five people only recognize 1 point of relevant content, accounting for 25 % of the total number. Only 8 people recognize more than half of the points, less than half of the total number. The average number of cognitive points is 2.9, less than half of the total number of points, and the specific situation accounts for Table 2.

Table 2: Cognitive breadth results(1)

Subjects of survey	Number	Percentage(%)
1	2	28.57
2	1	14.29
3	1	14.29
4	1	14.29
5	3	42.86
6	4	57.14
7	1	14.29

8	5	71.43
9	3	42.86
10	2	28.57
11	2	28.57
12	4	57.14
13	5	71.43
14	3	42.86
15	1	14.29
16	4	57.14
17	3	42.86
18	4	57.14
19	5	71.43
20	4	57.14

From different aspects, 'implication' contains a point, all people can recognize this, accounting for 100% of the total number. The 'requirements' are divided into four points, 13 people can recognize B1 (It can clarify the object and significance of operation), accounting for 65% of the total number; 7 people can recognize B2 (Understand the relationship between algorithm and arithmetic), accounting for 35% of the total number; 12 people can recognize B3 (To understand the problem of operation, choose a reasonable and concise operation strategy to solve the problem), accounting for 60% of the total number; 6 people can recognize B4 (It can promote the development of mathematical reasoning ability through operation), accounting for 30% of the total number; the 'significance' aspect is divided into two points, of which C1 (Operational ability helps to form the quality of standardized thinking problems) is recognized by 8 people, accounting for 40% of the total number; C2 (Operational ability helps to develop a meticulous, rigorous and realistic scientific attitude) is recognized by 7 people, accounting for 35% of the total number. See Table 3 for details.

Table 3: Cognitive breadth results(2)

Index	Label	Number	Percentage(%)
A Implication	**A1**	20	100.00
B Requirement	**B1**	13	65.00
	B2	7	35.00
	B3	12	60.00

	B4	6	30.00
C	**C1**	8	40.00
Significance	**C2**	7	35.00

Although all the points of operation ability literacy can be realized by the respondents, each respondent cannot recognize all the points, and only 8 people can recognize more than half of the points. Although a point of 'implication' can be recognized by all respondents, it may be only because the first question of the interview outline involves this aspect. In terms of 'requirements', only two points can be recognized by more than half of the respondents. Only no more than half of the respondents can recognize each point of 'significance'. Therefore, it can be seen that the current pre-service junior high school mathematics teachers have a narrow cognitive range of mathematical operation ability literacy.

5.2. Cognitive Clarity

The expression of the survey object determines the degree of cognition according to the integrity and accuracy of its expression, and calculates the total number of points with clear cognition of each survey object and the ratio of the number of people with high and low cognition at each point.

The content of mathematical operation ability literacy in the 'Compulsory Education Mathematics Curriculum Standards(2022 Edition)' is divided into 7 items. The respondents can clearly recognize up to 5 points, with only 1 person, accounting for 5% of the total number. Nearly half of the people have a clear number of points of 0. Only 2 can clearly recognize more than half of the points, accounting for 10% of the total number. The average number of cognitive clarity points of all respondents was 1.2, accounting for only 17.14% of the total points, and the specific situation accounted for Table 4.

Table 4: Cognition clarity results(1)

Subjects of survey	Number	Percentage(%)
1	0	00.00
2	0	00.00
3	0	00.00
4	0	00.00
5	3	42.86
6	2	28.57
7	0	00.00
8	5	71.43
9	2	28.57
10	0	00.00

11	1	14.29
12	0	00.00
13	4	57.14
14	0	00.00
15	0	00.00
16	1	14.29
17	3	42.86
18	1	14.29
19	1	14.29
20	1	14.29

From different aspects, through the investigation, it is found that the current pre-service junior high school mathematics teachers have a relatively clear understanding of ‘the relationship between understanding the algorithm and the algorithm’, ‘being able to understand the problem of operation, choosing a reasonable and concise operation strategy to solve the problem’, but the number of people who have a clear cognition is less than half of the number of people who can recognize. The most unclear cognition of the respondents is that 'operational ability helps to develop a meticulous, rigorous and realistic scientific attitude'. See Table 5 for details.

Table 5: Cognition clarity results(2)

Index	Label	Percentage of cognitive clarity (high degree: low degree)
A Implication	**A1**	35.00:65.00
	B1	30.77:69.23
B	**B2**	42.86:57.14
Requirement	**B3**	41.67:58.33
	B4	33.33:66.67
C	**C1**	25.00:75.00
Significance	**C2**	14.29:85.71

It can be seen that there are few points in the current pre-service junior high school mathematics teachers' clear understanding of mathematical operation ability literacy. In comparison, the respondents' cognition of the 'requirements' is relatively clear, while for other points, although the respondents are aware of it, the respondents'

cognition is relatively vague. On the whole, the current pre-service junior high school mathematics teachers' cognition of mathematical operation ability literacy is relatively vague.

6. DISCUSSION

6.1. Cognitive Breadth

From the above data analysis, it can be seen that the current pre-service junior high school mathematics teachers have a narrow range of cognition of operation ability literacy, and only no more than half of them can recognize more than half of the content. In terms of specific content, only three points such as 'implication' and B3 (To understand the problem of operation, choose a reasonable and concise operation strategy to solve the problem) are recognized by no less than half of the people, less than half of the total points. The rest points are recognized by less than half of the total number. From this, we can see that the current pre-service junior high school mathematics teachers do not have a wide range of cognition of mathematical operation ability literacy. On this issue, Wang finds that the new teachers in the upper and lower grades do not have a comprehensive understanding of operation ability by investigating the operation ability of new junior high school mathematics teachers [12]. Thus, hypothesis 1 is confirmed.

6.2. Cognitive Clarity

From the above data analysis, it can be seen that there are few clear points in the current pre-service junior high school mathematics teachers' cognition of operation ability literacy, and they mainly focus on the 'requirements' aspect. Although other points can be recognized, their cognition is relatively vague. On the whole, the current pre-service junior high school mathematics teachers' cognition of operation ability literacy is relatively vague. From this, we can see that the current pre-service junior high school mathematics teachers have low cognitive clarity on the literacy of operation ability. On this issue, through the investigation of the new junior high school mathematics teachers' operation ability, it is found that the new junior high school mathematics teachers' understanding of operation ability has nothing to do with the high and low grades they teach, and they have no accurate and complete understanding of operation ability [12]. Thus, hypothesis 2 is confirmed.

7. CONCLUSION

The existing research shows that teachers' cognition of operation ability literacy directly affects the formation of students' operation ability literacy. Through previous studies, it is found that the current junior high school students' operation ability literacy is not high. So, is the current teacher's cognition of operation ability literacy not high? To this end, the study selected 20 masters of education and undergraduates. Through interviews, the pre-service junior high school mathematics teachers' cognition degree of operation ability literacy was investigated. Through investigation and analysis, it can be seen that the current pre-service junior high school mathematics teachers: 1. the cognitive scope of operation ability literacy is not wide, less than half of the people can recognize more than half of the content; 2. the cognitive clarity of operation ability literacy is low, although all points of operation ability literacy can be recognized, the expression error rate is high and the clarity is

low.

Based on the above conclusions, it is suggested that: through training, pre-service junior high school mathematics teachers should pay more attention to the literacy of operation ability; Pre-service junior high school mathematics teachers should learn and study the curriculum standards independently, improve their understanding of operation ability literacy, and should: 1. Comprehensively understand the relevant content of operation ability literacy; 2. Accurately understand the relevant content of operation ability literacy; 3. Think more about teaching, and comprehensively think about targeted training strategies in combination with the current situation of junior high school students' mathematical operation ability.

The research object of this survey is 20 masters of education and undergraduates. The sample is small, and it is concentrated in the same college. It is not involved in other types of pre-service junior high school mathematics teachers, and the sample selection range is narrow. Therefore, in the future, it is necessary to expand the scope of research samples, carry out a more comprehensive investigation and analysis, and adopt a variety of research methods, in order to understand in more detail the current pre-service junior high school mathematics teachers' cognition degree of operation ability literacy.

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