Asian Journal of Education and Social Studies

Volume 48, Issue 1, Page 132-143, 2023; Article no.AJESS.104026
ISSN: 2581-6268

Research on the Cognitive Level of Abstraction Ability Literacy among Pre-service Junior High School Mathematics Teachers

Qin Sun [a] and Zezhong Yang [a*]

[a] School of Mathematics and Statistics, Shandong Normal University, Jinan, China.

Authors' contributions

This work was carried out in collaboration between both authors. Both authors read and approved the final manuscript.

Article Information

DOI: 10.9734/AJESS/2023/v48i11046

Open Peer Review History:
This journal follows the Advanced Open Peer Review policy. Identity of the Reviewers, Editor(s) and additional Reviewers, peer review comments, different versions of the manuscript, comments of the editors, etc are available here: https://www.sdiarticle5.com/review-history/104026

Original Research Article

Received: 23/05/2023
Accepted: 27/07/2023
Published: 05/08/2023

ABSTRACT

The cultivation of students' abstraction ability in junior high school is of great significance for their personal development, and the education about abstraction ability literacy has received widespread attention from all sectors of society. So far, many scholars have studied this aspect, but there has been no research on the cognitive level of abstraction ability literacy among pre-service junior high school mathematics teachers. This study investigated the cognitive level of 11 Master of Education (M.Ed.) and 9 Bachelor of Education (B.Ed.) teacher education graduates from a university regarding abstraction ability literacy using open-ended interviews. Through analyzing data, it can be found that the current pre-service junior high school mathematics teachers' cognitive situation regarding abstraction ability literacy is as follows: 1 The cognitive scope is not broad, and more than half of the content is not recognized; The cognitive breadth of Master of Education is slightly higher than that of undergraduate normal university graduates. 2. The overall cognitive clarity is relatively low, with only individual points being recognized.

**Corresponding author: Email: zhongzee@163.com;*

Keywords: Pre-service junior high school mathematics teacher; abstraction ability literacy; cognitive level.

1. INTRODUCTION

Abstraction ability mainly refers to the ability to obtain mathematical research objects and to form mathematical concepts, properties, rules, and methods through the abstraction of quantitative relationships and spatial forms in the real world. The mathematics key competencies are clearly defined in the *Mathematics Curriculum Standards for Compulsory Education of the 2022 edition* (hereinafter referred to as *Curriculum Standards (2022)*). In compulsory education, mathematical vision is expressed in terms of abstraction ability (including number sense, quantity sense, and symbolic awareness), geometric intuition, spatial concepts, and innovation consciousness. It also specifies that the compulsory mathematics curriculum should enable students to develop the key competencies required for future social and personal development through the learning of mathematics [1]. The abstraction ability in junior high school is an extension of the number sense, quantity sense, and symbolic awareness in primary school, and also lays the foundation for a more rigorous and formalized mathematical abstraction in senior high school [2]. Therefore, the cultivation of abstraction ability among junior high school students is significant for their personal development. However, after summarizing the current situation of junior high school students' abstraction ability in existing studies, it was found that most researchers believe that the current level of junior high school students' abstraction ability is at a moderate or even lower level, and there is still much room for development. Abstraction ability literacy has not been well implemented in actual teaching. What are the reasons for this? How best can students be assisted to cultivate abstraction ability literacy? This is a question that deserves our study.

2. LITERATURE REVIEW

There have been many studies on the implementation of abstraction ability in junior high school mathematics teaching. Through the literature review, it can be found that the relevant research content mainly focuses on four aspects: the current situation of junior high school students' abstraction ability, the current situations of teachers' teaching on the training of abstraction ability, influencing factors of students' abstraction ability, and strategies for cultivating students' abstraction ability.

2.1 Current Situation of Junior High School Students' Abstraction Ability

Researchers such as Wang, Zhong, and Zhou analyzed the test papers and get that the overall level of mathematical abstraction ability of the study participants was mostly in the middle or even low state, and there was still much room for improvement [3-7]. Fan found that 7th-grade students were better at representational abstraction than principle-based abstraction and constructive abstraction through a survey [8]. Chen found that junior secondary students were weak in representational abstraction and principle-based abstraction, so he believed that students' abstraction ability in mathematical concepts and laws, abstraction of special mathematical symbols, and generalization of mathematical laws should be improved [9]. There is no significant difference in the level of abstraction ability between boys and girls. Almost all researchers who have analyzed gender differences on this question have concluded that there is no significant difference in the abstraction ability of boys and girls in junior high school [3,6-10].

Zhou and Dai analyzed the data and concluded that there was a significant difference in the mathematical abstraction ability between students in the experimental and ordinary classes [6,7]. Fang went further and analyzed the gaps in each sub-dimension, concluding that students in the experimental class had better principle-based abstraction ability and constructive abstraction ability than those in the ordinary class and that there was no significant difference in representational abstraction ability [8].

Yin and Zhao analyzed the scores and level distribution of mathematical abstraction-related problems in the Mathematics Academic Quality Monitoring for second-year junior high school students in Jiangsu Province, and the results reflected that students in urban schools were better than students in their mathematical abstraction ability, students in schools in southern and central Jiangsu were better than students in schools in northern Jiangsu, and

students in private schools were better than students in public schools [10].

2.2 Current Situations of Teachers' Teaching on the Training of Abstraction Ability

First of all, teachers' teaching concepts are backward. Shao's analysis showed that quite several math teachers still remain in the mechanical teaching stage of knowledge points, and lack the awareness of cultivating students' independent thinking [4]. Wu believes that traditional mathematics teaching tends to focus more on the learning and application of knowledge and lacks the awareness of developing students' abstraction ability in the design and implementation of teaching [11].

Secondly, teachers themselves do not have a deep understanding of the concept of abstraction competence. Chen and Huang believe that teachers have a single view of f the elements of mathematical expression ability and do not have a deep enough understanding of mathematical abstraction ability [3,9].

Finally, the level of teachers' teaching in developing students' abstraction ability needs to be improved. The survey results of Wang and Zhong showed that teachers do not give students enough time for independent thinking in teaching, the deep integration of information technology and disciplines needs further study, and teachers do not study the overall teaching of the unit enough [5]. Huang's survey concluded that a few teachers had never combed the mathematical knowledge system in the classroom, and the overall level of teachers needed to be improved [3].

2.3 Influencing Factors of Students' Abstraction Ability

Zhao found that: students' interest in learning mathematics, whether they are good at discovering mathematical problems in life, whether they are good at summarizing laws, whether they will take the initiative to construct a framework of knowledge, their attitude when they encounter abstract mathematical problems, teachers' teaching skills, other teaching aids, and other factors are significantly correlated with students' mathematical abstraction ability [12].

2.4 Strategies for Cultivating Students' Abstraction Ability

Strategies for developing students' abstraction ability have been analyzed and discussed by researchers at six aspects: teachers' level, teaching methods, students' level, use of modern educational tools and resources, deepening of mathematical thought, and joint training with other key competencies. And a large number of suggestions were provided.

At the teachers' level, Qiu and Zhu believe that the cultivation of students' key competencies in mathematics requires teachers to constantly update their teaching concepts and use more scientific teaching methods to improve students' learning efficiency and learning quality [13]. Chen believes that teachers themselves must master the concepts, basic processes, and teaching theories of mathematical abstract thinking ability and improve their abstraction ability to teach students well [9]. Huang believes that teachers must recognize the importance of abstraction ability, and the mathematical activities designed by teachers should make students experience the process of mathematical abstraction [3].

In terms of teaching methods, Li, Yu, and others believe that it is necessary to create reasonable teaching scenarios, use problems as carriers, and explore the essence of problems [4,14-25]. Zhong , Qiu , Zhu, and others argue that teachers should take students as the main body, guide them to think independently and actively learn, form the correct methods, and let them gradually establish their mathematical abstract thinking [13,15,23]. Wang, Liu, and others proposed to do Integral Teaching, compare horizontally and vertically, and focus on teaching the unit as a whole [3,5,26]. Bao put forward that the transition from arithmetic to algebraic thinking is a key link to developing abstraction ability. In teaching, attention should be paid to symbolic representations, symbolic transformations, and meaning construction [27]. Qiu and Zhou emphasize the importance of concept teaching in abstract thinking and the need to strengthen the application of examples and scenarios in concept teaching. Qiu also mentions that the proof of theorem formulas, as well as the explanation of results, are highly symbolic and abstract methods [6,28]. Lin believes that it can be based on mathematical concepts and principles, and promote the improvement of students' abstract thinking ability through the process of seeking common ground, classification, transformation as

well as refinement [29]. Yang, Xie, and others discuss how to design exercises. The questions should be carefully selected, designed in a novel way, and can be designed for variant training, solving multiple problems with one question [4,24,25,30]. Fan and Liu point out that teachers need to optimize the teaching content and eliminate information that is not conducive to students' active thinking [23,31]. Huang proposes that abstraction ability is also needed in other disciplines, such as the concepts of mass and vector in physics. Therefore, teachers should do a good job in the horizontal transfer of abstraction abilities between different disciplines. In addition, teachers should also strengthen the evaluation of students' mathematical abstraction literacy, including but not limited to process evaluation and outcome evaluation [3]. Zhao and Chen suggest combining the physiological and psychological characteristics of junior high school students and combining the Zone of Proximal Development to teach according to aptitude and teach according to class [6,12].

In terms of students, Chen argues that students should fully utilize their subjective initiative in cultivating abstraction abilities. Junior high school students should learn to observe and explore [9].

In terms of the use of modern educational tools and resources, most researchers have mentioned information-assisted instruction such as making animations and PPTs or applying Geometer's Sketchpad and electronic whiteboards to concretize abstract knowledge [7-9,12,15,19,26,30,32]. Liu, Fang, and others argue that abstract concepts can be visualized through the use of objects and examples. For example, in the teaching of triangle interior angle summation theorem, experiments are conducted using triangular pieces of paper [8,9,19,26]. Li, Guan, and others believe that classroom verification activities or comprehensive practical activities should be carried out to help students internalize abstract knowledge, transform abstract knowledge into practical operation ability, and let students experience the formation process of knowledge [4,8,19,26,33]. Sun and Zhou believe that extracurricular reading and classic mathematical stories are good teaching materials to develop students' abstraction abilities [21,34].

In terms of deepening mathematical ideas, Guan, Li, and others argue that the flexible transformation between intuition and abstraction can be achieved by combining numbers and shapes, which builds a platform for students [4,8,19,26,33]. Wang, Zhong, and others believe that when learning abstract new concepts or meeting new situations, they can associate and distinguish the relationship and difference between new and old knowledge by analogy with the knowledge structure, learning methods, or exploration paths of old knowledge [5,20,35].

In terms of joint training with other key competencies, Wu and Fang propose that focusing on students' thinking in the process of mathematical modeling can effectively grasp students' thinking processes and characteristics, and can also effectively develop students' ability to abstract thinking [8,11]. Jiang believes that computing ability has a certain hierarchy and development and gradually develops as the theory increases and the level of abstraction rises [36]. Qiu and Zhu believe that the cultivation of students' abstraction ability in junior high school mathematics teaching must focus on the cultivation of students' thinking and logical ability and cultivating the learning habits of active thinking and observation so that students' logical ability and generalization ability can be enhanced [13].

From the above studies, it can be seen that the previous research on the current situation of abstract ability literacy of junior high school students and the current situation of cultivation and cultivation strategies is relatively mature, and there has been some exploration of the factors affecting abstraction ability literacy. In addition, it can also be seen that teachers play an important role in the cultivation of abstraction ability literacy among junior high school students. However, few researchers have been conducted on teachers' abstraction ability literacy, and there is a gap in research on teachers' cognitive level of abstraction ability literacy. The key to the development of key competencies lies in the classroom, and teachers play an important role in cultivating students' abstract abilities. It can be seen that the cognitive level of teachers towards abstraction ability literacy is an important factor in influencing students' abstraction ability literacy. Therefore, this paper aims to investigate the cognitive level of abstraction ability literacy among current pre-service junior high school mathematics teachers through surveys.

Cognitive level generally includes cognitive breadth and cognitive clarity. Therefore, the main issues studied in this paper are:

1. How broad is the current cognition of abstraction ability literacy among pre-service junior high school mathematics teachers?
2. Is the current pre-service junior high school mathematics teachers' cognition of abstraction competence literacy clear?

It has been shown that the current level of abstraction ability literacy among junior high school students is low and that the level of teachers' cognitive level of abstraction ability literacy is an important factor that affects students' abstraction ability literacy. Therefore, the hypotheses of this study are:

Assumption 1: Current pre-service junior high school mathematics teachers do not have a wide range of cognition about abstraction ability literacy;

Assumption 2: Current pre-service junior high school mathematics teachers do not have a very clear cognition of abstraction ability literacy.

3. THEORETICAL BASIS

When Engels talked about the abstraction ability of mathematics, he said, "To count, it is necessary not only to have objects that can be counted but also an ability to focus on numbers when examining objects, disregarding all other characteristics of the objects, ... To be able to study these forms and relations from a pure state of being, it is necessary to detach them entirely from their content, and to lay aside the content as something of no importance." The concept and connotation and other related contents of abstraction ability literacy can be traced back to 1988 in the database of China National Knowledge Infrastructure (CNKI). Huang believes that mathematical abstraction only preserves the relationship between quantities and spatial forms while abandoning everything else. The abstraction ability of mathematics is the result of long-term historical development based on experience [37]. According to Zhu, abstraction ability is an integral part of mathematical ability, including four kinds of abstraction ability: weak abstraction ability, strong abstraction ability, constructive abstraction ability, and axiomatic abstraction ability [38]. Subsequently, abstraction ability has been studied mostly as a component of mathematical ability. Unlike other key competencies, abstraction ability is not mentioned in the *Mathematics Curriculum Standards for Compulsory Education(2011)*, but in the latest version of the *General High School Mathematics Curriculum Standards (2017 Edition)* issued in January 2018, the key competencies of senior secondary school mathematics have been condensed and provided the most formal term of Mathematical Abstraction. Then in April 2022, the Ministry of Education issued *Mathematics Curriculum Standards for Compulsory Education of the 2022 edition*, which defined the connotation and performance of the key competencies in the compulsory educational stage, gave the most formal expression of abstraction ability, and realized the coherence of the core literacy in the disciplines of senior high school and the compulsory educational stage.

The new curriculum standard states that abstraction ability mainly refers to the ability to obtain mathematical research objects and to form mathematical concepts, properties, rules, and methods through the abstraction of quantitative relationships and spatial forms in the real world. Be able to abstract core variables, rules of variables, and relationships between variables from actual situations or interdisciplinary problems, and express them with mathematical notation; Be able to summarize general conclusions from specific problem-solving and form mathematical methods and strategies. Understand the role of mathematical abstraction in the emergence and development of mathematics. Understand the significance of observing the real world from a mathematical perspective. Form mathematical imagination. Enhance the interest in learning mathematics [1].

In order to ensure the objectivity of the study, the definition of abstraction ability literacy in the Mathematics Curriculum Standards for Compulsory Education (2022) was used to examine the level of pre-service junior high school mathematics teachers' cognition of abstraction ability literacy.

4. METHODS

4.1 Participants

In order to truthfully reflect the cognition situation of pre-service senior high school mathematics teachers to abstraction ability, this paper selected 11 masters of Mathematics education in class of 2022 and 9 undergraduate students majoring in Mathematics and Applied mathematics (normal) in class of 2019 from the School of Mathematics and Statistics, Shandong Normal University, as the respondents of the survey. Those who hold the qualification certificate for teaching mathematics and are

interested in future employment in a junior high school will be selected. The selected individuals promised to cooperate seriously with the investigation.

4.2 Instruments

This paper was conducted using an open-ended interview method, and a question was designed in the interview outline, which is "What do you think is abstraction ability literacy? Please provide your understanding in detail and comprehensively." This question was chosen to find out the cognition of pre-service junior high school mathematics teachers about abstraction ability literacy. The open-ended interview method was adopted because it is fast, convenient, flexible, and not limited by the written language text, and easy to conduct an in-depth investigation and obtain the most direct information.

4.3 Data Collection

To ensure the reliability of the research, the open-ended interview method was used to interview the interviewees individually one by one, and the entire interview content was recorded after seeking their consent. (Due to scheduling conflicts, some of the interviewees were interviewed by questionnaire, and the other party answered the questions and then sent voice or text feedback.)

4.4 Data Collation

Firstly, the contents of the Curriculum Standard (2022) on abstraction ability literacy were divided and coded, with A, B, and C indicating the connotation, main manifestations, and significance of abstraction ability, respectively. A total of three dimensions from A to C and ten items from A1 to C4 were identified, as shown in Table 1. Subsequently, the interview recording content was converted into text, with the exception of tone words such as "um, ah", and strictly organized according to the original words, and compared with the encoded content one by one. If the content has similar meanings, it is considered that the respondents can recognize this point. The number of nodes was recorded by Nvivo. In addition, the level of cognition was determined based on the completeness and accuracy of the respondents' expressions. Finally, the number of people who mentioned each item was counted, the corresponding percentage was calculated, and a statistical table was made.

The new curriculum standard states that abstraction ability mainly refers to the ability to obtain mathematical research objects and to form mathematical concepts, properties, rules, and methods through the abstraction of quantitative relationships and spatial forms in the real world. Be able to abstract core variables, rules of variables, and relationships between variables from actual situations or interdisciplinary problems, and express them with mathematical notation; Be able to summarize general conclusions from specific problem-solving and form mathematical methods and strategies. Understand the role of mathematical abstraction in the emergence and development of mathematics. Understand the significance of observing the real world from a mathematical perspective. Form mathematical imagination. Enhance the interest in learning mathematics [1].

Table 1. Content-codings

Index	Code	Content
A Connotation	A1	Through the abstraction of quantitative relationships and spatial forms in the real world
	A2	Obtain the mathematical research objects
	A3	form mathematical concepts, properties, rules, and methods
B Main Manifestation	B1	Be able to abstract core variables, rules of variables, and relationships between variables from actual situations or interdisciplinary problems
	B2	Express them with mathematical notation
	B3	Be able to summarize general conclusions from specific problem-solving and form mathematical methods and strategies
C Significance	C1	Understand the role of mathematical abstraction in the emergence and development of mathematics
	C2	Understand the significance of observing the real world from a mathematical perspective
	C3	Form mathematical imagination
	C4	Enhance the interest in learning mathematics

5. RESULTS

5.1 Cognitive Breadth

The content on abstraction ability literacy in the *Curriculum Standards (2022)* is divided into 10 items, and the maximum number of cognitive points among pre-service junior high school mathematics teachers surveyed is only 4, which is still less than half of the total points. From the perspective of different groups, 7 senior graduates, or 77.7 percent of the total number of senior graduates, recognized 0 or 1 point, with an average number of points recognized of 0.889. 8 Master of Education students (M.Ed). students, or 72.7 percent of the total number of M.Ed. students, had a mean cognitive score of 2.182.

Among the Master of Education students, 8 students have knowledge points less than or equal to 2, accounting for 72.7% of the total number of Master of Education students, with an average knowledge point of 2.182. The specific statistics are shown in Table 2.

From different aspects, the connotation can be divided into three points, with only 1 senior graduate realizing one point and no one else realizing the rest. All three points were recognized by some M.Ed. with four recognizing A1(Through the abstraction of quantitative relationships and spatial forms in the real world), which is 36.4% of the total number of M.Ed.s. And A1 is one of the best-recognized content points for M.Ed.

The main manifestations are divided into three points, each of which is recognized by a different group of people, but the number of people who recognize it does not exceed 3.

The significance was divided into four points, of which C1(Understanding the role of mathematical abstraction in the emergence and development of mathematics) was recognized by 0 people, while C2(Understanding the significance of observing the real world from a mathematical perspective.) was recognized by 2 graduates and 4 Masters of Education, which was the content point with the largest number of recognizers, accounting for 30% of the total population. The specific statistical situation is shown in Table 3.

From this, it can be seen that the current pre-service junior high school mathematics teachers have a narrow cognitive range of abstraction ability literacy, failing to recognize more than half of the content, and everyone's understanding is also relatively scattered. For different groups, the cognitive breadth of Masters of Education is slightly higher than that of senior graduates. In terms of specific content, people have the best understanding of the point that understanding the significance of observing the real world from a mathematical perspective, and the worst understanding of the point that understanding the role of mathematical abstraction in the emergence and development of mathematics. The Master of Education has a good understanding of connotation, while senior graduates have a better understanding of the main manifestation.

5.2 Cognitive Clarity

We determined the level of cognition based on the completeness and accuracy of the expression of the respondents, and calculated the percentages of the number of people with high or low levels of cognition, respectively. Through the statistical analysis, it is found that pre-service junior high school mathematics teachers were most aware of three items: Obtaining the mathematical research objects, expressing them with mathematical notation, enhance the interest in learning mathematics. Although the number of people who were aware of these items was small, the proportion of high cognitive clarity has reached 100%. On the contrary, the ratio of pre-service teachers' perceived clarity on forming mathematical imagination (low: high) was 100:0.

Table 2. Overall situation of the cognitive breadth

Number of points recognized(points)	0	1	2	3	4	≥5
Number of undergraduate graduates	4	3	1	1	0	0
Percentage（%）	44.4	33.3	11.1	11.1	0	0
Number of M.Ed	1	2	5	0	3	0
Percentage（%）	9.1	18.2	45.5	0	27.3	0
Average cognitive points of undergraduate graduates(points)	0.889					
Average cognitive points of M.Ed (points)	2.182					

Table 3. Cognition of specific content in cognitive breadth

Index	Code	Cognition population of undergraduate graduates	Percentage（%）	Cognition population of M.Ed	Percentage(%)	The total number	Percentage(%)
A	A1	0	0	4	36.4	4	20
Connotation	A2	0	0	2	18.2	2	10
	A3	1	11.1	3	27.3	4	20
B	B1	1	11.1	2	18.2	3	15
Main	B2	1	11.1	2	18.2	3	15
Manifestation	B3	1	11.1	1	9.10	2	10
	C1	0	0	0	0	0	0
C	C2	2	22.2	4	36.4	6	30
Significance	C3	1	11.1	2	18.2	3	15
	C4	1	11.1	3	27.3	4	20

Table 4. Cognitive clarity

Index	Code	Proportion（low : high）
A	A1	50.00:50.00
Connotation	A2	0.00:100.00
	A3	75.00:25.00
B	B1	33.33:66.67
Main	B2	0.00:100.00
Manifestation	B3	50.00:50.00
	C1	0.00:0.00
C	C2	83.33:16.67
Significance	C3	100.00:0.00
	C4	0.00:100.00

It can be seen that current pre-service junior high mathematics teachers have a clear understanding of fewer and more scattered points of abstraction ability literacy. And most of the other points are either not recognized or more vaguely recognized. On the whole, the current pre-service junior high mathematics teachers' cognition of abstraction ability literacy is vague. The details are shown in Table 4.

6. DISCUSSION

Regarding cognitive breadth, it can be seen that the current pre-service junior high school mathematics teachers have a narrow cognitive range of abstraction ability literacy, failing to recognize more than half of the content, and everyone's understanding is also relatively scattered. For different groups, the cognitive breadth of Masters of Education is slightly higher than that of senior graduates. The Master of Education has a good understanding of connotation, while senior graduates have a better understanding of the main manifestation. There are certain cognitive differences among different groups of pre-service teachers. As far as specific content is concerned, everyone's cognitive points are relatively scattered, and the number of cognitive people in each content point is relatively low, without significant concentration, and their understanding of detailed content is worse. The recognized points are relatively scattered and do not have significant concentration, and the number of cognition people for each content point is lower, and the cognitive level of detailed content is worse. In summary, it can be concluded that the cognitive range of abstraction ability literacy among current pre-service junior high school mathematics teachers is not broad. Assumption 1 has been confirmed.

Regarding cognitive clarity, it can be seen that current pre-service junior high mathematics teachers have a clear understanding of fewer and more scattered points of abstraction ability literacy. Short and easy-to-understand content such as Obtaining mathematical research objects is recognized more clearly, and although the number of people is not large, it has high cognitive clarity. On the contrary, pre-service teachers have a vague understanding of the content that requires a certain level of understanding or contains more homogeneous content, such as forming mathematical imagination, forming mathematical concepts, properties, rules, and methods. On the whole, the current pre-service junior high mathematics teachers' cognition of abstraction ability literacy is vague. Regarding this issue, Chen Jing recorded after the 6th Teaching Seminar of the Guangdong Teachers' Continuing Education Association that the introduction and implementation time of the *Curriculum Standards (2022)* was relatively short, and some frontline teachers did not study deeply enough. There were still some cognitive misunderstandings and unclear cognition [39]. Thus assumption 2 is confirmed.

7. CONCLUSIONS AND RECOMMENDATIONS

Previous studies have shown that teachers play an important role in the cultivation of abstraction ability literacy among junior high school students. As the current level of abstraction ability literacy among junior high school students is generally low, is the cognitive level of teachers' abstraction ability literacy also low? This paper selected 11 Master of Education and 9 undergraduate graduates to investigate the cognitive level of abstraction ability literacy among pre-service middle school mathematics teachers through interview methods.

The following conclusions were drawn from the investigations and analyses. (1) Current pre-

service junior high school mathematics teachers have a narrow cognitive range of abstraction ability literacy, failing to recognize more than half of the content, and everyone's understanding is also relatively scattered. The cognitive breadth of Masters of Education is slightly higher than that of senior graduates. (2) The current pre-service junior high mathematics teachers' cognition of abstraction ability literacy is vague, with few clear points and a focus on brief and direct content. For most other points, either they are not recognized or their understanding is relatively vague.

Based on the above conclusions, the following suggestions are given. Relevant teachers and experts in training pre-service teachers should increase their emphasis on abstract ability literacy; Strengthen the training of pre-service junior high school mathematics teachers by adding relevant courses, imparting accurate and comprehensive content on key competencies to pre-service junior high school mathematics teachers; Encourage pre-service junior high school mathematics teachers to learn lifelong learning, and constantly improve their academic qualifications and academic level; Pre-service junior high school mathematics teachers themselves should take the initiative to conduct studies to improve their understanding of abstraction ability literacy so that they can have a comprehensive understanding of the relevant content of abstraction ability literacy, clarify the expression of abstraction ability literacy and gain a deeper understanding of its meaning.

CONSENT

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

ETHICAL APPROVAL

As per international standard or university standard guideline participant consent and ethical approval has been collected and preserved by the authors.

FUNDING

This research was supported by Shandong Provi ncial Education Department (Grant number: SDYJG21023).

COMPETING INTERESTS

Authors have declared that no competing interests exist.

REFERENCES

1. Ministry of Education of the Ministry of Education of the People's Republic of China. Mathematics Curriculum Standards for Compulsory Education (2022 Edition). Beijing, China: People's Education Press.
2. Bao JS. One of the main manifestations of mathematics key competencies in junior high school: Is abstraction ability. China Mathematics Education. 2022(09):4-9+13.
3. Huang SY. Research on the current situations and improvement suggestions of mathematics abstraction literacy teaching in junior high school. Xian: Shaanxi Normal University; 2020.
4. Shao MY. The current situations and strategies of cultivating junior high school students' mathematical abstraction literacy. Friends of Mathematics. 2020(06):71-72.
5. Wang GF, Zhong SJ. Research on the current situations and countermeasures of the development of junior high school students' mathematical abstraction ability. Reference for Middle School Mathematics Teaching. 2022(14):66-69.
6. Zhou GQ. Research on the teaching design of mathematical concepts for junior high school students to cultivate mathematical abstraction ability. Shanghai: Shanghai Normal University, 2021.
7. Dai CL. Investigation and research on mathematical abstraction ability and logical reasoning ability of junior high school students. Nanjing: Nanjing Normal University, 2021.
8. Fang MJ. Investigation and research on developing mathematical abstraction ability in junior middle school mathematics teaching. Yanbian Korean Autonomous Prefecture: Yanbian University; 2019.
9. Chen JK. Practical research on the cultivation of mathematical abstraction ability of junior high school students under key competencies. Hefei: Hefei Normal University; 2022.
10. Yin RY, Zhao WK. Investigation on the development of mathematical abstraction of junior high school students based on quality monitoring. Journal of Mathematics Education. 2017;26(01):14-15+63.

11. Wu JL. Cultivation of mathematical abstraction ability of junior high school students from the perspective of core literacy - taking the teaching of application of univariate linear equations in junior high school mathematics as an example. Mathematics Teaching Communication. 2020(02):35-36.
12. Zhao Y. A case study on the cultivation of mathematical abstraction ability of junior high school students. Yinchuan: Ningxia University; 2021.
13. Qiu MW, Zhu HP. How to cultivate students' key competencies in mathematics classroom teaching in junior high school - mathematical abstraction. New Curriculum (Middle). 2018;12:249.
14. Gesaletti Dawuti. The significance of using appropriate teaching methods for mathematics teaching in junior high school. Connecting Beijing and Tianjin - coordinating and promoting the collection of papers on basic education. 2022;2186-2188.
15. Zhong JM. How to cultivate students' mathematical abstraction ability in junior high school mathematics teaching. Proceedings of Academic Forum on Curriculum Education Exploration. 2022; (II):261-263.
16. Lin XF. The cultivation of students' ability from the perspective of junior high school mathematics key competencies. The Big World of Mathematics (first ten-day), 2020; 09:44-45.
17. Zeng YM. Measures to improve students' abstraction ability in mathematics teaching in junior high school. Love science every day (frontier of education). 2020;09:105.
18. Gao J. Innovative teaching strategies penetrate key competencies - a study of junior high school mathematics teaching strategies from the perspective of core literacy. Popular Science Fairy Tales. 2019;27:51.
19. Li Jing. Examples of developing abstraction skills in junior high school students. Middle School Mathematics Teaching Reference. 2022;15:6-9.
20. Yu M. The teaching of mathematical concepts in junior high school with the idea of abstraction literacy under the new curriculum concepts – taking an inversely proportional function as an example. Mathematical Teaching Communication. 2021;29:43-44+66.
21. Zhou WQ. Cultivation of students' mathematical abstraction literacy under key competencies. Course Education Research. 2020;03:174-175.
22. Chang JM. Cultivate abstraction ability and develop mathematical key competencies. Examination Weekly. 2018;49:76.
23. Fan HL. Research on effective teaching of junior high school mathematics classroom based on key competencies improvement. Mathematics Learning and Research. 2022;11:86-88.
24. Yang J. Research on junior high school mathematics teaching under key competencies. Research on mathematical, physical and chemical problem solving, 2022;14:38-40.
25. Xie J. How to cultivate students' mathematical abstraction ability in junior high school mathematics teaching. Intelligence. 2020;36:84-85.
26. Liu GJ. Cultivation of abstraction ability in junior high school mathematics key competencies. Middle School Teaching Reference. 2020;18:23-24.
27. Bao JS. One of the main manifestations of mathematics key competencies in junior high school: Is abstraction ability. China Mathematics Education. 2022;09:4-9+13.
28. Qiu SY. Cultivation of mathematical abstraction ability and mathematical generalization ability in junior high school. Rural Youth. 2019;06:56-57.
29. Lin YY. Strategies for cultivating students' key competencies in junior high school mathematics class. Science Fiction Illustrated. 2022;01:227-228.
30. Wang HY. Rumination on the teaching of junior high school mathematics from the perspective of key competencies. Mathematical Learning and Research. 2020;07:77.
31. Liu P. Analysis of the cultivation of students' core literacy in junior high school mathematics teaching. Academic Weekly. 2021;36:139-140.
32. Lv YJ. An investigation of measures to cultivate students' thinking ability in junior high school mathematics review under the core literacy -- taking the review of the same course of the univariate quadratic equation and quadratic function as an example. Examination Weekly, 2021; 42:61-62.
33. Guan MS. Strategies for cultivating mathematical abstraction ability in junior

high school. The Big World of Mathematics (late). 2021;06:32-33.
34. Sun JP. The teaching importance of reading and thinking in junior high school mathematics textbooks under core literacy. Tianjin Education. 2022;15:165-167.
35. Li Z. Analysis of strategies for cultivating junior high school students' mathematical abstraction ability. New Intelligence. 2018; 15:88.
36. Jiang XF. How to cultivate students' abstraction ability in the process of problem-solving. Mathematical, Physical and Chemical Learning (Junior Middle School Edition). 2019;10:13-14.26.
37. Huang KP. The empirical basis of mathematics. Journal of Henan Normal University (Philosophy and Social Sciences Edition). 1988;02:15-21.
38. Zhu SG. The components of mathematical ability. Journal of Mathematics Education. 1995;03:73-74.
39. Chen J. Clarifying the cognitive misconceptions about key competence of middle school mathematics. Collected Papers of the 6th Teaching Seminar of Guangdong Teachers' Continuing Education Association. 2023;5:1023-1025.

© 2023 Sun and Yang; This is an Open Access article distributed under the terms of the Creative Commons Attribution License (http://creativecommons.org/licenses/by/4.0), which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited.

Peer-review history:
The peer review history for this paper can be accessed here:
https://www.sdiarticle5.com/review-history/104026