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Research Article

Studies on the Strategies of Promoting Positive Transfer in Mathematics Teaching in China

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Abstract: To guide students' learning transfer scientifically in the process of teaching practice for teachers and help students to improve learning efficiency, this study used the literature analysis method to summarize the relevant research on the strategies of promoting mathematics learning transfer in China. The conclusions are as follows: (1) In recent years, the research on the strategies of promoting mathematics learning transfer mainly focuses on four aspects: teaching or learning of mathematical thinking methods, teaching or learning of mathematical knowledge, thinking ability and emotional attitude, and teaching or learning methods. Previous studies are not only in-depth but also have many achievements. (2) We can find some obvious deficiencies by reviewing the previous research. In terms of research methods, most of the previous studies have adopted the method of theoretical speculation with few empirical methods, which greatly reduced the credibility of the research results. In the previous research results, most of the predecessors discussed the methods and strategies directly based on the migration theory, which is still theoretical and less feasible, which made these strategies are very broad and not suitable for direct implementation. (3) There are also some gaps in previous studies. There is almost no research on the evaluation mechanism of the above-mentioned strategic suggestions and little research on the strategies for promoting the transfer of other specific courses of college mathematics, so there is still a lot of space in the research scope.

Keywords: Positive transfer, Mathematics, Promotion, Strategy, Method, Thinking.

1. INTRODUCTION

The psychological research show that the efficiency of students' learning mostly depends on the quantity and quality of students' knowledge transfer. Therefore, the transfer plays an important role in improving learning efficiency and promoting meaningful learning (Li, 2020). At the same time, the current "teaching for transfer" advocated by cognitive psychology also confirms this point, because it conforms to the law of human cognitive development, demonstrates the value orientation different from the traditional teaching concept (Fan, 2009), and is of great significance to students' scientific learning, to teachers' scientific teaching and educational reform and development. In mathematics learning, transfer refers to the mutual influence among mathematics knowledge, mathematics skill, mathematics thought and mathematics method (Chen, 2019). Therefore, to guide students in mathematics teaching and learning more scientifically, promote students' meaningful learning, improve learning efficiency and effect, the strategies and measures to promote students' positive transfer of mathematics in the past are summarized. Through the summary of previous research, we can guide teachers' teaching in teaching practice better, and in the process of summary and reflection, we can learn from previous research experience and lessons, and find the breakthrough of future research.

2. METHOD

2.1 Data Source

All references in this paper are from the CNKI database. CNKI is a large-scale full-text database that covers and integrates various forms of literature such as journals, erudite papers, meeting minutes, newspapers, patents, yearbooks, etc., and it is the most authoritative literature retrieval tool for national academic journals, basically collecting all the contents of journals in China, including all disciplines and fields. Therefore, this paper chooses this database to ensure the persuasiveness and reliability of the research based on the integrity of its literature collection and its great academic influence in China.

2.2 Data Collection

To avoid leaving out documents as much as possible, the author first consulted used "promote mathematics transfer" as the search term, and "theme"

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as the search item. According to the ascending order of publication time, 41 results were retrieved. The earliest one was "*how to promote learning transfer in mathematics teaching*" published by Mao in 1989. After a thorough reading, 14 representative pieces of literature were selected. After that, 22 results were retrieved with "promoting the positive transfer of mathematics" as the search term and "subject" as the search item according to the ascending order of publication time. Based on the research strategies and measures to promote positive migration, some irrelevant or less scientific are eliminated. After searching for "positive transfer of mathematics", we got 250 results. We found that the earliest time to study the strategy of promoting the positive transfer of mathematics was about 1981 after browsing all the literature.

2.3 Data Collation

Although it is not too late to start the research on the strategy of promoting the positive transfer of mathematics in our country, it is found that the depth and breadth of the research are limited after the preliminary browsing of the literature, so there are not too many representative, scientific and professional articles, so the author uses the method of taking notes to read the literature and sort out the previous research results. In the process of reading literature, the author summarized the research methods, research problems, research results and conclusions in each literature. After reading and sorting out all the documents, the author initially thinks that the current research mainly focuses on four aspects: the strategy for mathematical knowledge, the strategy for mathematical thinking methods, and the strategies for methods and the strategy for students' thinking.

3. The Current Situation of Strategy Research on Promoting Positive Transfer of Mathematics Learning

3.1 Strategies for teaching and learning mathematical knowledge

Zhou pointed out that the similarity among mathematics learning materials is a major factor affecting students' migration. From the relationship between the new and old knowledge, he proposed to teachers that they should guide students to reveal the common elements between the new and old knowledge and strengthen the cultivation of students' knowledge generalization ability (Zhou, 2006). Yang believes that the introduction of new knowledge through the practice of old knowledge which is closely related to new knowledge can effectively strengthen the relationship between new and old knowledge and promote the transfer (Yang, 1996). Dang believes that students should be proficient in the basic knowledge and skills they have learned. There is a close relationship between these contents and new knowledge, and attention should be paid to the cultivation of students' generalization and analysis ability in this process (Dang, 2013). Chen's comparative teaching experiment shows that when teaching knowledge, teachers should arrange the contents of teaching materials, put the same or similar but substantially different contents together for centralized teaching, and pay attention to the teaching of concepts, rules and terms so that students can not only know what it is, but also know what it is, to guide students to have the positive transfer to the greatest extent (Chen, 1983).

Luo proposed that we should pay attention to the study of basic concepts and principles of mathematics, accurately understand the connotation and extension of concepts, and incorporate them into our experience system, which is an important prerequisite for guiding follow-up learning and positive transfer (Luo, 2006). He thought that we should pay attention to the order of teaching and try to introduce new knowledge based on recalling old knowledge (He, 2019). According to Gao, we should pay attention to the relationship between the old and new knowledge, cultivate the ability of generalization, reveal the similarities and differences among knowledge, organize scientific exercises to eliminate the negative transfer to the greatest extent, and promote the positive transfer (Gao, 2016). Wang believes that teachers should organize teaching scientifically based on understanding the content of teaching materials. In teaching, students should understand the basic principles of knowledge to promote the transfer of principles and rules and master the basic knowledge to promote the assimilation of new and old knowledge (Wang, 2002). Tang and others think that in addition to improving students' knowledge generalization level and mastering basic concepts, principles and thinking methods, it is also necessary to prevent the negative transfer and promote positive transfer from two aspects: improving the understanding degree of original knowledge, comparing and discriminating easily confused knowledge (Tang and Wan, 2005).

He believes that students should learn concepts and improve the ability to analyze problems through repeated practice of basic knowledge (He, 1984). Sun and others think that we can use the performance function of information technology to show students mathematics concepts, axioms, theorems and other knowledge (Sun and Wei, 2006). Ning suggested that teachers should create many conditions to promote knowledge transfer in mathematics teaching, such as adopting new guided knowledge teaching, strengthening students' understanding of knowledge, and improving students' generalization level of knowledge and experience (Ning, 2014). Chen believes that teachers should guide students to change their learning methods in the process of mathematics learning, strengthen the practice of knowledge consolidation, and adjust teaching content according to teaching experience and students' needs (Chen, 2017). Li thinks that the key to promoting students' positive

transfer of mathematics is that teachers should make a deep analysis of the connotation of concepts so that students can understand the basic concepts thoroughly (Li, 2002).

In the process of sorting out the previous literature, it is found that the strategies of teachers' teaching and students' understanding and generalization of knowledge account for a large proportion. Almost every literature emphasizes the importance of the understanding and generalization of mathematical knowledge for the generation of positive transfer. The above strategies for knowledge teaching and learning can be roughly divided into three aspects: first, teachers should understand the contents of teaching materials to scientifically organize the order of knowledge teaching and reasonably arrange the contents of teaching; second, students should strengthen the understanding and mastery of mathematical knowledge and improve the level of knowledge generalization; Thirdly, teachers should pay attention to the teaching of basic knowledge such as mathematical concepts, principles and rules, to ensure that students can understand them, and at the same time, they should arrange exercises scientifically for basic knowledge to enhance the consolidation of students' basic knowledge. It can be seen from this that students' understanding and mastery of knowledge, teachers' scientific arrangement of teaching contents, students' ability to analyze and summarize knowledge affect students' follow-up learning. If these aspects are valued and the current situation is improved, students will be greatly promoted to have the positive transfer of mathematics.

3.2 Strategies for Mathematical Thinking Methods

Zhang thinks that paying attention to the basic thinking methods of mathematics is an effective way to promote students to produce positive transfer and let students know the essence of various thinking methods (Zhang, 2013). Ma believes that ideas and methods of mathematics are the essential understanding and high generalization of mathematics knowledge and skills, the guiding ideology of learning mathematics and applied mathematics, and the important guarantee of realizing extensive migration (Ma, 2003). According to Shi and others, teaching vocational college students with mathematical modeling can not only let students understand the origin and development of problems, grasp their essence, but also develop students' thinking of induction, thinking and solving problems (Shi *et al.*, 2013). Mi thought that mathematical thinking methods are helpful to cultivate students' generalization ability; the formalization and generalization characteristics of mathematical thinking methods can promote the transfer of mathematical problem-solving, improve students' cognitive structure and promote the occurrence of positive transfer (Mi, 2011).

Zhang and others think that mathematical thinking methods include mathematical discovery thinking methods and solving logic methods. The process of mathematical solving is the process of repeated use of mathematical thinking methods. Teachers should pay attention to the teaching of thinking methods to cultivate students' creative ability (Zhang and Feng, 1997). Through empirical research, Mo put forward suggestions to junior high school mathematics teachers that they should pay attention to the infiltration of mathematical thinking methods, and that teachers should carry out the teaching of thinking methods in the process of using questioning strategies so that students can form a rational understanding of mathematical knowledge and methods, so as to promote the positive transfer of problem-solving (Mo, 2018). Xiong *et al.* studied the transfer teaching of complex variable function in engineering and thought that in the teaching of complex variable function, teachers should strengthen the connection teaching of higher mathematics and this course, and pay attention to the teaching of thinking methods such as transformation and analogy (Xiong *et al.*, 2010). Zhou and others used case study method to study how to induce transfer in mathematical analysis courses and thought that teachers should pay attention to the teaching of ideological methods to promote students to have positive transfer (Zhou and Li, 2007).

It can be seen from the above-mentioned induction and arrangement of thinking methods and strategies that researchers generally agree that "mathematical thinking methods are a red line throughout the teaching and learning of mathematical knowledge". Mathematical thinking methods are generalization and formalization of mathematical knowledge. If the essence of students' mathematical problem-solving process is raised to the height of mathematical thinking methods, it is the process of repeated use of various mathematical thinking methods for the continuous transformation of concepts, formulas and theorems. It can be seen that mathematical thinking methods are the key for students to grasp the essence of mathematical problems and solve mathematical problems. Therefore, to promote students to have positive transfer of mathematics, teachers should permeate the teaching of mathematical thinking methods in knowledge teaching, let students understand the context of thinking methods, learn to refine mathematical thinking methods in mathematical problems, These generalized thinking methods will have a positive impact on the follow-up learning of students, thus promoting the transfer of students in the process of problem-solving.

3.3 Strategies for Mathematics Teaching (Or Learning) Methods

According to Lu, teachers should set up vivid situations reasonably to induce students to have positive transfer, such as connecting mathematics problems with real life, using multimedia teaching methods to stimulate students' interest in learning, etc. (Lu, 2014).

According to Yang, teachers can build a bridge to produce positive transfer using physical operation demonstration, question guidance and students' learning methods of trying to learn by themselves and questioning by themselves, give full play to students' subjective initiative, mobilize students' interest in learning, and thus induce positive transfer to the greatest extent (Yang, 1996). Wu and others think that teachers can use the teaching strategies of a combination of number and shape, a combination of movement and static, separation and combination to help students understand the essence of mathematical problems and promote problem-solving (Wu and He, 2013). Duan thinks that teachers should pay attention to the combination of mathematical problems and real-life, let students understand mathematical concepts with life-oriented language, show students mathematical conclusions with life principles, and let students practice knowledge points with life phenomena as materials (Duan, 2015).

Zhou proposed to use the training method of "one problem with multiple solutions", broaden students' thinking, and carry out more variant training, so that students can fully understand the problem and grasp the essence (Zhou, 2015). Li put forward the method of "breaking before setting up", that is, to guide students to overthrow the mistakes caused by negative transfer first, and then to clarify the essence of the concept. Only in this way can we not avoid contradictions, understand superficially, or prevent troubles in advance (Li, 2002). Zhao thinks that teachers should adopt the teaching methods of inspiration, analogy and association to improve the transfer speed; they also should make full use of the modern teaching methods, in the form of audio-visual teaching to present the action and static, and deepen students' understanding (Zhao, 2002). Li discussed the causes and preventive measures of negative transfer, and put forward to let the students master the basic concepts by connecting teaching methods (Li, 1993). Zeng proposed that teaching should be guided by Gagne's theory of intelligent skill level, which is helpful to teach students the method of learning knowledge transfer, that is, the previously learned intelligent skills promote the learning of new higher-level intelligent skills (Zeng, 2006). Sun and others studied the important role of information technology in promoting students' positive transfer. They believed that students should experience the mathematical process of "discovery learning" with the help of information technology, use network resources reasonably to strengthen the interrelationship between mathematics and other knowledge, and promote students' positive transfer of computer-related mathematical skills (Sun and Wei, 2006).

Li takes the similar problems in mathematics as the research object, and the validity of the migration taking "compression solution" as the medium is verified, that is, learning to abstract strategic knowledge from the problem situation and solution method of the example (Li, 2000). Zhang and others put forward the "abstract degree analysis method" that is, giving three indicators to different abstract degrees of mathematical knowledge to quantify its profundity and importance by introducing concepts such as "order" and "chain" to describe the different ways of knowledge evolution (Zhang and Feng, 1997). Zhou thinks that teachers should be good at using variant exercises, series exercises, basic exercises and association exercises to help students consolidate the foundation of positive transfer, promote thinking mode, master the rule of solving problems, and then transfer mathematics learning more effectively (Zhou, 2012). Mo used classroom observation and questionnaire method to affirm the value of questioning strategy in actual teaching, analyzed the classroom records of teachers using questioning strategy and compared the results of students' pre-test and post-test to verify the positive role of questioning strategy in promoting the positive transfer of mathematics problem-solving of junior high school students (Mo, 2018). Ye studied the application strategy of transfer theory in linear algebra teaching. He thinks that teachers should help students first establish the "knowledge point structure diagram" model with the help of a concept diagram, which can help students to establish a good cognitive structure (Ye, 2011).

From the above summary of teaching and learning strategies, it can be seen that whether teaching or learning, mastering scientific and effective methods is a powerful tool to promote students' positive transfer. From the perspective of teaching means and methods, predecessors have put forward many suggestions, such as the combination of modern information technology and knowledge, the creation of vivid question situations to introduce knowledge, the integration of mathematical knowledge into practical life applications, classroom questioning strategies, etc., which are all effective ways to stimulate students' interest in learning and induce migration. From the perspective of learning methods, the former emphasis on variant training and comparative practice, discovery learning, questioning self-learning, trying to self-learning, "compression solution" and learning methods with the help of information technology also have a guiding role for students' learning.

3.4 Strategies for thinking, ability and emotional attitude

Zhou thought that good thinking quality and ability as well as thinking stereotypes had a positive effect on students' migration (Zhou, 2006). Dang thinks that teachers should cultivate students' positive learning attitudes towards mathematics, and only when they have interest can they actively explore and study, and induce transfer (Dang, 2013). Zhou thinks that if we combine positive transfer and retroactive transfer, we can form a new transfer mode, called retroactive

positive transfer. Its use will enable students to expand their original knowledge into new knowledge and gain more profound significance. Therefore, we should pay attention to the cultivation of students' converse thinking in teaching (Zhou, 2015). Ma thinks that the way to realize transfer is association. The premise of association is flexible thinking, which depends on solid basic knowledge reserve. The key to cultivate the students' flexibility of thinking is the quality of problem-solving (Ma, 2003). To promote positive transfer, Huai thought that teachers can classify knowledge and problem-solving methods, develop students' thinking of seeking common ground, and form a fixed thinking pattern (Huai, 1999).

Zhao believed that teachers should pay attention to the cultivation of students' multi-directional thinking, broaden their horizons, especially converse thinking, so as to cultivate students' ability to promote migration; they should also give full play to the positive role of stereotype, overcome the influence of negative stereotype, promote the development of thinking, and contribute to the occurrence of positive migration (Zhao, 2002). Cao changed his research perspective and thought that teachers should pay attention to guiding students to differentiate their thinking and distinguish the differences of knowledge, which is helpful to produce more effective transfer (Cao, 2017). According to Mao, the mental set can promote the occurrence of positive transfer, and also can interfere with it. Therefore, teachers should pay attention to guiding students to form mental set that is conducive to new knowledge learning (Mao, 1989). Ning thinks that the interference of stereotyped thinking mainly comes from intuitive thinking. To eliminate this interference, teachers need to create a problem situation in which students use intuitive thinking and analytical thinking, or a problem situation in which students use divergent thinking and converse thinking, so as to guide students to transfer knowledge deeply and effectively (Ning, 2014). Ji studied the influence of analogy on the transfer of university mathematics knowledge and proposed that teachers should pay attention to the cultivation of students' thinking flexibility and increase the frequency of association to induce the transfer (Ji, 2016).

Through the induction of this part, we can see that the way to realize transfer is the association, which is a complex thinking activity in the human brain, so the development of students' thinking has become the key to induce students to have the positive transfer. In the process of teaching, consciously developing students' positive thinking set, eliminating the negative interference of thinking set, cultivating flexible and divergent multiple thinking and converse thinking can help students to establish a close relationship with the knowledge they have learned, increase the number of connections, and then promote the occurrence of association activities, which can also more effectively induce students to carry out positive transfer activities. It should be noted that the foundation of association is to have a solid basic knowledge structure system. Only in this way, students will not be confused and a sense of chaos when the association is carried out. Also, previous studies mentioned that students' interest and enthusiasm in mathematics learning and other positive emotional attitudes can lead to positive transfer. Students' positive emotions can mobilize students' subjective initiative, make students spontaneously discover, explore and solve problems. Students' active thinking can help to generate more positive transfer.

4. DISCUSSION

It can be seen from the above sorting out of the current situation of the research on positive transfer promoting strategies that predecessors mainly discussed the strategy from four aspects: knowledge teaching and learning, ideological methods teaching or learning, teaching or learning method strategies, thinking ability and emotional attitude. In the aspect of knowledge teaching and learning, the predecessors thought: first, teachers should arrange teaching contents reasonably. Second, students are required to strengthen understanding and mastery of the basic knowledge and skills of mathematics, improve the level of generalization of knowledge, and grasp the universality and generality of the meaning of basic knowledge, because understanding the essence of basic knowledge is the solid foundation for generating positive transfer of mathematics, and grasping the commonness of basic skills is the prerequisite for generating positive transfer. Third, teachers should arrange exercises for basic knowledge science to enhance students' consolidation of basic knowledge, such as arranging some comparative exercises and variant exercises; In the teaching and learning of thinking methods, researchers mostly agree that mathematical thinking methods are generalized and formalized mathematical knowledge, which is the key for students to grasp the essence of mathematical problems and solve mathematical problems, the guiding ideology for learning mathematics and applied mathematics, and the important guarantee for realizing extensive migration. Therefore, teachers should infiltrate the teaching of mathematical thinking methods, and students should learn to refine mathematical thinking methods in mathematical problems, which will have a positive impact on students' follow-up learning, thus inducing students to have a positive transfer.

In terms of the strategy of the methods, the previous research mainly divided into the discussion of the teaching method and learning method, such as the teaching method of "breaking first and then setting up", the classroom questioning teaching strategy, the network teaching method, the situational introduction method and other teaching methods. The learning methods mainly include "abstract degree analysis", "compression solution", discovery learning, trial self-

learning, questioning self-learning, variable training , contrast exercises, etc. In terms of the strategies of thinking ability and emotional attitude, the previous research advocated to enhance the flexibility of students' thinking through training, use the positive role of thinking set, overcome the negative interference, develop the convergent thinking, at the same time, pay attention to the training of divergent thinking, converse thinking and other different perspectives. Besides, teachers should create a vivid learning situation to stimulate students' interest in learning. Students' thinking agility can enhance the association frequency, and the realization way of transfer is association; also, students' learning interest will make students actively explore, solve problems, carry out thinking activities, and then induce transfer. It can be seen from the above that the previous studies have been very extensive, and some of them have a certain depth.

However, it can also be seen from the above that there are still some deficiencies in the previous studies, such as the research methods applied by the predecessors. In the past, most of the studies were based on the migration theory, and some of them were based on the classroom teaching cases, which weakened the professionalism and research-oriented to a certain extent. Only a small number of researchers use quantitative research methods such as questionnaire surveys and experimental methods, which greatly reduces the persuasiveness of the research. Another is the strategic suggestions put forward by previous studies. In previous studies, many strategic suggestions are put forward by researchers based on migration theory and speculation. Even if some teaching cases are combined, they are still not flexible enough and are not really combined with teaching practice and experience, so these measures are very broad and should not be directly implemented. Therefore, based on the existing research, it is necessary to improve the research methods and adopt more scientific methods to further explore how to maximize and effectively induce positive transfer of students in mathematics teaching from the perspective of implementation.

In addition to the above defects, there are also some gaps in previous studies. For example, there is almost no research on the evaluation mechanism of the above strategies, which leads to the inability to judge whether these strategies are effective; In addition to the three higher mathematics courses, complex function, linear algebra and mathematical analysis, which are involved in the review, there is little research on promoting transfer strategies for other specific courses of college mathematics, and there is still a lot of research space; moreover, the strategies of promoting positive transfer in college mathematics teaching are the same as the strategies of taking primary and secondary school students as the object. Based on the current achievements, in-depth research on the migration strategy which is especially suitable for college students is also one of the blank points. Therefore, it is necessary to expand the scope of future research to make this research more systematic and comprehensive.

5. CONCLUSIONS

It is of great value to review and summarize the research on strategies to promote students' positive transfer in mathematics. Through reviewing, combing and analyzing previous studies, this study found that:

(1) In recent years, the research on how to promote the positive transfer of students' mathematics mainly focuses on four aspects: teaching and learning of mathematical thinking methods, teaching and learning of mathematical knowledge, thinking ability and emotional attitude, and teaching or learning methods. Previous studies are not only in-depth but also have many achievements.

(2) Reviewing the previous research, there are some obvious deficiencies. In terms of research methods, most of the previous studies have adopted the method of theoretical speculation, with few empirical methods, which greatly reduce the credibility of the research results. In the previous research results, most of the predecessors discussed the methods and strategies directly based on the migration theory, which are still theoretical and less feasible, and these strategies are very broad and not suitable for direct implementation.

(3) There are also some gaps in previous studies. For example, there is almost no research on the evaluation mechanism of the above-mentioned strategic suggestions; Besides the three kinds of college courses involved in the review, there is little research on the strategies of promoting the transfer of other specific courses of college mathematics, so there is still a lot of space in the scope of research; On the basis of the current research results, in-depth research on the transfer strategies specifically suitable for college students can also be one of the future research directions.

Therefore, future research must improve research methods and adopt scientific methods based on existing research, and further explore how to more effectively promote students' positive transfer in mathematics learning from the perspective of implementation; It is necessary to study the strategies and suggestions of promoting students to produce the positive transfer of mathematics from a broader perspective to make this study more comprehensive, systematic and in-depth.

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