Research on Strategies of Cultivating High School Students' Sense of Mathematical Self-efficacy

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Keywords: High School Students; Mathematical Self-efficacy; Strategies

Abstract: With the advancement of the new curriculum reform, the curriculum concept increasingly emphasizes that in the process of mathematics teaching, not only the development of students' intelligence should be paid attention to, but also the cultivation of students' non-intelligence factors. As a non-intellectual factor, self-efficacy has received great attention. This article first introduces the current research status of self-efficacy at home and abroad, and then analyzes the sources of factors that affect self-efficacy, and finally combines theories of success or failure attribution and recent development area to propose strategies for cultivating high school students' mathematics self-efficacy. So as to better promote the development of students' psychological characteristics and further improve the quality of teaching.

1. Introduction

The new curriculum reform emphasizes that we should pay attention to the non-intellectual factors in the learning process of students, and the three-dimensional goals proposed by the Mathematics Curriculum Standards for Compulsory Education (2011 Edition) include emotional attitudes and values[1]. In the process of mathematics teaching, we should not only pay attention to the development of students' intelligence, but also pay attention to the cultivation of students' non-intelligence factors. The self-efficacy of mathematics is an important non-intelligence factor, which is of great significance to the development of students. At present, the sense of self-efficacy is a hot topic in the field of psychology. For students, the sense of self-efficacy is a special emotional feature in the learning process. In the process of learning mathematics, the level of self-efficacy plays a key role in students' learning. A high level of self-efficacy can better promote the physical and mental development of students. So theoretically, the study of mathematical self-efficacy is very valuable. For high school students, this period is the key stage of the development of psychological characteristics, so it is particularly important to understand the current situation of students' self-efficacy in mathematics.

2. Literature Review

2.1. Research Review

2.1.1. Foreign Research Status

In 1954, the American Cough was the first to recognize the phenomenon of “a large number of people who are afraid of mathematics”. In 1977, Bandura put forward the concept of self-efficacy for the first time, that is, “a person's subjective judgment of whether he can successfully carry out a certain behavior” [2]. In 1996, Wigfield, Pintrich et al. found that female students' self-efficacy in mathematics learning was lower than male students in junior middle school [3].Virginia et al. (2014) found the influence of self-efficacy perception on academic performance [4].

In the 1980s, a lot of research on self-efficacy was carried out abroad, and it was widely used in many fields. Through a literature search, it is found that the number of foreign literatures on

mathematical self-efficacy is very small, mainly at the level of professional fields.

2.1.2. Domestic Research Status

Domestic research on self-efficacy began in the 1980s. In 1994, Zhou Yong and Dong Qi published “Research on the Relationship between Learning Motivation, Attribution, Self-efficacy and Students' Self-Monitored Learning Behavior” in the Journal of Psychological Development and Education. The article pointed out that there is a significant correlation between self-efficacy and learning methods [5]; In 2006, Zhang Changjun argued in Practical Research on Cultivating Middle School Students' Sense of Mathematical Self-efficacy that there was a positive correlation between junior high school students' sense of mathematical self-efficacy and math achievement [6]. Gao Huan and Chen Liansheng(2019) proposed that self-efficacy in mathematics learning can directly affect academic achievement[7].

In a word, domestic research on self-efficacy is not as early as western countries, and there are also few articles on self-efficacy in various disciplines. The existing research on self-efficacy in mathematics is not rich.

2.2. Concept Definition

2.2.1. The Concept of Self-efficacy

The representative figure of self-efficacy theory is the American psychologist Bandura. He believes that researchers only value knowledge or only behavior, ignoring the close connection between knowledge and behavior. Therefore, he proposed the concept of self-efficacy, which refers to people's subjective judgment on whether they can successfully perform a certain behavior [8]. People’s self-efficacy is not inborn, but is acquired in the interaction between individual self, behavior and environment. The mutual influence between them is uninterrupted. Once one of the factors changes, the other two factors will also change accordingly, which will affect self-efficacy. Based on the actual situation, the sources of factors that affect self-efficacy are divided into four parts, as shown in Table 1.

Table 1. Sources of influencing factors of self-efficacy

Classify	Concept
Direct experience	It shows that the individual has achieved success in behavioral activities, and most powerfully affirms that the individual has the ability to achieve success.
Substitute experience	It is a kind of indirect experience, which is the judgment of self-behavior produced by the individual in the process of observing the behavior and results of others.
Verbal persuasion	It means to obtain the belief and expectation of oneself to achieve the goal successfully from the language of encouragement, advice and suggestion of others.
Emotional response	That is, the individual’s physical and mental reaction when facing a certain activity task.

2.2.2. The Concept of Mathematical Self-efficacy

In this paper, the author defines the concept of mathematical self-efficacy as the judgment or evaluation of whether students can successfully complete a certain mathematical task by using the basic mathematical knowledge, basic skills and basic experience they have learned[9]. Such judgment is subjective and limited to the mathematical field. According to the sources of self-efficacy, the sources of influencing factors of mathematical self-efficacy are also divided into four parts, and the specific concepts are shown in Table 2.

Table 2. Sources of influencing factors of mathematical self-efficacy

Classify	Concept
Direct experience	Refers to the success or failure experience directly obtained in previous mathematical activities.
Substitute experience	In previous mathematical activities, by comparing with other students' mathematical achievements, so as to improve or reduce their own mathematical self-efficacy indirect experience.
Verbal persuasion	Evaluation or persuasion by peers, teachers, or parents to convince students that they can successfully cope with a previously feared mathematical situation or activity.
Emotional response	In the process of mathematical activities, students' physiological and emotional reactions change their mathematical self-efficacy by influencing the process of mathematical cognitive processing.

3. Theoretical Basis

3.1. Attribution Theory of Success or Failure

Attribution is the explanation and evaluation made by people about the causes of their own or other people's activities and their results. That is, after a certain task is over, people summarize what caused these results. American psychologist Weiner attributed success or failure to three dimensions and six factors. The three dimensions are internal attribution and external attribution, stable attribution and unstable attribution, controllable attribution and uncontrollable attribution; the six factors are ability level, effort level, task difficulty, luck, physical and mental condition and external environment. Attribution has a great influence on students' behavior, expectations and emotions. This shows that the theory of self-efficacy and the theory of success or failure attribution have a certain internal connection, the level of students' self-efficacy is often inseparable from the way of success or failure attribution.

3.2. Zone of Proximal Development Theory

Zones of proximal development were put forward by Vygotsky, an educator of the former Soviet Union. Zones of proximal development refer to the gap between a student's current level and the higher level that can be achieved with the help of others. Teaching and development have an inseparable connection, determines the content, speed, level and other aspects of student development, it must go in front of the existing level of student development. Mathematics teachers can use this theory to better promote the development of students' sense of self-efficacy.

3.3. Theory of Self-worth

The self-worth theory is represented by the American educational psychologist Covington, who divides motivation into four types. The specific contents are shown in Table 3.

Table 3. Motivational classification table of self-worth theory

Type	Concept
High trend low avoidance	Also known as an "optimist", he has infinite curiosity, works hard, and is confident and resourceful.
Low trend high avoidance	Also known as "escape from failure", the interest in the course and study is not too high, has the ability but does not work hard.
High trend and high avoidance	Also known as the "overachiever", "hidden learner", to a task to show both pursuit and rejection of the mood.
Low trend and low avoidance	Also known as "failure takers," neither expect success nor fear failure.

This theory can explain the conflict between teachers' and students' views on effort, and teachers can take corresponding measures to guide students to conduct correct self-evaluation and improve

their sense of self-efficacy.

4. Cultivation Strategies

4.1. Increase the Experience of Personal Success

Previous learning experiences have the most important influence on personal self-efficacy. Experiences of success and joy can help cultivate self-efficacy. Conversely, experiences of bad failures will lead to a decrease in self-efficacy. In the process of teaching, teachers should let students gain more successful experience in the process of learning mathematics. First of all, the teacher should take the student as the main body, fully mobilize the student's initiative and enthusiasm, use the student's proximal development area, and take the induction way to inspire the student to succeed step by step. At the same time, we should pay attention to students' doubts and give those help and encouragement appropriately, so that students can fully understand and master what they have learned, flexibly and comprehensively use knowledge, so as to cultivate students' thirst for knowledge and self-confidence. In addition, for comprehensive knowledge points or mathematical problems, cooperative teaching mode can be adopted. Students can have group discussion and learn to express their own views. It is easier to experience the joy of success. For the students who experience failure, teachers should timely guide them to formulate scientific and reasonable teaching objectives and learning strategies, cultivate students' sense of mathematical self-efficacy, so as to promote the improvement of mathematical performance.

4.2. Give Full Play to Surrogate Role

The substitution role is mainly carried out through observational learning. Observational learning is to have certain cognition of one's own abilities by observing the behavior of others, so as to avoid certain behaviors, and can also "learn from each other's strengths". Teachers' words and deeds will deeply affect students. The teacher’s explanation of mathematics problems will give students a certain role model. Students will put themselves into the role of the teacher to judge whether they can learn this behavior. Students will put themselves into the role of the teacher to judge whether they can learn this behavior, which has an incentive effect in a certain sense, so as to improve students' sense of mathematical self-efficacy. On the other hand, the role model of peers will also promote the generation and development of students' sense of self-efficacy. In the learning process, based on the answers of their peers to a certain math problem, students judge whether they can master the method to solve this math problem through comparison. Therefore, teachers should provide different levels of role models for students at different levels. However, teachers should pay attention to the fact that the selected role model must play a positive role, so as to encourage students' self-confidence, strengthen students' sense of self-efficacy, and promote the progress of mathematics learning.

4.3. Positive Use of Verbal Evaluation

At present, most students in adolescence are very concerned about other people's evaluation of themselves, especially teachers' views of themselves, so teachers can use this to help students improve their mathematics self-efficacy. In mathematics teaching activities, when students perform well, teachers give appropriate encouragement or praise, which will increase students' self-confidence in mathematics; conversely, when teachers give severe criticism, it will have a negative impact on students. Therefore, teachers should analyze specific situations in detail, actively use the "Pygmalion effect", and constantly use verbal hints and persuasion to enhance students' sense of self-efficacy. For students of different levels, teachers can have different requirements for them. Combining the theory of self-worth and the theory of recent development zones, the mathematics tasks assigned must meet the actual level of the students, but they must be challenging, and they can be completed by the students through their own efforts. In addition, teachers should also pay attention to student feedback, reflect on which aspects of themselves need to be improved and which aspects have a positive impact on students, form a scientific and reasonable evaluation

system, and exert the best effect of verbal persuasion.

4.4. Guide Students to Make Scientific and Reasonable Attribution

In the process of learning mathematics, almost all students will experience success or failure. Different students have different attribution ways, which have different influences on individuals. Students always have a new understanding of themselves after each test or successful solution to a question. Students with high test scores or correct problem solving will attribute their success to their own ability and effort, while students with poor grades and unable to solve problems correctly will attribute the reasons to uncontrollable factors such as insufficient self-ability, bad luck, etc. Over time, it will have a negative impact on students, which is not conducive to the growth and development of students. Therefore, teachers should train students' attribution mode according to the actual situation, and correctly guide and constantly strengthen students' scientific attribution. When students succeed, guide them to affirm their own efforts and ability; when they failed, they were instructed to attribute the failure to controllable factors such as not working hard enough or learning methods. This will further stimulate children's learning motivation, give full play to the positive role of effort attribution, enhance students' self-confidence, cultivate mathematical self-efficacy, and help students improve their mathematical performance.

4.5. Create a Relaxed and Pleasant Educational Situation

Emotional state is one of the factors that affect self-efficacy. A relaxed and harmonious classroom atmosphere can promote the development of students' sense of self-efficacy. On the contrary, a tense and serious classroom atmosphere is not conducive to the improvement of students' sense of self-efficacy[10]. In teaching activities, the emotional state of students will affect their processing of mathematics cognition, and different emotional states will have different motivations for achievement, which also affects mathematics self-efficacy to a certain extent. Therefore, teachers should create a relaxed and happy teaching situation for students, arouse students' positive emotional experience in mathematics, and let students maintain a positive and optimistic attitude to enter the mathematics classroom. At the same time, creating a relaxed educational situation is inseparable from a good teacher-student relationship. Mathematics is a rigorous subject. Most students will have a "smile" stereotype about mathematics teachers, which brings psychological pressure to students to a certain extent. Therefore, teachers should love, understand and respect students, be patient, confident, careful and caring for students, be able to establish an equal and harmonious teacher-student relationship with students, and lay a solid foundation for cultivating students’ sense of self-efficacy in a subtle process. Foundation.

5. To Summarize

By referring to relevant literature, this paper understands the research status of mathematical self-efficacy. Based on the sources of influencing factors and related theories of self-efficacy, this paper puts forward strategies to cultivate the sense of mathematical self-efficacy of high school students. In the future teaching work, the author will apply the research conclusions to practical teaching, and carry out detailed and in-depth quantitative research on students' mathematical self-efficacy, so as to put forward more effective training strategies.

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