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An Exploration of the Path of Moral Education Infiltration in High School Mathematics Subjects

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Abstract
In High school mathematics classroom teaching, moral education infiltration is an inevitable requirement for the implementation of the fundamental task of fostering character and civic virtue. The elements of moral education in mathematics can be divided into four dimensions: "Rationality", "Humanity", "Personality" and "Responsibility". Taking the elements of moral education in mathematics as the starting point and combining the basic characteristics of moral education infiltration in the subject, the path of moral education infiltration in high school mathematics is explored: the infiltration of "rationality" and "humanity" through the integration of moral intelligence. The path of moral education infiltration in high school mathematics is explored: the infiltration of the elements of "rationality" and "humanity" through the integration of moral intelligence; the infiltration of the elements of "personality" and "responsibility" according to typical patterns.

Keywords: *Moral education in mathematics; Connotation; Infiltration; Pathway*

Education is not only about teaching, but also about nurturing. The fundamental aim of education is to promote the all-round development of the individual, so that he or she not only learns knowledge and masters skills, but also improves cultivation and forges moral character. Since the 18th Party Congress, the Ministry of Education has made fostering character and civic virtue a fundamental task of education. Fostering character and civic virtue is linked to subject teaching, and the key to implementing the fundamental task of fostering character and civic virtue is to practice moral education in the subject.

1. Connotations and elements of moral education in mathematics

Subject moral education mainly refers to a form of moral education that integrates the connotation of moral education and its subject characteristics to infiltrate moral education in the teaching of various subjects, so as to realise the integration of teaching and character education of various subjects, or the infiltration of moral education by teachers of various subjects in combination with teaching contents [1]. For the subject of mathematics, moral education in mathematics means that mathematics teachers combine the elements of moral education and the characteristics of the subject of mathematics to carry out moral education infiltration in classroom teaching, so as to realize the nurturing value of the subject of mathematics.

To practice moral education in mathematics, we must first clarify the essence of the connotation of moral education in mathematics. Professor Zhang Dianzhou also divided the moral education in mathematics into three dimensions: HUMANITY spirit, scientific literacy and moral quality [2]. Dr Li Xiaoni conducted an empirical study based on Professor Zhang Dianzhou's division and constructed a framework for classifying the connotative elements of moral education in mathematics [3], as shown in Table 1.

Table 1: Framework for classifying the connotative elements of moral education in mathematics

Type	Specific connotations
Rationality	Learning mathematics can train students to think critically, help them analyse problems from multiple perspectives and dialectically, cultivate the virtue of seeking truth from facts and reasoning, and cultivate their appreciation of the beauty of mathematics, etc.
Humanity	Mathematics learning can help students understand the process of human pursuit of truth; cultivate the spirit of perseverance, hard work and exploration; the more frustrated students are, the braver they are; cultivate students' critical spirit and the awareness and habit of examining their own learning status
Personality	Students are taught to be non-self-centred, to learn from others and to think from their perspective.
Responsibility	Learning mathematics develops students' awareness of social rules, patriotism, multiculturalism, etc.

2. The path of moral education penetration in high school mathematics

Based on the above table, the connotative elements of moral education in mathematics are divided into four areas, and the permeation of these four elements in classroom teaching is the key to practising moral education in mathematics. One of the fundamental characteristics of moral education in mathematics is its permeability, and this is also true of moral education in mathematics. Based on this characteristic of permeability, the following approaches can be taken to implement moral education in mathematics. On the one hand, teachers can infiltrate moral education into the teaching of knowledge by integrating the elements of "rationality" and "humanity" through moral intelligence. On the other hand, teachers can lead students to learn about the outstanding qualities of mathematicians and infiltrate the elements of 'character' and 'responsibility' according to the typical examples.

2.1. The integration of ethics and wisdom with elements of 'rationality' and 'humanity'

Moral and intellectual integration means linking the teaching of knowledge in mathematics with moral education, achieving an organic blend of the two. It is a form of internal infiltration of the moral education embedded in the subject of mathematics. Unlike external moral indoctrination, it is more natural and easier to develop good moral qualities in students.

2.1.1. Exploring mathematical ideas and penetrating the element of "rationality

The General High School Mathematics Curriculum Standards (2017 Edition) states that "Mathematics plays an irreplaceable role in forming one's rationality thinking, scientific spirit and in promoting one's intellectual development [4]." How can students' rationality thinking be developed through mathematics teaching? Mathematical thinking is the soul of mathematics, which can reveal the essence of mathematics and link all aspects of mathematical knowledge [5]. The infusion of mathematical ideas in the teaching process helps students to develop rationality thinking and scientific spirit, thus penetrating the element of "rationality".

For example, for the "equidistant series of the first n terms and formula" teaching, you can infiltrate mathematical ideas to develop students' rationality thinking. The key to this lesson is the transformation of the first and last pairing method to the inverse sum method. In the teaching process, the story of Gauss is introduced and students are guided to find the sum of $1+2+3+\cdots+100$ so that they can appreciate the first and last pairing method. Further, from the particular to the general, students are asked to find the sum of $1+2+3+\cdots+n$. At this point students are still thinking in terms of the first-tail matching method and will naturally follow this method, so it is necessary to discuss the parity of n at this point. By sorting and discussing, students obtain that the sum of n is $\frac{n(n+1)}{2}$, regardless of its parity. At this point, the question is asked, since the sum of A is independent of the parity of n, can we have an easy way to calculate the sum of A directly, and avoiding categorical discussions? In this way, the mathematical idea of adding numbers in reverse order is introduced. Furthermore, it can be applied to the general summation of series of equal differences to obtain the formula for the sum of the first n terms of a series of equal differences.

In the above case, students are guided to transform numbers that cannot be easily added directly into numbers that can be added directly, and to achieve the transformation of the first and last matching method to the reverse order addition method, which permeates the mathematical idea of transformation[6]. The idea of transformation is a fundamental idea in mathematics. Students' mastery of the idea of transformation can prompt them to switch their thinking and analyze problems from multiple perspectives, which is of great value to the formation of their rationality thinking. The development of this thinking also helps them to learn to transform complex problems into simple ones in their daily lives. By turning unfamiliar problems into familiar ones, they can overcome difficult problems in their lives and increase their self-confidence.

Infiltrating mathematical ideas in the teaching process and practicing methods at the superordinate level of mathematical thinking helps students develop a mathematical way of thinking and the spirit of mathematical rationality. By infusing the classroom with mathematical ideas, the element of "rationality" can be infused, bringing into play the unique nurturing value of the subject of mathematics and thus realizing the moral education of the subject.

2.1.2. Appreciating the culture of mathematics and the element of 'humanity'

Mathematics has had a profound impact on the natural sciences, the social sciences and even the humanities throughout human history, and is of great scientific and humanistic value [7]. However, at present, only the scientific

value of mathematics is valued, but its humanity value is neglected. The humanity value of mathematics is overlooked. The humanity value of mathematics is hidden in the culture of mathematics, which is rich in cultural heritage and connotations. Promoting mathematical culture to students can pass on the value of humanity contained in mathematics to students, thus infusing them with the element of "humanity".

For example, the teaching of 'The expansion of the number system and the introduction of complex numbers' can be infused with mathematical culture to reveal the value of humanity in mathematics and to develop students' humanity literacy. In the teaching process, Cardano's problem is introduced, followed by Cardano's formula for solving a cubic equation, which leads students to solve a cubic equation, making them feel that negative numbers can be squared, just beyond the real numbers. At this point, students are left wondering, a doubt that was also shared by mathematicians of the time. To solve this problem, by analogy with the real numbers, students are led to investigate the expansion of the number system thereby introducing imaginary numbers. Introduce students to the origin of the name imaginary numbers, which are called imaginary numbers, denoted by i, because the mathematician Euler considered them to be imaginary or fanciful numbers. Mathematicians have turned to the geometric meaning of complex numbers, so lead students through the geometric meaning of an imaginary number in order to study it thoroughly. Students are introduced to the geometric interpretation of Argand diagrams given by the mathematician Argand's analogous photographic theorem and to the complex plane established by Gauss, which establishes the geometric meaning of complex numbers. Once the complex numbers are thoroughly understood, their operations must necessarily be studied. Hamilton builds the logic of complex numbers on the real numbers, making the discussion of complex numbers dependent on the real numbers, and in doing so defines the arithmetic operations of complex numbers in their pure form [8], that is, the four operations of complex numbers, and so leads students through the four operations of complex numbers.

The teaching example above is introduced by the history of mathematics and takes students through the process of mathematicians' exploration of complex numbers. Today, we learn about complex numbers in one lesson, but it took mathematicians hundreds of years to give the concept of complex numbers and perfect the study of complex numbers. Students' exploration of the history of complex numbers allows them to appreciate that the origin of any knowledge does not come about smoothly and suddenly. Even great mathematicians had to be persistent in their search for new knowledge before they were able to investigate it thoroughly. At the same time, students can appreciate that learning is also such a process, thus fostering in them the mental qualities of perseverance and hard work that will enable them to move forward with more and more frustration.

The infiltration of mathematical culture allows students to experience the process of people's pursuit of truth, and students can feel the culture of mathematics in order to be culturally infected and have cultural resonance, thus infiltrating the element of "humanity" and bringing the value of humanity in mathematics into effective use.

2.2. Penetration of the elements of 'personality' and 'responsibility', according to the archetypes

Every advancement in mathematics has relied on the creativity of mathematicians, and this reflects the outstanding qualities of mathematicians. By using mathematicians as models of excellence and by infusing them into classroom teaching, the elements of 'character' and 'responsibility' can be implicitly infused.

2.2.1. Telling a typical example, penetrating the element of 'personality'

Mathematicians have excellent character qualities in them and these qualities are valuable assets embedded in the teaching of mathematics. Introducing students to the good qualities of mathematicians is an effective way to help them develop good character qualities.

For example, during the teaching of "Permutations and Combinations", students can be introduced to Li Shanlan's constant equation and his work. After the outbreak of the Opium War, China was gradually reduced to a semi-colonial and semi-feudal society. In order to save and revitalize China, it was necessary to study Western science and technology. In the late Qing Dynasty, when Chinese science was extremely backward, Li Shanlan combined the practical algorithms of traditional Chinese mathematics with the Western axiomatic mathematical system to obtain Li Shanlan's Combinatorial Constant Equation, and became an outstanding Chinese scientific researcher and pioneer of science education [9]. The combinatorial constant equation proposed by Li Shanlan is a very rare and innovative achievement that should be cherished.

In the above case, Li Shanlan paid attention to both traditional Chinese mathematics and advanced foreign scientific theories. By integrating the two, students can understand that in order to "catch up" with the world's advanced level, they must first learn and absorb all the best cultures, which is conducive to the development of students' quality of inclusiveness. Secondly, Li Shanlan's relentless innovation in a difficult environment is conducive to the cultivation of students' creative qualities of perseverance.

Teachers recount typical examples to students in classroom teaching. Infecting students with typical examples can play an effective role in shaping students' excellent personality qualities.

2.2.2. The power of role models and the element of "responsibility"

Our mathematicians, both in ancient and modern times, have profoundly demonstrated their 'sense of responsibility' in the context of their own societies. By introducing students to the stories of mathematicians and using them as role models, students can be motivated to take on their own responsibilities.

For example, the aforementioned Li Shanlan, who took on the mission of training scientific and technological forces for the country. Hua Luogeng, in response to the saying "Although Liang Yuan is a good place to live, it is not a place to live for a long time", gave up his generous salary abroad to return to China and nurtured a number of outstanding mathematical talents for his country. Su Buqing, known as the "King of Mathematics", said, "To love the motherland and to fight for its future is a sacred duty given to us by the times". As Chinese mathematicians, they have not only made brilliant achievements in the field of mathematics, but have also stepped forward to shoulder the burden in times of national crisis.

From ancient times to the present, China has had its share of great mathematicians in different eras. By telling students the stories of mathematicians, we can give full play to the power of their example and strengthen the responsibility of young students. At the same time, introducing students to mathematicians and their achievements helps them build cultural confidence and a strong sense of national pride, and nurtures their patriotism.

3. Conclusion

Achieving the fundamental task of 'fostering character and civic virtue' is a process of continuous exploration and gradual advancement, and requires the joint efforts of teaching in all subjects. Mathematics teachers must develop a consciousness of moral education, take up the responsibility and task of moral education, and practice moral education in the classroom. High school mathematics teachers are expected to make use of all aspects of moral education infiltration in their classroom teaching, which is a natural way of practicing moral education in mathematics. They can make use of mathematical ideas, mathematical culture and typical examples of mathematicians to give full play to the unique value of mathematics teaching in nurturing people and to provide an inexhaustible impetus for the practice of moral education in mathematics.

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