Integrating Moral Education into Calculus Teaching

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Abstract. In this paper, we describe the necessity and importance of ideological and political education in Calculus, and how to integrate moral education into the curriculum. First the purpose, meaning and difficulties of moral education are discussed. Then several keys for the success of cultivating morality are discussed. Finally, we demonstrate where and how to introduce different teaching materials for moral education from different concepts in details.

Keywords: Calculus, Ideological and Political Education, Moral Education.

1 Introduction

Calculus [1,2,3] is one of the most fundamental mathematical courses for undergraduate students major in Science or Engineer. There are quite a lot of developments on teaching skills together with the updated teaching materials [4,5] to improve the teaching quality of the Calculus course in recent years. At the same time, curriculum civics becomes more common in Chinese universities [6,7,10,11]. Curriculum Civics requires teachers to fully integrate the development of competencies, imparting of knowledge, and shaping of proper values into each stage of classroom teaching. Appropriate cultivations of morality in teaching help foster in the young the morally sound values and outlook on the world and life. In this paper we first discuss the purpose and importance of integrating moral education into Calculus teaching. Secondly, several keys for the success of cultivating morality are described. Thirdly, we demonstrate where and how to introduce different teaching materials for moral education from different concepts in details.

2 Purpose

China has entered a stage of high-quality development, and economic, political and cultural exchanges at home and abroad continue to intensify. Tertiary education also needs to keep pace with the times. Therefore, colleges and universities should take the cultivation of morality as a fundamental task, in which curriculum teaching is the key content for the effective implementation of cultivating morality [8,9,15]. As a professor who teaches higher mathematics, it is necessary to link theory and practice in

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specific classroom teaching, to explore and tap into several ways of integrating moral education into Calculus teaching in the new era. This means that it is important for the professor to integrate curriculum politics into the teaching of Calculus effectively, and guides students to analyze the connotation of mathematical knowledge from diverse point of view. The approach will improve the quality of teaching significantly.

3 Ideological and Political Education

In our opinions, there are several keys for the success of cultivating morality.

1. Compassion, patience and craftsmanship are necessary virtues. Compassion is the foundation of all educational processes. It is possible to be a great teacher unless one teaches with compassion. At the same time, it is not enough with compassion only. Confucius said, "It's hard to serve your parents for a long time and be pleasant to them". It's also not easy when teaching students. For example, right after the class, students ask the key content which the professor emphasized repeatedly during the lecture. The professor is very difficult to answer the questions with a peace of mind. In this case, patience is a more important virtue. In addition to compassion and patience, a great teacher needs craftsmanship. A lesson can only be taught well if it is crafted like a work of art by an artisan.
2. When one integrates moral education or cultivation of morality into the classroom teaching, the materials must be interesting to students. It cannot be insipid or be similar with a hard advertising implantation. We will use a few examples to demonstrate that later.
3. When integrating the elements of civics into the classroom teaching, one should nurture and develop the ideological and political thinking gradually. It is better to be less than more. Otherwise, it may produce a rebellious mentality. The process of cultivation of morality into Calculus teaching is similar with cooking a good dish. Ingredients and spices two should be integrated properly.

4 Strategies for Cultivating Morality

Now we propose the strategies for cultivating morality in Calculus in detail.

4.1 Famous Quotes

When we teach Calculus, it is often useful to add famous quotes in certain sections. There are several examples.

- When the differentiation and integration are introduced, we can quote, “Calculus is the supreme triumph of the human spirit” (by Friedrich Engels (1820-1895), see [12]).
- There are often different ways to solve the same mathematical problem, e.g. different substitution strategy for integration. In this case, we can quote Xiaoping Deng’s

well-known saying, “It doesn't matter if a cat is black or white, so long as it catches mice”.

- When one encourages students to learn by themselves. We can quote Benjamin Franklin’s famous words, “Tell me and I forget. Teach me and I remember. Involve me and I learn.”

In our experience, proper additions of quotes of historical celebrities during classroom teaching make lectures more interesting and enhance enthusiasm for learning easily.

4.2 Self-confidence in Culture

The second strategy for cultivating morality is to develop and improve the self-confidence in Chinese culture [14]. For instance,

- When the real number is described, we can emphasis the importance of the decimal system which is first introduced by ancient Chinese scholars, i.e., “It's almost impossible to have the unified mathematical world without the decimal system” (see [12]).
- Note that Stokes’ Theorem generalizes the tangential (curl) form of Green’s Theorem from a flat surface in the plane to a surface in three-dimensional space, while the Divergence Theorem generalizes the normal (flux) form of Green’s Theorem from a two-dimensional region in the plane to a three-dimensional region in space. When one teaches this section, one can quote “the dimensionality reduction strike” as in the famous science fiction by Cixin Liu, “The Three-Body Problem”. This can draw the attention of most students and improve the self-confidence in culture dramatically.

Properly interspersing knowledge of the history of (Chinese) mathematics (for example, see [13]) in the teaching of Calculus is proven to be effective for cultivating morality. This can stimulate students' interest in learning, attract their attention, and mobilize their enthusiasm and initiative in learning Calculus.

4.3 Stories of Famous Mathematician

When explaining theory and techniques to students, teachers can describe the stories of internationally renowned mathematicians to draw the interest from students, as well as to assist students in understanding the spirit of the mathematician.

- When we introduce Euler’s method to solve the ordinary differential equations (see Chap. 9 in [1]), we can describe Euler’s biography as well as his story. Euler enrolled at the University of Basel at the age of 13. He lost sight in his left eye at the age of 28, and lost both eyes at the age of 56. Moreover, he studied mathematics through perseverance and mental arithmetic for 20 years before his death at age 76. These stories can inspire students to learn mathematics.

- When we introduce the ϵ-δ language for the strict definition of “limit”, we can describe the biography and stories for Weierstrass (German mathematician) who invented the ϵ-δ language. Born in Germany to a family of customs officers, Weierstrass was sent by his father to the University of Bonn to study law and commerce. With no interest in law or business, he spent most of his time studying his favorite math and practicing fencing against his father's expectations. And at one time he became a fencing star in the hearts of the people of Bonn. After 15 years of teaching at a high school during the daytime and writing papers at night, he was appointed professor at the Technical University of Berlin after a sensational mathematical paper.

Introducing the stories of well-known mathematicians during the lesson allows students to listen to the stories and realize that the development of mathematics is not smooth, but rather a winding road. In this way, students learned that in the process of learning mathematics, it is difficult to avoid encountering difficulties. If students do encounter difficulties, they should not doubt their own ability, but to be quiet and hard work. Then they can certainly overcome the difficulties.

4.4 Bridging Art and Mathematics

Mathematics is inextricably linked to all aspects of philosophy, art, aesthetics, and human exploration of the universe. There is a well-known proverb that "Example is better than precept". We suggest the following examples to bridge art and mathematics in Calculus teaching.

- When students study quadratic surfaces (See Chap. 12 in [1]), we can quote that the outlook of Canton Tower (one of the landmarks in Guangzhou) is a hyperboloid of one sheet.
- When the professor teaches explicit, implicit, and parametric equations for curves and surfaces, it would be better to emphasis that Descartes' analytic geometry is a model of mathematical symmetry, in which algebraic equations and geometric shapes form a correspondence that combines abstract algebra with visualized geometry.
- Many important theories and solutions in Calculus are often the concise and beautiful. The aesthetic value of mathematics can be emphasized by quoting Russell's famous saying: "Mathematics possesses not only truth, but supreme beauty".

4.5 Stories from the Podium

Professors teach from the podium with care and dedication day in and day out. The good behaviors not only illustrate the spirit of dedication, but also provide good exemplary for the students.

- For instance, one professor brings one water bowl and six car wiping cloths during any lecture. He wrings out clothes with water before class (still wet) and place them on the podium to replace blackboard erasers. In a classroom with four black-

boards, the first one is wiped clean after three of the blackboards have been used. Therefore, the first one will be dry enough to write on by the time the fourth blackboard has been fully written.

- When teaching, we often ask students this question: "If we were researchers at that time, what should we do?" Let students "go back to the past", with the predecessors along the track of history, and then put forward and solve "new" problems. This not only cultivates scientific research literacy, but also stimulates the interest of independent exploration.
- Professor Chen, the winner of university distinguished teaching award in 2022, has never missed a lecture for the past 5 years, even though he had a bad cold several times. Every lecture was well prepared. Sometimes he answers the questions from students for 20 minutes after class. These really demonstrates professionalism to students.

In an era of great changes with pluralistic values and diverse cultures, students' worldviews, outlooks on life and values are easy to change. The behaviors of professors have great effects on their outlook on life and values. Therefore, it is important for professors to be role models for students.

5 Conclusions

In the context of the new era, with the rapid rise of curriculum politics in colleges and universities, the teaching of advanced mathematics courses is facing a new challenge. The way to integrate curriculum politics into the teaching of higher mathematics courses is a key concern of college and university mathematics teachers at this stage. In this paper, we suggest the designs and constructions for integrating the cultivating morality into Calculus teaching, i.e. famous quotes, self-confidence in culture, biography and stories of renowned mathematicians, bridging arts and mathematics. When professors integrate the elements of civics into classroom teaching in the above manner, students not only appreciate the beauty of mathematics easily, but also develop the morally sound values and outlook on the world and life. Furthermore, it is much easier to stimulate their enthusiasm for learning.

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