Bridging the Gap: Continuity and Integration of Mathematics Education from High School to College

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Abstract: Mathematics education is a comprehensive scientific system that holds significant importance in studying the seamless integration between university mathematics education and secondary mathematics education. This research paper delves into the challenges encountered during the transition from high school to university mathematics and offers analytical strategies and recommendations for both teachers and students. The objective is to enhance the continuity and coherence of mathematics education. Furthermore, tailored recommendations are provided to bridge the gap between high school and university mathematics education, taking into consideration the unique characteristics of students from different provinces and cities.

Keywords: High School Mathematics; College Mathematics; Continuity; Connection

1. Introduction and Background

This study adopts a student-centered perspective to visually represent the challenges students may face during the transition from secondary mathematics to university mathematics. By directly addressing and categorizing these issues, the study offers practical and tailored solutions for both teachers and students. The objective is to facilitate a seamless and efficient transition for students from high school to university, ultimately ensuring their academic success.

The issue of articulation between secondary mathematics and university mathematics, although seemingly minor, is of paramount importance and often overlooked. A smooth transition from secondary to university mathematics is pivotal in establishing the groundwork for students' academic journey and plays a crucial role in the identification and cultivation of exceptional talent[1]. Through thorough investigation and data analysis, the following problems have been identified:

1)Lack of alignment between high school and university textbooks

2)Disparity in educational standards across regions affecting mathematics instruction

3)Variations in the quality of mathematics education across different regions

3) Adaptation to changes in learning approaches:

4) Differences in thinking patterns between higher-level and elementary mathematics:

Effectively addressing the articulation problem between university and secondary mathematics is essential for helping freshmen adapt to university learning, thereby preventing feelings of fear and discouragement. It also enhances students' self-directed learning abilities, equips them with a solid foundation of mathematical knowledge, and lays the groundwork for their future study of mathematics and subsequent specialized courses at the university level.

2. Research Method

In-depth research: We conducted in-depth research using various methods such as interviews, online questionnaires, and literature review to gain a comprehensive understanding of the key issues. Our investigation focused on the learning experiences of students in different majors, including maritime studies, science and engineering, and business management, during their first year of university.

We specifically examined the challenges that arise when transitioning from secondary to university mathematics education in these majors.

Data analysis: Through meticulous analysis and organization of the collected data, we created informative tables for visual analysis. Taking Shanghai Maritime University as an example, we delved into several crucial aspects related to the continuity and articulation process from secondary to university mathematics education. By thoroughly studying these issues, we could better identify the challenges that students might encounter during the articulation process, and we give targeted advice.

3. Research Result and Evaluation

3.1 Research Result

After a year of meticulous data collection and comprehensive research, we have successfully categorized and organized the gathered data. Taking Shanghai Maritime University as a case study, we have made it readily available to teachers and incoming freshmen to effectively address the curriculum articulation challenges stemming from regional disparities and incomplete reform in high school and university textbooks.

To begin with, we have conducted a thorough analysis of the curriculum articulation issues in the transition from secondary to university mathematics education.Furthermore, we have conducted strategic analyses to address other curriculum articulation issues and provided practical recommendations for both teachers and students.

3.2 Analysis of Strategies

3.2.1 Recommendations for Students

3.2.1.1 For Shanghai Students

First of all, Shanghai students do not learn derivatives in high school. However, in the "Advanced Mathematics" and "Linear Algebra" in universities, the basic nature and application of derivatives are regarded as the content already mastered by default, while candidates from other provinces and cities have mastered derivatives and comprehensive derivatives in high school, and the study of college mathematics is also a good connection[2]. In Advanced Mathematics, the first chapter is about functions and limits. According to the syllabus and the interview with the merchant Marine students, the concepts of mapping and functions will be briefly discussed in class, and the concept of mapping has not been discussed in the class of Shanghai high school. Therefore, it is suggested that students in Shanghai use the summer vacation to learn the basic knowledge of derivatives by themselves, such as the basic concepts of mapping and function, the definition of derivatives, and the rules of derivatives. If there is no connection process in advance, it will sound difficult or difficult to keep up with the pace of the class.

Secondly, Shanghai students are less involved in parametric equations and polar coordinates. However, the basic concepts of parametric equations and polar coordinates in college are the ones mastered in high school by default, which will be directly used as a tool. Therefore, it is recommended that students in Shanghai lay a solid foundation for this part in advance.

3.2.1.2 For Students from Other Provinces

We focus on Anhui examinees, which have the largest number of school enrollments. The contents of inverse trigonometric function and matrix and determinant are not included in the national paper examination outline. In Advanced Mathematics, the inverse trigonometric function will be regarded as a known content to directly conduct derivative, integral, etc. Therefore, it is recommended that students from other provinces who have not come into contact with the inverse trigonometric function preview its function image and characteristics in advance, so that it is easier to understand in class. Matrix and determinant are important test points in Linear Algebra, so it is suggested that students learn this part of the content in advance during the summer vacation, which will play a good role in connecting, and it is easier to keep up with the teacher's ideas in college classes.

Furthermore, regardless of whether students are from Shanghai or other provinces, it is crucial to develop self-discipline and study habits. The learning patterns in university are significantly different from high school, as there is no constant supervision or guidance. Independent learning, self-discipline, and diligence are essential for success in university.

3.2.2 Recommendations for Teachers

Organize Teaching Content Appropriately and Pay Attention to Students' Past and Future

For disconnected knowledge points, it is important to smoothly introduce them based on students' existing knowledge to achieve effective articulation. University teachers should not only be familiar with university textbooks but also understand high school mathematics textbooks and syllabi. They should identify the similarities and differences between the two and address issues related to content omission and repetition. University teachers often assume that students have already mastered content that was not covered or emphasized in high school, such as inverse trigonometric functions and sum-difference product formulas, which are less emphasized in most provinces. In such cases, teachers can use these foundational knowledge points as an introduction during new lessons and review them to solidify understanding[3]. For example, in the case of derivatives, students from Shanghai have not been exposed to them in high school, while the difficulty and coverage of derivative topics in other provinces and cities vary significantly.

Infiltration of Teaching Philosophy

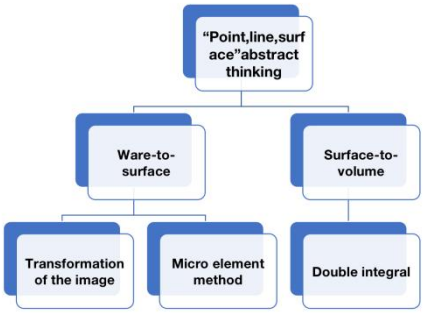
University mathematics requires students to undergo a significant transformation and enhancement in their thinking abilities compared to high school mathematics. Teachers need to cultivate students' ability to think and learn independently in a subtle and integrated manner during the teaching process. By giving students the autonomy to explore and learn, teachers can promote the development of students' logical thinking skills and foster their independence and autonomy in learning and thinking. For instance, in teaching objectives such as Cauchy's Mean Value Theorem and Taylor's series, the focus should not only be on students' ability to apply the conclusions to problem-solving but also on their understanding of the proofs and derivations of these theorems and formulas[4]. This allows students to appreciate the mathematical ideas and investigative approaches embodied in the exploration process.

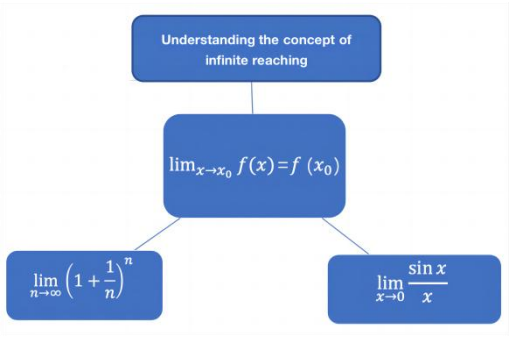
Encouraging Students to Develop Good Study Habits

Teachers, as knowledge providers, also play a crucial role in supervising the learning process. The learning mode in high school is significantly different from that in university, where teachers provide more hands-on guidance. Therefore, students entering university may experience some difficulties in adapting. In this transition process, university teachers play an important role in helping students adjust to the new learning mode and ensuring a smooth transition. Teachers can effectively supervise students' learning through various means, such as monitoring homework completion, attendance, and classroom participation. Each assessment criterion can carry a different weight, aiming to cultivate students' good study habits, such as completing assignments on time and attending classes punctually.

The following table compares the differences in thinking between high school and college mathematics subjects .

Table 1 Specific Differences in Thinking Approaches Between Higher-Level Mathematics and Elementary Mathematics.

High school	University	Differences in thinking styles
Definite integral of a function of one variable	Calculus of multivariate functions	

Constant mathematics of uniform finite variation	The mathematics of non-uniform and infinitely varying variables	

4. Conclusion

From the perspective of students, the research is based on the problems that students will encounter in the learning process from high school mathematics to college mathematics. It is practical to start from the problems, visualize the problems, classify them according to the problems, and put forward corresponding solutions, which is more targeted and convenient for students to complete the transition from high school to college.

References

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