Research on the Application of the MATLAB Simulation Technology in Higher Mathematics Teaching

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Abstract

With the advent of the Information Age, technology-powered information multimedia have become part of the classroom teaching means at colleges and universities and a major instrument in deepening China’s teaching reform at colleges and universities, producing high-quality talents and improving teaching quality. Traditionally, the teaching process of higher mathematics, as a typical discipline with abstract concepts, is boring and insipid, and thus affects the teacher’s achievement of teaching objectives. Against such a background, the MATLAB simulation technology emerges with a powerful computing system. Its use in the teaching process of higher mathematics can not only help to stimulate students’ interest but also make the otherwise boring explanation of learning points more visually vivid and appealing. In view of this, the paper is intended to discuss in detail the application of the MATLAB simulation technology in the teaching process of higher mathematics after a review of theories related to the technology to provide a theoretical basis for college or university teachers of higher mathematics to develop new teaching methods and improve teaching quality.

Keywords: MATLAB simulation technology, Higher mathematics teaching, Application, Research.

1. RESEARCH BACKGROUND

1.1 Literature review

As an important basic course designed by colleges and universities for students of science and engineering, higher mathematics is characterized by abstract concepts and sophisticated theories. The application of multimedia to facilitate higher mathematics teaching can help save time, make the otherwise abstruse teaching contents clear and easy to understand, and improve teaching efficiency (Fang, 2010). Based on their actual teaching needs, colleges and universities can rely on the advantages of multimedia platforms to effectively address challenges facing current higher mathematics teaching (Zhao, 2011). A combination of concepts related to the MATLAB simulation technology with the multimedia platform can achieve sufficient use of the MATLAB simulation technology and accomplish teachers’ goals of implementing the teaching reform and improving higher mathematics teaching quality (Tang et al., 2007). By studying the language features of the MATLAB simulation technology and applying it to higher mathematics teaching, teachers can explain abstract theorems and concepts of higher mathematics in a vivid way and arouse students’ interest in learning (Tong, 2010). Besides, the introduction of the MATLAB simulation technology, a type of multimedia technology, into higher mathematics teaching can turn the traditionally boring and monotonous teaching model into an interesting, vivid and visual process to fully stimulate students’ enthusiasm for learning and achieve teaching results that traditional teaching can never attain (Liu, 2013). In the teaching of higher mathematics, the application of the MATLAB simulation technology, with its visual and flexible language and its powerful visualization tool, can present the otherwise static and obscure concepts in a dynamic and visual way with vivid diagrams and images, thus increasing the fun in teaching higher mathematics (Liu et al., 2013). Furthermore, teachers with experience in traditional teaching of higher mathematics can notice that the combination of the MATLAB simulation technology with the multimedia platform for teaching purposes has its advantages and disadvantages. Teachers should, on the basis of a thorough understanding of the MATLAB simulation technology, use multimedia to highlight their domination in the classroom. The results of the research into the effect of the MATLAB simulation technology on higher mathematics teaching and problems related to multimedia-based teaching indicate that, to achieve desirable teaching results, teachers of higher mathematics should, on the basis of the MATLAB simulation technology, adopt a teaching model that features traditional teaching as the focus and multimedia-based teaching as the supplementary means to enhance teaching effects of higher mathematics (Li and Ma, 2010).
1.2 Research purposes

With the increasing popularity of computer technologies, multimedia technologies have opened a new door for teaching institutions. The application of multimedia-based teaching can help improve teaching quality and teaching effects and create a good learning environment for students (Jia and Xue, 2010). Due to problems such as the abstractness of concepts related to higher mathematics that can limit students’ thinking, limited classroom teaching time, and esoteric teaching contents, the results of the traditional mathematics teaching are not good enough (Xi, 2014). The multimedia-based teaching by means of the MATLAB simulation technology features the computer as the major teaching tool and the representation of teaching contents in texts, diagrams, audios, and animations and other related forms. Teachers of higher mathematics can make full use of the advantages of the multimedia platform to show concepts in a vivid way, thus effectively facilitating mathematics teaching and enhancing teaching results (Liang and Pan, 2012). With the rapid development of the modern remote teaching, teachers of higher mathematics, an independent discipline in college education with its own system, patterns and features, can rely on the multimedia platform to remarkably improve teaching effects (Chen, 2011). Moreover, in higher mathematics education, the multimedia platform based on the application of the MATLAB simulation technology can effectively make up for the shortcomings of the traditional higher mathematics teaching model. Therefore, when applying the multimedia platform for teaching purposes, teachers should integrate traditional teaching methods with multimedia technologies to achieve better teaching results in a more efficient manner (Xu, 2012). Research into the application of the MATLAB simulation technology shows that the role of the multimedia platform in higher mathematics teaching has its pros and cons. Only proper utilization of the multimedia platform to highlight its advantages and avoid its shortcomings can make multimedia a useful tool for higher mathematics teaching and achieve the best teaching effects (Yang and Ding, 2011). It can be seen that the MATLAB simulation technology, one of the best software solutions of our times that can achieve powerful computing, relieve teachers of the teaching pressure, optimize students’ learning results, has been playing an increasingly important part in higher mathematics teaching (Tang et al., 2016). Thus, we should attach great importance to the role of the MATLAB simulation technology in higher mathematics teaching to effectively improve teaching quality and achieve universities’ goal for enhancing teaching levels.

2. OVERVIEW OF THE MATLAB SIMULATION TECHNOLOGY

The MATLAB simulation technology is a major teaching tool for advanced courses such as mathematical statistics, automatic control, method optimization, dynamic system simulation, linear algebra, and image processing. In recent years, it has been widely applied in modeling processes of higher mathematics in China. A typical application of the MATLAB simulation technology includes functions such as research and development of new algorithms, simulation computing, modeling, data analysis and exploration. In real-life applications, the MATLAB simulation technology has the following key features. First, the MATLAB simulation technology can provide a wide variety of mathematical functions, such as factor decomposition, function calculation, analytic expressions, calculus, and limit computing. Second, related research suggests that the MATLAB simulation technology can make complicated concepts easy and simple for learners to understand and apply. Third, the MATLAB simulation technology is highly intelligent technology. Mapping can be done automatically on the selected coordinates as long as data are inputted in accordance with appropriate requirements. In higher mathematics teaching, the MATLAB simulation technology can express abstract concepts in an intuitive form. Take the following formula for example:

\[
\int \sec x \tan x \, dx = ?
\]

\[
\int \frac{1}{\sin^2 x} \, dx = ?
\]

\[
\int \frac{1}{\sqrt{1-x^2}} \, dx = ?
\]

(1)

When students are taught the above integral equations, they often have difficulty remembering or understanding them. By using the MATLAB simulation technology to explain and demonstrate the above equations, teachers can help students to gain a much better understanding of these concepts. On the basis of the above integral equations, one can execute the drawing command at the command window of the MATLAB simulation technology and get the corresponding integral function diagrams (C=0), as shown in Figure 1.
According to the above figure that shows the drawings of the functions $\int \sec x \tan x \, dx$, $\int \frac{1}{\sin^2 x} \, dx$, and $\int \frac{1}{\sqrt{1-x^2}} \, dx$, module 1, 2 and 3 respectively indicate that, when $C=0$, the results of the above undefined integral equations are as follows:

$$\int \sec x \tan x \, dx = \sec x + C$$

$$\int \frac{1}{\sin^2 x} \, dx = -\cot x + C$$

$$\int \frac{1}{\sqrt{1-x^2}} \, dx = \arcsin x = C$$  \(2\)

Hence, the use of visualized graphics to express abstract and abstruse equations can facilitate both teaching and learning, and efficiently help students to understand and memorize key learning points.

3. RESEARCH ON THE APPLICATION OF THE MATLAB SIMULATION TECHNOLOGY IN THE TEACHING OF HIGHER MATHEMATICS

The application of the MATLAB simulation technology in higher mathematics teaching is mainly manifested in three aspects in the teacher’s teaching process, namely, the selection of an appropriate multimedia platform, the demonstration of the MATLAB simulation technology and the representation of the application results of the MATLAB simulation technology.

3.1 Selection of an appropriate multimedia platform for higher mathematics teaching

The selection of an appropriate multimedia platform refers to the process where teachers of higher mathematics select a suitable type of media for teaching in accordance with specific teaching requirements and conditions. It is a key step in higher mathematics education and a major contributor to the achievement of teaching purposes. Though seemingly simple, the selection process actually involves multiple factors, as shown in Figure 2. From Figure 2, it can be seen that, to select a proper multimedia platform, it’s important to consider four factors, namely, real-life constraints, effective communication, people, and reasonable costs of teaching. After comprehensive consideration of the above factors, teachers of higher mathematics can start their selection of a suitable multimedia platform.
Figure 2. Factors Influencing Teachers’ Selection of Multimedia for Higher Mathematics Teaching at Colleges and Universities

Normally, it’s the teacher that plays a significant role in choosing the multimedia platform for higher mathematics teaching. At present, there are three major methods for choosing the multimedia platform, including the equation-based method, the matrix-based method, and the question-list-based method.

3.1.1 The equation-based method.

The use of the equation-based method for choosing multimedia for higher mathematics teaching is a process where the teacher completes a series of calculations through relatively fuzzy values to determine on a specific multimedia platform. To use this method, the teacher normally needs to consider factors such as the cost of using the multimedia platform and the functions and management of the platform and decide on a fixed value. In the process, the functionality of multimedia is set as \( X \), the cost of multimedia as \( Z \), and the following equation is used to calculate the benefit index (\( Y \)) of the selected multimedia platforms and determine the best multimedia platform.

\[
Y = \frac{X}{Z}
\]

3.1.2 The matrix-based method.

The use of the matrix-based method for choosing multimedia for higher mathematics teaching normally involves two-dimensional array, one-dimensional classification and multi-dimensional array, and two-dimensional array is the most commonly used. On the basis of William Allen’s two-dimensional selection table, the selection results of multimedia for higher mathematics teaching are listed, as shown in Table 1. Teachers of higher mathematics in colleges and universities can make the final choice of multimedia according to the data shown in Table 1.

Table 1 Two-Dimensional Array Matrix for the Selection of the Multimedia Platform for Multimedia-Based Teaching of Higher Mathematics

<table>
<thead>
<tr>
<th>Multimedia-based Methods of Higher Mathematics Teaching</th>
<th>Main Learning Objectives</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Theoretical Information</td>
</tr>
<tr>
<td>Oral Explanation</td>
<td>Middle</td>
</tr>
<tr>
<td>Textbook Explanation</td>
<td>Middle</td>
</tr>
<tr>
<td>Static Images</td>
<td>Middle</td>
</tr>
<tr>
<td>Teacher’s Demo</td>
<td>Low</td>
</tr>
<tr>
<td>TV Watching</td>
<td>Middle</td>
</tr>
<tr>
<td>Movie Presentation</td>
<td>Middle</td>
</tr>
<tr>
<td>Application Teaching</td>
<td>Middle</td>
</tr>
</tbody>
</table>
3.1.3 The question-list-based method.

To select an appropriate multimedia platform for higher mathematics teaching, the teacher mainly relies on a list of questions related to the selection of multimedia, such as whether static or dynamic images are required, whether dubbing is required, whether the teaching contents represented by multimedia are consistent with students’ learning level, and whether interaction with students is needed. Based on the list of questions, the teacher needs to make a sound decision as to which multimedia platform should be selected for higher mathematics teaching.

3.2 Demonstration of the MATLAB simulation technology in higher mathematics teaching

3.2.1 The teacher should study the basics of the MATLAB simulation technology and become proficient in using operation menus and user interfaces of the technology in combination with multimedia.

3.2.2 On the basis of the multimedia platform, the teacher should master symbolic computing and formula editing of the MATLAB simulation technology as well as its language expression form.

3.2.3 To get limits of relevant functions, it’s important for the teacher to master the drawing commands of the MATLAB simulation technology and use the technology to deepen understanding of related mathematical concepts.

3.2.4 The steps involved in getting derivatives of unary functions are similar to those required for getting limits. The teacher should master the grammatical format and commands of the MATLAB simulation technology and conduct the calculation process at the command window of the technology. In practice, the teacher should have function symbols converted into corresponding numeric expressions.

3.2.5 To have a demonstration by means of the MATLAB simulation technology, teachers of higher mathematics need to conduct a rehearsal on the basis of the MATLAB simulation technology, and input appropriate commands depending on teaching contents and based on the multimedia platform to ensure direct application in real-life teaching situations. Take the calculation process of the mathematical formula \( x^2 - 3x + 2 \) for example.

The calculation process is as follows: \( \text{>> clear} \)

To clarify the command is to avoid wrong results arising from any undesirable impact of the command on the following operation. \( \text{>> x, y} \) By generating symbolic expressions \( x, y \) for the command function, we get:

\[
\begin{align*}
\text{>> y} & = x^2 - 2*3x + 2 \\
\text{>> y} & = \text{factor(r)} \\
& = (x-1)(x-2) \\
& = x^2 - 3x + 2 = (x-1)(x-2)
\end{align*}
\]

3.3 Presentation of the results of the application of the MATLAB simulation technology in higher mathematics teaching

After preparation of the abovementioned teaching materials via the multimedia platform, teachers of higher mathematics can start teaching students by accessing and using the interface to formally present in the classroom the multimedia-based teaching contents prepared in advance through the application of the MATLAB simulation technology. Then, by evaluating students’ learning results, teachers can decide whether such teaching methods are effective or not. In real-life teaching situations, higher mathematics teaching based on the MATLAB simulation technology is also affected by various subjective and objective factors. Such uncertainties and complexity of teaching require teachers to make appropriate adjustments during the teaching process on the basis of their understanding of the MATLAB simulation technology. Besides, teachers should, on the basis of the MATLAB simulation technology and by an analysis of the external teaching environment and psychological
attributes of different students, make timely adjustments of their teaching contents and methods. Moreover, teachers should, based on the functions of the MATLAB simulation technology, select the best teaching tools, methods and forms to replace the traditional and boring teaching model and disseminate knowledge to students in an interesting environment supported by the MATLAB simulation technology to achieve desirable teaching results and enhance teaching quality.

4. CONCLUSION

In recent years, with changes of teaching methods and rapid development of information technologies, the MATLAB simulation technology has been widely applied to higher mathematics teaching. As can be seen from the abovementioned research on the application of the MATLAB simulation technology in higher mathematics teaching, teachers of higher mathematics have been making use of multimedia platforms to apply the MATLAB simulation technology to higher mathematics teaching, which has exerted some influence on higher mathematics education at colleges and universities. In addition, on the basis of the MATLAB simulation technology, teachers can diversify teaching forms of higher mathematics via multimedia-based teaching, online teaching and virtual teaching, which can help to produce good surroundings and channels for the development of students’ independent learning, inquisitiveness and innovativeness and to remarkably enhance teaching quality. It is believed that, in the near future, higher mathematics teaching based on multimedia can create new learning experience for students and have a wide and profound influence on college and university education.

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