Journal of Education and Educational Research
ISSN: 2957-9465 | Vol. 4, No. 2, 2023

A Comparative Study of Mathematics Teaching with Information Technology Support

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Abstract: The rapid development of information technology has brought about radical changes in school education. The traditional teaching methods used in the past were very homogeneous and basically consisted of teacher's dictation with the aid of blackboard chalk. With the development of science and technology, there are more and more intelligent devices, and classroom teaching is changing day by day. Students often report that mathematical knowledge is too abstract and that mathematical subjects in school education are useless in real life. This article attempts to compare two teaching designs on parabolic knowledge at different times, to analyse the role of information technology in mathematics teaching, and to reflect on the possible problems of information technology in mathematics teaching.

Keywords: Information Technology; Mathematics Classroom Teaching; Parabola.

1. Background of the Study

In 2018, the Ministry of Education issued a notice on the Education Informatization 2.0 Action Plan, the document that indicates that "the development and service capacity of digital education resources is not strong, the construction and application level of the informatized learning environment is not high, teachers' IT application capacity is basically available but their ability to innovate in informatized teaching is still insufficient, and the in-depth integration of IT and subject teaching is not sufficient. " In order to promote the modernization of education and strive to build a strong education country, the document calls for adhering to the education of people, adhering to integration and innovation, adhering to systematic promotion, adhering to leading development, supporting and leading the modernization of education with information technology in education, is a strategic choice for the reform and development of education in China in the new era, and is of great significance for building a strong education country and a strong human resources country. With the development of information technology, teachers are using modern education technology more and more frequently in the teaching process. What kind of changes have been produced in teaching with the support of information technology?

2. Research Object

The comparative materials chosen by the author are all on the topic of "Parabola", with Teacher A's teaching design taken from "Famous teacher teaching record: middle school mathematics. High school edition" and Teacher B's design was taken from "Computer Knowledge and Technology". Teacher A was at a time when teaching tools were scarce and limited, while Teacher B used modern technology in the classroom.

3. Study Results

According to the relevant materials, I have collated the main teaching activities of Teacher A and Teacher B. Although there are differences in the order of teaching points, the main teaching sessions of both teachers are basically the introduction of the topic and the new lesson, while the definition of the parabola, the standard equation of the parabola, the application of the four standard equations, the relationship between the P and the size of the opening, and the geometric properties of the parabola are introduced in the new lesson session. To facilitate comparison, I have collated the teaching activities of the two teachers by teaching sessions, as detailed in the table below.

3.1. Comparison of Organizational Mathematical Tasks

The two lessons are more than thirty years apart, but there are still many similarities in the organization of the mathematical tasks. Teacher A organizes a heuristic lesson typical of the 1990s, introducing the topic and helping students to review their knowledge before moving on to a new lesson. After a lecture on the definition of a parabola and the standard equation of a parabola two example problems were given for students to apply the four standard equations and the class ended with a lecture on the geometric properties of parabolas. In contrast, Teacher B's classroom integrated information technology and, after explaining the definition of a parabola and the standard equation of a parabola, used modern technology to demonstrate the relationship between the P and the size of the opening. In terms of teaching, Teacher B paid more attention to the preconceptions of knowledge situations, hoping to make the knowledge more relevant to students' lives, which reflects the changes in teachers' conceptions of teaching as time progresses.

3.2. Comparison of the Implementation of Mathematical Tasks

3.2.1. Introducing the Topic

Teacher A starts the class by asking students about their knowledge of parabolas and the characteristics of parabolas studied in quadratic functions. Teacher B uses computer software to show real-life parabolas, such as the trajectory of a comet, the trajectory of a bomb thrown at the ground by a fighter jet, the trajectory of a sphere when throwing a shot put, and the parabolic shape of an arched bridge. In contrast, Teacher A already had a certain amount of knowledge about parabolas in students' minds by default and generated new

knowledge on this basis, while Teacher B used technology to visually and realistically represent real-life parabolic scenarios, which both stimulated students' interest in learning and gave them a sense of the application of mathematics in real life.

Table 1. Comparison of teaching between teacher A and teacher B

	Teacher A in the 1990s	**Teacher B with IT support**
Introducing the topic	Teacher proposes to study the fourth type of conic curves (board topic: Standard equations and properties of parabolas)	Computer simulations are used to reveal parabolas in reality and introduce the topic using software to create images related to parabolas.
	Teacher's question: What do students know about parabolas? What are the characteristics of the parabola studied in the quadratic function? Teacher proposes to study parabolas whose axis of symmetry is not parallel to the y-axis.	
Definition of the parabola	(Board) Teacher's Question 1: What is the relationship between the distance from any point P on the parabola y = ax to the fixed-point F (0, 1/4a) and to the fixed line l: y = -1/4a? (Let a > 0 and draw the diagram.)	Computer-designed animation demonstrating: the trajectory of a moving circle moving at a fixed point and on a fixed line.
	Students draw a diagram and analyses and calculate it, concluding that the distances are equal. Teacher's question: Can we say that a parabola is the trajectory of a point of equal distance to a fixed point and a fixed line? The teacher uses a triangle, ruler and string to demonstrate on the board and draws an image of the parabola. Ask students to generalize and write the definition of a parabola on the board.	
Standard equation of the parabola	Teacher's question: Set the distance from the point F to the fixed line l to be p (this is a known number and is greater than zero) and find the equation of the parabola. How do you choose a plane rectangular co-ordinate system?	Use the computer to show the equation of the parabola in these cases, based on the positions suggested by the students for establishing a right-angle co-ordinate system.
	Students discuss while the teacher circulates and enlightens. Teacher summarizes the 6 ways in which students can set up a plane right-angle co-ordinate system. Teacher's question: Which equations should be chosen as the standard equations of a parabola? The teacher concludes that the study of the parabola from the point of view of the equation of the curve is more general than from the point of view of the quadratic function.	
Application of the four standard equations	Given two example problems, students apply their knowledge of parabolas to write the coordinates of the focal point, the collinear equation and the standard equation. Teacher summarizes the solution.	——
the relationship between the P and the size of the opening	——	Use the measurement and graphing features of Geometry Drawing Board to show how the size of the opening of a parabola change as the p changes.
geometric properties of parabolas	Teacher question: How can the standard equation of a parabola determine its geometric properties? Ask students to fill in the table.	Use computer simulations to reveal the origins of the parabola, hyperbola and ellipse collectively known as the conic curve.
	Ask students to compare the geometric properties of ellipses and hyperbolas and to answer the characteristics of the geometric properties of parabolas. Teacher and student's summaries together.	

3.2.2. Introduction to the New Lesson

1. Definition of a parabola

Teacher A uses questions to guide students to draw a diagram and calculate to discover that any point P on the parabola $y = ax$ has equal distance to the fixed point $F(0, 1/4a)$ and to the fixed line $l: y = -1/4a$, and generalises from the point to the essential property of a parabola - the trajectory of a point in the plane with equal distance to a fixed point and a fixed line. Afterwards, teacher A uses a triangle, ruler and string to demonstrate on the board and draws an image of the parabola to deepen students' understanding of the parabola. Teacher B uses computer software to design an animation to demonstrate: the trajectory of a moving circle moving at a fixed point and on a fixed line. This can bring students an intuitive mathematical experience and allow them to actively generalize the nature of the parabola, enabling them to understand or internalize the points they have learnt in a much shorter time.

2. The standard equation of a parabola

Teacher A asks questions about the equation of the parabola and the method of choosing a right-angle co-ordinate system and asks students to think and discuss, summarizing the six methods of establishing a right-angle co-ordinate system proposed by students and guiding them to choose the standard equation of the parabola. Teacher B uses the computer to help students understand the relationship between 'numbers' and 'shapes', which facilitates their understanding and memory, and improves teaching efficiency.

3. Application of the four standard equations

This section is unique to Teacher A. Two examples are given for students to apply their knowledge of parabolas to write the coordinates of the focal point, the collinear equation and the standard equation, after which the teacher summarizes the ideas for doing so. This step consolidates what students have learnt previously and prepares them for the mathematics exam.

4. P in relation to the size of the opening

Teacher B uses the Geometry to show the process of changing the size of the opening of a parabola as the p changes. In traditional teaching, this point is often taught to students as a conclusion, which the teacher then proves. In contrast, Teacher B's classroom presentation is more intuitive, and students can conclude for themselves that "the larger the p, the larger the opening of the parabola", a direct experience that is often better remembered over time.

5. Geometric properties of the parabola

Teacher A asks questions and guides students to compare the geometric properties of ellipses and hyperbolas, and summarizes with them the characteristics of the geometric properties of parabolas. Teacher B uses 3Dmax software to show the different intercepts (parabola, hyperbola, ellipse) that are produced when the plane is cut from a conic surface at different angles.[3] This allows students to understand some of the geometric properties of the parabola without too much verbal description, and to understand why the parabola, ellipse and hyperbola are collectively known as conic curves.

4. Conclusion

4.1. Information Technology for Teaching and Learning in Mathematics

4.1.1. Providing a Visual and Imaginative Learning Environment

With information technology, the images teachers want to present in the class can often be dynamic, unlike traditional teaching, which relies on teaching tools such as blackboard chalk, teachers can only show static images, for example, in the study of parabola, teacher A wants to introduce the geometric properties of the parabola to the students, can only draw pictures on the blackboard plus the form of verbal description of the painstaking display, in such conditions, students with poor visual imagination may not be able to understand the information conveyed by the teacher and the class is not as effective as it could be.

4.1.2. Facilitating Students' Review of Class Content

With the support of IT, the images and files presented in class are not 'disposable' and students have the opportunity to repeat the content presented in class using the appropriate software afterwards. In contrast to traditional teaching, where students who do not understand a certain point well enough can only explore it themselves after class using textbooks and other materials, IT can reproduce class content repeatedly, facilitating students to check their knowledge after class and improve their learning efficiency.

4.1.3. Fast and Capacious Display

If teacher B uses the Geometry to show students the relationship between the p and the size of the opening, moving the focal point F causes the p to change and thus the opening of the parabola to change as well, an act that takes less time to show students the phenomenon clearly. In a traditional classroom it would take a lot of time to plot the parabola based on the change in p, and with limited classroom time, such a slow delivery rate would lead to slow progress.

4.1.4. Facilitate the Cultivation of Innovative Talents

Liang (2011) concludes that innovative talents are the very few who can make a sustained and significant contribution to society and humanity with their knowledge and experience, superb innovation, creative thinking and innovative and freely developing personality. With the support of information technology, students are able to have more opportunities to develop innovative thinking. Students may ask questions in the class, for example, about parabolas and linear focal points, and can then use the computer to investigate further so that their curiosity is satisfied and their desire to explore is fuelled.

4.2. Possible Disadvantages of Using IT in Mathematics Teaching

Constructivism emphasizes that students do not enter the classroom with an empty head, but that they learn by generating new knowledge on the basis of their prior knowledge and experience. Modern educational technology can carry more educational content and show students more content in a shorter period of time. On the surface, such a class appears to be "fast", but in reality, the construction of students' knowledge structures may not be able to keep up with such a pace. If IT is not integrated with the mathematics, it is not conducive to students digesting and absorbing knowledge and building their own 'schema'. This is the fundamental strength of traditional teaching [4], where teachers guide students through the teaching process and help them to generate knowledge. The IT-enabled mathematics class is often pre-determined by the teacher, who may not be able to successfully capture the sudden sparks of thought, and is a mere spectator in the process of knowledge growth.

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