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# *Research on Improving Classroom Teaching Ability by Using Multimedia Image Processing Technology*

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***Abstract:*** In China, with the rapid development of multimedia technology, multimedia image processing technology has made great progress. The application of multimedia technology has greatly improved the image processing ability. The purpose of this article was to analyze the learning behavior of students in the teaching process. Therefore, in the teaching process, the edge box of the image was first used to mark the position of the students, and then the selected students were classified and analyzed individually. In this paper, the target detection algorithm had the function of connecting the preceding and the following, and the analysis of individual students' behavior mainly depended on the accuracy of individual target markers. In the questionnaire survey of 300 students and 9 teachers, it was found that 93.33% of teachers often use slides of multimedia materials. It can be seen that most teachers' multimedia resources have mainly chose slides, which mainly depend on teachers' computer ability and advantages of slides. In fact, multimedia teaching resources are diverse. Teachers should learn more, practice more and create various excellent coursewares.

## 1. Introduction

Multimedia technology is crucial in educational development today. It facilitates resource sharing, extends time and space, enables multi-directional interaction, collaborative learning, and independent selection, benefiting classroom teaching, student learning, and teacher-student interaction. It covers a wide range, sharing information resources widely, enriching and activating classrooms, and promoting practical teaching applications. Multimedia teaching emphasizes cooperative learning, deepening understanding, and broadening thinking, enriching learning methods, and improving learning efficiency.

In recent years, there are more and more researches on classroom teaching ability. Ziernwald Lisa examined the effects of differentiated instruction (DI) on high-achieving students' performance and classroom teaching ability, as well as its usage and perceptions among excellent teachers and high-achieving students, along with obstacles and facilitators in its implementation [1]. Widyasari F. demonstrated through qualitative data that pre-service chemistry teachers could effectively integrate technology, teaching methods, and content in chemistry learning, suggesting early integration of technical teaching knowledge and specific treatment methods for better classroom teaching [2]. Suhrheinrich Jessica assessed the outcomes of a large randomized trial on training teachers in classroom critical response teaching (CPRT), highlighting the acceptability and feasibility of CPRT training programs and incorporating limited sample randomized controlled trials to evaluate student interventions [3]. Baier Franziska found that almost no research combined the central general variable and professional specific variable when determining its relative importance to teaching quality. In his research, he tried to narrow this research gap. The results showed that general and professional teacher variables were relatively important to teaching quality. In general, the characteristics of teachers could explain the huge differences in teaching quality [4]. However, the content of the study has not been discussed in depth.

At the same time, the application of multimedia image processing technology is more and more extensive. Peng Xindong proposed two algorithms that combined distance based evaluation and multi parameter similarity measurement to solve the q order orthomorphic fuzzy decision-making problem. The feasibility of these methods was proved by the quality of classroom teaching and the impact of different parameters on the ranking. Finally, the proposed decision-making method was compared with the existing decision-making method to show its effectiveness [5]. Valiandes Stavroula reported the results of a study designed to investigate and examine the characteristics of teacher professional development plans designed specifically to support teachers in designing and applying differentiated instruction. This research proved the success of the program from the aspects of teachers' professional development and students' achievements, and discussed the factors that made the program successful [6]. However, these studies need to consider the influence factors from reality in many aspects.

The integration of multimedia and intelligence makes the integration of modern educational technology and teaching becomes the focus of attention. This paper innovates by integrating target detection algorithms with students' learning behaviors in videos, introducing the student target detection algorithm and discussing image processing and enhancement.

## 2. Detection Methods for Students' Classroom Behavior

### 2.1 Multimedia Image Processing Technology

Initially, multimedia teaching fell short of expectations due to a limited teaching approach where teachers dominated, hindering students' active learning, exploration, and comprehension abilities [7-8]. Incorporating vibrant visuals into classroom activities enhances students' understanding, retention, and mastery of content. Consequently, image processing plays a crucial role in creating multimedia textbooks, as illustrated in Figure 1[9-10].

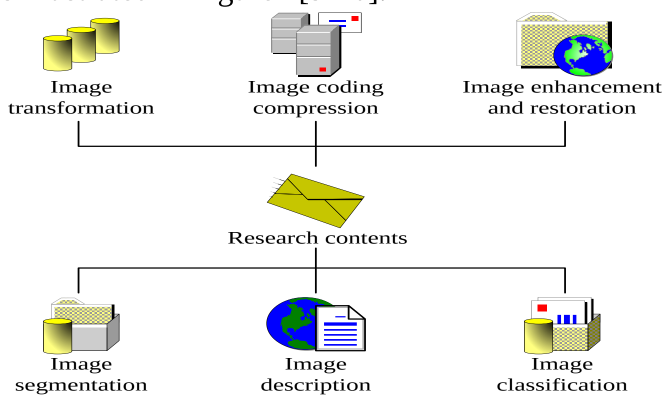


Figure 1: Research contents of multimedia image processing technology

Image enhancement and restoration involves understanding image quality degradation, establishing degradation models, and using filtering technology for reconstruction. Image segmentation extracts meaningful features from images, still in exploration due to lacking satisfactory solutions. Image classification employs pattern recognition technology, involving preprocessing, extraction, segmentation, and classification.

## 2.2 Student Target Detection Algorithm

Histogram of Oriented Gradients (HOG) serves as an effective image descriptor, extracting features like edges and gradients while automatically correcting human body contours. The HOG detection algorithm involves several steps, as depicted in Figure 2.

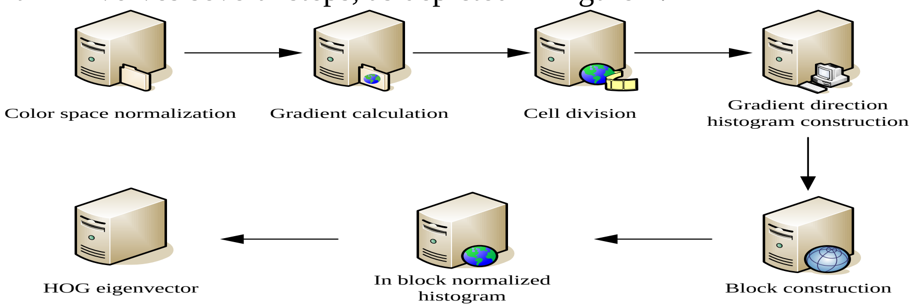



Figure 2: HOG detection algorithm steps

First of all, the collected original image should be preprocessed. Then, the image quality and effects are adjusted to emphasize the desired characteristics, mainly grayscale and Gamma correction. RGB (Red, Green, Blue) images in color are transformed into grayscale images by Formula (1):

$$Gery = 0.299 \times R + 0.587 \times G + 0.114 \times B \tag{1}$$

When the illumination of the image is uneven, the brightness of the whole image is adjusted by gamma correction method. When the gamma value is lower than 1, the contrast of the high gray area decreases and it looks brighter. When it exceeds 1, the contrast in the low gray value range becomes smaller and the display is dimmer.

$$Y(x, y) = O(x, y)^{\lambda} \tag{2}$$

Gradient calculation. After standardization, the first order differential is used to calculate the gradient. Different gradient operators are utilized to calculate gradient components in two directions, and the formulas are:

$$G_x(x, y) = O(x+1, y) - O(x-1, y) \tag{3}$$

$$G_y(x, y) = O(x, y+1) - O(x, y-1) \tag{4}$$

$$G(x, y) = \sqrt{G_x(x, y)^2 + G_y(x, y)^2} \tag{5}$$

$$\varepsilon(x, y) = \tan^{-1}\left(\frac{G_y(x, y)}{G_x(x, y)}\right) \tag{6}$$

x is horizontal, y is vertical. $G_x(x, y)$ and $G_y(x, y)$ represent the gradient of $(x, y)$ in the horizontal and vertical directions, respectively. $G(x, y)$ is the image at $(x, y)$, and $\varepsilon(x, y)$ represents the direction of gradient.

The picture is divided into several cells, and each has 64 (8 × 8) Pixel. There is no overlap between adjacent cells. The size and direction of the gradient can be obtained by gradient operation on the image to form a gradient vector. Then, nine bin gradient histograms are used for gradient statistics of cells. Block building. A block is composed of 2 × 2、3 × 3, each cell has an overlapping relationship. The adjacent pixel information is fully utilized, thus improving the detection effect.

In block normalized histogram. To reduce the gradient difference between different cells in a block, the histogram inside the block must be normalized. The eigenvector is normalized as follows:

$$b \leftarrow b / \sqrt{\|b\|_2 + \alpha^2} \tag{7}$$

b is an eigenvector to be normalized, and $\|b\|_2$ represents two norms. HOG eigenvector. The eigenvectors in each block are combined to form the eigenvectors of HOG. Then support vector machine is used to classify them, and the final result is obtained.

## 2.3 Image Processing and Enhancement

When teachers use classroom images for object detection during teaching, the quality may be unstable due to factors like light, angle, and position. Proper image processing can highlight required features while reducing irrelevant ones [11], necessitating further research. To address the imbalance in students' individual behaviors, data augmentation methods are necessary to ensure comprehensive data processing across different classes and teaching situations, facilitating better data training. In image processing, the use of grayscale processing involves converting RGB images to grayscale images to reduce computational complexity and improve image characteristics, as shown in Figure 3.

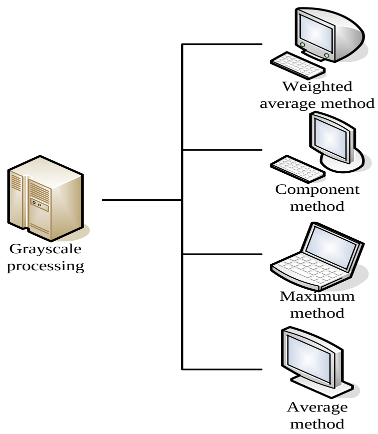



Figure 3: Gray level processing method

The weighted average method uses formula 1 to convert an RGB image to grayscale. The component method divides grayscale values of RGB images into three categories, selecting different grayscale values for transformation as needed. Binarization reduces image complexity by using thresholding to distinguish pixel points, enhancing image contours. Image enhancement techniques like offset, rotation, flip, and zoom increase the number of images in the dataset. Offset shifts pixels horizontally or vertically. Rotation maintains pixel distances from the center. Flip mirrors images horizontally or vertically. Picture zooming adjusts image size through downsampling or upsampling [12].

## 3. Experiment of Multimedia Technology Applied Mathematics Classroom

### 3.1 Investigation Purpose and Object

This paper examines the understanding and use of multimedia teaching among high school math teachers and students through questionnaires. The study focuses on a key high school in Z City, encompassing 24 classes across three grades and 15 math teachers. Questionnaires are distributed to six classes with 300 students and nine teachers selected from each grade. All 300 student questionnaires and nine teacher questionnaires were distributed and fully recovered, resulting in a 100% effective rate. Below are the survey findings and analysis.

### 3.2 Questionnaire Results

(1) Students' likes and dislikes of mathematics and their learning situation

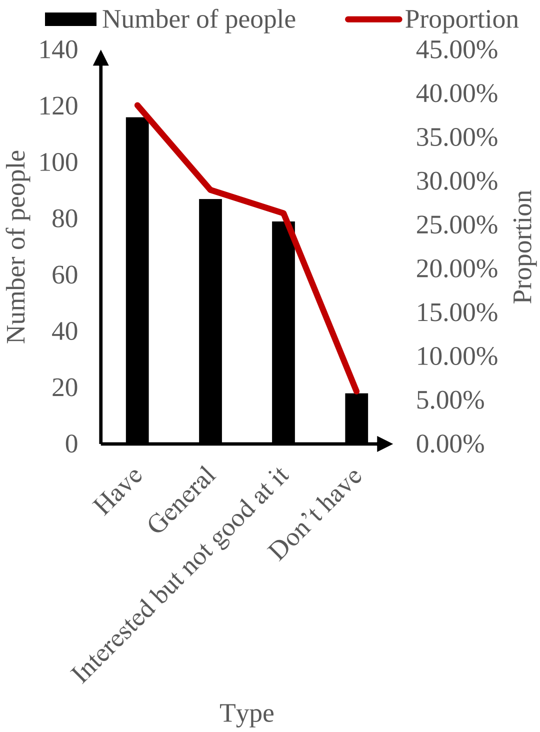
Mathematics in senior high school is a very difficult subject. Whether students listen carefully is the key to improving students' mathematics learning effect, and teachers' selection and application of teaching methods in the classroom also play a decisive role [13-14]. In the classroom, students are absent-minded, so the listening situation in the classroom is very critical. As shown in Table 1, 10.33% of the students are very serious when listening to the math class. 79.67% of the students are sometimes distracted.

Table 1: Students' listening status in mathematics class

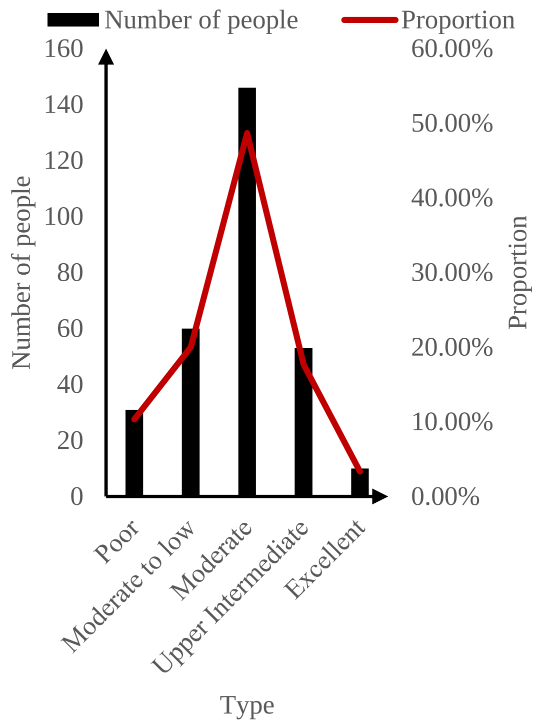
| | Option | Number of people | Proportion |
|---|---|---|---|
| Students' listening state in mathematics class | Very serious | 31 | 10.33% |
| | Sometimes distracted | 239 | 79.67% |
| | Listen occasionally | 25 | 8.33% |
| | Hardly listen | 5 | 1.67% |

Figure 4 shows the students' interest in learning mathematics and the relevant data of mathematics scores. As shown in Figure 4 (a), 38.67% of the students say they are interested in learning mathematics. 29.00% say they are average. It can be seen that most of the students in the survey are still interested in mathematics learning. In Figure 4 (b), 48.67% say their math scores are average. 17.67% say their math scores are above average, and 3.33% say their math scores are excellent.

As shown in Figure 5, 9.33% of the students say they often preview before math classes, 59.67% of the students occasionally, and 31.00% of the students never preview. At the same time, 19.00% of the students say they often review after math class, 67.67% of the students occasionally, and 13.33% of the students never review. It can be seen that in the classroom, both the preview before class and the review after class are not very good. After high school, students have to complete all kinds of subjects in their daily life, but they have not formed a good habit of preview and review. Therefore, there are some deficiencies in extracurricular learning.




(a) Interest in learning mathematics




(b) Mathematics achievements

Figure 4: Students' interest in learning mathematics and mathematical achievements

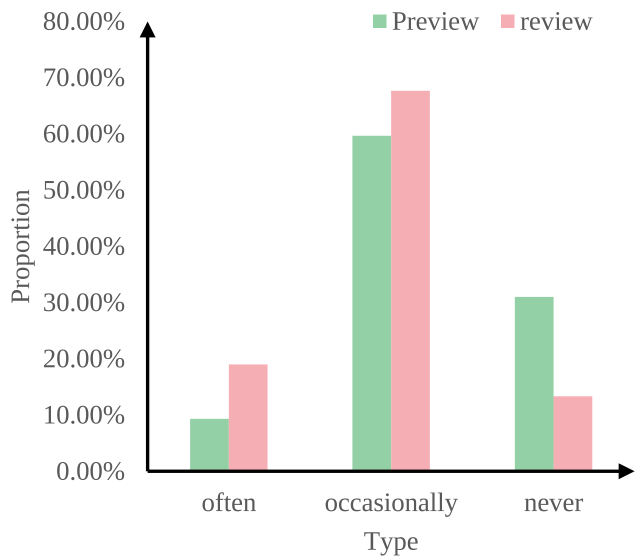



Figure 5: Students' preview and review before and after math class

(2) Frequency of teachers' experimental courseware and class computer hardware

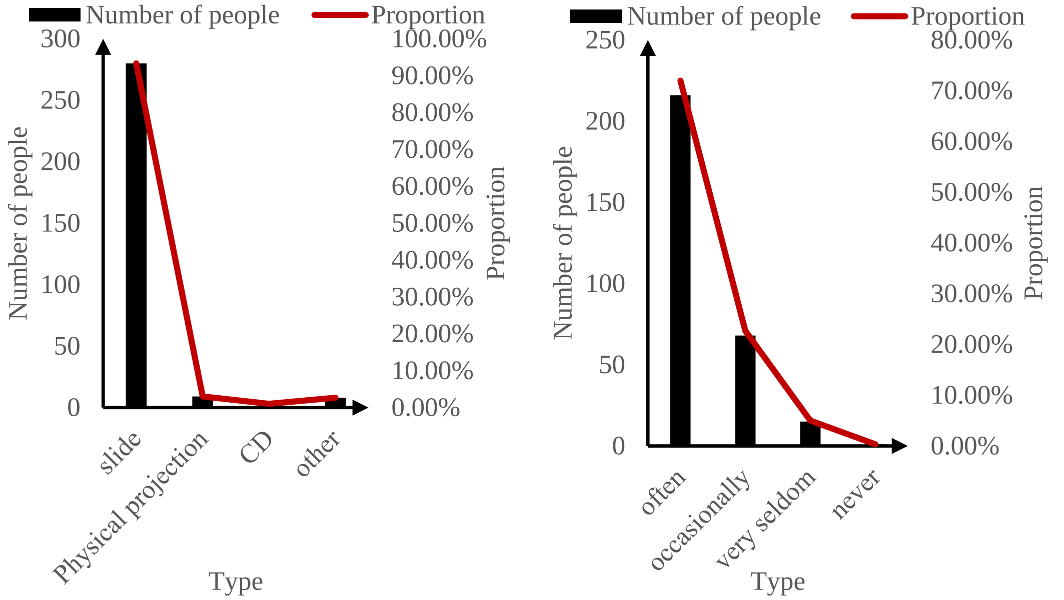
To carry out multimedia teaching, teachers must have computer software, hardware and multimedia equipment. As shown in Table 2, 36.33% of the students are satisfied with the multimedia hardware equipment in the classroom. 55.00% are basically satisfied. 3.00% are dissatisfied and 5.67% are very dissatisfied, respectively.

Table 2: Student satisfaction with classroom multimedia hardware equipment

| | Option | Number of people | Proportion |
|---|---|---|---|
| Student satisfaction with classroom multimedia hardware equipment | Very satisfied | 109 | 36.33% |
| | Basically satisfied | 165 | 55.00% |
| | dissatisfied | 9 | 3.00% |
| | Very dissatisfied | 17 | 5.67% |

Figure 6 shows the multimedia materials frequently used by teachers and the frequency of multimedia teaching. According to the analysis of the student questionnaire, as shown in Figure 6 (a), 93.33% of teachers often use the slides of multimedia materials. Physical projection, CD and others are 3.00%, 1.00% and 2.67% respectively.

As shown in Figure 6 (b), 72.00% of teachers often use multimedia teaching, 22.67% occasionally use it, 5.00% rarely use it, and 0.33% never use multimedia teaching. It can be learned that the development of information technology has deeply affected classroom teaching.




(a) Frequently used multimedia materials (b) Frequency of multimedia teaching

Figure 6: Multimedia materials frequently used by teachers and frequency of multimedia teaching

(3) Situation of teachers making multimedia courseware

The key to the implementation of multimedia teaching is whether teachers make courseware carefully.

Table 3 shows that 18.33% of students like the combination of text and video. 2.67% like the combination of text and audio. 10.00% like the combination of text and pictures, and 69.00% like the combination of four kinds of content. This shows that students love multimedia materials. Teachers should pay more attention to making courseware and enrich their courseware on the basis of teaching content, so that media resources can play their advantages.

In terms of whether the courseware or fonts have been carefully designed, 40.67% of the students say that the teacher's courseware or fonts have been carefully selected and designed. 37.00% say that they are just ordinary backgrounds and fonts. 22.33% say that they have not noticed. The courseware, which is rough and monotonous, causes hearing and vision fatigue and cannot give full play to its advantages.

Table 3: Multimedia courseware made by teachers

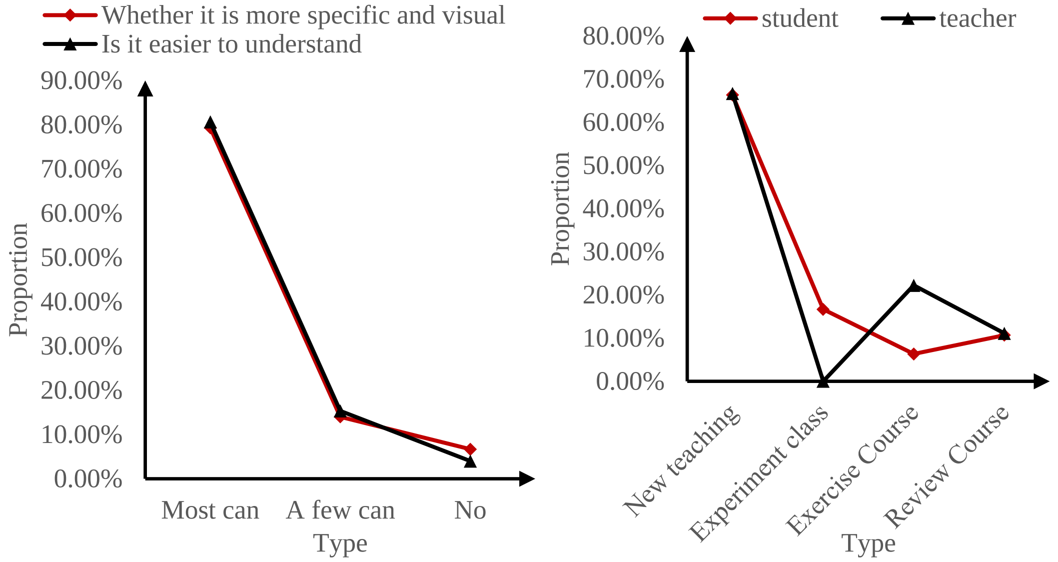
| | Option | Number of people | Proportion |
|---|---|---|---|
| Students' favorite multimedia forms | Combination of text and video | 55 | 18.33% |
| | Combination of text and audio | 8 | 2.67% |
| | Combining text with pictures | 30 | 10.00% |
| | Combination of four contents | 207 | 69.00% |
| Whether the courseware or fonts are carefully designed | Careful selection and design | 122 | 40.67% |
| | Normal background and font | 111 | 37.00% |
| | Never noticed | 67 | 22.33% |
| Whether the courseware is inserted with audio, video or animation | A lot of | 62 | 20.67% |
| | Once in a while | 93 | 31.00% |
| | It depends on the teaching content | 130 | 43.33% |
| | There is no | 15 | 5.00% |

In terms of whether teachers' courseware inserts audio, video or animation, 20.67% of students say that many courseware have inserted audio, video or animation. 31.00% say that it is only occasionally. 43.33% say it depends on the teaching content, and 5.00% say that it is not inserted.

(4) Influence of multimedia technology on mathematics classroom teaching

Figure 7 shows the data related to the impact of multimedia technology on mathematics classroom teaching. It can be seen from Figure 7 (a) that 79.33% of teachers choose to use multimedia teaching to make most of the mathematical laws more specific and visual. 80.67% say that most of the multimedia teaching can make the teaching content easier to understand.

It can be seen from Figure 7 (b) that 66.33% of students and 66.67% of teachers have chosen the new teaching type for multimedia teaching. Among students' choices, 16.67%, 6.33% and 10.67% are selected for experiment class, exercise class and review class respectively. 0.00%, 22.22% and 11.11% of teachers respectively. Through the analysis of these data, it is found that most students have been used to multimedia teaching and are aware of the existence of multimedia, which makes the mathematics classroom full of vitality.




(a) Whether the mathematical laws are more visualized and easier to understand (b) The type of multimedia teaching selected by students and teachers

Figure 7: The influence of multimedia technology on mathematics classroom teaching

Table 4: Overall impression of students on multimedia courseware

| | Option | Number of people | Proportion |
|---|---|---|---|
| Whether students like multimedia teaching | Like it very much | 126 | 42.00% |
| | Like | 64 | 21.33% |
| | Commonly | 105 | 35.00% |
| | Dislike | 5 | 1.67% |
| Comparison between multimedia and traditional teaching | More attractive | 228 | 76.00% |
| | More boring | 11 | 3.67% |
| | No difference | 61 | 20.33% |
| The teaching form that students are more willing to accept | Traditional teaching | 6 | 2.00% |
| | Multimedia teaching | 63 | 21.00% |
| | Combination of the two | 231 | 77.00% |

(5) Overall impression of students on multimedia courseware

In the survey on whether students like multimedia teaching, 77.00% of students are more willing to accept the combination of traditional teaching and multimedia teaching. Specific data are presented in Table 4.

## 3.3 Suggestions on Multimedia Technology Teaching

According to the survey of the high schools in Z City, the high schools in Z City are equipped with multimedia teaching equipment. In order to make better use of the application of multimedia technology in mathematics classroom, this paper gives some suggestions according to the results of the survey, as shown in Figure 8.

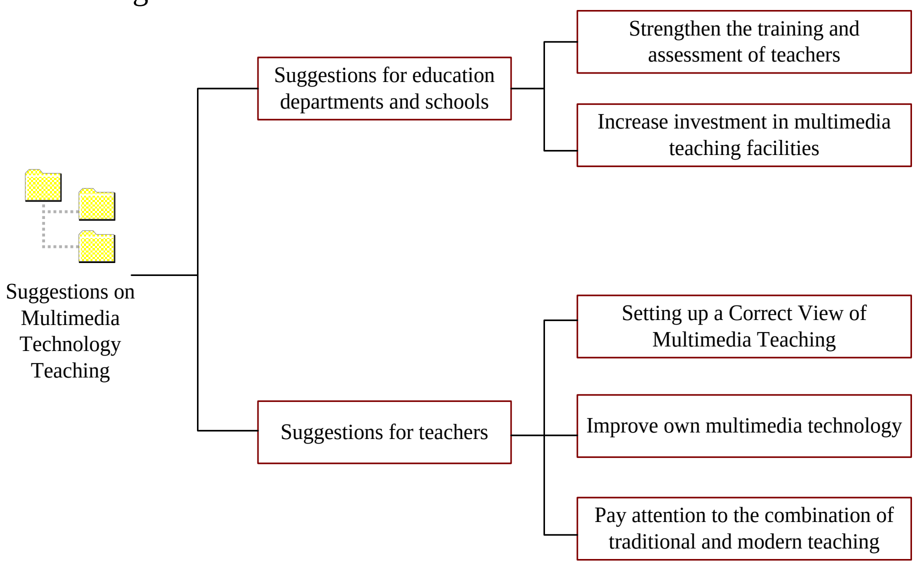



Figure 8: Suggestions on multimedia technology teaching

Modern teachers should possess strong skills in information teaching concepts and modern educational technology. Therefore, education departments must organize training and evaluate teachers' capabilities in modern educational technology to enhance their teaching skills and deepen their understanding of multimedia teaching. This integration of multimedia technology and mathematics education can be achieved through effective training and evaluation processes. Regular assessment and training sessions should be conducted to ensure teachers' proficiency in educational technology skills.

To improve teaching quality and maximize multimedia's benefits, teachers must consider students' learning characteristics and language abilities during courseware development. They should also stay updated with new multimedia technologies and enhance their application skills.

While multimedia technology facilitates resource sharing and knowledge updates, teachers should design their own content rather than relying solely on pre-made courseware. Additionally, not all math classes may require multimedia, so teachers should apply it appropriately based on student needs. By selecting suitable teaching aids and combining multimedia with traditional methods, teachers can optimize teaching effectiveness.

## 4. Conclusions

Using multimedia technology for mathematics teaching in senior high school is essential in keeping with contemporary requirements. This study examines the application and impact of multimedia technology in high school mathematics education, considering its specific characteristics and its relationship with multimedia teaching. Preliminary strategies to enhance multimedia teaching effectiveness are explored. Problems were identified at managerial, implementation, and student levels, with efforts made to integrate multimedia into the mathematics classroom. A questionnaire survey conducted in four senior high schools in Z City provided insights into the current status of multimedia teaching in mathematics. However, due to regional limitations, this study couldn't fully represent the situation across most provinces in China. Future work will focus on refining and improving strategies within resource and time constraints.

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