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# Research on Data Visualization Technology in Teaching and Learning

Jiang Xiulian
School of Management
Xuzhou University of Technology
Xuzhou, Jiangsu, China

Song Yining
School of Mathematical Sciences
Yangzhou University
Yangzhou, Jiangsu, China

***Abstract*—Data visualization can convey unlimited information in limited space, and display intuitively the internal relationship between data, which is conducive to the discovery of implicit information. Use data visualization technology and tools, the teacher can visually process teaching content, intuitively and dynamically display teaching content, improve teaching level and efficiency, achieve expression superiority of "one figure is worth thousand words". Visualization supports students' cognitive construction. According to visual processing and analysis results of learning process data, the student can find the gap, adjust learning plan, change learning strategy, and promote autonomous learning, build their knowledge framework and association system. According to analysis of teachers and students data by data visualization technology, the teaching managers can timely adjust objectives, methods and strategies of teaching management, to better promote the management process and level of school. Data visualization technology is a powerful tool for future education, to promote teaching reform and optimize teachers' technology application.**

***Keywords—Data visualization technology; Teaching data; Teaching content; Mind mapping***

## I. INTRODUCTION

Data visualization technology appeared in the 50s of last century, when people use computer technology to create a batch of visual graphics and charts, data visualization technology began to develop. At present, the research and application of data visualization has entered a period of rapid development, covering computer, biological engineering, meteorology and other important fields. With the progress of society, the development of information technology is changing with each passing day. The management methods of managers, the teaching methods of teachers, and the learning methods of students are constantly changing and innovating. Data visualization technology can display large amounts of complex data that people cannot understand directly and display them in a way that people can understand easily. Using data visualization technology can change the forms of teaching content, stimulate students' interest and enthusiasm, promote students' thinking and improve the quality of teaching [1]. At present, there are a large number of visual chemical tools for research and use, and in the field of computing, finance and other commercial applications have been achieved, in the field of education and other noncommercial applications are still inadequate. Using data visualization technology can make the teaching content and teaching program more perfect, provide higher level of teaching services for learners, and promote the overall improvement of the ability of managers, teachers and learners. In recent years, in the field of education, Tsinghua University, Zhejiang University and University of Chinese Academy of Sciences have carried out research work in data visualization, and have made great achievements in many fields, such as geographic information. The application of data visualization to teaching is the trend of the development of education and teaching in the future.

## II. EASY DATA VISUALIZATION TECHNOLOGY

Data visualization is using computer graphics and image processing technology, to convey and display data intuitively and dynamically in the form of chart and image [2], so that people are more likely to understand the hidden information behind their data, make it easier to understand and remember the content expressed through data. Data visualization technology is the meaning of human visual perception data, the data set to be processed to create data images, to observation data from multi-dimensional. Data visualization includes basic processes of data collection preparation, filtering, mapping, rendering images, display, and feedback[1]. That is, by collecting raw data, filtering the original data into valid and available data, and then mapping it into visual structural data, and finally rendering the structured data into an image for display to learners and users. Each process module transfers data information in sequence.

There are four basic characteristics of data visualization technology [1]. First, visualization. Data visualizations can visually display unrelated data, allowing users to arrange and display the collected data and information in an orderly and regular way. Second, association. Data visualization can correlate the potential relationships between data through its dimensions and index. Third, artistic. Through data visualization technology, the data can be displayed in the form of aesthetics, so as to enhance the artistic effect of data. Fourth, interactivity. The interactive nature of data visualization technology is to realize the user's management of data, finally, the data can be personalized with visual graphics [3]. The four basic features of data visualization are the main advantages of data visualization in teaching. With the visualization and relevance of data visualization, teachers can display data

intuitively and visually, and find out the unique key correlation between the data [4]. Interactive and artistic visual processing realizes the effective communication between teachers and students.

This paper studies the data in teaching, and the teaching data are generally unstructured and disorderly data. Data visualization tools is particularly important on processing and analysis of unstructured data. Through visual processing of student achievement, it is possible to find out what teachers need to improve, or find out the problems of students' learning from the teaching information system.

*MindMapper* visualization mind mapping is a visual concept map in data visualization tools. It sorts the information content of users into structured logical content for reference and utilization. We can use it's intelligent drawing function to build ideas and divergent thinking. Its function is to organize confused and disorderly ideas into a clear and logical content system. *MindMapper* mind map allows you to free thinking, because it does not like other software is limited by format and the structure of the outline, and can capture your emerging ideas in an integrated fashion, then arrange and organize to form a logical knowledge system. Mind mapping has unique advantages in the arrangement of teachers' teaching content, students' review and research teaching.

## III. Optimization of Teaching Process by Data Visualization Technology

### A. *Perspective of teaching managers*

Define Teaching managers not only supervise the quality of teaching, students' learning situation, but also make management system. They can evaluate the performance of teachers and students' learning effectiveness according to the visual results of students' scores, and find out the problems existing in the teaching of teachers, students' learning and performance, and rectify the problems.

TABLE I. 2005-2016 College English Test Band 4 Passing rate

| *Exam time* | *Passing rate* | *Exam time* | *Passing rate* |
|---|---|---|---|
| 200506 | 31% | 200512 | 20% |
| 200606 | 22% | 200612 | 31% |
| 200706 | 25% | 200712 | 35% |
| 200806 | 10% | 200812 | 25% |
| 200906 | 15% | 200912 | 27% |
| 201006 | 36% | 201012 | 16% |
| 201106 | 28% | 201112 | 23% |
| 201206 | 31% | 201212 | 20% |
| 201306 | 22% | 201312 | 31% |
| 201406 | 25% | 201412 | 45% |
| 201506 | 26% | 201512 | 47% |
| 201606 | 28% | 201612 | 50% |

The following is a visual chart (Fig.1) creation and analysis based on the sample data (TABLE I.) of the students' participation in College English Test Band 4 (CET-4) in our School of Management from 2005 to 2016.

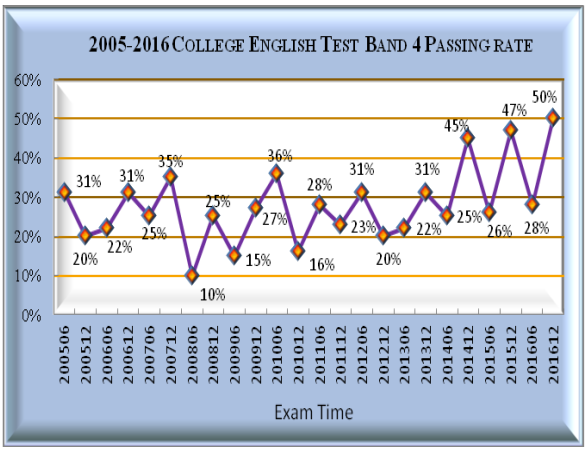


Fig. 1. 2005-2016 CET-4 passing rate line

Using the data in TABLE I. to create a broken line chart of exam times and passing rate using Excel (Fig.1).The CET-4 pass chart shows that the passing rate of 19 exams between June 2005 and June 2014 was always below 40%, while the passing rate of examinations in December from 2014 to 2016 was More than 40%, the passing rate was significantly higher than in previous years. There was no significant difference between the exam passing rate in June and the previous year in the three years from 2014 to 2016. Further analysis of this phenomenon, before June 2014, the University stipulates that only 10% of the freshmen in the class can take part in the CET-4 in December of the year. In June 2014, the University adjusted the examination management measures, canceled the number of candidates to participate in the exam, everybody can go in the CET-4 exam. After the examination methods were adjusted, the passing rate of CET-4 in December of that year was greatly increased. As a result, the university office can arrange students to take part in the CET-4 exam in time. The English teaching department should strengthen the English training for the freshmen in September, so as to make the students become familiar with the CET-4. as soon as possible. After nearly 4 months of learning and counseling, most of the students can successfully pass the CET-4, so that students experience the joy of success, stimulate students' enthusiasm for learning, cultivate students' ability and confidence in university learning, and lay a good foundation for their follow-up study.

Counting the 2015 and 2016 Grade students' passing rate of CET-4 in the School of Management, using data visualization tools to show it. It can be seen from Fig.2 that Accounting Major and Information Management And Information System Major CET-4 passing rate is high. The reason is that the two major students are mainly Jiangsu students, they are good at English. Every year, more than 50% students of top 100 students of the freshmen's entrance examination enrolled in Accounting Major. These students

have good learning ability in high school, and have continued their strong study skills in college. Real Estate Management Major and Tourism Management Major CET-4 passing rate is low. The reason is that the two major some students are from other provinces, their basis of English is poor. Educational administrators can arrange English teaching according to these situations. At the same time, we can find that the passing rate of grade 2016 is higher than that of grade 2015. The reason is that the students of grade 2016 have just entered the University, they have high learning enthusiasm, and their English foundation is still in existence. Educational administrators can arrange the students to take part in the CET-4 examination as soon as possible to improve the passing rate.

TABLE II. CET-4 PASSING RATE OF EACH MAJOR

| Grade / Majar | Grade 2015 | Grade 2016 | Average |
|---|---|---|---|
| Accounting | 83.98% | 87.87% | 85.93% |
| Financial Management | 61.67% | 63.60% | 62.64% |
| Real Estate Management | 56.00% | 55.26% | 55.63% |
| Information Management And Information System | 72.65% | 76.35% | 74.50% |
| Marketing | 59.81% | 64.90% | 62.36% |
| Tourism Management | 52.38% | 55.11% | 53.75% |
| Logistics Engineering | 54.60% | 67.10% | 61.62% |

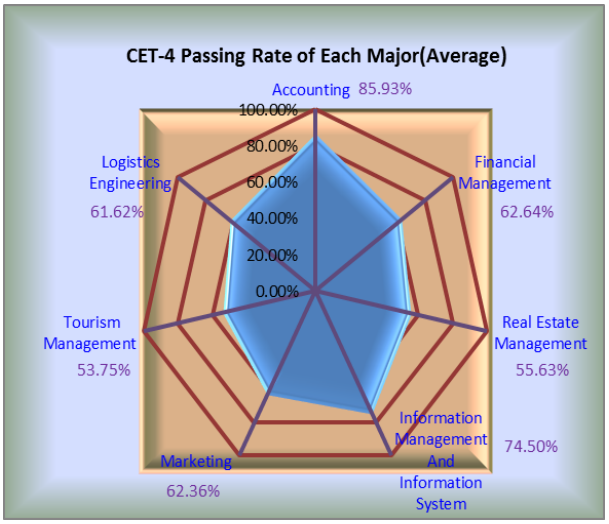


Fig. 2. CET-4 passing rate of each major in School of Managerment

They can also visualize student assignments and classroom teaching data. For students, teaching managers can establish a teaching feedback platform, students can timely feedback learning and living conditions, adjust the management methods and methods according to the feedback of students to make management more humane. Teaching managers can also visually process the records of the students visiting library, explore the independent learning situation of the students. By analyzing the time and content of the students login to the school learning platform, analyzing the students' learning needs, provides resources, and makes up the deficiency of teachers' face-to-face communication.

### *B. Optimization of teachers' Teaching*

Avoid Using data collection tools and visual analysis tools, which can visually obtain the data of students' learning links, academic achievements and other data. The visual analysis results of information provide basis for teachers' teaching and individualized guidance of students [5]. Teachers can use *Xcelsius* visualization tools to build a visual model using students' achievements, and display the data in the form of graphics or images. Teachers can visually observe the students' learning situation and weak links, and then have targeted teaching and guidance. Teachers can also access the students' behavioral data through the school network teaching platform, including the login time, login times, online duration, browsing content, self-test, video viewing, job completion and participation in the discussion. Through the visual processing of these data, teachers can intuitively obtain the students' self-study situation, find the students' learning rules, learning hot spots, so as to provide teaching resources, answer questions and guidance purposefully. The visual processing and analysis of the data in teaching based on the teacher's perspective can not only improve the quality of teaching, but more importantly, can be targeted teaching, improve the quality of student training.

For example, when making "Sensitivity Analysis" by profit planning model, the teacher can make a "dynamic chart of profit changes". Click on the "Sales" and "Management Cost" adjustment buttons on the chart to adjust their values. Based on the adjusted data, the output automatically changes, we can select the required scheme according to the actual situation(Fig.3).

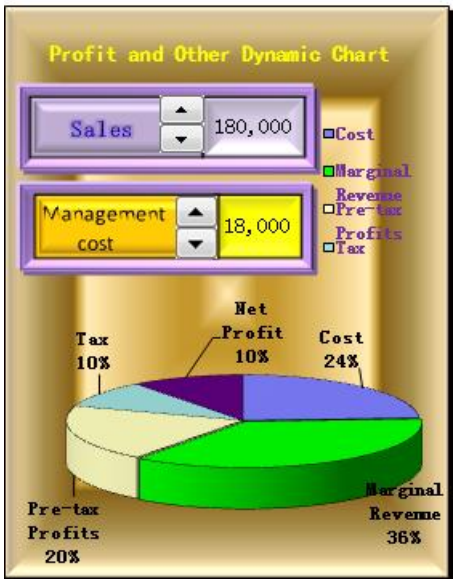


Fig. 3. Profit and other dynamic chart

### C. Optimization of students' learning process

The most important thing for students to learn is to find the gap between themselves and other students, improve their own knowledge system and improve their skills. Using visualization tools can find their own learning problems, so as to improve learning methods and improve learning efficiency. Using the file list generator in *Xcelsius*, you can record the score information of each student, whichever record you choose will be displayed in the target cell, easy to find each student's score information. Students can find their own weaknesses according to their own and the class of other students. Then compare the learning content and learning time of other students who have advantages in this aspect, then find the deficiency, study them accordingly. Students can not only find the gap between themselves and others in the performance, but also find gaps in other areas. Many problems and reasons can be found through visual processing results.

## IV. VISUALIZATION OF TEACHING CONTENT

After Nowadays it is usually to make use of multimedia teaching. Most of the presentation of teaching content is PPT, which is more and more difficult to arouse students' interest in class. Therefore, how to use visual tools to deal with teaching content is particularly important. *MindMapper* can not only directly convert the content displayed by PPT into structural knowledge in teaching, but also convert knowledge into PPT, which is convenient for teaching. The diagram created by Mind Mapping is the connection of the conceptual themes, which presents a structured system through memory, induction and creation. It can understand the thoughts and intentions that you input, and allow you to exert the superiority of thinking. You can visualize these teaching contents so as to facilitate the visualization of the teaching contents intuitively by the teachers, so as to arouse students' interest in learning and thinking, pomote students to take the initiative to learn. In the course of explaining The Earth/Human System, Columbia University puts forward that students should apply VUE (Visual Understanding Environment) concept map tool to create curriculum knowledge map. This way of learning helps students master the knowledge of the course, guide students to link the course content with other disciplines [1]. Professor Marcia C. Linn applied visualization technology to teaching, achieved good teaching effect, active classroom atmosphere, enhance student interest in learning, students have also been divergent thinking. Students can also conduct scientific exploratory experiments through visual tools to help students understand the intrinsic value of knowledge.

Using data visualization technology, teachers can organize the scattered teaching contents around a subject and display them intuitively and graphically. Compared with text teaching, visual teaching has more advantages. It can develop learners' thinking, make learners easier to accept teaching knowledge, and promote the visualization of thinking, so as to improve the learning effect of learners. It is easy to discover the internal relations of things by using data visualization technology. In the process of visualization teaching, learners can directly draw the internal logical relationship between topics and sub-topics by using visual tools [6]. The visual processing of teaching content can improve students' learning ability, thinking divergence and innovation ability, and improve the way students handle information.

## V. CONCLUSION

This paper analyzes the data in the teaching process from three aspects of teaching managers, teachers' teaching and students'' learning. It analyzes the data visually and finds out the problems in all aspects, and then puts forward some suggestions and optimization methods to solve these problems. Teaching managers can understand the quality of teaching and the level of teachers through data visualization technology, and adjust and formulate the teaching management system in time. Using data visualization technology, on the one hand, teachers can visualize the teaching content, form a structured system, facilitate classroom teaching, and display the teaching content visually and artistically for the students in the teaching, and improve the teaching level and efficiency. On the other hand, students can find out their own problems, find solutions and promote self-learning according to the results of visual processing and analysis of learning process data with other students. Visualization of teaching content can improve teaching effectiveness, stimulate students' enthusiasm for learning, promote students' thinking and enhance the quality of students' training.

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