

Research on Visualization Analysis and Decision Support Application of Teaching Supervision Classroom Observation Data from the Perspective of Big Data — A Case Study of Changji Vocational and Technical College

Xiaorong Shen, Xi Hu

Changji Vocational and Technical College, Changji 831100, Xinjiang, China

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Abstract: With the in-depth development of educational informatization, vocational colleges have accumulated massive amounts of teaching supervision classroom observation data in daily teaching management. Traditional data processing methods are insufficient to explore the in-depth value of data and provide intuitive support for decision-making. Taking the supervision data of Changji Vocational and Technical College from the 2022-2023 academic year as a sample, this study explores how to use technology stacks such as ECharts, Vue.js, and Python (Pandas, Scikit-learn) to build a decision support platform that integrates data integration, analysis, and visualization^[1]. The platform realizes functions including global situation awareness, multi-dimensional drill-down analysis, time trend tracking, individual portrait and correlation analysis, and incorporates algorithms such as K-Means clustering and correlation analysis to deeply explore data value. This application converts abstract scoring data into intuitive charts and dashboards, aiming to help school administrators quickly gain insights into the distribution of teaching quality, identify weak links in teaching and dominant disciplines. Thereby, it provides scientific and efficient data support for teaching reform, the allocation of teacher training resources and strategic decision-making, and promotes the continuous improvement of teaching quality^[2].

Keywords: Big data; Teaching supervision; Data visualization; Decision support; ECharts; Clustering analysis; Changji Vocational and Technical College

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1. Introduction

Teaching supervision is a core link in ensuring and improving the teaching quality of higher vocational colleges. As an important comprehensive higher vocational college in the Xinjiang Uygur Autonomous Region, Changji Vocational and Technical College organizes school-level and college-level supervisors to conduct a large number of classroom observation and evaluation activities every year, generating both structured and unstructured data, including course information, teacher information, evaluation indicators, scores, and text feedback^[3]. However, the current management and analysis of these data still face many challenges: first, the value of data remains untapped—massive amounts of data are only used for simple statistical summary, and potential patterns and correlations have not been explored; second, it is difficult to gain a

global insight, making it hard for administrators to quickly and accurately grasp the overall picture of the school's teaching quality and identify the location of problems; third, the decision-making feedback is lagging, as the decision-making model based on static reports cannot provide real-time and dynamic responses to teaching problems.

Against this background, this study, based on the perspective of “big data”, aims to use advanced data visualization technologies and data analysis algorithms to solve the above problems, activate the dormant supervision data assets, and provide an “intelligent brain” for the teaching management decision-making of Changji Vocational and Technical College. Featuring specific technical implementations and algorithm applications, this paper elaborates in detail a solution that can be implemented in practice^[4].

2. Research Design and Technical Path

2.1. Data Foundation and Preprocessing

This study takes the teaching supervision classroom observation data of Changji Vocational and Technical College from the 2022-2023 academic year as the sample. The original data is sourced from Excel spreadsheets organized by the Academic Affairs Office, with a total of 3,285 valid classroom observation records, covering 8 secondary colleges of the university. Each record includes the following fields:

Basic information: Observation date, class period of observation, secondary college, major, course name, teacher ID, and supervisor ID.

Quantitative scores: Using the standard evaluation form formulated by the college, it covers 6 dimensions with a 100-point scale, including “Teaching Objectives” (weight: 0.15), “Teaching Content” (weight: 0.20), “Teaching Methods” (weight: 0.25), “Classroom Management” (weight: 0.20), “Teaching Effect” (weight: 0.10), and “Integration of Ideological and Political Education” (weight: 0.10).

Text data: Qualitative evaluations and suggestions from supervisors.

The data preprocessing process is the foundation for subsequent analysis. We used Python's Pandas library to complete the following steps:

Data cleaning: Handling missing values (filled with the average score of the same dimension in the same college) and outliers (identified and corrected using the 3σ principle).

Data integration and transformation: Merging multiple Excel spreadsheets and calculating the total score (weighted average) for each record. Linking teacher IDs with the teacher information table (including teaching experience and professional title).

Text preprocessing: Using the Jieba word segmentation library to segment the text evaluations and remove stop words, laying the groundwork for subsequent word cloud generation and sentiment analysis^[5].

Finally, we constructed a structured “Teaching Supervision Data Warehouse” to provide a high-quality data source for visualization and analysis.

2.2. Technical Architecture and Algorithm Selection

This study adopts a technology architecture with separated front-end and back-end, and integrates machine learning algorithms for in-depth analysis^[6].

For front-end visualization, the Vue.js framework is used to integrate the ECharts component library. Leveraging ECharts' rich chart types and powerful interactive capabilities (such as data drilling, zooming, and hover details), an interactive dashboard is built.

For back-end services, the Python Flask framework is employed to construct a RESTful API, which is responsible for data query, logical processing, and model calling.

In terms of data analysis and algorithms:

Core analysis libraries: Pandas (for data processing) and NumPy (for numerical computation).

3.2. Multi-Dimensional Comparison and Drill-Down Analysis: Accurate Identification of Strengths and Shortcomings

Visual presentation and examples:

A multi-series bar chart is used to compare the average scores of each secondary college across various evaluation dimensions. The example shows that the College of Pharmacy and Medical Technology has the highest scores in “Teaching Content” and “Integration of Ideological and Political Education” (92 points), but a relatively low score in “Teaching Methods” (78 points); in contrast, the College of Information Science and Engineering has a high score in “Teaching Methods” (90 points), while “Classroom Management” becomes its shortcoming (75 points).

A drillable sunburst chart is designed, with the outer layer representing colleges. Clicking on a college allows drilling down to its subordinate majors. It is found that the average score of the “New Energy Vehicle Technology” major in the College of Energy and Power Engineering (94 points) is significantly higher than that of other majors in the same college, making it a benchmark for “advantageous majors”^[9].

Decision support: Teaching administrators can make accurate decisions, including: targeted training – organizing teachers from the College of Pharmacy and Medical Technology to participate in workshops on information-based teaching methods and flipped classrooms; experience promotion – summarizing the teaching methods of excellent teachers in the College of Information Science and Engineering and developing a case library for sharing across the school; resource inclination – providing key support for the College of Energy and Power Engineering to summarize and promote the construction experience of the New Energy Vehicle Technology major.

3.3. Time Trend Tracking: Gaining Insights into Dynamic Changes

Visual presentation and examples:

A line chart is used to show the changing trend of the average score of the College of Information Science and Engineering over the past three semesters: Spring 2022 (84 points) -> Autumn 2022 (87 points) -> Spring 2023 (89 points). Key events, such as all teachers in the college participating in a special training on “ideological and political education in courses” during the summer vacation of 2022, are marked on the chart.

The platform supports viewing the trend of individual teachers. For example, a new teacher with the ID “10345” saw their score rise steadily from 72 points in the first semester to 85 points in the third semester, reflecting good growth potential.

Decision support: Trend analysis can be used to evaluate the effect of policies (e.g., the “ideological and political education in courses” training has achieved obvious results) and track teacher development (e.g., identifying Teacher 10345 as a promising young teacher and providing more development opportunities).

3.4. Individual Profiling and Attribution Analysis: Focusing on Micro-Level and Precise Measures

Visual presentation and examples:

By entering the teacher ID “10258” on the platform, a personal radar chart is generated. It is found that the teacher’s scores in the two dimensions of “Teaching Methods” and “Classroom Management” are significantly lower than the average score of their college.

At the same time, the system invokes a text analysis algorithm to generate a word cloud. In the word cloud, words such as “lack of interaction”, “fast speaking speed”, and “loose discipline” are the largest and most prominent. Sentiment analysis determines that the emotional tendency of the comments is mainly neutral to negative.

Decision support: Based on this, the dean of the secondary college can provide the teacher with a precise diagnostic report and improvement plan: suggesting that the teacher participate in workshops on “classroom interaction skills” and “rhythm control”, and arranging an experienced teacher with high scores in “Classroom Management” to provide one-on-one guidance.

3.5. Algorithm-Driven Correlation and Clustering Analysis: Exploring In-Depth Patterns

Visual presentation and examples:

Correlation analysis: A scatter plot is used and the Pearson Correlation Coefficient is calculated to analyze the relationship between “teaching experience” and “classroom management score”. The result shows a correlation coefficient of 0.68, indicating a moderate positive correlation. This suggests that the increase in teaching experience has a positive impact on classroom management ability^[10].

Clustering analysis: The K-Means algorithm (with K=3 set) is applied to group all teachers. The clustering results are clearly displayed through a scatter plot (with “Teaching Methods” and “Classroom Management” as axes):

Cluster 0 (35%): Balanced and high scores in all dimensions, referred to as the “comprehensively mature type”.

Cluster 1 (45%): High scores in teaching methods but low scores in classroom management, mostly young teachers, referred to as the “novel methods but insufficient management type”.

Cluster 2 (20%): Low scores in all dimensions, requiring key support, referred to as the “all-round growth type”.

Decision support:

In response to the correlation between “teaching experience and management ability”, the decision is made to optimize the orientation training system for new teachers (with teaching experience < 3 years) by significantly increasing the practical simulation sessions of classroom management.

In response to the clustering results, the decision is made to implement a differentiated teacher training strategy: for Cluster 0, encouraging them to apply for the title of “Distinguished Teacher” and giving full play to their role in mentoring; for Cluster 1, focusing on providing classroom management training; for Cluster 2, launching the “Teaching Ability Improvement Program” to provide all-round support.

4. Conclusions and Prospects

Addressing the current situation where the teaching supervision data of Changji Vocational and Technical College is underutilized, this study designs and implements a visual decision support platform based on modern Web technologies and data analysis algorithms. This solution not only enables the visual presentation of data but also realizes the exploration of the in-depth value of data by integrating machine learning algorithms (K-Means clustering, correlation analysis, and text mining), achieving three core goals:

Simplifying Complexity to Improve Perception Efficiency: Converting complex data into intuitive graphics significantly enhances the efficiency of information acquisition.

Gaining In-depth Insights to Accurately Locate Problems: Through multi-dimensional drilling, trend analysis, and algorithm models, it enables accurate identification of teaching quality issues from the macro to the micro level.

Enabling Scientific Decision-Making to Form a Management Closed Loop: Directly transforming data insights into management actions for resource allocation, teacher development, and policy evaluation, forming a positive “data-insight-decision-improvement” closed loop, which strongly supports the connotative development of the college.

Future work can be expanded in three aspects: first, introducing time series prediction models (such as ARIMA and LSTM) to attempt predicting the trend of teaching quality and conducting early warnings; second, constructing a multi-source data fusion system that integrates data such as student teaching evaluations, academic performance, and online teaching platform logs to build a more comprehensive teaching evaluation profile; third, introducing natural language processing (NLP) technology to improve the platform’s intelligent interpretation capability, automatically generating structured data analysis reports, further lowering the threshold for use, and allowing data wisdom to benefit every education manager.

Disclosure statement

The author declares no conflict of interest.

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