# Research on Classroom Teaching Behavior Analysis System Based on Artificial Intelligence Technology

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Abstract: So far, the mainstream of classroom teaching behavior analysis system is S-T analysis method, FIAS and ITIAS, these three analysis systems are aimed at teaching behavior in teaching video. Through the objective analysis of teaching behavior, we can make an accurate diagnosis of teaching practice, provide objective guidance for teachers ' teaching, and ultimately provide an effective way for teachers ' professional development. With the continuous development of artificial intelligence, computer vision and natural language processing technology are gradually applied to the teaching behavior analysis system, which solves the disadvantages of tedious data collection and large amount of calculation in the teaching behavior analysis system. Based on three different classroom teaching behavior analysis systems, this paper summarizes the current situation of teaching behavior analysis in the field of artificial intelligence, aiming to provide reference for how to construct an efficient intelligent analysis system of classroom teaching behavior based on artificial intelligence technology.

## 1 INTRODUCTION

During the 14th Five-Year Plan period, the Notice on the Implementation of the National Training Plan for Kindergarten Teachers in Primary and Secondary Schools (Ministry of education 2020) clearly stated that it is necessary to promote the integration of artificial intelligence and teacher training to help teachers develop with high quality. In the face of ' one teacher, one excellent lesson ' this huge high-quality teaching resources, teachers through observation can effectively improve the teaching level, promote teachers to improve the teaching process. However, this only stays on the surface. Most observation teachers can only imitate their gods but do not experience their shapes. The teaching behavior analysis system can effectively help the observation teachers to deeply understand the interaction between teachers and students. In the face of its disadvantages such as cumbersome data acquisition, large amount of calculation, and high labor consumption, Transana software and Nvivo software have proposed that the efficiency and accuracy are effectively improved through automatic processing of a large number of codes (Zhang 2020). With the maturity of computer vision and natural language processing technology, the most cumbersome data acquisition process can also be automated. Artificial intelligence empowering education (Jia 2018), facing three kinds of classroom teaching behavior analysis system and two kinds of artificial intelligence technology, how to build efficient classroom teaching behavior intelligent analysis system is attracting more and more scholars ' attention.

## 2 CLASSROOM TEACHING BEHAVIOR ANALYSIS SYSTEM

### 2.1 S-T Analysis

With the continuous change of education, the traditional classroom of single teaching mode has been unable to carry the needs of modern teaching, and the intervention of new technology has promoted the emergence of smart classroom. With the support of information technologies such as big data and learning analysis, teachers can fully implement diagnostic analysis and intelligent resource push in the teaching process, and carry out



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'cloud + terminal' learning activities and support services. The smart classroom ecological environment generally includes interactive screens, freely assembled desks and chairs, tablets, cameras and other hardware, as well as software such as e-schoolbag systems and intelligent recording and broadcasting systems (Li 2020). The intelligent teaching equipment of smart classroom provides a new situation for teachers' teaching and students' learning. Teachers can simplify and optimize the three teaching processes before, during and after class according to their characteristics.

## 2.2 FIAS

FIAS was proposed by American scholar Ned Flanders in the 1960s (Huang 2021). It believes that language interaction is the main way of classroom interaction, and 80 % of the teaching behavior in the classroom belongs to teacher-student discourse interaction. The system samples the classroom records for 3 seconds according to its coding system, and the data is recorded in the analysis matrix. By analyzing the composition of the row and column elements in the matrix, the classroom structure, teacher tendency or style of the course can be obtained.

## 2.3 ITIAS

With the continuous integration and development of new technologies and education such as meta-universe, artificial intelligence and big data, the application of smart classrooms is becoming more and more extensive. The ITIAS classroom interaction system based on information technology came into being on the basis of FIAS (Cen 2021). On the one hand, ITIAS refines the category of human interaction, on the other hand, it also expands the interaction between human and technology, and can effectively analyze the teaching behavior in new education methods such as smart classroom.

## 2.4 Comparison of Three Teaching Behavior Analysis Systems

Based on the analysis of the three teaching behavior systems, their advantages and disadvantages are summarized in Table 1.

Table 1 The advantages and disadvantages of three teaching behavior analysis systems

| | Advantages | Disadvantages |
|---|---|---|
| S-T analysis | Clearly defined teaching behavior reduces error rate during data sampling | Focusing on teaching behavior, ignoring the role of language in the classroom, and teaching behavior classification is too simple |
| FIAS | Rich dimensions of teaching behavior enable observers to accurately identify and classify classroom language behavior to a certain extent | Focus on linguistic analysis, ignoring meaningful non-linguistic information |
| ITIAS | Focusing on the role of technology in the teaching process, it is more suitable for new educational methods such as smart classrooms. | There are too many categories of teaching behaviors, which are prone to errors in identification. |

# 3 RESEARCH ON WAYS TO ANALYSE TEACHING BEHAVIOUR IN THE FIELD OF ARTIFICIAL INTELLIGENCE

Classroom teaching behaviour refers to the actions taken by teachers and students in the classroom in order to achieve certain teaching objectives (Yan 2017). Teaching behaviour can be divided into two categories: action and speech. For these two categories of teaching behaviour, computer vision can be used to identify the action subject at the current data collection point, and also natural language processing technology can be used to identify the discourse person at the current data collection point. Therefore, teaching behaviour analysis approaches under the AI domain are divided into two categories based on computer vision and based on natural language processing techniques (Zhang 2021). At present, the theoretical bases used for intelligent analysis systems of teaching behaviour are all S-T analysis methods due to their strong operational nature.

### 3.1 Computer Vision-Based Intelligent Analysis System for Classroom Teaching Behaviour

The main technique used to identify action subjects in videos using computer vision is face detection. Early face detection techniques were limited to a single background and could only solve videos where the face was facing the camera. With the continuous improvement of technology, face detection techniques now have three types of methods based on knowledge, feature-based and appearance-based (You 2017), and the most commonly used method applied to classroom teaching behaviour analysis is the appearance-based AdaBoost method.

Zhou Pengxiao et al (Zhou 2018) obtained data information from three aspects, such as the number of faces, contour features and subject action amplitude of the detected video frame images, used Bayesian causal net model to reason about the subject's behavioural features, obtained behavioural sequences, constructed a teaching model for teaching videos, and finally achieved the design of intelligent recognition of S-T behaviour in classroom teaching videos. Li Litao (Li 2017) converted the data sampling points of the video into images, used AdaBoost face detection technology and similarity metric to obtain teacher behaviour, and attributed data samples that were not teacher behaviour to student behaviour according to the definition of S-T analysis method, so as to obtain the S-T data sequences in the corresponding teaching videos.

### 3.2 Analysis of Teaching Behaviour Based on Natural Language Processing

Mu Su (Mu 2019) proposed an S-T analysis method based on speech similarity recognition from the perspective of classroom speech, in which teachers and students recorded vocal information in advance, and voice clips were collected at fixed time intervals to compare with the recorded vocal templates, so as to determine the identity of the speaker of the sample. This classroom discourse analysis system based on vocal recognition technology can only get accurate results after the vocal pattern model of teacher and student discourse is entered in advance. To address the above drawbacks, Guilin Liu (Liu 2020) established a classroom teaching corpus, proposed a speaker classification algorithm for pre-clustering recognition, and designed and developed a teaching behaviour analysis system where the input is a live classroom recording or audio based on the S-T analysis method as the theoretical basis.

### 3.3 2x3 Model

Through the above analysis of the three teaching behaviour analysis systems and two artificial intelligence techniques, the 2X3 model (table 2) is proposed in this paper. Where operability refers to whether the development and design of the intelligent analysis system can be achieved, and practicality refers to whether the system, once developed, can provide teachers with objective and comprehensive guidance. As the S-T analysis method of behavioural categorisation is too concise to provide teachers with a referenceable meaning, the practicality of an intelligent analysis system for teaching behaviour, whether based on computer vision or natural language processing techniques, is poor. On the other hand, the ITIAS behavioural categories are too complex, making computer recognition difficult, and neither computer vision nor natural language processing alone can define the categories, requiring the integration of two artificial intelligence techniques in the system, thus increasing the burden of system design and development. behaviour is derived from language, for which natural language processing is somewhat more tractable than computer vision.

Based on the 2X3 model (table 2), it can be concluded that of the two artificial intelligence technologies and the three teaching behaviour analysis systems, the intelligent teaching behaviour analysis system based on natural language processing technology and FIAS is the most efficient.

Table 2 2X3 model

| | Computer vision | Natural language processing |
|---|---|---|
| S-T | parsing Highly operational, poorly practical | Highly operational, poorly practical |
| FIAS | Weakly operational, highly practical | Highly operational, highly practical |
| ITIAS | Weakly operational, highly practical | Weakly operational, highly practical |

# 4 DESIGN OF AN INTELLIGENT ANALYSIS SYSTEM FOR TEACHING BEHAVIOUR BASED ON NATURAL LANGUAGE PROCESSING AND FIAS

## 4.1 Theoretical Foundation

FIAS is known as Flanders Interaction Analysis System (FIAS) in Chinese. It is based on its own FIAS coding system, which is used to describe the interaction behaviour between teachers and students in the classroom. The recorded video is sampled once every 3 seconds, the codes are recorded in a matrix, and then the classroom behaviour is analysed according to the meaning of the row and column elements in the matrix. In this paper, we take the 2018 ministerial-level excellent lesson "Reflection of Light" in the One Teacher One Excellent Lesson platform as an example and use FIAS to do a detailed analysis of classroom teaching behaviour.

### 4.1.1 Data Collection

Due to the subjective nature of the data collection process, the three data collectors were required to collect the data separately and then discuss and determine the points of contention when aggregating. A total of 874 coding sequences were eventually collected, and this data was used to form a Flanders migration matrix and a statistical table of classroom interaction rates.

| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | total |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 44 | 1 | 2 | 11 | 7 | 8 | 0 | 2 | 0 | 9 | 85 |
| 2 | 2 | 7 | 2 | 3 | 1 | 2 | 0 | 0 | 0 | 1 | 18 |
| 3 | 5 | 1 | 20 | 10 | 9 | 3 | 0 | 3 | 0 | 1 | 52 |
| 4 | 4 | 8 | 1 | 22 | 4 | 9 | 0 | 55 | 0 | 19 | 114 |
| 5 | 9 | 0 | 0 | 22 | 183 | 5 | 0 | 0 | 0 | 15 | 234 |
| 6 | 6 | 0 | 0 | 6 | 4 | 15 | 0 | 10 | 1 | 14 | 56 |
| 7 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |
| 8 | 6 | 0 | 17 | 26 | 9 | 6 | 0 | 33 | 1 | 2 | 108 |
| 9 | 0 | 0 | 3 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 3 |
| 10 | 8 | 1 | 7 | 14 | 17 | 7 | 1 | 5 | 1 | 107 | 168 |
| total | 85 | 18 | 52 | 114 | 234 | 56 | 1 | 108 | 3 | 168 | 839 |

Figure 1 FIAS migration matrix

### 4.1.2 Analysis of Classroom Behaviour

(1) The teacher language ratio is the proportion of teacher language to overall language, coded from 1 to 7. Therefore, the teacher language ratio is:

$$(85+18+52+114+234+56+1)/839 \approx 0.667$$

(2) The student language ratio is the proportion of the student language to the overall language, coded as 8 and 9, so the student language ratio is:

$$(108+3)/ 839 \approx 0.133$$

(3) The classroom silence rate is the proportion of silence or confusion to overall language and is coded as 10, so the classroom silence rate is:

$$168/839 \approx 0.200$$

(4) Indirect and direct influences are both part of the teacher's language, with expressions of emotion, encouragement and praise, taking advice and asking questions as indirect influences, and lectures, instructions and criticism as direct influences. The ratio of indirect to direct influence is therefore:

$$(85+18+52+114)/ (234+56+1) \approx 0.924$$

(5) Positive reinforcement refers to the positive guidance that teachers provide to students in the classroom, such as expressing emotions, encouraging praise and taking on board opinions, which can motivate students in the learning process. Negative reinforcement consists of both instruction and criticism, and usually when there is too much negative reinforcement, students become bored with the class. The ratio of positive to negative reinforcement is:

$$(85+18+52)/(56+1) \approx 2.719$$

The basic structure of Reflection of Light can be seen from the five data items above. Since the course requires students to do hands-on experiments,

the teacher needs to explain the principles, steps and precautions of the Reflection of Light experiment to the students before they actually do it, so the teacher's language accounts for the majority, about 66.7%. In the middle of the class, students were discussing with each other or doing the experiment quietly, and the class was silent or chaotic, so the percentage of silence in the class was higher, about 20.0%, which is the normal range of the laboratory course.

In the fourth data item, the ratio is less than 1, which means that the indirect influence is less than the direct influence, i.e. the teacher prefers to control the classroom directly and carry out teaching in an orderly manner according to the original teaching design, without giving the classroom enough flexibility.

In the fifth data item, positive reinforcement is much higher than negative reinforcement, about three times higher, indicating that teachers can easily motivate students to actively participate in teaching activities in the classroom and that such a classroom is preferred by students.

## 4.2 Technical Foundation

FIAS focuses on speech analysis in the classroom and therefore uses two key technologies: speech recognition and word frequency analysis. From the above data analysis, the classroom structure analysis can be summarised into five main data segments: teacher speech ratio, student speech ratio, classroom silence ratio, indirect vs. direct influence ratio, and positive vs. negative reinforcement ratio. With the continuous development and optimisation of artificial intelligence technology, these data can be derived through speech recognition technology and word frequency analysis, providing teachers with a quick and efficient analysis of teaching behaviour in the face of such a large and high-quality teaching resource as One Teacher One Lesson, and helping teachers to gain a deeper understanding of the interaction between teachers and students in the course.

### 4.2.1 Speech Recognition Technology

Among the physical properties of speech, it has four elements: pitch, intensity, length and quality of sound. Different speech therefore has different spectra, and when speakers are different, computers can produce and distinguish the vocal pattern of the current speaker based on these four elements.

Nowadays, KDDI has already matured in the application of speech recognition technology, which has two sub-categories under voice recognition technology and voice dictation technology. Using voice recognition technology to distinguish between teacher language and student language, three types of values can be derived: teacher language ratio, student language ratio and classroom silence ratio.

### 4.2.2 Word Frequency Analysis Method

Speech recognition and conversion of speech information into text information can be accomplished by calling the speech dictation API interface provided by KDDI. Word frequency analysis can be used to reveal the dynamics and research progress of a discipline, and word frequency analysis is an effective means of mining text. The word cloud is developed using Nodejs and JAVA, and the word segmentation tool uses the Jieba natural language tool to perform segmentation and word frequency analysis. By using a tool such as UWI to count and analyse the number of occurrences of important words in the teacher's language and the students' language in the video, the interaction behaviour between the teacher and the students can be clarified, resulting in two types of values: the ratio of indirect to direct influence, and the ratio of positive to negative reinforcement.

# 5 CONCLUSION AND OUTLOOK

The aim of this paper is to propose a theoretical study for the construction of an efficient intelligent analysis system for classroom teaching behaviour based on artificial intelligence technology. The 2X3 model is proposed through the analysis of three teaching behaviour analysis systems and two artificial intelligence technologies. From the 2X3 model, it can be concluded that the intelligent analysis system of teaching behaviour based on natural language processing technology and FIAS is the most efficient. When it comes to actually applying the system in practice, speech recognition technology and voice recognition technology are already mature and can be invoked directly. Therefore, text analysis is the top priority, and how to build a library of effective word pockets and calculate two types of data, indirect to direct influence ratio and positive to negative reinforcement ratio, by the number of word frequency occurrences will be the next research direction.

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