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# Design and Implementation of Intelligent Analysis Software for Teaching Behavior Based on near-Field Speech

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***Abstract*—The use of a finer-grained classroom language analysis coding form facilitates a more in-depth analysis of teachers' classroom language behavior. This study uses a finer-grained T-coding system to encode texts converted from teachers' near-field recordings, makes a preliminary exploration of multiple methods of visual teacher teaching strategies for coding sequences, and writes Python scripting software based on machine learning algorithms. This software can effectively assist teachers in self-observation and improve teaching quality.**

Keywords-component; classroom analysis; teaching behaviour; T-seda coding;

## I. INTRODUCTION (HEADING 1)

The development of video-based technology for the automatic analysis of classroom processes has been significantly limited[1]. Compared to video, instructional audio has the advantages of low-cost acquisition, independence from classroom specifications, ease of processing, low demand for computing resources, and no compromise of personal privacy. Automatic speech recognition using teacher near-field speech can obtain more accurate teacher speech, including teacher speech text, speech periods, etc. Therefore, teaching audio can generate three mode letters, such as teaching text, speech periods, and audio, to effectively carry out the analysis and evaluation of teacher-student interaction, teaching activities, and teacher speech intention.[1] . For these reasons, this study adopts an analysis method based on teachers' near-field speech, and develops intelligent analysis software for teaching behavior based on near-field speech, which only requires a recorder or a mobile phone, and a computer. It also facilitates teachers' professional development.

## II. OVERVIEW OF TEACHER NEAR-FIELD SPEECH ANALYSI

The theory and practice of analyzing classroom teaching and learning based on coding scales is relatively well established at home and abroad. In terms of the granularity of coding methods, those with relatively coarse granularity include: the Flanders Interaction Analysis System (FIAS) divides the verbal behavior of teachers and students in the classroom into three categories of teachers' speech, students' speech, and stillness or confusion with a total of 10 dimensions[2]. The S-T analysis method divides classroom teaching behavior into two categories: students' (S) behavior and teachers' (T) behavior, and determines classroom teaching patterns by observing The classroom teaching process is observed and the classroom teaching pattern is determined by sampling and calculating at certain time intervals[3]. Based on Flanders' interaction analysis system, Gu Xiaoqing et al. added the dimension of teacher-student interaction with technology and designed the Information Technology-based Interaction Analysis Coding System (ITIAS)[4]. The VICS coding system is a standard classification system for language analysis in teaching and learning, which appropriately classifies the language behaviors of teachers and students into 10 categories[5]. These codes provide a more comprehensive picture of teacher and student behavior in the classroom but at a coarser level of granularity. The codes with finer granularity in China include: scholars Song Yu et al. based on the Scheme for Educational Dialogue Analysis created by a team from the University of Cambridge and the Knowledge Building System, a knowledge-building framework proposed by a team from the University of Hong Kong, proposed a knowledge building-oriented classroom The Scheme for Educational Dialogue Analysis developed by a team from Cambridge University and the Knowledge Building System proposed by a team from the University of Hong Kong are used as the basis for proposing a classroom dialogue coding system for knowledge building.[6] . Ma Ruxia et al. adopted the cognitive process dimension of the 2001 Bloom's Taxonomy of Educational Objectives as the coding framework for classroom dialogue, dividing the cognitive objectives of learning into six major categories: remembering, understanding, applying, analyzing, evaluating and creating, and considering the first three categories as low cognitive levels and the last three categories as high cognitive levels, each of which contains several sub-categories.[7] Hu Torch et al. combined Zhang Delu's comprehensive framework for multimodal discourse analysis and the framework of teaching stages in the teaching process, and refined the modal types according to the characteristics of music lessons, forming a framework for analyzing the teaching behavior of music classrooms with 18 modalities[8]. In terms of data collection and analysis methods, the collection is mainly based on the information technology teaching environment such as smart classrooms, and the content of the collection involves various multimodal information. Holstein et al. give K12 teachers to wear mixed reality smart glasses to enhance teachers' perception of students' learning, metacognition, and behavior, facilitate teachers' real-time monitoring of students and provide targeted guidance[9]. Domestic scholars Zhang Liang et al. designed a "smart classroom" based on theories of psychology, neuroscience, and information science to provide an empirical basis for scientific teaching evaluation, which can improve teachers' classroom performance and promote changes in teacher education[10]. Based on multimodal natural perception technology, Chen Liangying et al. investigate the intelligent analysis of students' learning interests in the classroom, which can truly reflect students' learning interest status and provide a reliable basis and means for teachers to improve teaching methods and teaching effectiveness.[11] Wang Yanli et al. developed software for classroom teaching behavior collection and analysis, which improved the efficiency of data collection and analysis[12].

## III. CODING SYSTEM FOR TEACHING BEHAVIOR

### *A. T-SEDA code*

Maria Vrikki et al. guide how to explore and support conversational interactions (with or without the use of technology), as well as support for developing your cycle of inquiry[13]. Other adults in the classroom (e.g. teaching assistants) and even students can also use T-SEDA for self-reflection or to observe others. T-SEDA provides flexibility for teachers for different purposes by suggesting that teachers focus on one or two categories from the range offered by the full SEDA program. The coding tool emphasizes that teachers' interpretations of events take into account the dynamics and goals of the curriculum, the sequence of behaviors, and the mediating tools available, such as technological resources. This study proposes a classroom dialogue coding system for teaching strategies based on the Teacher Scheme for Educational Dialogue Analysis [14] (hereafter referred to as the T-seda coding scale) created by a team from the University of Cambridge.

### *B. Features of the primary school programming classroom*

The difference between primary school programming classes and those abroad is that they are still more teacher-led, with less communication between pupils and students during the teacher's lecture if the teacher does not ask for it on his or her initiative, and pupils generally do not question or actively ask the teacher. Students do not question or ask questions of the teacher. The classroom atmosphere is less active than abroad and is more teacher-led. In comparison with other subjects, programming classes are "hands-on and autonomous". From the perspective of technical knowledge, the declarative knowledge of the IT curriculum is represented in the form of technical concepts, technical rules, and technical principles.[15] The teaching of declarative technical knowledge in the IT curriculum can be carried out in the vicinity of primary school students' nearest developmental zone, by combining it with concrete contexts, project-based teaching, providing cognitive scaffolding, as well as through case studies, establishing links between knowledge through analogies, playing technology games and conducting technology experiments.

Table 1 Coding table for categories of teachers' classroom language behavior

| | **Type of behavior** | **Behavioral coding** |
|---|---|---|
| Knowledge Zone | Spotlight and guidance | 1 |
| | Introducing new knowledge | 2 |
| | Explanation of possibilities | 3 |
| | Analysis | 4 |
| Interactive area | Questioning and follow-up questions (or inviting classmates to questions) | 5 |
| | Invite students to voice their ideas | 6 |
| | Communication and coordination | 7 |
| | Summary and evaluation | 8 |
| | Applications and migration | 9 |

### *C. Construction of a near-field speech analysis and coding system for teachers in primary programming classrooms*

Based on the above characteristics of the primary school programming classroom, this study constructs coding sheets based on T-seda in terms of both localization and programming subject characteristics as follows.

## IV. DESIGN AND IMPLEMENTATION OF THE SOFTWARE

### A. *Software design*

To facilitate the processing and analysis of the data, python scripting software was written for this study to perform semi-automated analysis. Except for the coding part which still requires manual work, the rest of the process can be automated. The functionality and flow of the software implementation is shown in Figure 1.

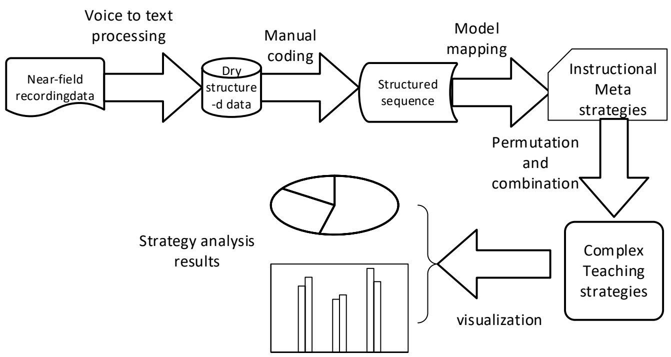


Figure 1 Software development flow chart

### B. *Software functional modules*

*1. Speech to text*

The speech-to-text module is used to achieve automatic conversion of the teacher's recording into text for subsequent analysis and is implemented using the KDDI interface, which has a high accuracy rate of speech recognition in China.

*2. Structured text data*

Speech-to-text can take unstructured information and transform it into semi-structured text information. It is convenient for further conversion into structured text information for analysis and processing. In this study, a Python script was written to convert the text into structured information, from which the software extracted the start and end times, the time information, and the manual encoding of the chopped semantic sentences were made together as structured information.

*3. Automatic text classification*

Based on the manually coded samples, the software does machine learning training on the manually coded samples, making it possible for the software to automatically classify teaching behaviors according to performance.

*4. Visual analysis*

The Python software automatically reads Excel to do some statistical processing and generates graphs for visual analysis by teachers. The results of the frequency analysis of one of the coding categories are shown in Figure 2.

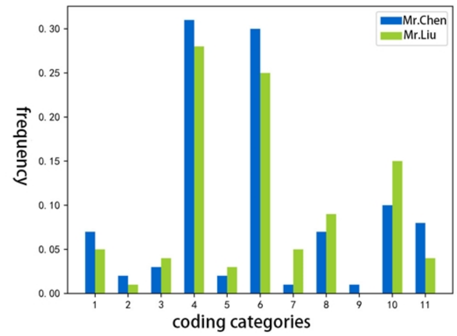


Figure 2 Frequency comparison of teacher coding categories

It can be seen that the two teachers coded similar frequencies throughout, with Liu being more frequent than Chen in categories 4 (analysis) and 6 (inviting students to voice their ideas), indicating that Liu focused more on explaining the various classroom outcomes and interacting with students, Chen focused more on summarising, and Liu focused more on guiding the teaching activities. In category 7 Chen was significantly higher than Liu, indicating that Chen communicated and coordinated more with students in order to be able to readily identify where students' nearest developmental areas were and thus adjust teaching strategies in a timely manner.

A time series analysis of the teaching behavior of the two teachers was conducted separately and the results are shown in Figure 3 and Figure 4.

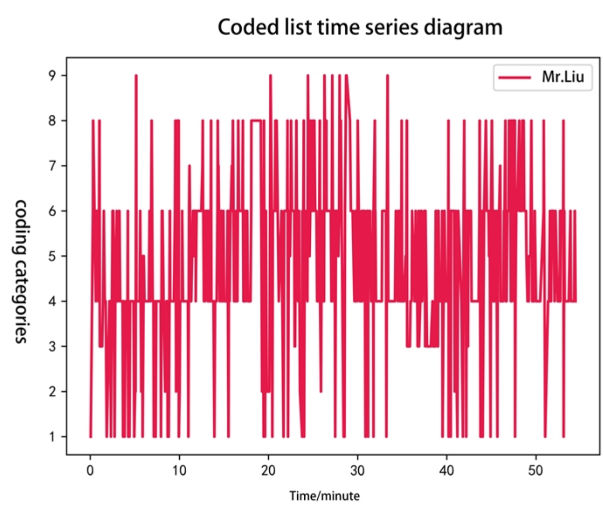


Figure 3 Time series graph of Ms. Liu's coding categories

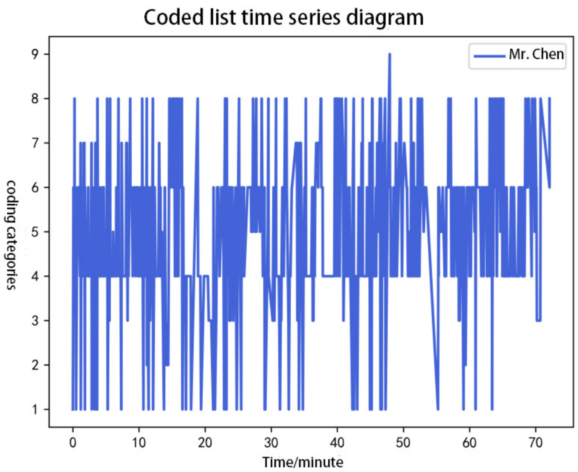


Figure 4 Time series plot of Chen's coding categories

A lesson is roughly 45 minutes long. Looking at the time sequences coded in Figures 3 and 4, both teachers' sequences hovered mainly between 4 and 6, but Liu's sequence was in the first ten minutes and around 40 minutes, with a brief gap above 6. Overall the two teachers' sequences are relatively similar.

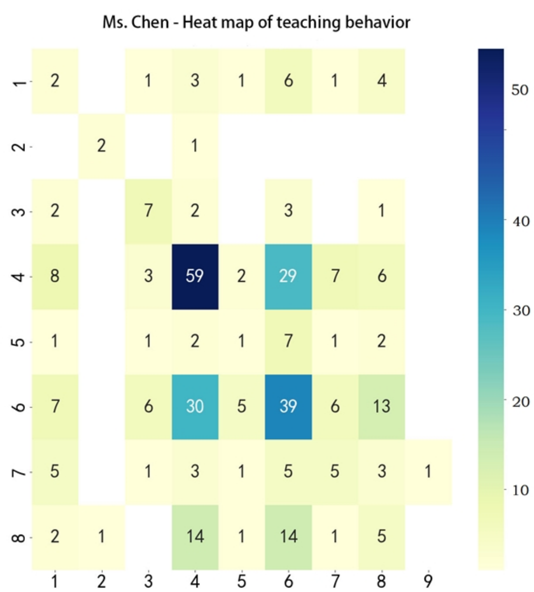


Figure 5 Heat map of Liu's teaching behavior sequence

## V. Concluding Remarks

The innovations of this study are mainly the following two: firstly, this study introduces and localizes, and improves a finer-grained coding table - T-seda coding - and explores the use of finer-grained coding tables in primary school programming classrooms, taking into account the disciplinary characteristics of the programming subject and the characteristics of our classrooms.

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