



Framework Design of Expression Concentration Feedback System in the Online Classroom

Xinyi Zhou¹, Shengrong Gong²(✉), and Wenhao Ying²

¹ School of Computer and Information Technology, Northeast Petroleum University, Daqing, Heilongjiang, China

² Computer Science and Engineering, Changshu Institute of Technology, Changshu, Jiangsu, China

{shrgong, ywh}@cslg.edu.cn

Abstract. The advancement of Internet technology has provided development space for online education. Catalyzed by the global epidemic, online education has been further promoted and has become the core proposition of education. However, teachers and students in the online classroom are separated in time and space, and teachers cannot fully understand the status of students in class, which affects the teaching effect. In this context, the development of computer vision allows solving related problems. Teachers can use visual technology to grasp the changes of students' expressions in class, track their concentration in class, analyze classroom dynamics, and adjust teaching methods in real-time. Therefore, this study uses the popular expression recognition technology in the field of computer vision to link classroom expressions and concentration and proposes a "Feedback System Framework of the Online Classroom Concentration Based on Expression Recognition". The framework operates in a progressive and hierarchical mechanism to assist teachers in teaching and meet students' learning needs.

Keywords: online education · classroom concentration · expression recognition

1 Introduction

In the smart learning environment, online education is increasingly becoming an active force in promoting basic education reform. In September 2019, China's Ministry of Education and eleven other departments issued the "Guidance on Promoting the Healthy Development of Online Education", clearly stating that online education changes the way education services are supplied and can effectively solve the difficult and blocking problems of the traditional education model. In July 2020, the National Development and Reform Commission and other thirteen departments jointly issued a document, clearly stating that they should vigorously develop integrated online education and form a benign interaction pattern through a mechanism for the normalized integration and development of online and offline education. The sudden new crown epidemic has boosted the development of online education. In this context, the Ministry of Education issued a policy

of “stopping classes without teaching, stopping classes without learning”, and schools actively responded to the national call to carry out online education to ensure the successful completion of teaching tasks under the premise of good prevention and control of the epidemic.

Online education is space-free and teaching resources can be shared, which provides convenience to school education, but the disadvantages are also gradually highlighted. Compared with traditional face-to-face teaching in the classroom, online education mode gradually removes students from the teacher’s live view. Although teachers can set up assessments or take questions to understand students’ concentration status, they cannot track students’ attention status in real time throughout the classroom. In addition, the teacher’s emotion also affects the teaching effect. Positive emotion will normalize the classroom teaching activities, while negative emotion will make the whole classroom in a dull state and greatly reduce the classroom teaching effect. Nowadays, expression recognition technology has become increasingly mature, but its application in online classroom is still in the research and exploration stage. This paper constructs an expression recognition application in online classroom for teacher-student concentration feedback mechanism, using expression data to analyze student behavior, which helps teachers complete teaching tasks while meeting students’ individual needs and improving teaching effectiveness.

2 The Definition of Classroom Expression Concentration Feedback

Classroom expression concentration testing is a method of testing the facial expressions of educational subjects to determine the effectiveness of their concentration in classroom instruction. In *Mastering Learning*, American psychologist Bloom emphasizes the importance of classroom feedback, arguing that the quality of instruction is governed by three factors: prompting, engagement, and feedback correction procedures. Through classroom concentration feedback, which effectively captures learning responses during instruction, teachers begin to reflect on their own teaching process to promote professionalism and students begin to identify errors, improve learning strategies and enhance independent learning [1]. There are various methods to detect classroom concentration in addition to the most basic observation and teacher-rated methods, there are also more precise biological measures such as EEG, eye movement and ECG. However, these methods are generally limited to data collection devices and application environments. In contrast to eye-tracking and wearable sensing devices, the maturity of expression recognition technology allows a simple camera to act on the entire classroom, allowing students to immerse themselves in the classroom without a sense of restraint.

Psychologist Mehrabian believes that emotional expression = 7% of words + 38% of voice + 55% of facial expression [2], indicating that facial expressions can largely reflect people’s inner emotions. Facial expression recognition is particularly important. The classroom expressions studied in previous work were based on the six or seven traditional expressions.

However, this does not work well in real classroom scenarios, where the actual classroom expressions of academic emotions are the ones that actually manifest, i.e., the various emotional experiences related to students’ academic activities during instruction, such as those experienced by students in terms of academic success or failure, or

in classroom learning, daily assignments, and exams [3]. Pekrun, a German professor of psychology, proposed nine main academic emotions dividing them into four dimensions according to arousal and pleasure, namely: cheerfulness, hope, and pride (positive-high arousal emotions); relief (positive non-arousal emotions); exasperation, anxiety, and guilt (negative-high arousal emotions); and despair and boredom (negative non-arousal emotions). Positive-high arousal prompts positive emotions of activity, positive-low arousal suppresses positive emotions of activity, negative-high arousal prompts negative emotions of activity, and negative-low arousal suppresses negative emotions of activity. Based on academic emotions and related classroom expression studies, this paper constructs an identifiable student classroom expression-concentration model, as shown in Fig. 1.

Online classroom teaching is a very complex teaching process, and teachers need to adjust their classroom behaviors in real time to fit students' needs in class, so it is necessary to make real-time diagnostic feedback on teachers' and students' behaviors in the classroom [4]. By judging and tracking classroom concentration with the help of expression recognition technology, the educational process is restored and timely feedback is given to teachers and students to manage the entire classroom for decision making, which is conducive to improving and enhancing learning effectiveness [5]. Some experts have shown that an effective educational decision should integrate both relevant educational and psychological aspects and implement specific strategies for different subjects so that the teaching subjects can be successfully implemented according to the goals set by the educational decision [6]. In this regard, the study should analyze not only the students' classroom state but also the teachers' teaching state, and seek the paths that can make the classroom feedback model land from the actual teaching, such as how to mobilize the students' participation initiative at the students' level; and how to use teachers to boost the students' ability at the teachers' level.

In this study, the feedback of classroom expression concentration is defined as follows: under the guidance of relevant education and teaching theories, we use expression recognition technology to collect, process and analyze expression data and provide real-time feedback to teachers, so that teachers can track students' attention during the online

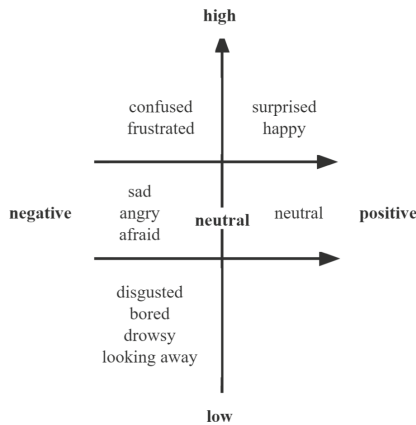


Fig. 1. A classroom expression-concentration model

education, which is helpful for the teacher to choose appropriate teaching strategies and students to discover their own problems in time, thus improving teaching efficiency.

3 Theoretical Analysis of Classroom Expression Recognition

The feedback system of classroom concentration mainly takes “students as the main body and teachers as the leading role” as the core idea. Students are the main body of learning and development, and teachers are the organizers, guides and promoters of the learning process. Students’ “learning” needs to be carried out under the guidance of teachers’ “teaching”, and teachers’ “teaching” is also based on students’ “learning”. Therefore, the design model of concentration feedback closely connects students and teachers in order to meet their classroom needs in time. However, in the face of education and teaching, which is a complex social group activity, it is difficult to accurately select all the class characteristics of teachers and students, and not all aspects must be taken into account. Therefore, reasonable theoretical analysis needs to be done before design to ensure that the individual characteristics of students and teachers can be fed back.

3.1 Analysis of Facial Expression Recognition Technology

In order to improve the objectivity of research feedback, the basic processes are: data acquisition, image preprocessing, feature extraction, expression classification. At present, the development of expression recognition technology has been relatively comprehensive, and the research methods are basically divided into two categories, one is traditional facial expression recognition method and the other is facial expression recognition method based on deep learning. The traditional facial expression recognition methods mainly use different types of artificial feature operators combined with corresponding classifiers to achieve expression classification [7], and the facial expression recognition methods based on deep learning mainly learn expression features automatically by designing convolutional neural network models, adjusting network parameters, and training the optimal model to achieve expression classification [8]. Traditional methods are inefficient and difficult to ensure that the manually selected features can effectively reflect facial expressions, using deep learning, which allows the computer to automatically learn the features applicable to a given task in the given data, makes up for the shortage of manual operators in the case of large amounts of data, thus improving the generalization ability of the model.

3.2 Analysis of Facial Expression Data Processing

As shown in the Fig. 1 model, students’ expressions are divided into 12 categories, but a single expression does not show students’ classroom concentration, which is a continuous and cumulative process. In the traditional classroom, teachers judge whether the students are focused on the classroom by themselves, and the online classroom makes the teachers in the visual blind area. Through the expert fuzzy comprehensive evaluation, the expression can be associated with the degree of concentration, and the students’ phased classroom state can be judged. Through the embedding of expert knowledge

to improve the level of machine analysis, to achieve the high efficiency of classroom feedback [9]. The dfuzzy comprehensive evaluation method is based on the $B = W * R$ evaluation results of the mathematical model, in which W is the vector composed of the weights of each index, R is the matrix composed of the membership degree vectors of each index, and B is the result vector of the comprehensive evaluation. The concentration of each expression is comprehensively evaluated according to the principle of maximum membership degree. Using facial expression recognition technology, according to the proportion of each evaluation factor to the classroom, determine the weight of each evaluation factor, and finally make a comprehensive score of the index. Finally, through visual analysis, intuitive feedback to teachers and students, so as to standardize the classroom behavior of teachers and students.

3.3 Analysis of Ethical

While serving the classroom, artificial intelligence technology has also raised a series of ethical issues that affect the whole teaching ecology of the classroom [10]. For example, excessive identification and analysis can easily lead the classroom to control and rules [11]; the massive data collection threatens the privacy and security of educational subjects [12]; excessive monitoring will cause physical and mental fatigue of students, reduce sense of security and trust between teachers and students, and cause “chilling effect”. Students may be forced to carry out emotional fatigue outside the learning curriculum [13].

- In order to prevent the classroom from leading to control and rules, we use facial expression recognition technology to give feedback to the teaching subject is not all feedback, not all the time feedback, but selective and conditional feedback.
- In order to protect the privacy of the teachers and students, the collected picture data is cleaned up directly after the collection and analysis of the course data, so as to prevent the privacy disclosure of educational subjects and avoid data abuse.
- The machine in human-machine collaborative decision making can learn the experience of experts to evaluate, thus having a higher level of classroom diagnostic function [14]. The fuzzy comprehensive evaluation involved in this system is to analyze the dynamics of classroom students through teachers’ experience, the teachers and the students will not be reminded systematically as long as they are in accordance with the traditional classroom status, and construct a dynamic analysis model based on time series so that teachers can accurately restore students’ emotional state in the classroom and develop students’ positive emotional state [15].

4 Construction of Concentration Feedback System Framework for Facial Expression Recognition

The construction of a concentration feedback system for expression recognition needs to address two aspects: first, to consider the connection between expression recognition and the classroom subject; second, to provide a basis for subsequent feedback decisions with respect to the recognition results. Referring to the “dynamic learning intervention system framework” proposed by Minsheng Fan [16], a concentration feedback model for expression recognition was constructed (shown in Fig. 2).

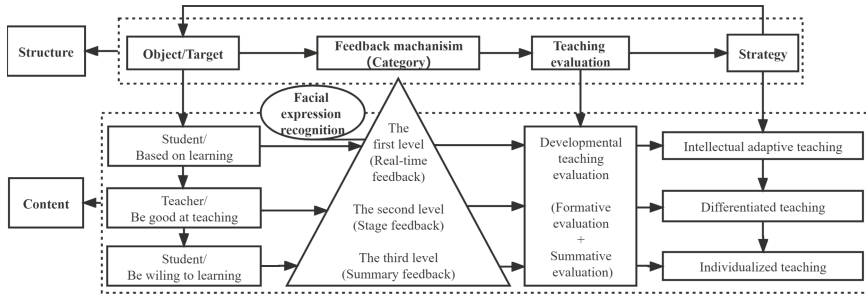


Fig. 2. A framework of concentration feedback system for expression recognition

The system is mainly composed of structure and content. Structurally, it is mainly divided into four systems: “Object/Target”, “Feedback mechanism (Category)”, “Teaching evaluation” and “Strategy”. Through the expression recognition technology, this paper makes a proper analysis of the performance of the teaching subject in the classroom and provides strategic inspiration and method guidance for timely feedback and evaluation of the problems in teaching practice, so as to achieve the ultimate goal of students’ “learning”. The following is an in-depth description of the content of the system.

4.1 Object/Target

The object/target layer of the online classroom focus recognition system based on facial expression recognition explains the ultimate goal of the teaching subject. With the development of educational reform, great changes have taken place in the relationship between teachers and students and between teaching and learning, from taking teachers as the main body to taking students as the main body and teachers as the leading role, and from “learning for learning’s sake” to “teaching for learning’s sake”. Teaching theory should be based on students’ development and explore teaching goals. Students should first be “based on learning”, then teachers should be “good at teaching”, and finally students should be “willing to learn” and progress step by step. Each target corresponds to the level and strategy of each line, and the elements coordinate with each other, and finally achieve the overall harmonious development.

4.2 Feedback Mechanism

The feedback mechanism of the online classroom concentration recognition system based on expression recognition is designed to facilitate classroom management. The feedback is provided by integrating the data from expression recognition through expression recognition technology. The cascading feedback is cascaded according to the lecture time, and small steps of feedback decisions are made on student behavior as the teacher imparted knowledge, creating a good learning atmosphere through the teacher’s control of the classroom state. The essence of feedback is to understand the classroom status of teachers and students through the system and teachers implementing decision reminders

for poor behavior in accordance with the classroom time process, helping teachers to complete their teaching while improving students' self-awareness in class.

1) Level 1 (real-time feedback)

This level is mainly applicable to all teachers and students. Due to traditional culture and quality education inculcation, teachers in domestic colleges and universities are generally mild, mainly presenting three relatively distinct expressions of smile, neutral and dissatisfaction. Teachers' negative emotions will affect students' state in class. Through the expression recognition system, teachers' emotions in class are monitored in real time, and timely feedback is given when emotions are presented negatively. Compared with teachers, students' expressions are richer. According to the constructed expression model of students' classroom, the expression recognition system monitors students' emotions in class in real time, and provides timely feedback when the emotions are negative. The classroom time is shared by teachers and students, and it is obviously undesirable for teachers to remind students of violations in the classroom at all times, and it is also incorrect for teachers to reprimand or get angry. Real-time feedback is used to manage teachers' poor status in the classroom and to assist teachers in reminding students to focus on the classroom and do what is conducive to a healthy classroom.

2) Level 2 (periodic feedback)

This level is mainly aimed at students with negative classroom atmosphere and low classroom concentration. On the one hand, the proportion of students' negative emotions to total emotions in each minute was counted and fed back to teachers in the form of a line graph; on the other hand, a self-made "Fuzzy Comprehensive Evaluation Questionnaire for College Teachers for Classroom Expression Concentration" was developed, ranging from "1 very low" "2 low" "3 average" "4 high" and "5 very high" were selected and the corresponding fuzzy integrated matrix was calculated. When the score is lower than the set threshold, the student's name is sorted in ascending order according to the score and sent back to the teacher, and the student is reminded with a heavier rating. The staged feedback allows teachers to manage the classroom scientifically and rationally, and is more conducive to healthy student development and the formation of a humane classroom management style.

3) Level 3 (summative feedback)

This level is mainly aimed at all students in the classroom. At the end of the course, the system automatically gives feedback to the teacher and all students on the data information of the top 15% of the students in the class in terms of concentration score. Through the expression recognition technology, 4 types of academic arousal weighting statistics are conducted, and the data is ranked according to the weighting of each category and fed back to the teacher. A time-series-based model table of affective dynamics analysis of the whole class is also constructed in the background to realize the academic situation analysis [17]. The study guide is dedicated to the formation of personalized learning strategies for students, each of whom is a distinctive learner, and based on the summative feedback, the learner's problems are diagnosed and the teacher makes optimal learning solutions and methods for the students concerned. By providing students

with intelligent and personalized learning guidance, the transformation of “teaching” into “learning” is achieved.

4.3 Teaching Evaluation

The ultimate goal of teaching is that students are willing to learn, in the final analysis, it is to have a good teaching effect [18], and teaching evaluation is the necessary means to measure the effect of teaching. Teaching evaluation, as the name implies, refers to the value judgment made on the teaching process and teaching results. Through systematic feedback, judgments are made on the value of teachers’ attitudes, abilities, and effects of teaching, and value judgments made on changes in students’ attitudes, abilities, processes, and results of learning, and the evaluation results of teachers and students’ performance in the classroom are derived in the form of visual charts. There are many methods of teaching evaluation, since this system does not involve quizzes, questionnaires, assignments and observations, this system uses developmental teaching evaluation.

Developmental teaching evaluation [19] pays attention not only to the results of teaching, but also to the process of teaching. It combines formative evaluation and summative evaluation, so that evaluation can be carried out throughout the teaching activities, forming a positive means of teaching and learning, teaching with evaluation, learning with evaluation, evaluation with teaching, and evaluation with learning, thus promoting the dynamic development of teachers to improve teaching and students to improve learning, and finally achieving a good teaching effect.

4.4 Teaching Feedback Strategy

1) Teaching feedback strategy process

The basis of the cross-fertilization of AI and education is humanism, and the core of humanism cannot be separated from human participation and decision-making, and human leadership is a strategy for the integration of AI and education [20]. There is no fixed set of solution strategies for decision making in the education process, and teachers are required to make flexible adjustments to the curriculum and students with their own experience and teaching level, bringing into play their own creativity. The teaching feedback strategy process of this framework is fixed (as in Fig. 3) and is divided into three main parts: the teacher and student are in learning, the teacher is beside learning, and the teacher is leading learning.

a) *The teachers and students are learning*

When teachers find teaching problems in the course of instruction or after the classroom at the end of the course (corresponding to the first and second levels of the feedback mechanism), they make timely corrections for some students or their own behavior, establish appropriate teaching programs, adapt to the appropriate problem personnel, and execute decisions; when students themselves find learning problems in the classroom, they make timely adjustments for the problems that exist. This stage is conducive to self-feedback, self-regulation, self-improvement and self-awareness of

teachers and students in the classroom. Not only are students learning the curriculum, but teachers are also learning how to adjust their teaching style and improve their information technology skills.

b) *The teacher is beside the learning*

When the students themselves find that the learning problems in the classroom can not be solved (corresponding to the second and third levels of the feedback mechanism), teachers need to guide them in time. If the problems cannot be solved in time, teachers can also solve them by communicating with students in private, providing additional guidance, providing advice and resources, and so on.

c) *The teacher is leading the learning*

The leading position of teachers should be respected in the whole curriculum. When there are no teaching and learning problems in the course (corresponding to the first, second and third levels of the feedback mechanism), it indicates the effectiveness of the teacher’s teaching, and the teacher can always comply with his or her own teaching style and means of implementation. When relevant problems in the course cannot be solved in time, the teacher can guide the students to solve them after class according to their own actual conditions.

2) **Feedback strategy**

The feedback strategy of the online classroom concentration recognition system based on expression recognition is designed to solve the problems exposed in the process of student learning in a reasonable way and method. Real-time feedback is helpful for teachers and students to take classroom teaching seriously, stage feedback is helpful for teachers to adjust teaching methods and improve students’ status in class, and summary feedback is helpful for teachers to reasonably solve different students’ problems.

The first level of strategy is intelligent adaptive teaching, which corresponds to the goal of “learning based”. Adaptive teaching, or “artificial intelligence + “ teaching, means providing an intelligent learning environment, instance or field for classroom participants to adapt to the teaching. Unlike adaptive teaching where participants find and solve problems on their own, adaptive teaching uses artificial intelligence technology to summarize and remind teachers and students of their shortcomings in the classroom. When the teacher is in a negative state, the students will also have a corresponding or

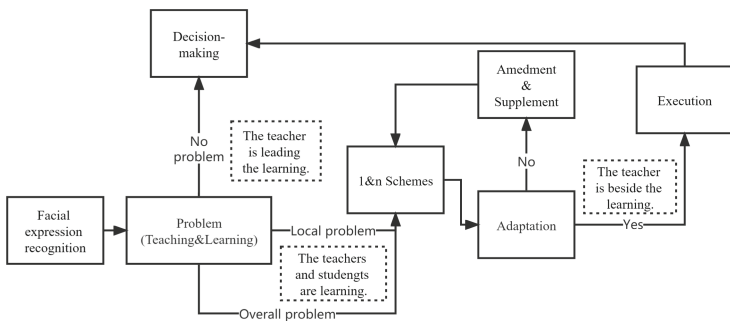


Fig. 3. A feedback strategy flow

worse attitude towards the class, and the system will help the teacher to adjust the state of the class; when the students are in a negative state, the timely reminder of the system can prompt the students to change their learning state and accept the course content efficiently.

The second level strategy is differentiated teaching, which corresponds to the goal of “being good at teaching”. The learning ability of students in the same classroom is different, and differentiated teaching can adjust the curriculum and teaching of general education to meet the educational needs of different students. When teachers find that students’ negative emotions account for a large proportion in the classroom, it may show that their own teaching methods are not easily recognized by students and are not conducive to students’ acceptance of new knowledge. Teachers should adjust classroom teaching methods in time to let students actively accept the course content. If there is a situation in which individual students show low concentration in the classroom, for these students, teachers can adjust teaching skills and teaching content to allow students to participate in the classroom.

The third level strategy is individualized teaching, which corresponds to “willing to learn”. Personalized teaching is to adjust the teaching progress according to different learners and teach students in accordance with their aptitude. For the students who show the top 15% of the class concentration, teachers can give praise and encouragement to the students by giving them usual scores, items, etc., so as to increase the students’ love for the course. According to the data of arousal degree and fuzzy comprehensive evaluation, and referring to the emotional dynamic analysis model, teachers accurately analyze the current emotional state of the relevant students. Positive emotion can broaden the scope of personal cognition and activities. Help students imagine goals, challenges and positive ideas [20]. Negative emotions may make it difficult for students to focus on the current learning task [21]. Teachers need to guide low-energy, negative students and encourage high-energy, positive students to personalize their teaching, so that students who love the course can take the initiative to learn the relevant knowledge and students who do not like the course can try to accept the course content, thus stimulating students’ interest in the course.

5 Conclusions

Classroom teaching is a work that requires emotional empowerment and is essentially a interaction between teachers and students. A classroom environment with a rapport between teachers and students contributes to deeper student learning [22]. Advances in information technology have provided a wide scope for online education, and the raging epidemic has driven the implementation of the online education and learning. However, the restrictive factors of online classrooms affect the spatial emotional interaction between teachers and students. Understanding the dynamics of the entire classroom is the key to achieving harmonious emotional interaction between teachers and students in the online education, and only by efficiently identifying the learner’s classroom status can teachers adjust their teaching methods accordingly to truly achieve wise adaptation and personalization, thus improving the effectiveness of classroom teaching. In this paper, we design a framework of concentration feedback system for online classroom by

correlating academic expressions and concentration with expression recognition technology. The elements in the framework are not simply stacked on top of each other, but operate in a progressive and cascading feedback mechanism, which providing a referencable method for studying classroom concentration and promoting the development of efficient online classrooms.

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