Visualizing Emotional Experiences in Computer-supported One-to-One Tutoring: Based Analysis of Data of Automatic Facial Expression Recognition

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Keywords: Emotional experience; One-to-one tutoring; Computer-supported; Visualization; Big data

Abstract: Automatic facial expression recognition (AFER) is able to record big data based on seven kinds of each teacher or student expressions during computer-supported one-to-one tutoring processes. In our analysis of classroom videos, we combined four kinds of expressions (disgust, anger, sad and fear) to be one simple kind of disturbance, and two kinds of expressions (happy and surprise) to pleasure, which we thought could be easier for visualizing emotional experiences. As a result, we utilized a simpler three-dimensional analysis framework for the student' emotional experience in classroom, comprising pleasure, neutrality, and disturbance, was constructed by us. This framework was used in visualizing teacher's and student's different emotional experiences in computer-supported one-to-one tutoring with large data from AFER, which occurred in five tutoring courses in mathematics.

1. Introduction

In recent years, the integration of artificial intelligence and education has become a major boom. With the help of technology, artificial intelligence has many advanced capabilities, such as problem-solving skills, reasoning skills, and event design capabilities [1]. It also includes speech recognition and facial image recognition as well as the ability to process knowledge, learn, plan and manipulate ideas [2,7]. Among them, personalized online one-to-one tutoring has been favored by many researchers.

The teacher and the student make full use of the technology-rich learning environment for video interactive learning [3]. The teacher determines the communication and cognitive conflicts with the student based on the student' real-time feedback (including language, facial expressions, etc.), and the student do not spontaneously generate complex explanations or questions [4]. The student evaluates, integrates and articulates knowledge in new ways and negotiations between the teacher and the student to help raise awareness of common goals [5].

Encouraged by national policies, the education industry continues to explore intelligent education to promote efficient interaction and knowledge transfer between the teacher and the student. Using facial recognition technology, a large number of teacher and student expression data are obtained. Through the data mining, the emotional experience of the teacher and the student in the one-to-one coaching process is visualized to understand the student' learning rules, optimize the teacher's teaching strategies, stimulate the student' enthusiasm for learning, and realize the rational allocation of educational resources.

2. Research review

2.1 Learning emotional experience

From learning experience, the student gain knowledge, form emotions, and finally gain insights.

Emotion can not only stimulate the student' learning motivation, but also is a promote important factor in learning cognition. The depth of emotion determines the intensity of emotion [6], which can be mutually common in one-dimensional dimension. Emotional classification generally uses discrete and continuous methods. Typical discrete types have six basic types of emotions: anger, disgust, fear, happiness, sadness, and surprise [8], while continuous types produce various types in different time series.

Based on the classification of discrete emotions, this study combines the student' actual emotional data to establish a three-dimensional sentiment analysis framework to deal with positive and negative emotional changes of the teacher and the student in different periods.

2.2 Artificial intelligence big data in online tutoring

Many online teaching programs are one-size-fits-all certification programs [9,11], which is not conducive to the teacher' comprehensive understanding of the student, and is not conducive to the diverse development of the student. Teacher training and support are critical to the successful implementation of online education programs [3,5,13]. Dartmouth Institute proposes a new technical science of artificial intelligence for simulation Research, development of human intelligent behavior and thinking processes [10]. Understanding the cognitive communication feedback in teaching, provides theoretical basis and script materials to use artificial intelligence to assist the online teaching practice. In the one-to-one online classroom, the teacher uses facial recognition technology to collect the expressions of the teacher and the student, combine video language, and understand the specific situation of the student through the calculation and judgment of artificial intelligence, such as attention, enthusiasm and teaching effectiveness, etc.

3. Research design

In this section, we will introduce how we design our research. This section describes our research questions, data processing, and how we use data to analyze emotional changes in the teacher and the student.

3.1 Research questions and assumptions

In this study that recording and analysis facial expressions the teacher and the student have in mathematics classes, we focus on the following questions:

1. Are there any correlations between the emotional experiences of the student and the teacher?
2. The emotional experience of the student and the teacher, who is more obvious, mainly in what aspects?
3. What are the characteristics of the emotional experiences of the student and the teacher in the chapter study?

This study is a descriptive study focusing on the study of teacher and student emotional changes in the teaching process of classroom artificial intelligence support. The limited finiteness of this case study inevitably affects its so-called representation, and the findings are not comprehensive enough, which indicating that more research is needed.

The emotional experience analysis of the student in classroom teaching is based on the following assumptions:

- The classroom emotional experience of the teacher and the student can be divided into several levels.
- The emotional experience of the teacher and the student in the classroom can be divided into different categories.
- The classroom emotional experience of the teacher and the student is different from each other.

3.2 Three-dimensional emotional analysis framework

We developed a cognitive value framework based on consensus theory [12] to visualize the

process in computer-supported one-to-one tutoring [14]. Further theoretical considerations support the validity of the hypothesis. We visualize the emotional experience of the teacher and the student and quantify the expression of them, so that the sum can be drawn on the timeline. We assign each emotional expression, as shown in Table 1.

Table 1 Three-dimensional emotional analysis framework and its value of learning.

Score	Description	Example of expressions
1 Happiness	Emotions experienced when in a state of well-being.	
0 Neutrality	Neither too great nor too little.	
-1 Sadness	Emotions experienced when not in a state of well-being.	

3.3 Online environment

With the development of the Internet, the online education model has become a craze. One-to-one online education not only saves the student' time, but also strengthens the pertinence of individual teaching. The Internet is designed as an information space [17]. Through this information space, the student enjoys high-quality teaching experience and teaching services to complete the transformation between the teacher and the student. However, the integration of artificial intelligence and online environment is still in the exploratory stage. This study uses facial intelligent recognition technology to study the characteristics and achievements of online education.

There are two online teaching interface modes in this study: the first is the teacher operation interface, including the teacher video window, the student video window and the courseware PPT rendering window, as shown in Figure 1; the second is a playback interface consisting of a courseware PPT window and a teacher video window.

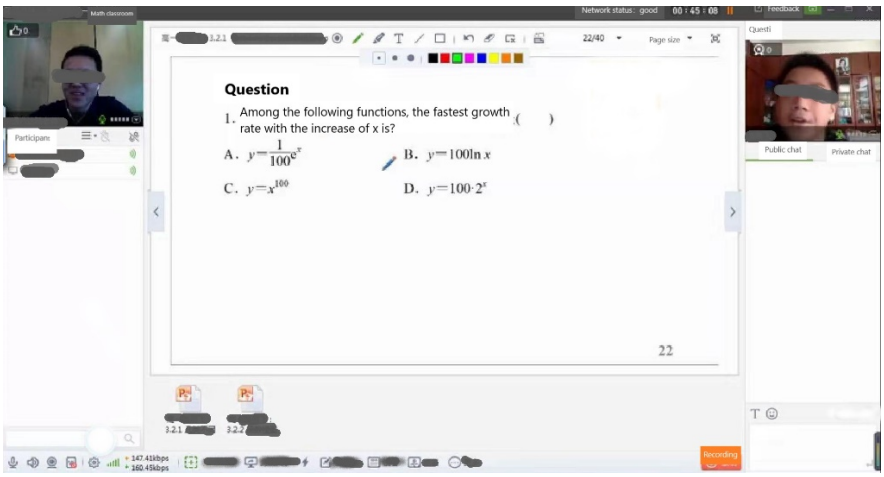

Figure 1 Online teaching demonstration platform 1

3.4 Participants

Considering that senior the student is more likely to have a rich communication and awareness with the teacher, we chose a senior student as a participant. The student is a 15-year-old boy from Fujian Province, China, with a moderate academic record. The teacher who participated in the study was a Chinese teacher who taught in high school for six years.

3.5 Lesson samples

The course sample for this study was produced by the teacher in July 2018. A total of four course samples consisted of two 70-minute classes, one 100-minute class and two 90-minute sessions for a total of 420 minutes. The specific courses are as follows: 1. The root of the equation and the zero of the function; 2. Find the approximate solution of the equation by the dichotomy; 3. The function model of several different types of growth; 4. The application of the function model; 5. The distribution of the root of the quadratic equation.

Set theory is the basic branch of mathematics and the beginning of Chinese high school mathematics.

4. Results

We processed the student expression data to obtain the overall expression statistics for the class, as shown in Table 2.

Table 2 Expression Summary

	Expression	Score	Number	Total score
Teacher	Pleasure	1	8962	8962
	Neutrality	0	1746	0
	Disturbance	-1	12236	-12236
	Sum	–	22944	-3274
Student	Pleasure	1	5607	5607
	Neutrality	0	893	0
	Disturbance	-1	6386	-6386
	Sum	–	12886	-779

According to the time series, we change the way of expression and obtain the trend of emotional changes in classroom teaching by the teacher and the student.

4.1 Overall trend analysis of teacher emotions

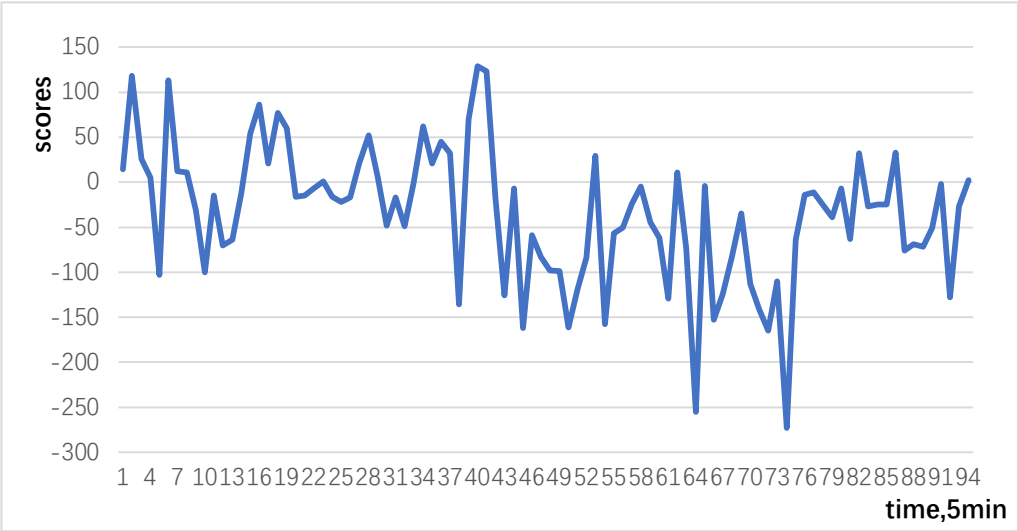

Figure 2 Overall trend of teacher emotions

From Figure 2 we can see that the teacher's overall emotions fluctuate greatly, and especially in the 37-77 interval, that is, between 185 and 385 minutes, the teacher has experienced the highest peak and the lowest valley. The overall emotion score ranges from -273 to 123. The teacher's emotion increased significantly in the first 5 minutes of the class. Combined with video analysis, we find that it is because the teacher and the student both have strong expectations for the course effect and process when they started the class. And during this time, the teacher and the student communicated with each other in pleasant topics and ways, such as asking in a pleasant spoken language: “Is there a wrong question?” The student was embarrassed to smile. The teacher inspired the student' enthusiasm, and both the teacher and the student made their emotions active.

Within 10-15 minutes after class, the teacher's emotions increased overall. During this period of time, the teacher analyzed a college entrance examination question about the range of odd functions. The calculation was relatively easy to make mistakes. The teacher's emotions reached a high point for finishing the topic in one go. But then, the inner feelings are relatively low because the student are more confused and unable to understand and repeat the explanation.

In interval 5-6, the teacher began to learn new teaching content: the equation root and Zero point of the function. At the beginning of the class, the teacher used a more interesting teaching method to mobilize the classroom atmosphere, and his emotions reached a high point. At the same time, 1 student raises questions based on his own independent thinking and understanding during this time period, so that the teacher's teaching process receives positive feedback, which in turn improves the teacher's class emotion. This similar 38-42 interval is also an explanation of the content of the new course. It can be seen that the teacher's emotion will be higher when teaching new knowledge.

Interval 15-20 is a time period for the teacher to explain the “zero point” question for a function containing absolute values and parameters. During this time period, the teacher's emotion generally showed an upward trend, and there were two small peaks under the big trend. Combined with the content of the video material, the teacher jokingly analyzes the psychology of the student to attract the attention of the student while finishing the topic. When explaining the second question, the teacher was motivated by the reaction of the student thinking, and then the emotion of the topic itself fell back during the explanation of the topic.

When the interval is 52-53, the student asks questions about the use of the wrong title. The use of the wrong title is the learning method that the teacher has always advocated. At this time, the positive feedback received by the teacher makes the teacher intuitively feel the effect of the learning method teaching. His emotion is correspondingly improved.

The lowest emotional interval is 74 when teacher talked about applying the function model to solve problems in life and ended course in a hurry for the time is not enough.

4.2 Overall trend analysis of student emotions

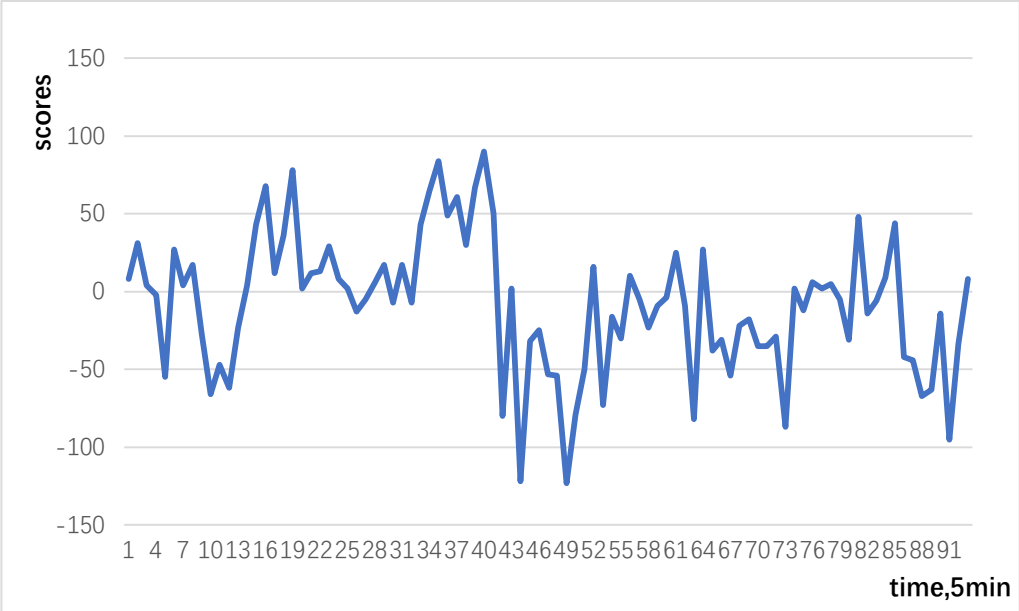

Figure 3 Overall trend of student' classroom emotions

From Figure 3 we can see that the fluctuation range of student' emotions is smaller than that of the teacher, between -150 and 150, but the frequency of fluctuations is still very large and as the teacher's overall emotion fluctuates, the student's emotion will be effectively moved.

In the first five minutes of the class, the student' emotions increased significantly. The reason was that the teacher mentioned that the student might not actually make the wrong questions, which made the student awkward, which caused a comic effect.

Within 10-15 minutes after the start of the course, the student' overall emotions increased. Under the teacher's repetitive explanation of the function's skillful simplification, the student has a preliminary understanding of the more difficult topics.

Interval 5-6 is the time period during which student are exposed to the new chapter content. During this time period, student is exposed to newer knowledge and learning new knowledge is satisfying. At the same time, due to the teacher's better classroom atmosphere, the student was guided by the teacher to understand the content of new knowledge, and the learning effect was more effective. This similar 38-42 interval is also to listen to new knowledge, to learn the new chapter: function model and application, there is a joy of harvest, and feel the teacher's classroom atmosphere, the emotion will be improved overall.

Interval 15-20 encountered new problems that were difficult to understand, but the student' emotions still showed an overall upward trend, and there were two rising peaks in the process of interacting with the teacher. When first listening to the teacher's analysis of the topic, the student's embarrassing psychology was revealed by the teacher's joke and the atmosphere was moderated. Then during the thinking process, the student showed an embarrassed smile due to the uncertainty of the subject and the teacher's emotional mobilization. In the first time, when listening to the teacher's analysis of the topic, the student's embarrassing psychology was revealed by the teacher's joke. The atmosphere was moderated, and the process of thinking was uncertain because of the uncertainty of the topic, and the embarrassed smile appeared because of the teacher's emotional mobilization. Such a comedic move in turn raises the teacher's emotion. After the teacher's request, the student did the problem again, and the emotion fell due to the focus on the topic itself.

In the 44-45 interval, there is the lowest point of emotion due to hard problems. The student is more confused and puzzled about the difficulty of the topic and the presentation process of the problem-solving methods.

4.3 Comparative snalysis of teacher’s and student's emotions

In general, the emotions of student and teacher will affect each other, that is, the positive feedback from the student will mobilize the teacher's emotions, and the teacher's active classroom mobilization can cause students' thinking and interest. Reflected in the data, the trend of the two data lines is almost close.

From the details of the video, within 2-3 intervals from the beginning of the course, the content is a question about the range of values for the odd function. The teacher started with high emotions, but the student could not understand the teacher's first explanation at first. When the student receives more difficult to understand knowledge, their emotion is relatively low; at the same time, because the first explanation does not get good feedback, the teacher will also have a lower emotion when repeating it again, and emphasize the key steps of simplification. After getting the better results by repeating and emphasizing, the two people's emotions rise synchronously.

In the interval 52-53, the teacher received positive feedback from the student, and the emotions were higher. The higher emotions in the process of waiting for the student to record the wrong questions gradually gradual, and the two men's emotions tend to be consistent.

Finally, analyze the interval 74, here is the lowest point of emotion that the teacher will arrive at the end of the lecture. In combination with the course video observation, the teacher showed the meaning that time is not enough to finish, and hurriedly arranged the after-school homework questions. We guess that the original course rhythm was disrupted because of repeated explanations in some details, which resulted in a bad class experience. The student' emotions are not as low as the above. The analysis believes that the emotional communication between the teacher and the student is beyond the scope of the class. At the last time of class, the student can’t feel the frustration of the interruption of the course.

5. Discussion

Due to the limitations of the facial recognition system, the expressions of the teacher and the student cannot be completely and clearly defined. Therefore, we divide the expressions of the teacher and the student into three types: happiness, neutrality and sadness. Based on the three-dimensional analysis framework to analyze and summarize the student' emotional time series, it is possible to further strengthen the facial recognition technology and refine the expression. More precisely, defining boundary criteria divides positive emotions into several levels, and negative emotions are divided into several levels. Through this technology and modeling, we can observe the emotional changes of the teacher and the student more carefully [15]. At the same time, we will deeply study the causes of the micro-changes of the teacher and the student' emotions, thus forming a more appropriate teaching mode or learning mode.

Unlike the entire class, the teacher and the student have a higher frequency of emotional changes in one-on-one tutoring. Moreover, we find that the teacher' emotions will greatly affect the student' emotions. For example, when the teacher takes classes in a pleasant way, the student is more likely to produce positive emotions and reactions, and when the teacher is blaming and angry, the student' emotions will be even the whole class in the short term [16]. The study can further explore the influence of the teacher' emotions on the student' emotions after refining emotional classification. In the research, we find that the teacher' emotions have a leading role. At the same time, the teacher' behaviors, language and teaching methods will work with the teacher' emotions to interact with the student. We can further combine the teacher' classroom behaviors, language and teaching methods with teacher-student emotions, and design the appropriate quantitative rating.

6. Conclusion

All facial expressions are divided into three categories by using a three-dimensional analysis framework. Through data processing, this study shows that the emotional experience of the teacher and the student shows strong fluctuations in a time series. Unlike class classroom teaching, teacher

and student have a higher frequency of emotional changes in one-to-one tutoring. Moreover, the emotions of teacher and student have a strong correlation, and teacher's emotions have a dominant role. Student will have obvious emotional changes due to the enthusiasm of teacher. For example, when teacher take angry emotions to class, student is likely to show a downturn in the short term or even the entire class. The teacher's emotion swings are larger than student. Besides, the teacher's and the student's emotions generally rise when they first start class. This is because the teacher and the student have higher expectations of classroom processes and classroom effects, which is quite different from class teaching [17]. One-to-one tutoring makes it easier to focus on the student's attention and further motivate the student.

In the explanation phase of the problem, the student's emotion seems to be related to the difficulty of explaining the content. However, when the student has a certain relevant foundation for new knowledge, and the level of understanding is not too difficult, the student' emotions are usually higher. At this time, the teacher will also have a pleasant emotion as the accuracy of the teacher' answers increase, and the teacher's emotions have risen sharply in the short term. In this way, in one-to-one tutoring, the emotions of the teacher and the student have great influence on each other. Teacher' emotions not only have a leading role, but also are easily led by the student. Importantly, the study provides a model for one-on-one tutoring research and demonstrates the wider application of this approach to track the potential of student's participation and identifies the relevance of teacher and student emotional influence in teaching.

Acknowledgements

We would like to thank the students, teachers, and staff of Hangzhou No.11 High School and Hangzhou Hikvision Digital Technology CO., LTD for their invaluable support of this project. This research was conducted with the Key Projects funding scheme (2018CCTTA04) provided by the dream Foundation in Shanghai, China, financial support of the Hangzhou No.11 High School and Hangzhou Hikvision Digital Technology CO., LTD.

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