Using an Ethnographic Approach to Collect Emotional Data in Affective Learning Research

Xiaomei Tao, Qinzhou Niu, and Mike Jackson

***Abstract*—Affective computing is an interdisciplinary research field that has made plentiful and substantial achievements in this decade. In previous Artificial Intelligence research, computers are expected to be endowed with intelligence analogous to human intelligence. In affective computing, computers are expected to be endowed with Emotional Intelligence, which means that the computer can recognize and interpret the emotional states of humans and adapt its behavior to give an appropriate response to those emotions. This paper describes the design of an experiment that is used to collect the emotional data for a cognition & emotion support e-learning project. The goal of this experiment is to explore the interrelationship between the teacher and the student from both emotional and cognitive aspects in a teaching situation, and then construct the interaction models of the emotional and cognitive levels. These models will be integrated in an affective learning system which supports the learner both from cognitive and emotional aspects. The paper addresses issues in experimental design including ethnography, ethical and practical problems related to this form of experimental work.**

***Index Terms*—Affective learning, data collection experiment, ethnography, contextual data.**

I. Introduction

Affective computing [1] is an interdisciplinary research field across computer sciences, psychology, and cognitive science. It has made plentiful and substantial achievements in this decade. The realm of affective computing mainly embraces the study and development of systems and devices that can recognize, interpret, process, respond, and simulate human emotions [2]. Emotion is an important research object because it is a fundamental but subtle component of a human being. Due to its complexity, in prior research work, qualitative and quantitative methods have been employed. Common qualitative methods are interviews, simulated recalls, diaries and observational analyses, and frequent quantitative methods are questionnaire survey, interactional content analyses, and transcript video analyses. A more detailed classification about the methods to collect emotion can be found in [3]. The selection of the research method depends on the goal and the requirement of each individual research project. In addition, on account of the particularity of emotion, in the process of emotional data collection, ethnography methodology and ethical issues also need considering carefully. This paper introduces a cognition & emotion support e-learning project and describes the process of designing an experiment to collect emotional data in this project. Furthermore some issues in experimental design including ethnography, ethical and practical problems will be addressed.

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II. Background

This project was proposed in the author's PhD research proposal that sets out to design a framework to analyze and respond to learners in an affective e-Learning environment, and to develop an e-Learning system which responds to a learner's affective state. In order to achieve this goal, an experiment to explore the interrelationship between the teacher and the student in both emotional and cognitive aspects in a teaching situation needs to be designed. From this the computing models of the interaction from emotional and cognitive angles will be produced and be integrated in an affective learning system which supports the learner both in cognitive and emotional aspects. In the evaluation stage, a video-based e-learning system will be developed that will automatically react to the student's emotional states and learning context. When the students watch an instructional video, their emotion will be detected/reported in real time. The aim of the emotional interpretation tool will be to detect the reasons for changes in the students' emotional states. The associated feedback model will generate the emotional feedback and the next instructional tactic.

Initially, a quantitative pilot experiment using a questionnaire survey was designed and conducted as data collection method. One class of 49 students were required to mark the frequency of the listed affective states appeared during their study using a five-level scale and describe the scenario(s) in brief when this affective state appeared on the basis of their personal experience. When these questionnaires were assessed it was found that quite a large proportion of questionnaires were not completed in the descriptions of the scenario(s) when each affective state appears. A small number of them misunderstood the requirement, e.g. several students described some scenario(s) out of the study context. From the uncompleted answers in the questionnaires, we deduce one reason for this is that there is a serious imbalance existing in individual meta-affective ability [4]. In other words, the students have different feelings about their affect. Some of them know clearly what they feel, but some of them feel difficult to describe it.

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The result from the pilot survey by questionnaire was not helpful in furthering the research, it was realized that we should combine a qualitative research approach with the quantitative method to collect data about emotion. Another reflection from the pilot survey was that a more specific context should be given although an open questionnaire might collect the data in different scenarios. It is, however, not feasible to integrate all scenarios in different contexts into the e-learning system in evaluation.

III. An Ethnography Based Experimental Design

In the light of the reflection from the pilot experiment, we determined to use video plus simulated recall to collect the raw data concerning the teaching process. Different aspects of the teaching process will be captured, and in the interviews that will be held after the video capture, the student and the teacher will be required to recall and interpret their behavior in the video.

A. Quick and Dirty Ethnography

In this ethnography video study, we will adopt the methodology of "Quick and Dirty Ethnography" [5]. There is a trade-off between the efficiency and the completeness in this methodology. Fieldworkers, however, could undertake short focused studies to quickly gain a general picture of the setting by this approach. Using this ethnographic approach, four teaching sessions will be video recorded and analyzed. The emphasis is on the interaction between the teacher and the student. This video study starts with outline project meetings. Debriefing meetings will be held after each teaching session and finally the scoping document will be produced to describe the cognition and emotion interaction models.

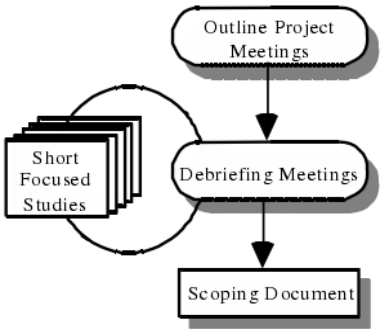

Fig. 1. Quick and dirty ethnography

B. Outline of the Experiment

The purpose of the experiment is to observe sessions in which a student is tutored in elements of the C programming language. The majority of the session will consist of a lecture. During the teaching session the student will be given programming exercises to attempt and there will be feedback and assistance from the teacher. A session should take no more than 45 minutes. The time allocated for the lecture should be limited to around 30 minutes and the rest of the time for exercises. The whole teaching process will be recorded from different angles, such as the student's upper part of the body by a web camera, the teacher's teaching and the interaction with the student by a digital video camera.

C. Experiment Steps

The main experimental steps are listed below:

1) Meeting with the teacher to illustrate the research aims and process, and a consent form will be signed by the teacher.
2) Design the lesson plan. In this step, the research team and the teacher team should work together.
3) Introduce the study aim and process to the student volunteers and ask them to fill in their personal information and sign the consent form. The students' background knowledge about programming will be assessed and recorded by the teacher in advance.
4) Teaching session. Start the video capture by a digital video camera and a web camera simultaneously.
5) Stimulated recall. After the teaching process, the teacher and the student will be asked to review and interpret the video.
6) Divide the video into small segments and mark every segment. Two inter-coders will mark the segments individually and the inter-coder reliability will be considered.
7) Debrief meeting within the research team and the teacher team. Collect any positive advice to improve the experiment in next group.
8) Repeat from step c to step g for the remaining 3 groups.
9) Analyze all the video and produce an analysis report.
10) Based on the analysis report, construct the interactive models.

One single teacher and four students (two males, two females) will be invited to participate in the C programming language sessions. The reason why we select two male and two female students is to acquire the raw data from different students. In order to focus on our experimental aims of emotion understanding and feedback, analysis of the gender bias in programming will be omitted, although the research in [6] found that males are approximately 17% more likely than females to have an interest in computer programming. All students should be taught the same material but it is expected that the teacher will react differently in each case to the individuals' interest and level of understanding. It is this variant reaction that the experiment should capture.

As stimulated recall, after the class, the teacher and the student will look at the video to interpret their behavior in the video. Researchers will be involved in this process to guide the recall. Since we have two video files of the same recorded scene from the digital video camera and web camera respectively, synchronizing video file is needed. Whenever the students' emotional states change, the video will be stopped by any one of the research member, the student or the teacher, and then the students will explain their emotional state and the cause of the change. In addition, the teacher will explain her understanding, such as the students' emotional state, the cause of the change and her feedback tactic. The simulated recall will be audio-taped. In research in [7] it was found that if the recalls were prompted a short period of time after the event (generally 48 hours), recall was 95% accurate. Accuracy declined as a function of the intervening time between the event and the recall. Therefore, in order to ensure the accuracy, the interview will be conducted after a short break e.g. 15mins following the teaching session.

IV. Coding the Videos

This section will illustrate how to code the videos.

A. Coding Unit

The coding unit refers to the decisions about when to code within an interaction and the length of time the observation should last, and it has two broad variants - event based and interval based [8].

There are three ways to produce the coding units in our experiment showed below, latter two are event based:

- based on fixed time intervals, such as 30s
- based on the instructional steps/instructional event
- based on knowledge points

It is not feasible to use fixed time intervals to split the video because continuous behavior would probably be interrupted or a transient emotion may be missed. So we will divide the video based on the instructional steps. The instructional steps to be adopted in our study were specified in [9], as a nine-step process that is also called instructional events. In a teaching session, some events might appear repeatedly or be completely absent. These instructional events are presented below, and the codes will be adopted directly in the later coding scheme.

TABLE I: Gagné's Steps of Instruction

Codes	Steps of instruction/ Instructional event
1	Gain attention
2	Inform learner of objectives
3	Stimulate recall of prior knowledge
4	Present stimulus material
5	Provide learner guidance
6	Elicit performance
7	Provide feedback
8	Assess performance
9	Enhance retention transfer

If the duration of the step is too long, such as "Present stimulus material", in which there could be several sub-knowledge-points (explained in next subsection), then this event will be divided into several small segments based on relatively independent sub-knowledge-point. There will be at most one change in one segment, because this would be helpful to the following coding and analysis. If there are two or more changes exist in one segment, more small segments will be divided out.

A. Coding Scheme

TABLE II: Attributes used to Code the Video

Attributes	Coding examples
The active knowledge point	eg. 6.3 Initialization of array. This could be coded by the knowledge point map, see Figure 2.
Instructional event	eg. 1 Gain attention. This is coded by Gagné's steps of instruction. See TABLE I.
The script of the participants' discourse	Teacher "…" StudentA "…"
The interactive activity	eg. teacher asking question--student thinking. See Person's turn categories [10] and TABLE III.
The interactive emotion	eg. teacher neutral—student confused. See TABLE IV.
The cause of why the student's emotional state changed	eg. student forgets the related old knowledge point. TABLE V.
The related knowledge point(s)	eg. 6.2 Declaration of array. This could be coded by the knowledge point map, see Figure 2.

1) Attributes used to code the video

For every segment, we need to complete the Table II below:

2) Coding scheme of the instructional step

This coding scheme will follow Table I.

3) Codes for knowledge point

a) Knowledge point: This means an independent content in the learning material. This should be a small teaching unit, such as the declaration of array.

b) Codes for knowledge point: We use the knowledge map in Fig. 2 to present and code the knowledge point. In addition, each knowledge point will be combined with a description of the level of difficulty. Numbers from 0 to 4 will be used to describe the level of difficulty from easy to hard. This will be marked by an experienced teacher in advance. Each knowledge point will be identified to show whether it is a key point or not.

c) Knowledge point map: This is used to describe the relationship among all the knowledge points. For example:

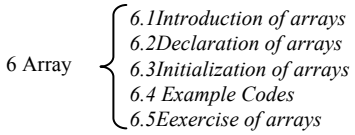

Fig. 2. Knowledge point map

In this knowledge map, code "6" includes "6.1, 6.2, 6.3, 6.4, 6.5", and "6.1" is the prerequisite of "6.2", "6.1" and "6.2" is the prerequisite of "6.3" and then running down accordingly.

4) Coding scheme of the interactive activity

Flander's interaction analysis technique [11] is used to measure the teaching-learning situations in the class-room involve interaction between the teacher and the students. Person et al. developed elaborate turn categories for both students and tutors in [10] as well. These two category schemes are used to describe the verbal interactive behavior in classroom; nevertheless, there are two common problems as below:

- The category of silence is omitted. Episodes of silence might contain valuable information, such as student thinking, or exercises.
- These two category schemes are both on the basis of the verbal interaction, but the non-verbal interaction is omitted, such as a gentle head shake for "no" or nod for "yes.", facial expressions or other gestures.

In response to the two problems mentioned above, we developed an extended category scheme to Table III below:

TABLE III: Extended Interaction Categories

Teacher	1. Accepts feeling, acompanied with behaviour such as nodding, smile. 2. Praises or encourages, acompanied with behaviour such as nodding, smile. 3. Negative feedback to the student, accompanied with behaviour such as shaking head.
Student	4. Accepts teacher's view, accompanied with behaviour such as nodding 5. Does not accept the teacher's view, acompanied with behaviour such as shaking head. 6. Does not understand the teacher's view, accompanied with behaviour such as shaking head.
Silence	7. Student thinking. 8. Student doing exercise.

In our research, the Person's turn categories for both

students and tutors and our extended interaction category will be jointly adopted. In the Person's turn categories, there are 11 categories for the student's turn and 17 categories for the teacher's turn. For the student's turn, we include partial answer and error-ridden answer, and for the teacher's turn, we include question to assess student's knowledge about a particular topic and positive feedback.

5) Coding scheme of emotional state

Ekman listed the basic emotions in [12]: Anger, Disgust, Fear, Happiness, Sadness, Surprise, and also expanded his list of basic emotions in [13], the newly included emotions are: Amusement, Contempt, Contentment, Embarrassment, Excitement, Guilt, Pride in achievement, Relief, Satisfaction, Sensory pleasure, Shame. In fact, there are only a part of the full set of emotions which appear in the teaching-learning process. In the experiment in [14], however, it was indicated that the basic emotions (anger, disgust) play nonsignificant roles in learning. Our pilot questionnaire survey also proved that few students experience anger and disgust in study. Based on prior empirical observation in the classroom and literature study, the following set of emotions, that has close relevance to learning, has been selected:

TABLE IV: THE CODING SCHEME OF EMOTIONS

Codes	Emotion category	Positive/Negative Emotion
1	neutral	/
2	bored	Negative
3	confused	Negative
4	happy	Positive
5	frustrated	Negative
6	interested	Positive

6) Coding scheme of the reasons why the student's emotional states change

Understanding why a student changes their emotional state from one to another is very important in selecting an appropriate teaching tactic. For example, if a student shows confusion in a teaching situation, the cause might be (s)he does not comprehend the current knowledge point, or (s)he has forgotten the relevant knowledge point(s). To understand and gather the causes why the students change their emotion is a vital task in our experiment because a systematic category scheme is not available from prior study. Some common causes are listed below, and the categories of the causes are subject to increase in the light of the result of our video study.

TABLE V: CODING SCHEME OF THE CAUSES WHY THE STUDENT'S EMOTIONAL STATES CHANGE

Codes	Category of the causes
1	Did not learn the current knowledge point
2	Did not learn the related knowledge point
3	Forget the related old knowledge point
4	Do not comprehend the current knowledge point
5	Teacher's praise
6	...

V. DISCUSSION

A. Spontaneous Emotional Data

Spontaneous emotion means authentic emotion occurring in natural communication settings. Due to the ethical issue and facility issue, the spontaneous emotion and behavior are difficult to capture. When a subject is told that his behavior and talk will be video recorded, he might act and speak unusually. In addition, the camera in the settings is not invisible to the subject, thus, this will also enhance the subject' feelings that he/she is being recorded.

The psychological study [15]discovers that the intentional emotions may differ in appearance and timing from spontaneous emotions. In terms of the difference between the spontaneous emotion and the intentional emotion, it could be deduced that there also exists difference in the teacher-student interaction in a natural situation and in an experimental setting. Before the video capture starts, the subjects will be told act normally and naturally during the process and the devices will be settled in inconspicuous locations. These measures are taken to decrease the gap between the spontaneous behavior and intentional behavior, although it cannot be completely eliminated.

B. Interaction with E-learning System vs. Real Teaching Situations

In prior research, the users' facial expression, speech or other biological information were collected to form the training sample for emotion recognition software when they are using an e-learning system to study. Capturing the user's emotion when interacting with a computer system is a feasible way in the emotion recognition stage, but in the emotion understanding and feedback stage, this is not enough, more data about the interaction in real teaching situations need to be collected. Much effort in Artificial Intelligence in education has been expended to discover how teachers deal with student errors and how teachers motivate students [16]. Compared with the error-driven pattern, in real teaching situations, the teacher not only responds the student's error to change their teaching tactic but also responds the student's emotion. Hence the emotion-driven pattern is also an effective way to adapt the student's learning process. There is, however, little previous work that directly addresses the question of how human tutors adapt to student's affective state. So, one goal of our experiment is to extract the interactive models of how the teacher responses the student's emotion and adjusts their teaching tactic in real teaching situations.

C. Task Difference

The experiment results in [17] show that task difference is a major factor affecting emotional behavior. So, it is reasonable to design a teaching plan with stimulus, such as an interesting video to get the learners' attention at the start or a joke to let the learners feel relaxed when they meet a difficult task. Hence, the researcher and the teacher should work together to design a well-organized lesson with stimulative elements and questions in different level.

D. Contextual Data Collection

Contextual data is crucial for the emotion understanding. For example, in classroom teaching, experienced teachers know well on the contextual information, such as the student's knowledge background, the complete teaching plan, the knowledge point map, etc., those would be helpful to form an understanding to the student's emotions. Thus, in our

experimental design, not only the video, but also the contextual data mentioned above will be collected for modeling.

E. Ethical Issues

The ethical issues identified in this research are addressed below:

- The research overview and purpose will be introduced to the participants and the participants have the right to withdraw from the study during any stage.
- All participants will be given the option to be anonymous in the experiment.
- The provisions of the data protection act and related data and privacy legislation will be implemented.

VI. Summary and Conclusions

Up to now, the study of emotion recognition has achieved prominent progress, building on this to achieve emotion understanding and feedback is a greater challenge due to the complexity of emotion, cognition and motivation. A qualitative research methodology and technique will be introduced to affective computing research. This paper introduced an experimental design using "Quick and Dirty" ethnography to collect emotional data in a cognition & emotion support e-learning project and discussed some issues such as ethnography, ethical and practical problems. These experimental techniques and measures need to be further evaluated and improved to meet the complex requirements of affective learning research.

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