A Comparison of the Experience of Confusion Among Filipino and American Learners while Using an Educational Game for Physics

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Abstract. In this paper, we propose to investigate the affective experience among Filipino learners and compare it to their American counterparts while using Physics Playground. In particular, we focus on the confusion affective state and compare the experience between learners based on facial expressions, confusion trajectories, behaviour and interactions inside the learning environment. We present our methodology, analysis and preliminary results and possible contributions.

Keywords: Confusion, Affect detection, facial expression, Physics Playground

1. Introduction

Affect detection in learning environments has gained interest among researchers. The most commonly observed affective states in Intelligent Tutoring systems are engaged concentration, frustration, boredom, and confusion (D'Mello, 2013). Recent findings suggests that confusion may be beneficial for learning (D'Mello, et.al, 2014) but prolonged state of confusion may lead to frustration and may eventually lead to disengagement and boredom which eventually may result to the learner giving up (Craig, et.al., 2004; D'Mello et.al., 2011; Liu, et.al, 2013). D'Mello and Graesser studied the chronometry of confusion and proposed a model that predicts specific confusion trajectories based on the severity of discrepant events that triggers confusion (D'Mello & Graesser, 2011). They posit that there is a zone of optimal confusion, a certain point of time where confusion may be beneficial for learning. D'Mello and Graesser also proposed a model on the affect transitions of learners in educational learning environments (see Figure 1) (D'Mello & Graesser, 2012).
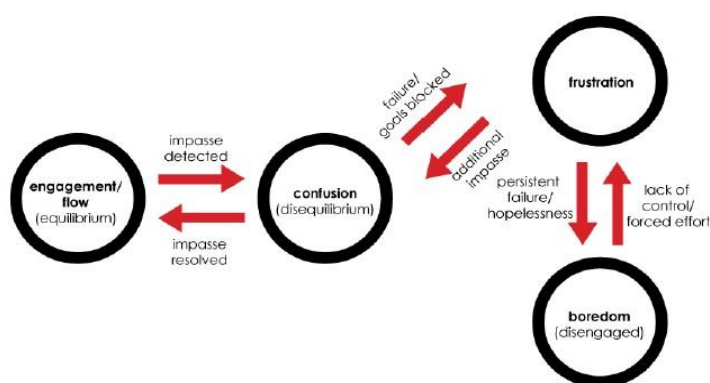

Figure 1. D'Mello & Graesser Affect Transitions Model

At the heart of this model is the theory of cognitive disequilibrium. According to this theory, a learner who encounters a new event or stimuli that does not match his expectations or contradicts his prior knowledge or understanding is in a state of disequilibrium and is experiencing confusion. When the learner acts on the stimuli with a deliberate effort to resolve the discrepancy and restore cognitive equilibrium, the learner is expected to have attained learning gains as a result of the effort. However when the efforts to resolve the impasse results to failure, the learner may transition to a state of frustration. When further impasses are experienced, the learner may oscillate back to confusion. The learners tend to disengage when they consistently fail to resolve the impasse, at which point they will experience boredom. When forced to keep on doing the task even when they have already mentally disengaged can lead back to frustration (D'Mello & Graesser (2012). This model was tested and developed with American learners using AutoTutor (Graesser, et.al., 2014).

We wish to investigate whether the model holds among Filipino learners while using Physics Playground, an educational game in Physics. In particular, we will narrow our investigation on the experience of confusion and compare these experiences among American learners of similar age using the same software.

2. Proposed Research Work

The furrowed brow particularly AU4 (brow lowerer) sometimes accompanied by AU 7 (tightened lids) was found to be associated with confused expressions (McDaniel, et.al. (2007); Bosch, Chen & D'Mello, (2014)). We would like to find if the Filipino learners shows the same facial expressions when they are confused. We would also like to investigate the temporal dynamics of affective states of our subjects to see if they align with the Affect transitions model proposed by D'Mello and Graesser. We particularly want to check on the rise and decay of confusion along with what are the factors causing the rise and decay of confusion including the facial expressions during these events. We would also like to build a model of confusion among Filipino learners and test this model against the American learners. If the model is able to predict confusion among the American learners well, it could mean that Filipino and American learners have the same confusion characteristics. However, if the model performs poorly, this probably means that Filipino confusion is different from the American learners' experience of confusion. It is our goal to determine what are the differences and similarities of these experiences.

Ekman's basic emotions (anger, disgust, fear, happiness, sadness and surprise) are found to be accurately recognized across cultures hence they are labelled as universal emotions (Ekman, 1992) However, he also acknowledged that there are subtle differences in the way emotions are facially expressed within cultures which could be accounted for due to gestures being culture specific; through cultural norms that regulates when to display or hide facial expressions; and through cultural influence on the causes of emotion (Elfenbein & Ambady, 2002).

Though the study that we are proposing focuses on confusion, we would like to posit that if in case we find differences in terms of the way confusion is experienced between the Filipino and American learners, we take it as due to the cultural differences between these learners. Though we will only be looking at two different nationalities in this study, given the geographic location of the subjects that we are proposing to study (East and West part of the globe), clearly, the two groups of subjects are culturally different.

3. Research Methodology

3.1 Data Collection

Participants of this study used Physics Playground, a two-dimensional computer game that is designed for high school students better understand physics concepts related to Newton's three laws of motion: balance, mass, conservation and transfer of momentum, gravity, and potential and kinetic energy (Shute et al., 2013). Inexpensive webcams were mounted at the top of each computer monitor. At the start of each session the webcam and its software was configured so that the students can adjust themselves in a position where their face is at the center of the camera's view. Students played the game for an hour inside computer laboratories. Student affect and

behavior was collected using the Baker-Rodrigo-Ocumpaugh Monitoring Protocol (BROMP), a method for recording quantitative field observations, described in detail in (Ocumpaugh, Baker, and Rodrigo, 2015). The affective states observed within Physics Playground in this study were engaged concentration, confusion, frustration, boredom, happiness, and delight. The affective categories were drawn from (Ocumpaugh, Baker, and Rodrigo, 2015). The observers recorded their observations using the Human Affect Recording Tool, or HART. HART is an Android application developed specifically to guide researchers in conducting quantitative field observations according to BROMP, and facilitate synchronization of BROMP data with educational software log data. FACET a facial expression analysis software was used to extract facial features from the video recordings.

3.2 Preliminary Analysis and Findings

We have made initial analysis on the Filipino learners data. The prevalent affective state is Concentrating at 76%, followed by Frustrated at 7%, Confused at 6%, Happy at 5%, Delight at 2% and the other five affect combined at 4%.We have applied Logistic Regression to determine which facial features are associated with the affective states. Our findings so far is shown in Table 1.

Table 1. Initial Results

Affective State	Our Findings	Previous Findings
Concentrating	AU6 (cheek raiser), AU1 (inner brow raiser) , AU5 (upper lid raiser)	AU1, AU2, AU4, AU14 Grafsgaard,et.al. (2013)
Confusion	None so far	AU4, AU7 AU1, AU1 & AU4, AU45 McDaniel, et.al. (2007) Bosch, Chen & D'Mello, (2014)
Delight	AU12 (lip corner puller)	AU7, AU12, AU25, AU26 McDaniel, et.al. (2007)
Frustrated	AU20 (lip stretcher)	AU12, AU45, yaw, AU4 McDaniel, et.al. (2007) Bosch, Chen & D'Mello, (2014) Grafsgaard,et.al. (2013)
Happy	AU6 (cheek Raiser)	AU6, AU7, AU2 Kohler, et.al (2004)

4. Contribution Of The Proposed Research

There is a need to establish that confusion is part of the learning process and beneficial for the learners. Though there are studies showing that this is so, further results confirming it will strengthen the acceptability and universality of this claim. Technology has allowed us to develop Intelligent Tutoring Systems that can be further instrumented to detect the learners' affective states and respond appropriately. Seeing the potential of learning gains on the experience of confusion among learners, providing the right amount of challenges that maximizes learning gains is advantageous to the learners. Hence, being able to detect it while students are using intelligent tutoring systems is essential for us to build systems that are able to provide the right intervention for learners to be gainfully learning.

The literature on cultural differences suggests that culture impacts learning and emotion (Joy & Kolb, 2009; Elfenbein & Ambady, 2002). Our investigation may shed light on how different learners from the eastern and western cultures are in terms of their experience of confusion while using a game-based learning environment.

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