Affective Learning Analysis of Children in a Card Sorting Game

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Abstract. The purpose of this paper is to provide an affective learning analysis on children while they were playing a card sorting game. The electroencephalogram (EEG) signals of 8 preschoolers aged between 4 to 6 years were collected (a) while they were playing a card sorting game; and (b) observing affective faces. The features from EEG signals were extracted using Kernel Density Estimation (KDE). The Multi-Layer Perceptron (MLP) was used to classify and generate the affective maps of the EEG signals while the children were playing the game. The initial results show that the children's affective states are unique and there might be different affects that drive a child's performance. This analysis shows the potential of using the affective learning analysis approach in assessing educational tools such as computer games.

Keywords. Emotion, computer games, preschoolers, affective computing

1 Introduction

Many researchers have reported the negative effects of playing computer games such as aggressiveness due to the violent nature of computer games [1]. However, recent experimental studies have suggested that playing computer games might improve cognitive abilities of the players [2]. Thus, the biggest challenge may actually lies in the identification of suitable games genre for educational purpose. A possible solution is setting clear learning outcomes for computer games and how they can be aligned with the cognitive skills that can be obtained by the children [3].

From another perspective, the over-emphasis on cognitive abilities might be at the price of relative neglect on affect [4]. The capability for affect regulation is known to be partly responsible for children academic performance [5] that leads toward confidence, creative thinking and problem solving [6]. Thus, the contribution of an affective learning analysis simply cannot be denied.

In this paper, the affective states of children with the aged of 4 to 6 years old were investigated by monitoring their EEG signals while they were playing a card sorting game, called the Dimensional Change Card Sorting [7]. Through observation of the EEG affective maps and EEG dynamic affect satisfied the affective component

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of our analysis. These works might lead toward the establishment of intelligent machines that can replace a skilled tutor in teaching, learning and assessment in the future.

1.1 Computer Games and Learning

Currently there are thousands of computer games in the market. A frequently asked question by educators is how to adapt the games for teaching and learning. A study has proposed a few videogames genres as follows [8]:

1. Imagination: *consists of fantasy role-playing, action-adventure, strategy and sims.*
2. Traditional: *consists of classic board games, arcade, card dice, quiz-trivia and puzzles.*
3. Physical enactment: *consists of fighters, shooters, sports and racing speed.*

To date, a few of the widely investigated games genre in relation to education are action based and puzzle games [8]. However, it is acknowledged that many of these action based games can be violent in nature. Thus, puzzle based games is chosen since it is easily adaptable for a classrom setting.

1.2 Blooms Taxonomy

For the past few decades, the most renowned assessment model for cognitive skills in education is Bloom's taxonomy [9]. Traditionally, the Bloom's taxonomy is described as 5 orders of assessment (i.e. knowledge, comprehension, application, analysis, synthesis and evaluation). It is thought that the experiential environment in computer games might present a better opportunity for developing higher order cognitive processes such as analysis, synthesis and evaluation (i.e. up to the fifth order of Bloom's) [10].

1.3 Affective Space Model

In the past, psychologists have attempted to explain affect using a two-dimensional structure namely *pleasant-unpleasantness* and *relaxation-attention* [11]. The problem with this approach is that certain affective states such as fear and anger are placed in almost similar position in the two dimensional structure, but significantly differs in terms of physiological manifestation.

The affective space model was later introduced with the belief that affect can be placed in varying degree on the circumplex of *valence* and *activation* (Fig. 1 below) [12]. The circumplex model placed feeling-related concepts in a circular order, departing from the bipolar dimensions [11]. Based on the model, it is possible to quantify an affect based on the level of valence and arousal.

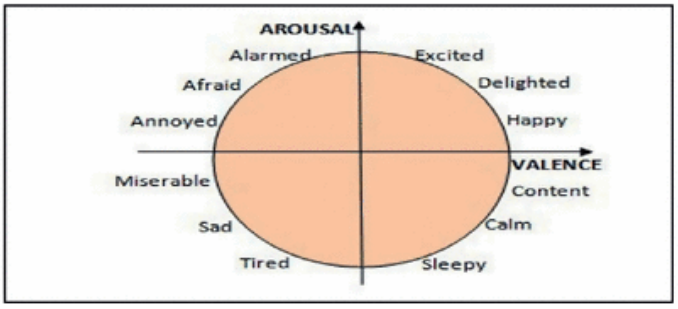

Fig. 1. The circumplex model of affect (adapted from [12])