Holistic Framework for accelerated learning by Adapting & Personalizing lesson plan for children based on emotions

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Abstract: Affective education is a formal curriculum designed to help children better understand their feelings and respond to challenging situations, thereby transforming themselves and the world around them. Emotions impact the learning ability at multiple levels (Attention, Memory and decision making etc.). Though they have been advancements in terms of the content (Rich multimedia-based lessons etc.) for effective-learning, proportionate advancements have not taken place in the affective-learning domain – for example “How to adapt the learning based on the current mood and situation?” Can we mitigate the adverse effects of emotions? This problem of learning is especially compounded for university students where each student has flood of information to absorb & assimilate and is constantly under stress, furthermore, Personalized & Real-time/continual mentoring by the teachers to students is not practical. We have developed a framework and prototype which can be used to adapt the learning-content based on the current mood of the student. We achieve this by capturing the real time gestures & facial expressions (based on universal facial expressions of seven emotions – anger, contempt, disgust, fear, joy, sadness, and surprise) and adapt the content shown to mitigate the negative & amplify the positive impacts of emotion. The Task (Chess Puzzles) given to validate the effectiveness of Methods show significant Improvement on sample size of 80 students.

Keywords: Affective education, Facial Expressions, Holistic Learning, Emotions and Learning, Personalized Feedback

1. INTRODUCTION
Affect is a concept used in psychology to describe the experience of feeling or emotion. Affective computing is the study and development of systems and devices that can recognize, interpret, process, and simulate human affects. It is an interdisciplinary field spanning computer science, psychology, and cognitive science. Affective computing is also sometimes called emotion-AI [4]. Affective education is a formal curriculum designed to help students better understand their feelings and solve their problems, thereby transforming themselves and the world around them. [3]. Though it is recognized that emotions are very crucial there is lack of consensus regarding how to incorporate them into the existing frameworks.

The term affective computing involves the intention of Artificial Intelligence researches to model and incorporate emotions in intelligent systems. The aim of affective computing is to build an intelligent computing system which can recognize and understand human emotions, and can respond intelligently, sensitively, and friendly; like a human. This concept combines the perspectives of many disciplines, such as neuroscience, psychology, and philosophy.

Figure 1: Human Behavior & Emotive Markers

The Main goal of this research is the following:
1. Develop an affordable system that will make learning a joyful experience & accelerate rate of
learning (especially for Students). To achieve this grand goal, we realized that incorporating emotions into the architecture was paramount. So, the sub-tasks are the following:

2. Study & Synthesize the existing literature related to emotions and its impact on the learning ability at multiple levels (Attention, Memory and decision making etc.).

3. Design and Develop a Framework where effective methods of learning (with respect to emotion) can be validated

4. Develop automated Facial emotion recognition system so that the different strategies to mitigate the negative effects of emotions can be studied precisely.

5. Test and Report the findings on “one strategy” and its effectiveness

6. Based on the findings develop a Road MAP for future experiments.

Procedure for collecting data:

a. Select an Appropriate Task & Prepare Data
b. Select appropriate users
c. Remove the outliers based on the expertise of the users with respect to the task.
d. Split the users into control group and test group in phase 1(counter balancing) and again reverse the role (Control become Test subjects and vice-versa) in phase 2.
e. Administer the tests
f. Remove outliers
g. Analyze results

“Gaining attention”, any lapse in attention at the starting point and the learning will be sub-optimal.

Modeling emotion plays an important role for emotional computing because of the necessity of making human computer interaction more natural. [6].

Figure 2: Relation between Personality Mood and Emotion [6]

Emotion is analogous to the state of the mind that is only momentary. It is influenced by personality and Mood.

2.2 Interrupts to Cognition due to emotions

1. Impact of Emotions on Judgement and Decision making: Range of cognitive dimensions (rather than just valence) usefully differentiates emotional experience and effects [1]

2. Emotion-related cognition interrupts ongoing cognitive processes and directs attention, memory, and judgement to address the emotion-eliciting event [1]

3. Appraisal tendencies are goal-directed processes through which emotions exert effects on judgement and choice until the emotion-eliciting problem is resolved [1].

2. Background

2.1 Intelligent Tutoring systems

Robert Gagne [5] proposed a taxonomy of learning outcomes based on the cognitive theory of learning. Robert Gange was a leading scientist regarding learning theory. He lists of nine instructional events for planning lessons:

1) Gaining attention, 2) Informing students about the objective, 3) Stimulating recall of prior learning,
4) Presenting the Content, 5) Providing learning guidance, 6) Eliciting performance, 7) Providing feedback, 8) Assessing performance and 9) Enhancing retention and transfer

As you can see from the above list, the starting point is
2.3 Perception is affected by bodily states
1. Perception: Perception is affected by the bodily states & this in turn affects judgement and cognition.
2. There is relationship between our emotional/cognitive state and our time perception.
3. Time seems to flow fast when you expect something positive compared to when you expect negative.
4. There is a promising application area with regards to the modification of the perception of time to take more rational decisions.

2.4 Universal Emotions & Action Units
1. Facial Action Coding System (FACS)

The essence of the above scenario is that taking a step back and being aware of the emotions- Step 3 gives enough room to mitigate the harmful effects of the emotion and then optimal decision can be taken (which may include 7 (take time out) or 9 (avoid it altogether).

Awareness of our emotions means understanding how they are triggered, what they feel like and how we taxonomizes Facial movements by their appearance on face.
3. These emotions are Sadness, Fear, Anger, Enjoyment and disgust (& Neutral)
4. The rest are Derived from these fundamental emotions.
Researchers have also found that mindfulness meditation lead to slower perception of time (Kramer, et al. 2013)

3. Methods
The study aims to explore the strategies currently available to mitigate the negative impact of the emotions and quantify the effectiveness. We administered tests for Undergraduate students at IIIT Hyderabad, India. To avoid variation due to gender, context & in limited time available to conduct experiment, we selected students who were already familiar with chess (Familiarity with Chess rules and ability to evaluate - Value of pieces & familiar with Chess notation). Why chess was selected for evaluating the cognitive skills?
Chess is a good model to study high-level human brain functions such as spatial cognition, memory, planning, learning and problem solving [11].

Chess Puzzles were selected because it is one of the few fields that has a quantitative and reliable measure of skill (the Elo rating). It is, therefore, an ideal environment for studying expert performance and skill acquisition. [9] According to Nobel Prize Winner Herbert Simon, the impact of chess on cognitive science is comparable to that of Drosophila (fruit fly) for the field of genetics.

One Review article published [9], spans 19 studies and more than 1,700 participants. This paper evaluated chess players' performance on cognitive tasks. The findings show overall correlations between chess skill and four cognitive abilities: fluid intelligence (the ability of solving new problems and adapting to novel situations); processing speed (for example reaction time); short-term memory; and comprehension knowledge (knowledge and skills assimilated through experience, such as vocabulary and reading comprehension). [9]
Figure 8: Control Setup
Please Note: Students were counter balanced.

i. 40 students worked on Experimental/Test setup first while another set of students (40) worked on Control setup.

ii. The roles were reversed in the next round. So, at the end of the tests, the set of 20 people participated in both the setups.

4. Results
The experiment was conducted during February-April 2018.
The results (control and Experimental setup) were analyzed and one strategy to mitigate the adverse impact of emotions was proven to be effective.

1. Participants
We did experiment with 92 students (Undergraduate Engineering students) after eliminating 12 of them (as they were outliers: Experts/Novices), we were left with 80 students. All the students were (All male, Mean 19.1 Years, SD 1.5; range 16-22 Years). (Reason for only Male: we wanted to limit the number of variables affecting our analysis we did not want to introduce gender/expertise into the results)

2. Results – Graphs and Tables

Figure 9: Chess Scores – Paired [ ELO vs #Student-ID]

Figure 10: Box Plot of Scores (ELO rating [Y-Axis])

Figure 11: Relative change in Chess Scores
Normality Test for Changes in Scores(ELO): Shapiro-Wilk test was applied. P value = 0.233481. (Skewness = 0.184605 and Excess kurtosis: -0.628239)
Since p-value > α (.05), H0 was accepted. The data can be considered normal.

Table 1: Paired T-Test and Key Results

<table>
<thead>
<tr>
<th></th>
<th>Control</th>
<th>Test</th>
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<tr>
<td>Mean</td>
<td>1535.4</td>
<td>1591.1875</td>
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<tr>
<td>Variance</td>
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<td>2472.8125</td>
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<td>Pearson Correlation</td>
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<tr>
<td>t Critical two-tail</td>
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Wilcoxon Signed-Rank Test (For Difference In scores):
Significance Level: .05
Two-tailed hypothesis
Result Details
W-value: 703

5. Discussion
Though, on an average the results look promising (71.25% of participants have improved the score), individually analyzed there are some participants were the method did not prove to be effective [28.75%]. Further experiments on a large scale and varied condition need to be conducted to establish conclusive results. Due to the time and resources available we were unable to conduct the experiment on larger scale/Different setups.

6. Conclusion
The results based on the experiments conducted indicate that understanding emotions by just being aware of them has a significant impact on the cognitive skills. The ability to detect emotions and being aware of them at the earliest has significant benefit. We believe that this is to some extent explainable as the test setup in the experimental setup facilitates for alternating between focused and diffused mode of brain and for problems like chess, taking a fresh look at the position by alternating between the Focused Mode(Depth) and Diffused mode (for alternate options) is extremely critical. Nevertheless, the method is very effective. This also could in part explain the promising results. The automated facial analysis serves to detect the emotions in un-biased way and real-time feedback helps student to re-focus on the current task saving valuable time. This we believe has tremendous potential for accelerated learning – which is essential in the current age of information overload. Our current study was limited due to resources available, we plan to extend the experiment to include larger & heterogenous group. We have collected the gaze data and gaze time, we need to analyze and find insights
into the root cause which we believe can open doors to develop applications of immense benefit.

7. Acknowledgement
We thank the students of IIIT Hyderabad for participating in the experiment.

8. References
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