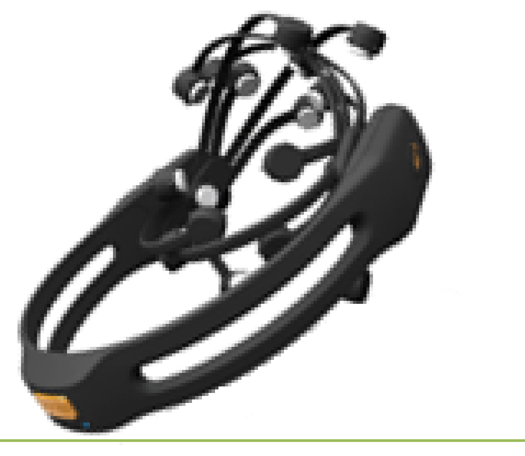
Introduction:

This poster presents the results of an initial study which observed whether and to what degree tailoring of training content (e.g., clarity and flow of task) in a computer-based cultural negotiation trainer had on self-reported levels of engagement. It also evaluated if specific sensors are practical for gathering data for cognitive-state modeling. Engagement is a state of interest. It reflects processes that involve information gathering, visual scanning, and periods of sustained attention [7]. A secondary research objective is to correlate signals from physiological sensors and other variables of interest to arousal leading to development of a model of learner engagement. Longer-term, the results of this study could contribute to establishing the validity of using commercial off-the-shelf (COTS) cognitive-state sensors for manipulations designed to improve engagement and provide inputs sufficient for enabling engagement modeling.

The Link of Engagement to Learning:

Emerging evidence suggests that enabling a training system to access affective and cognitive states can enable it to adapt an individual student's learning experience and improve learning outcomes [1]. Personalizing instructional content on the individual level requires real-time cognitive state assessments that aim to interpret the attentional resources a particular student is devoting to a task and to determine a student's "readiness"‖ to learn [2]. Ultimately, this can lead to enabling training systems to better diagnose student errors and improve learner engagement. Developing reliable methods to measure and classify learner engagement, as well as better understand its connection to learning has been a research focus within the computer-based tutoring community [3]. The methods for detecting engagement levels across individuals in real-time rely primarily on physiological sensors. A number of sensors have been empirically tested for detecting engagement levels, including: electrocardiogram (ECG) [4], galvanic-skin response (GSR) [6], and EEG. EEG is the prominent variable of interest for this research because commercial EEG systems have been used to track and model user attention in real time [5].

Metrics of Engagement

Metric	Instrument/ Sensor	Time of Collection	Description
Five-Factor Personality Model Dimensions	Neuroticism-Extraversion-Openness Personality Inventory (NEO-PI) Short Form	Opening Experimental Questionnaires	The Big Five Personality Test provides percentile scores on the Five-Factor Model (FFM) [8] dimensions of Openness, Conscientiousness, Extraversion, Agreeableness and Neuroticism. Research suggests these dimensions provide insight into how an individual governs their cognitive resources [9].
Pleasure-Arousal-Dominance Mood Dimensions	Self-Assessment Manikin (SAM)	Opening Experimental Questionnaires and Following Each Scenario Completion	Validated non-verbal graphical approach for evaluating Mehrabian's three dimensions of mood: pleasure, arousal and dominance [10]
Self-Report Engagement Scores	Independent Television Commission-Sense of Presence Inventory (ITC-SOPI) Engagement Index (14-items)	Following Each Scenario Completion	The engagement index assesses a subject's attention and involvement during task interaction [13]. This survey was selected because attention signals have been shown to be highly correlated with "presence", which is reasonably correlated with engagement in virtual environments [11, 12]
Electroencephalography (EEG)	Emotiv EPOC Neuroheadset 	Continuous Data Log from Experimental Start	The Emotiv EPOC Neuroheadset is a commercial-off-the-shelf EEG brain-computer interface, and is composed of 14 electrodes with locations following the American EEG Standard. This device provided rolling continuous measures of associated states, including: Short-Term Excitement (STE), Long-Term Excitement (LTE) and Engagement.

Results:

Engagement Item	Personality Dimension	Correlations
‘I paid more attention to displayed environment than I did my own thoughts’	FFM Openness FFM Agreeableness	r(16) = -.564, p = .023 r(16) = -.498, p = .049
‘I felt myself being drawn in’	FFM Agreeableness	r(16) = -.524, p = .037
‘I felt involved’	FFM Agreeableness	r(16) = -.527, p = .036
‘I feel I wasn’t just watching something’	FFM Agreeableness	r(16) = -.547, p = .028
‘I responded emotionally’	FFM Agreeableness	r(16) = -.546, p = .029
Average Score for All Items	FFM Agreeableness	r(16) = -.767, p = .001
‘I felt the characters were aware of me’	SAM Pleasure	r(16) = .516, p = .041
‘I feel I wasn’t just watching something’	SAM Dominance	r(16) = .596, p = .015

Table 1. Personality (based on FFM) and SAM correlations with reported Engagement scores for individual items within the **WDNI** Conversation Scenario

Engagement Item	Personality Dimension	Correlations
Average Score for All Items	FFM Agreeableness	r(16) = -.612, p = .012
Average Score for All Items	FFM Neuroticism	r(16) = .535, p = .033
‘The experience was intense’	SAM Pleasure	r(16) = .617, p = .011

Table 2. Personality (based on FFM) and SAM correlations with reported Engagement scores for individual items within the **IDNI** Conversation Scenario.

Engagement Item	Personality Dimension	Correlations
‘I felt involved’	FFM Agreeableness	r(16) = .499, p = .049
‘I paid more attention to displayed environment than I did my own thoughts’	FFM Agreeableness SAM Pleasure	r(16) = -.566, p = .022 r(16) = .621, p = .010
‘I felt that interacting with the character was difficult’	SAM Dominance	r(16) = -.512, p = .043

Table 3. Personality (based on FFM) and SAM correlations with reported Engagement scores for individual items within the **IDI** Conversation Scenario

Table 4. Emotiv Short-Term Excitement (STE), Long -erm Excitement (LTE), and Engagement correlations with reported Engagement scores for individual items within all Conversation Scenarios (WDNI, IDNI and IDI)

Engagement Item (WDNI, IDNI, IDI)	Emotiv Dimension	Correlation
‘I feel I wasn’t just watching something’ (WDNI)	STE LTE	r(16) = -.523, p = .019 r(16) = -.436, p = .046
‘I felt the character was aware of me’(WDNI)	STE LTE	r(16) = -.563, p = .012 r(16) = -.450, p = .040
‘I felt that interacting with the character was difficult’ (WDNI)	STE	r(16) = .485, p = .029
‘I responded emotionally’ (WDNI)	LTE	r(16) = -.428, p = .049
‘I was surprised by something the character did or said’ (WDNI)	Resting Engagement (RE)	r(16) = -.516, p = .020
‘I feel I wasn’t just watching something’ (IDNI)	RE	r(16) = -.455, p = .038
‘I lost track of time’ (IDNI)	RE	r(16) = -.542, p = .015
‘I paid more attention to displayed environment than I did my own thoughts’ (IDNI)	RE	r(16) = -.436, p = .046
‘I felt myself being drawn in’ (IDI)	STE LTE	r(16) = -.447, p = .041 r(16) = -.473, p = .032
‘I felt that interacting with the character was difficult’ (IDI)	Engagement	r(16) = -.457, p = .037
‘I lost track of time’ (IDI)	RE	r(16) = -.569, p = .011
‘I feel I wasn’t just watching something’ (IDI)	RE	r(16) = -.440, p = .044

Table 5. Regression Analysis examining the reliability of assessed personality, mood, and physiological measures and their influence on self-reported engagement.

Scenario	Regression Analysis Results
WDNI	***Self Reported Engagement* = 4.374 – 0.013 * *agreeableness* - 0.099 ****arousal* Adjusted R^2 = .66, F(2, 13) = 15.68, p< .001
WDNI	***STE* = 0.677 – 0.091 * *feeling that character was aware of you*** adjusted R^2 = .21, F(1, 14) = 5.08, p = .041
WDNI	***RE* = 0.702 – 0.057 * *surprised by character actions*** adjusted R^2 = .27, F(1, 14) = 6.49, p = .023
IDNI	***Self Reported Engagement* = 3.295 – 0.007****agreeableness*+0.010 ****neuroticism* *Adjusted* R^2 = .54, F(2, 13) = 9.89, p = .002
IDNI	***RE* = 0.722 – 0.063 * *lost track of time*** adjusted R^2 = .24, F(1, 14) = 5.82, p = .030
IDI	***Feeling of being involved* = 2.566 + 0.014 * *agreeableness*** adjusted R^2 = .20, F(1, 14) = 4.65, p = .049
IDI	***More attention to environment* = 4.598 - 0.020 * *agreeableness*** R^2 = .20, F(1, 14) = 6.59, p = .022
IDI	***RE* (IDI) = 0.714 – 0.065 * *lost track of time*** adjusted R^2 = .28, F(1, 14) = 6.69, p = .022

Conclusion:

The results of this study show personality factors (agreeableness, neuroticism) are predictors of general engagement and could easily be used to tailor instructional strategies where engagement was not predicted to be optimal. It was also evident that Emotiv provided significant near real-time measures of engagement and excitement where head movement (and thereby signal noise) is restricted. Emotiv would have significant limitations in predicting engagement (or other states) in any interactions where head movement was significant (e.g., natural interfaces like Xbox 360 Kinect).