THE AFFECTIVE TUTOR

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ABSTRACT

In this paper we present our initial work on an application, The Affective Tutor, envisioned to help instructors keep all students in a large lecture class engaged and actively learning material related to the course. We have found, by asking for feedback after every class, that in a large class of over 50 students, a significant number of students will feel the class went too slow and another group will feel the class went too fast. One of the most challenging aspects of teaching a large class is to keep the entire class engaged in the course material. The Affective Tutor helps instructors to determine in real-time how students feel about the pace of the class. The tool also helps instructors to pin-point confusing topics, and to tackle the problem of keeping students engaged by providing a monitored back-channel that allows the bored students to help the confused students get back on track and into an engaged mode.

INTRODUCTION

One common issue in a large class is the challenge of keeping track of the emotional and cognitive states of the students while lecturing. Evidence suggests that most instructors in large classes are unable to perform student modeling at a fine-grained level and are thus limited to performing approximate assessments on the psychological states of students [3]. Compounding the problem, students in large classes find it difficult to communicate their affective and cognitive states to their instructors for a number of reasons including cultural differences, language difficulties, the need for anonymity, the discomfort in speaking to a large audience and the lack of the opportunity to express their concerns. This presents a two-sided problem that impairs both classroom learning and teaching. One side is the inability of students to effectively and efficiently voice their emotional and cognitive feedback in real-time during lectures, and the other side is the lack of efficient and practical tools that would enable instructors to receive and utilize students' feedback to improve engagement, overall learning, and teaching.

RELATED WORK

Students' emotions can either interfere with or support learning. Darling-Hammond, L., et al. [4] recognize the importance of emotionally safe learning environments, and they emphasize the importance of helping students master five essential affective skills; being aware of one's emotions, managing those emotions, motivating oneself, empathizing, and relating with

others in a group. D'mello and Graesser address this problem with their Affective AutoTutor [3], which is a complex system designed to assess and incorporate students' cognitive and affective states into its pedagogical and motivational strategies using conversational dialogue. Although this tool introduces many interesting and innovative features to improve learning outcomes, its widespread adoption poses many challenging problems; apart from being complex and expensive for traditional large classes, the conversational dialogues may be tedious, long or irritating to students with minimal learning gains. According to Corbett, et al. [2], for Intelligent Tutoring Systems (ITS)[8] to seriously penetrate the educational system, the evaluation focus must shift to educational impact and away from artificial intelligence sufficiency.

Effective classroom assessment goes beyond affect and cognition states [5], it should be an ongoing feedback loop between the teaching and learning [1] which provides early feedback before students are examined for grades, so essential adjustments can be made. Siemens and Long [9], present a strong case that big data and analytics will be the most dramatic factors in shaping the future of learning and education. Even though we can still do with experience and 'gut instinct', research [6, 7] suggests that tutoring decisions based on data and evidence will greatly improve organizational output and productivity.

THE AFFECTIVE TUTOR DESIGN PRINCIPLES

From our analysis of students' feedback in large courses, we have learned of three broad categories of students' psychological states at any one time during lectures. In a typical lecture in an introductory computer science class, about 80-90% of the students are actively engaged and learning, 5-10% are bored and the other 5-10% are confused. The bored group is made of those students who momentarily happen to understand the materials being taught and find themselves ahead of the lecture pace; these students then tend to phase out of engaged learning or get bored.

Our goal is to develop a system to get the 10-20% of bored or confused students actively engaged in learning through both individual and collaborative classroom efforts. We developed a three-step plan to get all students engaged in learning.

(1). Detection: Allow or encourage students to report how they feel at any point throughout the lecture, if not engaged then report whether they are bored or confused. The application provides a simple graphical representation of how students are doing to the instructor, and perhaps audible cues when problems reach critical stages. This approach has two benefits, it encourages students to be aware of how they are doing in the lecture with the constant reminder that they ought to stay engaged for as long as possible, and it gives reliable feedback as opposed to technologically complex, expensive and otherwise invasive ways to detect or model students' cognitive and affective states.
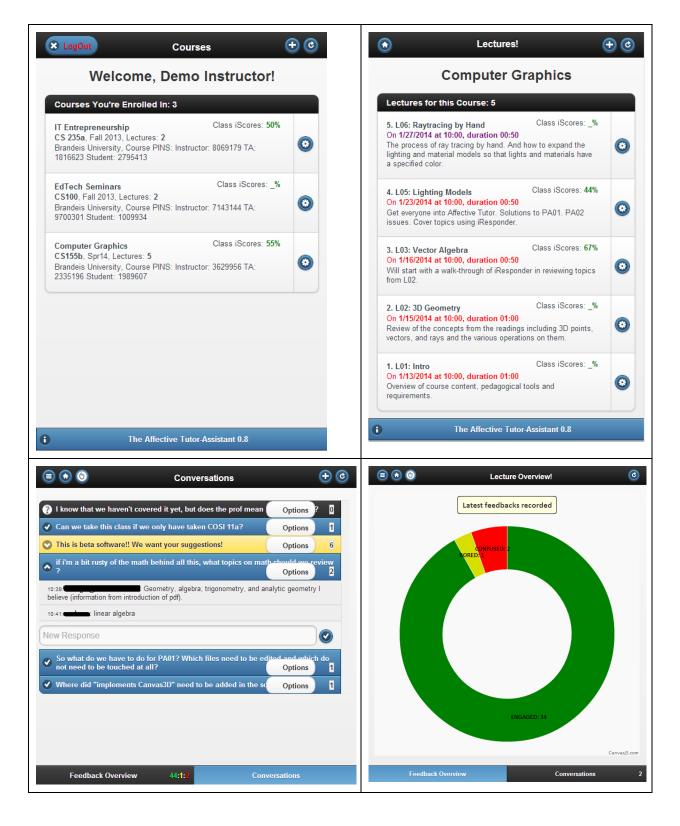
(2). Diagnosis: Provide (instant) quizzing and questioning features, which are simple and efficient for both instructors and students, to allow instructors to quickly assess students' understanding and to diagnose problems. When diagnosing students' understanding, the tool makes it clear to students that their responses are anonymous and ungraded so as to encourage them to participate and freely present how they are doing.

(3). Intervention: First, we facilitate an authorized backchannel where students (and Teaching Assistants -TAs) can collaborate in assisting each other behind the instructors' back in a safe supervised environment about class content. This approach allows students who are disengaged from the class because they already know the material or because they are confused to remain engaged by communicating with each other and the TAs about topics related to the class. While reporting being confused, students get the functionality to ask the class about their confusion after which they will automatically be sent back to the engaged mode so they don't get distracted longer and miss any on-going instructions. These students will then get notified by the application when someone responds to their questions. When a question is resolved the student can toggle that inquiry as being resolved and this action will stop further notifications from new responses. For supervision and control, students are anonymous to their peers (using pseudonyms) but not to the TAs or instructors. Furthermore, only confused students get the automatic access to post or view the conversations whereas by default engaged students don't have access to see or post new items, however then can request to only view the conversations. Instructors too can optionally access and engage with these conversations during class, but everyone can access and engage with these conversations before and after lectures.

USER INTERFACE FOR THE AFFECTIVE TUTOR

The first two figures on the next page show two screen shots from the Affective Tutor's current version. Not shown is the initial screen which asks users to sign up or login. Once a user logs in, he will see the screen on the left which allows him to create a course (if he is a teacher) or add/enroll in an existing course (for a student or TA). Technically, any user can create a new course or enroll in an existing one, the only difference is in enrolling where you'll need access to one of the three unique enrollment PINS for a particular course in order to be enrolled as instructor, TA or student. This page also lists all of the courses a user has created and/or enrolled. Selecting a course, brings them to the screen on the right with a list of lectures for that course. Instructors and TAs can add, modify and delete lectures (by specifying the name, date, time, and duration of the lecture), while students can only select and interact with lectures.

Once an active lecture has been selected, the students' standard view is a page with three buttons: I'm Engaged, I'm Bored, I'm Confused. When they press the I'm Bored or I'm Confused buttons, they also get access to the conversations pane where they can communicate with each other (and a TA who is also connected) about the course content, with the goal of either getting caught up or exploring the material in greater depth. Instructor and TAs also have

a view that shows how many students are engaged, bored, or confused which gives them an immediate sense of how well the students are following the material.

Courses

Welcome, Demo Instructor!

Courses You're Enrolled In: 3

IT Entrepreneurship
CS 235a, Fall 2013, Lectures: 2
Brandeis University, Course PINS: Instructor: 8069179 TA: 1816623 Student: 2795413
Class iScores: **50%**

EdTech Seminars
CS100, Fall 2013, Lectures: 2
Brandeis University, Course PINS: Instructor: 7143144 TA: 9700301 Student: 1009934
Class iScores: **_%**

Computer Graphics
CS155b, Spr14, Lectures: 5
Brandeis University, Course PINS: Instructor: 3629956 TA: 2335196 Student: 1989607
Class iScores: **55%**

The Affective Tutor-Assistant 0.8

Lectures!

Computer Graphics

Lectures for this Course: 5

5. L06: Raytracing by Hand
On 1/27/2014 at 10:00, duration 00:50
The process of ray tracing by hand. And how to expand the lighting and material models so that lights and materials have a specified color.
Class iScores: **_%**

4. L05: Lighting Models
On 1/23/2014 at 10:00, duration 00:50
Get everyone into Affective Tutor. Solutions to PA01. PA02 issues. Cover topics using iResponder.
Class iScores: **44%**

3. L03: Vector Algebra
On 1/16/2014 at 10:00, duration 00:50
Will start with a walk-through of iResponder in reviewing topics from L02.
Class iScores: **67%**

2. L02: 3D Geometry
On 1/15/2014 at 10:00, duration 01:00
Review of the concepts from the readings including 3D points, vectors, and rays and the various operations on them.
Class iScores: **_%**

1. L01: Intro
On 1/13/2014 at 10:00, duration 01:00
Overview of course content, pedagogical tools and requirements.
Class iScores: **_%**

The Affective Tutor-Assistant 0.8

Conversations

I know that we haven't covered it yet, but does the prof mean ? | Options | 0

Can we take this class if we only have taken COSI 11a? | Options | 1

This is beta software!! We want your suggestions! | Options | 6

if i'm a bit rusty of the math behind all this, what topics on math should we review? | Options | 2

10:39 Geometry, algebra, trigonometry, and analytic geometry I believe (information from introduction of pdf).

10:41 linear algebra

New Response

So what do we have to do for PA01? Which files need to be edited and which do not need to be touched at all? | Options | 1

Where did "implements Canvas3D" need to be added in the s | Options | 1

Feedback Overview   **44:1:2**   Conversations

Lecture Overview!

Latest feedbacks recorded

CONFUSED: 2
BORED: 1
ENGAGED: 34

CanvasJS.com

Feedback Overview   Conversations   2

iResponder which stands for intelligent responder is the feature which allows the instructor to create true/false, yes/no, multiple choice, or short-answer text or numeric questions and quizzes, which all students can respond to. When the instructor ends an instant quiz or question, all students and the instructor can see and analyze anonymous visual and textual summaries of the responses. This is similar to the Learning Catalytics or iClicker tools except that it is integrated into The Affective Tutor and is designed to be lightweight making it more efficient and seamless during lectures. (See next page for screenshots)

DISCUSSION

During fall 2013, The Affective Tutor was successfully tested in two classes of 55 and 17 students, in spring 2014 its improved version is being used in a 3D Graphics class of 40 students. Our work is preliminary but we have observed some interesting phenomenon: (1) The affective feedback is helpful in fine-tuning the pace of lectures in real time, (2) an instructor may need to have knowledgeable teaching assistants (TAs) monitoring the backchannel, (3) engaged students prefer reviewing the backchannel conversations even while staying engaged, (4) the level at which the tool is used or usable varies from class to class depending on the nature of class instruction and material being taught. In cases where everyone is engaged, for example, there is very little use of the application's main features. However it can still be used for other tasks like asking general questions, forming study or project teams, and commenting or rating on the lecture.

FUTURE WORK

At this point there are a few feature ideas from students and instructors that will be seamlessly integrated into the application to make it a complete classroom tool. Our plans include the integration of MathML capabilities allowing users to interact and converse using equations in various disciplines, implement and encourage collaborative note taking and sharing, use iResponder results to more accurately track students' understanding, test the tool in different classes to see which pedagogical style it is most suited for, explore its use in scheduled MOOC settings, explore automatic division of a very large class into smaller groups, and also explore its use in live webcasted lectures.

Of most importance to us is to run controlled studies in spring 2014 so we can further evaluate exactly to what extent the application is improving learning and teaching. We will also be in a better position to answer questions like whether students who use the tool feel that it's distracting, whether students feel more engaged with learning when this tool is being used (they may be confused by the teacher but be engaged in the backchannel), also whether students are less likely to go into social networking or play games when the tool is available.

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