Bears Breaking Boundaries

Information Technology for Society

ClassPace: an Ambient Classroom Response System

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Table of Contents

ClassPace: a Tangible Classroom Response System

Executive Summary

A number of studies show that deep understanding and lifelong learning are fostered when students actively engage in the learning process. These pedagogical goals can be difficult to achieve in large and anonymous lecture halls that limit faculty-to-student engagement. We argue that a classroom communication system should be redesigned to address the perspective of the student while benefiting both educators and students.

The *ClassPace* system aims to improve classroom interaction using three approaches: assessing student engagement or understanding, reflecting these factors to both students and instructor in lecture settings, and proactive fostering of student creativity and involvement in discussion and teamwork settings. The system will serve to further open the three lines of communication that exist within an educational setting: instructor-to-students, students-to-instructor, and students-to-students. Aggregate data gathered on student engagement (through explicit user input and implicit student behavior) can be used to analyze pedagogical patterns to improve instructor effectiveness. By visualizing student engagement and understanding, *ClassPace* will allow students to diagnose they're own progress and understanding. Additionally, instructors will be able to identify which topics require further time and attention.

ClassPace aims to proactively encourage student creativity and involvement by providing opportunity for researching the use of ambient light communication as an actor that responds to the students. We will explore how ambient lighting will enhance a setting that elicits creative behaviors.

1. Introduction

1) Motivation

Large classes can be dull and impersonal places where interactions between instructors and students are limited and detached[1]. These problems are minimized in smaller classrooms, where instructors are more easily able to engage and stimulate students. While smaller classes are almost always preferable to larger classes, large class sizes sometimes cannot be avoided due to facility and resource limitations, especially in undergraduate courses. In large classrooms, interactions that would usually increase engagement and promote creativity are often reduced. This classroom experience, for both the instructor and the students, can be improved.

2) Design Rationale

Educational researchers have developed a number of IT approaches to improving interactivity between students and instructors[2, 3]. Approaches such as these, called classroom response systems (CRS), are low cost, simple systems for achieving classroom interactivity for all students in large classroom environments. Several scholars argue that CRS allow students to gain greater comprehension and explore the subject material in more depth through student engagement[4, 5]. With existing CRS, instructors give regular quizzes to measure student comprehension, allowing students and instructors to correct misconceptions and to give more opportunity to review their understanding of the material. Both students and instructors report that these systems increase student participation and achievement[6]. Although many studies show the positive effect of CRS, students often feel frustrated by constant assessment and distracting technical problems[7].

3) Review of Commercial Products

There are many commercial CRS products on the market. The leading product is i>clicker system developed at the University of Illinois at Urbana-Champaign, now a commercial product (www.iclicker.com). Students register their unique ID in a central database and the receiver recognizes when each student sends an input value. This system has had extensive testing in science and engineering undergraduate classes. Other products with similar purposes are also available, including Trinity Remote, CPS Chalkboard, Activote, Keepad, H-ITT, Senteo. U.C. Berkeley has recently adopted the i>clicker system. Interviews with pioneering professors showed that enthusiasm for the potential of the system is high, if used correctly. Interviews with undergraduate students who attend science and engineering classes with a i-clicker device revealed that the current system is perceived instructor-centered. One student commented, “I am worried about losing the participation points in the case that my i>clicker doesn’t function well.” Another adds: “I am just being stressed that I am constantly tested by an instructor and GSIs”. From the student perspective, the i>clicker acted as another barrier between the student and instructor.

We argue that classroom response systems should be redesigned to address the needs of students. To students, devices like the i>clicker are often another barrier between them and their instructor. A classroom response system should be easily interpretable, non-intrusive, discreet, and mutually beneficial for teachers and students. We propose a system that uses ambient

lighting to increase engagement and creativity in a classroom. Light communicates information with little conscious thought; reactions to lighting are often instinctive.
For example, some students may find it difficult to engage with the material, instructor or even the other students in the class. They may also feel embarrassed to communicate these difficulties. We believe that when this feedback is retrieved and made available to both students and the instructor, students will become active learners and achievement will improve.

ClassPace is a classroom response system that attempts to increase student engagement and achievement in three areas. First, it will sense student engagement through direct input; future designs will move toward measuring implicit student engagement (body posture). Second, the data will be collected and used to track both student progress as well as instructor efficacy. Third, the data will be displayed to both students and the instructor in a *reflective* or *proactive* way.

2. Scenario

Emily, a freshman engineering student, enters her Chemistry 1A lecture at UC Berkeley and takes a seat among the other three hundred students. The professor begins lecturing onstage with a microphone. Students take notes and follow along with the lecture slides at the front of the room. Occasionally, the professor asks the class a question but does not expect a response.

Sometimes Emily gets lost during the lecture as a result of not being able to communicate in class and thinks to raise her hand and ask a question. Afraid of disrupting the class and possibly embarrassing herself with a “dumb” question she writes a note to herself to go back to the reading or ask a question during her discussion section. This happens several times throughout the lecture and Emily leaves class feeling stressed out about her upcoming mid-term exam. What Emily does not know is that many other students share her concerns.

In a scenario such as Emily’s, *ClassPace* could have helped Emily by reassuring her that she is not the only student who does not fully understand the material. With this knowledge, Emily would be able to ask questions and fully engage in the lecture without getting lost.

3. Scope

We propose *ClassPace*, a system that will provide a way for students to share and view non-verbal, non-textual feedback within the context of a classroom. Since this project will eventually include many different kinds of classrooms, we need to gather information about the effectiveness of our system as well as user-testing in many contexts. In the first iteration of the project, we will keep the scope small and concentrate on designing a system for one classroom, namely "E10: Engineering Design and Analysis" at UC Berkeley under the supervision of our advisor, Dr. Alice Agogino. Next, we will expand and modify the system, adding features to track and store data, adapting the system to be useful in other classroom contexts, and researching the system’s viability to be proactive by influencing student engagement.

4. Development Plan

1) Input Device

Students will relate their engagement to the *ClassPace* system using a discrete, intuitive input device. The input device is the way students will communicate and interact with each other and the instructor in the class room. This input translates a spectrum of input values ranging from not engaged to highly engaged.

The input device will satisfy identified design needs: it is familiar, connects well with the metaphor of pace, and returns to the middle (neutral position) after a user has inputted a value. We assume that during the normal operation of this system, a student might be motivated to input a value to show that he or she believes the class is going too fast. Furthermore, we postulate that if a student does not provide feedback, then the student is satisfied with the pace of the class (because he or she does not feel the need to provide additional feedback).

The initial design of the input was a joystick which students would "throttle" up or down depending on their opinion of the pace of the class. However, further iteration of the device focuses on the use of a pedal as the input of user opinion. The pedal provides a more discrete method of inputting class pace and continues with the metaphor of class pace. This input also has the additional benefit of being less distracting to the student who would now use only his or her feet for input instead of fiddling with a hand-operated device. The figure below shows a bi-directional pedal we plan to use for our initial design.

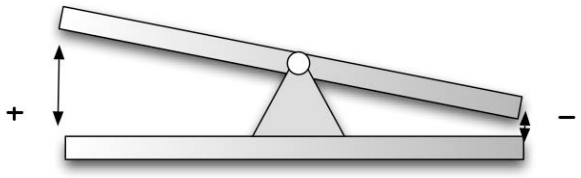

Figure 1. Bi-directional Pedal[8]

Instructors in small class settings often gauge student interest by observing factors such as body language. Ideally, the *ClassPace* system will be able to mimic such observations with sophisticated input sensors. With further research, we aim to find methods to measure such implicit factors.

2) Ambient Output Display

Data from *ClassPace* inputs will be transformed into a visualization using an Arduino micro-controller and the Arduino and Processing programming environments. The visualization of the system varies slightly in execution depending on a *reflective* or *proactive* modality: the *reflective*

system simply displays classroom engagement to the entire class; the *proactive* system looks to influence students to help promote creativity and participation in peer interactions.

Instead of using a display which provides and presents each individual user as an icon, the sensory input will be aggregated and communicated by lighting a wall (or other surface) with a color gradient. To communicate the overall class interest, the color gradient will shift depending on the input. The design change of moving to a color gradient is to situate the communication in a more familiar environment to the users (teachers and students) [9]: The goal for mapping colors to class pace opinion is to present the data to users using associations between the two. Further research will be conducted to determine which colors reflect overall class opinion. Research, such as Josef Alber's *Interaction of Color* details the way humans observe various colors.

Further, the design aims to account for the *cognitive* availability of the users[9]. A display featuring individually displayed icons requires users to personally process the data and form their own conclusions. By aggregating the data for the user and displaying in an unobtrusive manner using only colors, the system will remove the tax on user attention allowing the user to center their attention on the primary focus of class—learning or teaching. Because we can observe and respond to color without much conscious thought, ambient lighting provides a viable method of reflecting user input.

The color gradient display can also be used to test the *proactive* behavior of *ClassPace*. Again, color will be a primary driver in communicating with the users, but instead of being merely reflective of an aggregate opinion, it will attempt to foster creativity as an additional actor in the design space. Certain research claims that humans respond to specific colors with specific emotions[10], but more research must be done in this area. Individual variability of these reactions can occur and could be based upon psychological or physiological differences (with culture playing a dominant role). *ClassPace* provides a unique framework in order to conduct more research on possible mappings between lighting behavior and human response.

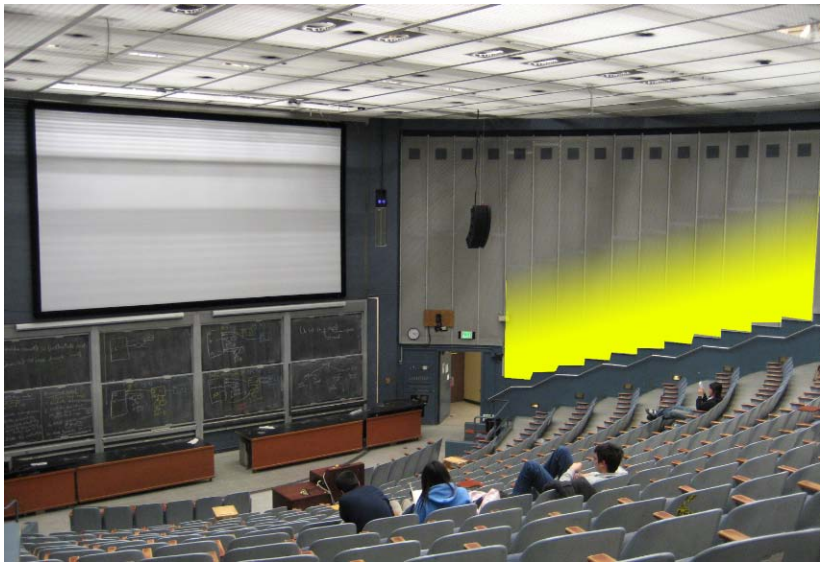

Figure 2. Ambient Display Mock-Up

3) Information Flow

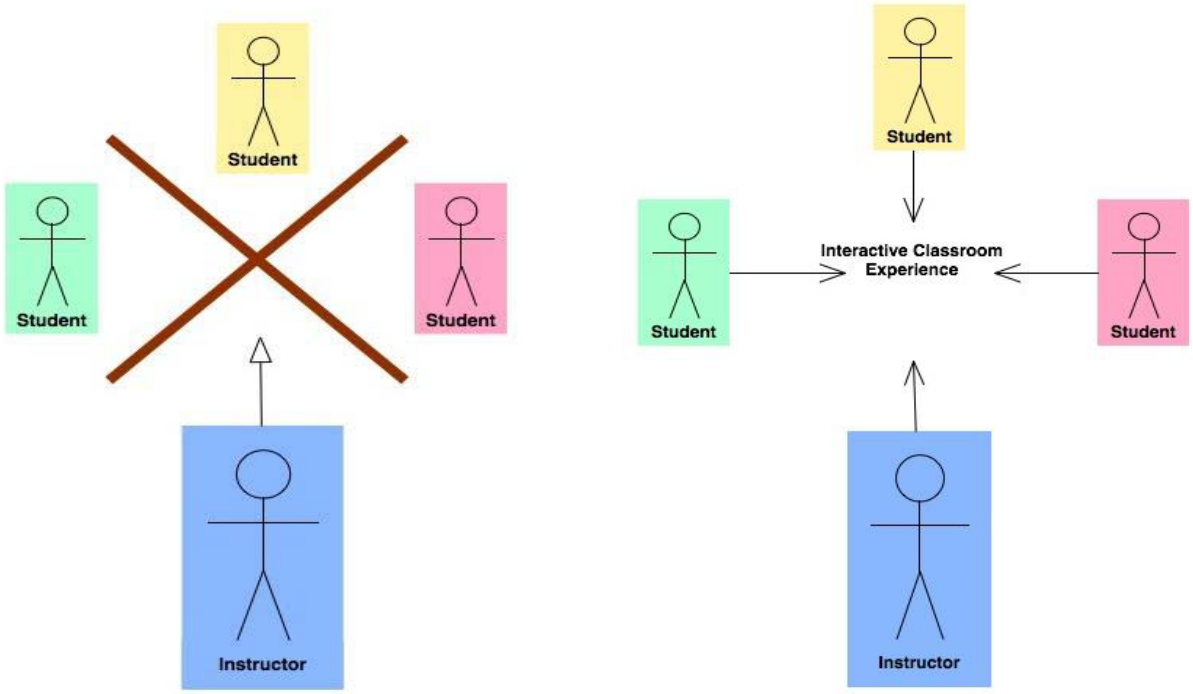

Figure 3. Disconnected Classroom and Interactive Classroom

Large classrooms often cause a feeling of disconnectedness in students. Students do not interact with each other, while the instructor delivers information to them. An ideal classroom creates an interactive experience where students engage with each other, the instructor and the material.

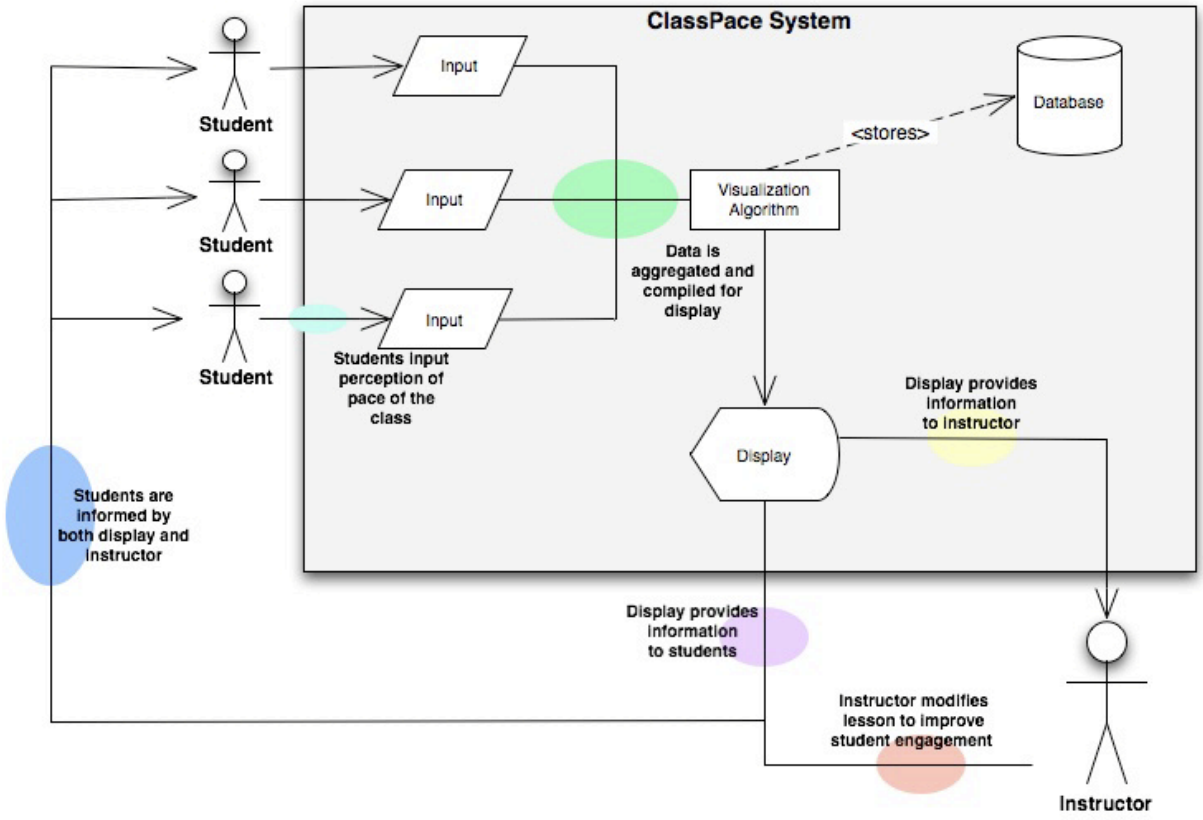

Figure 4. *ClassPace* System

Using this figure, we can recognize the processes and users involved in the *ClassPace* system. Students input their perception of the pace of the class using the input device. This information is aggregated and compiled for display. The data are logged in the database for future analysis, as well as sent to the display for classroom viewing. The display provides information the instructor about his or her lesson, and to the students about their classmate's perception of the class. As a result, the instructor is able to modify the lesson to improve student engagement and understanding. Students are then informed not only by the display, but also by the instructor.

5. Testing Plan

1) 1st Stage (Fall 2009)

We plan to conduct the testing with the first year engineering course, "E10: Engineering Design and Analysis" at the UC Berkeley College of Engineering during the Fall 2009 semester. We will collect survey data as well as conduct in-depth interviews with students, faculty, and educational technology researchers. We hope to achieve two goals. First, we would like to modify our initial design in response to the preliminary user feedback. We will test the various physical

aspects such as size, shape, material as well as user interface. Second, we are interested in exploring how to utilize and display data to provide instructors with the opportunity to redirect in-lesson to address student needs through the use of easily modifiable pedagogical patterns[12, 13]. For example, a response where half the class says the pace is too fast and the other half says it is too slow might indicate that a short peer learning exercise would be beneficial.

2) 2nd Stage (Spring 2010)

After modifying our initial design based on the feedback from the first stage, we will extend a testing from engineering to other subject areas including social sciences, business, etc. In addition, we will measure the effectiveness of the project with different classroom sizes.

6. Benefit

In summary, the *ClassPace* system aims to improve classroom interaction using 3 approaches:

- Assessing student engagement or understanding,
- Reflecting these factors to both students and instructor in lecture settings, and
- Proactive fostering of student creativity and involvement in discussion and teamwork settings.

The system will serve to further open the three lines of communication that exist within an educational setting: instructor-to-students, students-to-instructor, and students-to-students. Aggregate data gathered on student engagement (through explicit user input and implicit student behavior) can be used to analyze pedagogical patterns to improve instructor effectiveness. By visualizing student engagement and understanding, *ClassPace* will allow students to diagnose they're own progress and understanding. Additionally, instructors will be able to identify which topics require further time and attention.

ClassPace aims to proactively encourage student creativity and involvement by providing opportunity for researching the use of ambient light communication as an actor that responds to the students. We will explore how ambient lighting will enhance a setting that elicits creative behaviors. As with other ambient communication research, ethical issues exist. Given that the system attempts to use technology as an active driver in influencing human action, the question as to the appropriate uses of such modalities of the system must be examined.

Appendix

Required Information

Team Members:

Sohyeong Kim – is is currently a PhD student at Berkeley Institute of Design and Graduate School of Education. She graduated with M.S. from Stanford University and worked at Cisco Systems and Mercedes-Benz in the field of innovation management. Her research area is in Service Design and Engineering Education.

Nathan Gandomi - is currently a first year master's student at the UC Berkeley School of Information. He graduated with a B.A. in English from the University of Arizona in 2005 and worked as an English teacher as a part of Teach for America for two years in Oakland. His research is focused on the integration of IT and Education.

Nicholas Galano - is finishing his M.S. degree in Mechanical Engineering at the University of California, Berkeley where he also received his B.S. degree in the same field. Currently researching with Dr. Alice Agogino on the Smart Lighting project, he is investigating the applications of energy efficient lighting in mood lighting.

Contact Information:

Sohyeong Kim will be the main contact and can be reached by phone 510-717-0053, or email sohyeong@berkeley.edu.

Consent:

All team members consent to public, online dissemination of our white paper.

Funding:

Our team would distribute the money for the following expenses:

- Prototype development
- Possible compensation for user testing
- Possible scholarships for involved students in researcher capacities

Faculty Advisor:

Alice Agogino, PhD. - Professor of Mechanical Engineering, UC Berkeley

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