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ABSTRACT
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ACM Classification Keywords
H.5.m. Information Interfaces and Presentation (e.g. HCI): Miscellaneous

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INTRODUCTION

Large classes, wether they are MOOCs or traditional lectures, face many problems in providing high quality education to students. The sheer size of the class means that instructors have little ability to focus on any particular student's development. Students can easily become "out of synch" with the main flow of the class either understanding the material too quickly and becoming bored or simply being unable to keep up with the pace. Additionally students can become socially isolated, unable to form a connection with anyone related to the class who might work with them.

These problems manifest in a variety of ways. For example the inability to select problems that are appropriate for the student. For practical reasons many classes are forced to adopt a one size fits all philosophy for homeworks and reviews, since doing anything else would be to difficult. This means students might miss out both in terms of more difficult problems that pushing their knowledge forward as well as questions the ensure they don't have gaps in their knowledge.

Additionally this single homework/review setup means students can easily become isolated and disengaged with the learning pace of the class. And once they aren't in synch it becomes difficult to get back on track. Since If the class is moving too fast or too slow the the student they will need access to tailored resources that can either keep them occupied or help them catch up with the bulk of the students. But the course can only provide a fixed set of material that wont adapt to the student's needs.

??? Need more about the Social aspect ???

Providing timely feedback can also be an issue. Students may have questions about answers or concepts and if they are not provided at the correct time the student may forget or simply lose interest. Answering questions as they arise, and giving students a tight feedback learning loop, can greatly enhance the quality of a class.

We propose a general framework "Computer Directed Peer Tutoring", exemplified by a tool we are building the "Calculus Co-Tutor", whose goal is to alleviate or reverse several these traditional disadvantages of large classes. We propose to do this by taking advantage of several theories in learning, most notably the Teacher's Dilemma and Space Repetition, to create a framework where we will utilize computer support and peer tutoring techniques to correct these problems.

The main goal of the framework is to leverage the traditional disadvantage of a large number of students and instead turn it into an advantage. In particular we use a software environment to ensure that students are communicating in a reasonable way, in particular asking each other valid questions with correct answers. And the Teachers Dilemma provides a theory for ensuring that students not only ask each other valid question but also valuable questions in terms of ensuring the students knowledge. Then Space Repetition provides a method for ensuring the students are retaining the information beyond the initial interaction or when they need to review material.

Finally since students are being paired up and asking each other questions we can work on developing a social interaction between them. Making sure that students who can help each other are consistently paired up and a reoccurring dialog is developed.

With all these elements in place we can turn the issues associated with having a large number of students around. Each student is now a teacher in training who can assist the professor in teacher other students. The software environment ensures that they are asking each other pertinent questions. And spaced repetition ensures that the students retain the knowledge over time.

THEORETICAL FOUNDATION

Great deal of work showing students learn better when instruction is tailored to them

* Large effects have been shown with 1-1 tutoring Learning for mastery Benjamin Bloom 2 sigma * Zone of Proximal Development Vygotskys "Zone of Proximal Development" * Csikszentmihalyi suggests that when the difficulty level of a challenge matches the level of a learners skill, a positive flow experience can result. Mismatches, on the other hand, result either in boredom (given easy challenges and high skills) or in anxiety (given hard challenges and low skills) * item response theory? * Teacher's Dilemma Ari Bader Natal * Space Repetition 1973 Sebastian Leitner * Gamification * ??? Do we talk about Gee's work ??? * New concept of pairing up students as best teacher ??? Co-evolution ??? ??? Are there any theories about Learning by Teaching we can use ???

GENERAL APPROACH

The core of the system is a basic Questions Response loop; students are asked questions relevant to the domain of the class and they attempt to respond with the correct answer. This basic setup is used to facilitate student learning in several different ways.

Pushing the student's leaning forward

One of the great difficulties in any teaching environment is what to ask the student work on next. Large class sizes force teachers into one size fits all mass homework solutions. These can be alleviated somewhat by having additional practice sets

One of the most novel ones we present is the Co-Tutoring path based on the Teacher's Dilemma. Students are paired up and each is asked to create questions for each other. These problems are built using a construction toolkit that ensures the questions are valid (i.e. they are sensible in the domain and have an answer). The students then answer the questions that

Ensuring the student retains the information

Building up meta information about the problems and student learning

Students get points based on

The system is based around a basic Question Response

Our approached is based around picking questions that are

Our approached is based on a co-tutoring method where students design problems for each other. The framework ensures that these problems are valid and

the software and theoretical framework ensure student interactions are appropriate and productive.

EXEMPLAR APPLICATION

In order to test the framework we are building a exemplar application in the domain of Calculus, specifically differentiation.

The application has several capabilities - The ability to create and store a single variable equation - Symbolic differentiation of the equation - Simple symbolic equivalence test backed up by a numerical

We plan on using these capabilities to develop a system that allows students to build quizzes for each other. Either synchronously in a back and forth game

EVALUATION METHOD

Small Groups first

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ACKNOWLEDGMENTS

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