Team Members

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All team members contributed to brainstorming, writing, sketching, and editing.

Problem and Solution Overview

Our research identified that many students face difficulties asking questions aloud in class, and get varying value out of sections as a result. Furthermore, we found students consistently attempt to study areas they identify as difficult or important, but are inconsistent in keeping track of those areas over the course of a class term. Our solution aims to alleviate both of these problems by providing a low-distraction interface for taking in-class notes, and using that data to increase instructor-student communication and student self-evaluation. Students can write notes and questions directly on slides, as well as quickly note if a slide is difficult or important. Similar questions will be aggregated, and frequent questions will be displayed live to the teacher to receive immediate feedback, without requiring shy students to ask questions aloud. These questions, notes, and ratings can then be referenced and sorted later, so students can effectively judge their understanding of topics and choose essential areas to study.

Design Research Goals, Stakeholders, Participants

The people we expect to use our product are undergraduate college students. Undergraduates have typically begun to establish clear educational goals and are determined to perform well in their classes as they prepare to get into a major or

graduate program. They are personally invested in looking for ways to improve their ability to study, and we want to help them achieve their potential.

At the same time, undergraduate TAs and professors want to help motivated students learn, retain, and demonstrate the new knowledge gained throughout attending a course of study. They are interested in effective ways of communicating their hard-won knowledge to students in ways that are meaningful, effective, and will leave students passionate to learn more.

Our first choice for participants were TAs and students in the Math and Physics department. These are areas that many students identify as being difficult classes. We began emailing TA faculty of those departments, but after two days, we were unable to locate any of them willing to participate in our study. That was the reason for us to reach out to CSE TAs who we had more access to. Since, many members of our team study in CSE department, we were careful that none of us who participated in the CI personally knew the TA involved.

The group context of classroom lectures made CI more difficult for our design. We could certainly go to the classroom and observe, but it is not feasible to talk to the TA or students about the work during class without being overly disruptive. The classroom setting prevents asking questions while in the context of lecture, which limits the partnership and ability to “withdraw and return.” Instead, we performed CI during the TA lesson planning, fly-on-the-wall observation as recognized outsiders during lecture, and then brief follow-up interviews after the lesson where we could ask questions about unexpected events. Additionally, we interviewed a few students, and performed CI with some students who identified as planning their study time.

For our first participant, we worked with a senior in CSE, who currently works as a TA for non - majors CSE class. We referred to that TA as Alfred. Every week Alfred teaches a one-hour reading section and is available to students for two hours of open office hours. We conducted a CI with him during lecture planning, prior to his section presentation. To avoid disrupting lecture, two of our group members attended Alfred’s section as fly-on-the-wall recognized observers. The observers’ focus was on student/TA interactions, with little focus on the lecture content. After lecture, we asked Alfred a couple of brief follow-up questions.

For the rest of our participants, we worked with five undergraduate CSE students. With each of those students we conducted an interview focused on class communication, class effectiveness, and study habits. For communication, we discussed how the

students handled areas in sections that were confusing, specifically how they communicated their difficulty to the TAs. We then followed up by asking how well the TA seemed to acknowledge whether they were confused, and whether there was any change in the lesson as a result. We then asked how effective they found sections to be in general to increasing their understanding of topics. Finally, we reviewed student study habits, both in what detail they tracked areas for later study, how they used any such tracked data for studying, and any other methods they used to study.

Design Research Results and Themes

During our design research, we talked with both TAs and students, as we were looking for ways to increase communication in the classroom while reducing the burden on both students and TAs. From our research we uncovered a potential problem during section planning and presentation. There is currently little means for a TA to measure student comprehension of topics, other than gut feeling. Additionally, measuring comprehension during lecture is difficult, and so lessons are driven by innate ability to judge body language and the questions from the few students who ask questions aloud, rather than taught in a repeatable manner. In-class surveys help, but often have very limited negative feedback about problem areas, especially when a survey includes names and/or is graded. The time to take surveys also impacts available lecture/practice time.

This general disconnect in information was a high level theme we noticed from both TAs and students. TA’s don’t have a good platform for knowing exactly what students currently need help with, what they could use more review on, and what they understand well enough so that class time could be better spent elsewhere. For a more experienced lecturer who has been leading the same course for a number of years, intuitively getting a sense of student understanding and past experience is reasonable. However, a TA with little experience in a course they may have only recently taken may find it difficult to quickly gauge understanding.

Additionally, relying on students to ask questions aloud is unlikely to be an effective means of instructor-student communication, as we found that there is a significant portion of students who do not ask questions aloud, even when they do not understand a topic. The exact reason for not asking questions somewhat varied. For instance, some students struggled with general shyness or fear everyone else already understood the topic. No matter the reason, students who did not ask questions in section generally reported getting less value from attending sections.

Furthermore, from our research, we believe that many students may not be taking an effective and efficient approach to studying. The majority of students we talked with reported that in preparation for tests they studied any areas where they had previously recorded struggling. However, many students did not keep careful track of those areas, and so ended up studying everything. The general review shotgun approach that students appear to be taking, where they just review all information from lecture slides, without targeting the specific parts of a course that were difficult, takes an unnecessarily long time, and we believe that a more data driven approach could provide a better way.

Answers to Task Analysis Questions

1. Who is going to use the design?

The primary focus of our design is on undergraduate college students, although a small part of the design affects instructors. Our focus has been specifically on students and TAs in undergraduate STEM classes at the University of Washington, but as our design focus has narrowed, some special features have been removed, causing the potential user base to increase. Since we are designing for classroom communication, our design is inherently multi-user, and includes some display for instructors, although most of the direct interaction is done by students.

2. What tasks do they now perform?

Currently, students attend lectures, some of whom ask questions aloud in-class, while others communicate by giving the instructor bored or confused looks. Outside of class, students primarily review or study for quizzes or tests through an unfocused, linear approach where they read through all slides and notes, reviewing information in the order presented, rather than focusing on the specific gaps in their understanding. A few students track areas of difficulty, but do so through personal notes, which is inconsistent, private, and unsearchable.

3. What tasks are desired?

Our goal is to improve communication between students and their teachers, as well as providing a means of guidance to aid students in efficiently studying. The tasks desired are to:

- Allow students to ask questions anonymously during a class, and communicate common questions to the instructor.

- Allow students to track areas where they struggle or have questions for later review.

4. How are the tasks learned?

Tasks are learned through using the design. There will likely need to be some type of splash screen that points out a few key points for interaction, but generally the design should be simple enough that students find it reasonably familiar. Students write directly on slides to ask questions and take notes, which should feel natural. The rating menu uses the convention of stars to guide users. The topic review menu can be used as-is or reordered using the convention of clickable headers.

5. Where are the tasks performed?

The tasks are performed by the students while they are in class and when they are studying for the class as a whole outside of a classroom.

6. What is the relationship between the person and data?

Student's create the data, by taking notes and rating topics in class. They can then review their own data at any time, either in the original format, ordered by class presentation, or in a topic-review format where they can reorder to fit their desired use. Additionally, an aggregate student questions may be displayed to the instructor.

7. What other tools does the person have?

Currently, students can use pen-and-paper-notes to keep track of the areas in which they struggled in class. In order to ask questions, they can either raise their hand in class and ask them aloud in front of the entire class or write them down and ask them to the TA in office hours later.

8. How do people communicate with each other?

Currently, students and instructors primarily communicate with each other in class and office hours. Some classes include other methods of communication such as canvas/message boards and email.

9. How often are the tasks performed?

For classroom communication, generally section is 1 or two days a week, although if used for general lectures for all classes, the tasks might be performed for 1-3 hours per weekday. For study review, students study for major tests anywhere from 1-4 times a quarter, and may study for quizzes as often as twice that much.

10. What are the time constraints on the tasks?

The largest time constraint we face is class time. Class time is valuable, and spending a lot of time in class breezing through topics that students may be too shy to ask questions about or answering questions from the same people over and over again is not efficiently utilizing that time. Additionally, if we make tracking too difficult for either the students or the instructors, it is unlikely that they will be willing to try a new solution. Study planning is constrained because of the tradeoff between time spent planning studies and time actually spent studying.

11. What happens when things go wrong?

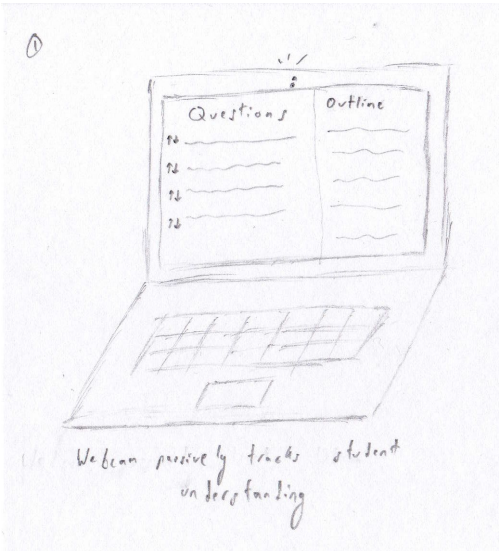
From our interviews with students, we found that when TA's don't fully understand what students understand they can end up wasting both their own time teaching unnecessary information, and student time in section. Students then study general information, and often devote little time to the areas they are really lacking. Ultimately when students and TA's can't clearly share understanding, learning suffers.

Proposed Design Sketches - "3 x 4"

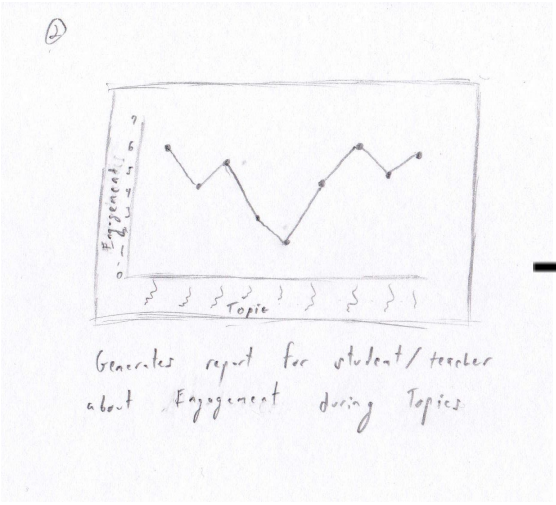
Design 1: Passive Student Tracking In-Class

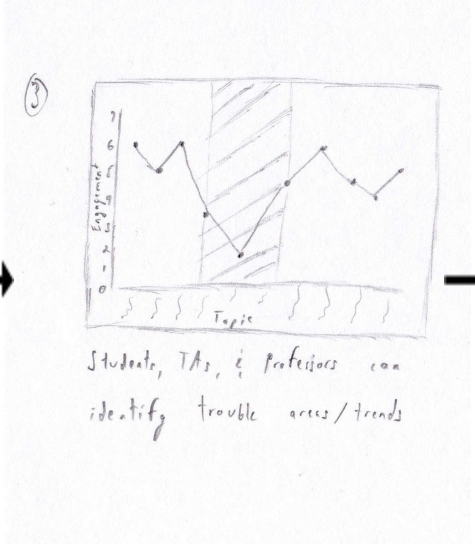
The purpose of this design is to unobtrusively gather the engagement level of student during a section, in order to identify potential patterns in class that are worth reviewing for both the student and the TA/Lecturer. This is done by monitoring students via a camera in the room and/or computer and using that data to gauge their engagement/attentiveness. The data is then presented to both the student and instructor in order to drive potential changes in studying, lesson planning, and overall curriculum. This design focused on tracking student understanding, data-driven study planning, data-driven lesson planning, and data-driven curriculum planning.

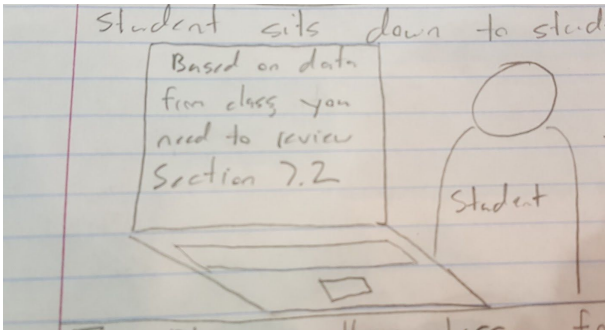
Data Collection



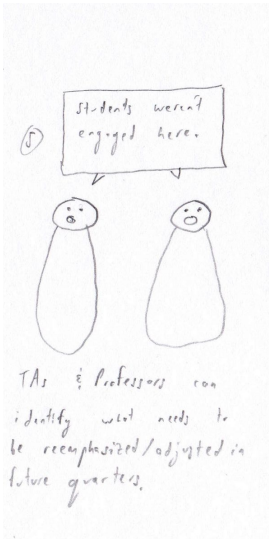
Data Analysis







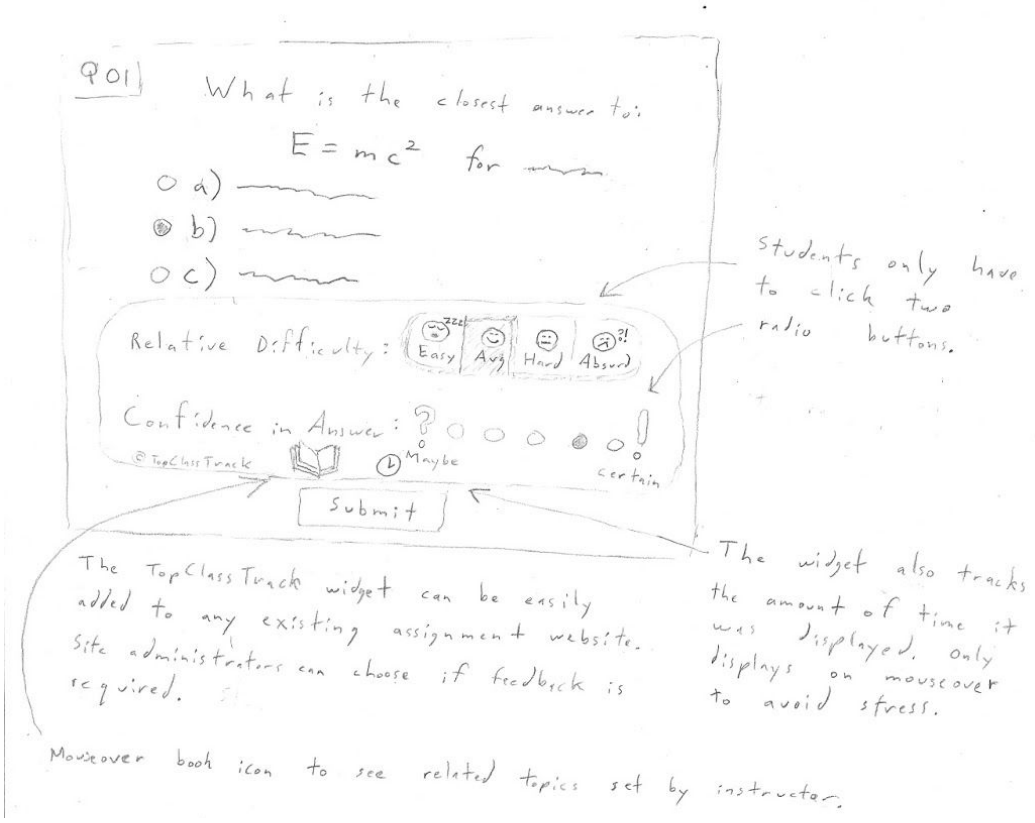
Data Driven Action



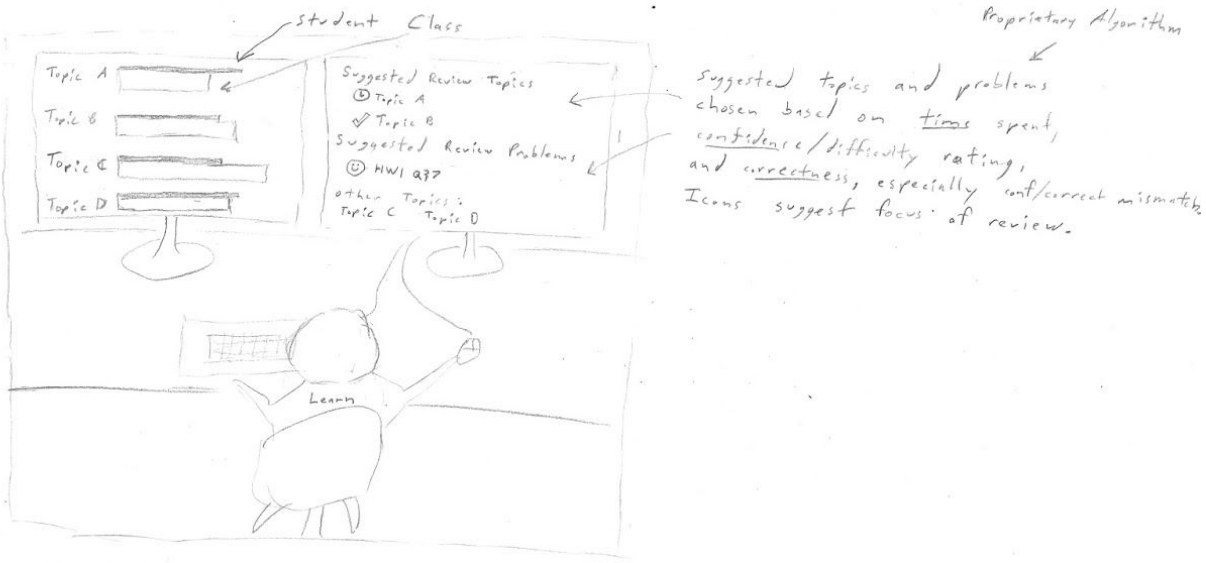
Design 2: Monitor Student Performance on Practice Questions Outside of Class

The goal of this design is to add a data tracking component on top of web-based homework platforms currently used in STEM classes at the University of Washington (WebAssign, ALEKS, etc.). Essentially, this would be some kind of widget that could be added to any site, that would track things like problem type, how long the student took to complete the problem, the number of tries they used, and after the student finished the problem it would give them a two question survey asking them the relative difficulty of that problem, and their confidence in solving it. The widget could also include additional information, such as links to relevant class material, to provide assistance if the student struggled with a problem or was interested in related topics. Once the data accumulates, there would be relevant interfaces to expose it and associated trends, to students, TA's, and Professors.The extra data allows instructors to see areas where there was a discrepancy between scores and student confidence/difficulty rating, providing a significantly more nuanced measure of lesson effectiveness. This design focused on community-driven questions, data-driven study planning, data-driven lesson planning, and data-driven curriculum planning.

Gathering the Data:

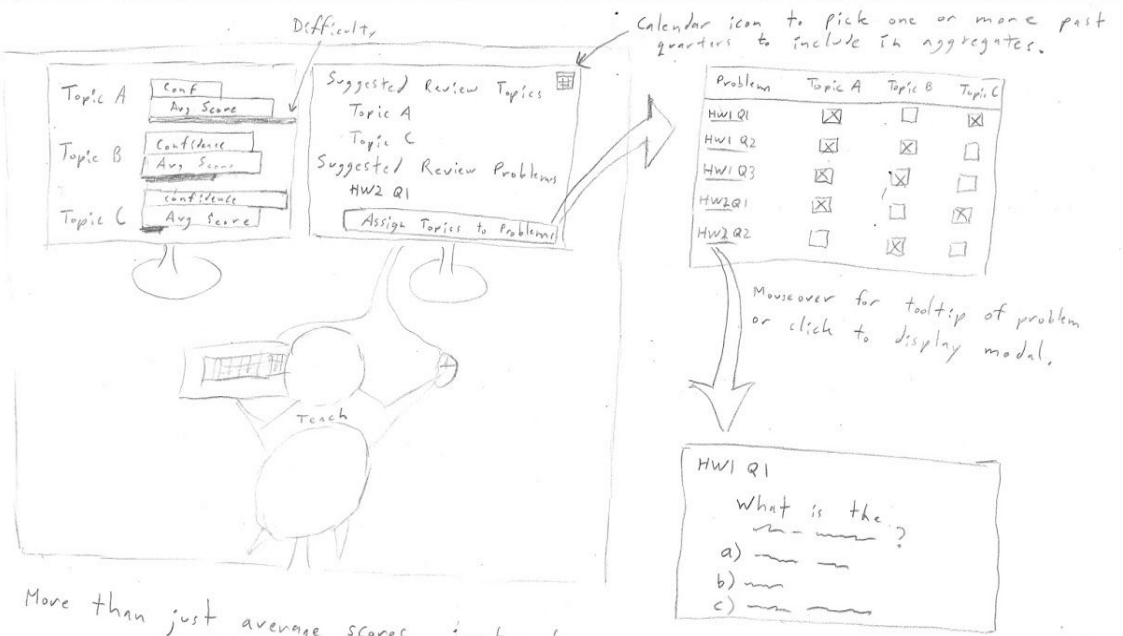


Student Interface



Students can see areas where they struggled and where the entire class struggled.

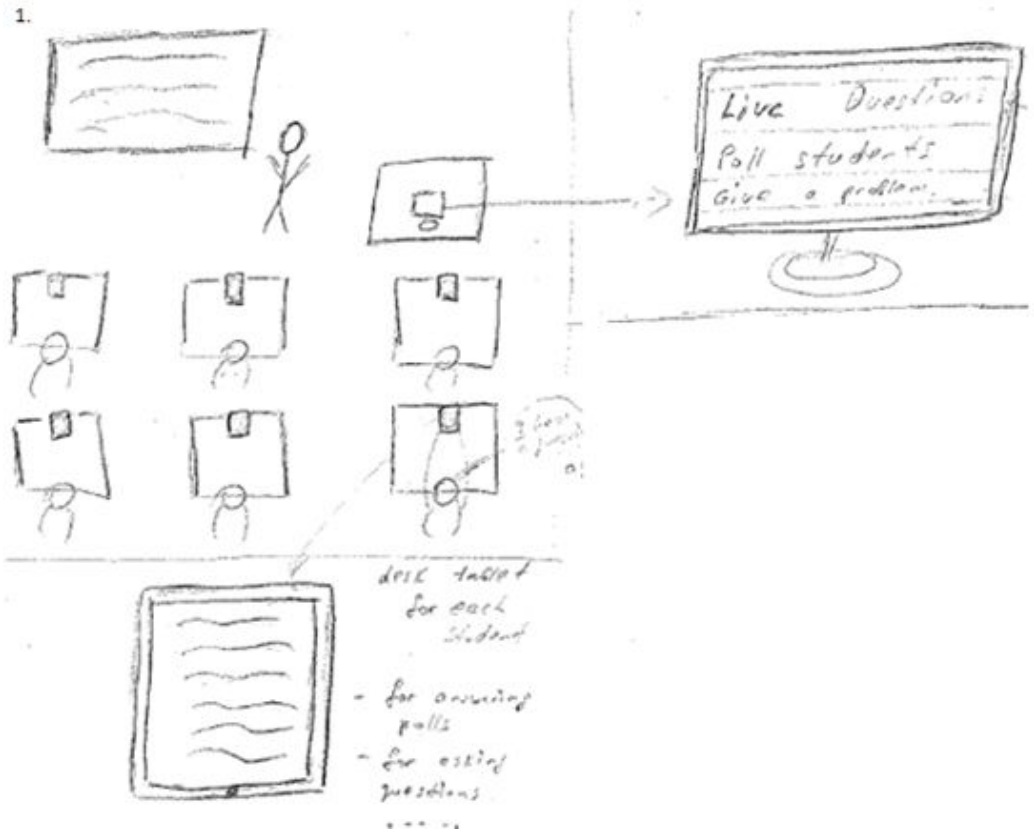
Teacher Interface

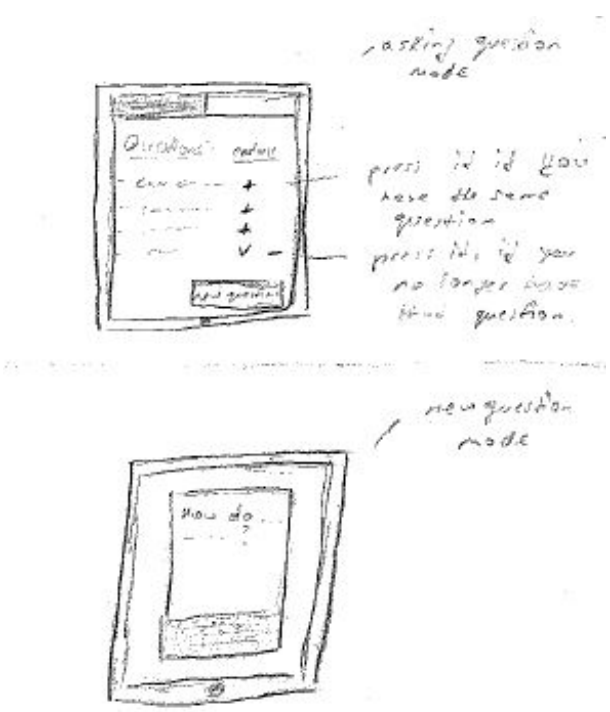


More than just average scores, instructors can now view student confidence and relative difficulty. They can now focus on reconciling areas where there is a mismatch between confidence/difficulty and score.

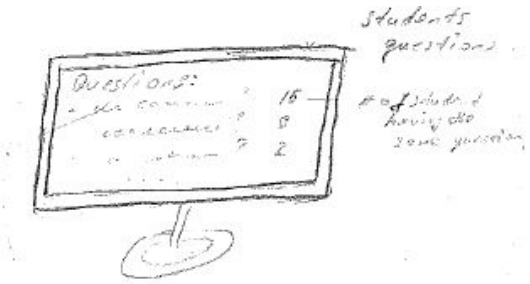
Design 3: Community Driven Questions

A goal of this design is to improve judging students understanding by teachers and TAs during a class, give students ability to ask questions anonymously, as well as enable data – driven study planning for students and data – driven curriculum and class planning for teachers. This will be done by supplying each student desk with a tablet connected to the teacher's' computer. A teacher will be able to use this system to do polls to ask student their understanding during a class, to see student's questions or to give students a problem to solve. This design focused on community-driven questions, data-driven study planning, data-driven lesson planning, and data-driven curriculum planning.

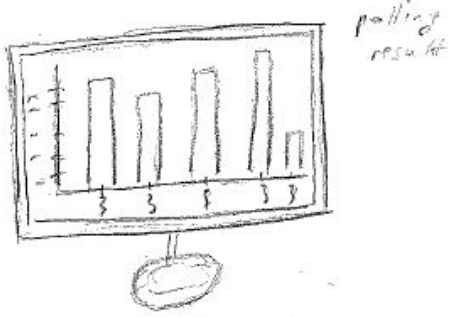


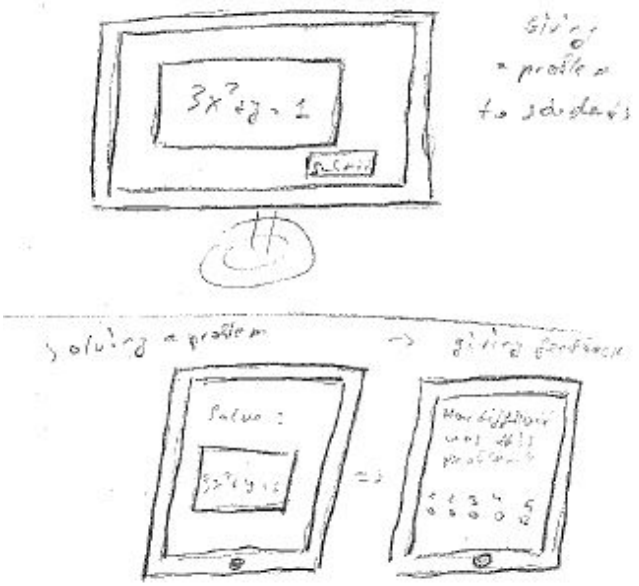


Students can see everyone's questions and can indicate that they have the same question by pressing “+”. By pressing “-” students would indicate that they aren’t interested in that question anymore or it was already answered. They can also create a new question.



A teacher can see all the questions from students and number of students that have the same question. He can poll students during a class and immediately see results with statistics in charts.

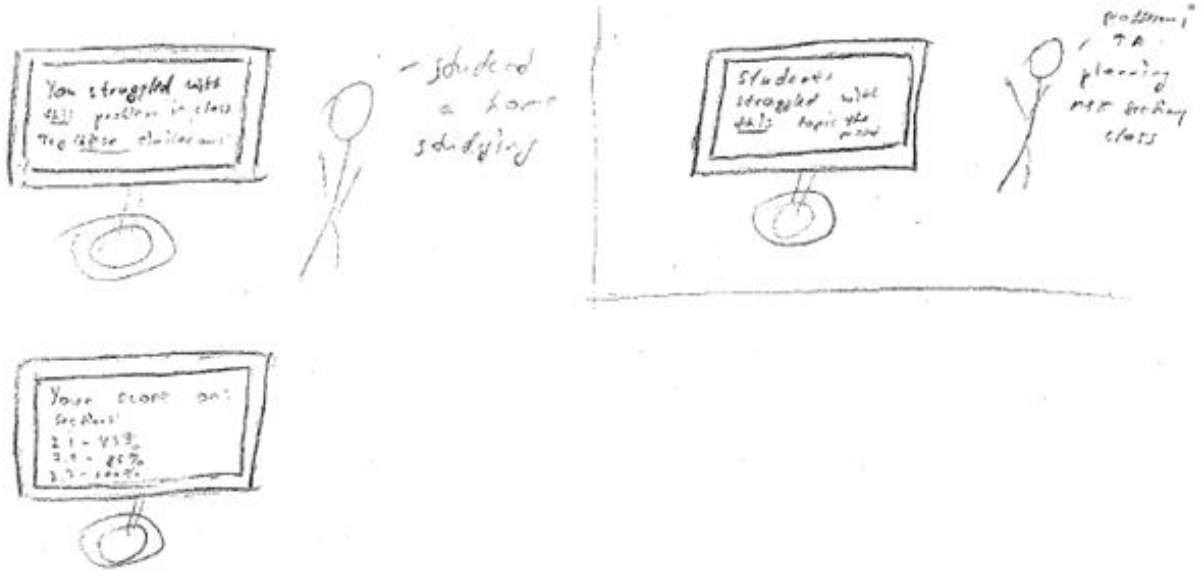




A teacher can ask students to solve problems and ask for their feedback.

Students can answer immediately using tablets.

All the questions, problems and results will be available to students and teachers after a class.



Why we chose our design and tasks to further pursue:

The two tasks that we decided to focus on were community-driven questions and data-driven study planning. Our initial thought was to design a solution that would equally benefit both instructors and students. Instructors would use our product to help with track how well their students understand the material so they could plan a more beneficial section. Students would use our product to ask more useful questions in class and make better use of study time outside of class. After presenting the task analysis and 3x4 sketches during our critique, we received feedback that our topic was a bit too broad and that we should pick one group to focus on between students and instructors. After some thought, we decided that the best way to gather any useful data is by focusing on student activities, which is how we came down to these final two tasks. We also noted that even though our new design would be tailored to students, it does not mean that instructors would not benefit from it as well. With these tasks in mind, we found that design three showed the greatest potential, so we took that design and iterated over it to come up with what we have now.

Written Scenarios - “1 x 2”

1. ### Community-Driven Questions

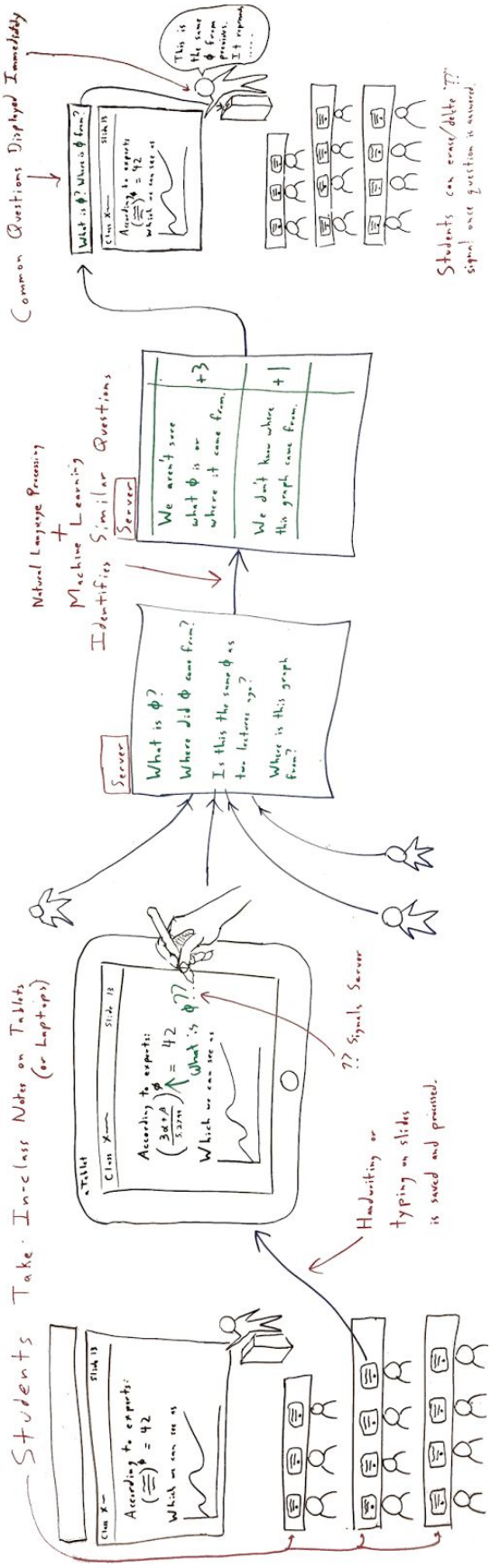
   Bobby is a student in an introductory level Math course. During section, the TA is going over a particularly challenging topic and Bobby gets lost. In the first scene of Storyboard 1, Bobby looks around the class to see if anyone else is in the same predicament, but all the other students seem to be following along. Since Bobby is shy and does not want to draw attention to his lack of understanding, he opts to use the in-class question-asking feature of his note taking app and writes the question directly on the slide as can be seen in the second scene. Bobby asks his question and then it pops up on the display, showing that the server in scenes three and four of Storyboard 1 identified his question as being similar to questions by other students. The final scene of Storyboard 1 shows Bobby’s question displayed to the TA, showing that Bobby was not the only student struggling and giving the TA a clear indicator to explain again.

2. ### Data-Driven Study Planning

   Frank is a student in an intermediate level Physics course. Seeing as how he is a busy student with only a limited amount of time to study, he wants to get the most out of his time. He finds going over all of the lecture slides to be overwhelming and unhelpful. Not only is there too much material to cover in his allotted time, but Frank can’t remember every topic that he found easy, and not worth studying, and every one he found was difficult and worth spending extra time on. Fortunately, as can be seen in scenes two and three of Storyboard 2, Frank’s note taking application allowed him to mark areas that were difficult and kept track of any questions he asked during the lecture. Frank is able to easily access this information via a dashboard, visible in scene four of Storyboard 2, quickly guiding his reflection on which aspects of the material were difficult or confusing. He then uses this reflection to allocate his study time and get the most benefit. Finally, he can use links from the dashboard in scene four to jump directly to the relevant slides, as visible in the transition to scene five, reducing the time needed to actually study.

Storyboards of the Selected Design

Storyboard 1



Storyboard 2