

# Quandary Process

## Proposal

We would like to address the needs of students who are not utilizing design thinking in their high school curriculum. Students are unprepared for college because of an inability to think critically. High school tends to focus on fact-based knowledge and regurgitation of material. "89 percent of high school teachers believe that their students are "well" or "very well" prepared for freshman-level college work. By contrast, only 26 percent of college faculty members think students are ready." There is also a lack of collaborative work in high school, which affects student performance in the classroom and later in life. Collaborative learning translates into the workplace as well; current jobs require much more creativity and collaboration and students are unprepared to enter this type of work space.

<http://www.cbsnews.com/news/is-your-a-student-really-ready-for-college/serc.carleton.edu/introgeo/cooperative/whyuse.html>

## Learner Profile

We are targeting an audience composed of high school students from the United States. We expect they had have minimal experience with collaborative work in school, and are not used to thinking critically. We also expect they will not be used to ideation, which will probably be the most challenging aspect of the process for them. It is important for our audience to be up to date with current technology and have a relatively wide breadth of knowledge. "They need to be 'literate' in as many subjects as possible, as they begin to understand that the most complex problems are often best solved through an interdisciplinary approach." Design thinking will allow for these students to have an easier time transitioning into college, which requires students to think more critically and work in groups.

## Original Concept

Our original concept was less focused; we tried to address too many problems with one product. We ended up abandoning this concept, but a lot of our learning goals were incorporated into our final design. We addressed the problem of exposing students to design thinking. We chose to define design thinking as critical thinking, problem solving, and systems thinking. In essence, we wanted to expose high school students to large problems that they would solve through the design process, meaning a constant cycle of iteration and critique. We chose to focus on humanitarian design projects, providing motivation for students. We also wanted students to work in groups with peers they don't know. As an example, three students would be paired up through our online platform and presented project topics from which they would choose one. (ie the issue of low voter turnout). The students would work on their own, as well as collaboratively to address this problem. Their work would constantly be updated online, to keep other groups informed on the status of their project. Other members of the organization would be able to provide critiques to push the group forward. Advanced users would be given some sort of status to make group members aware they received a critique from an advanced member. In essence, our system allows a small group of students to work in collaboration, with the option of benefiting from outside information through critiques.

### Here is a list of things we would like to provide students through our program:

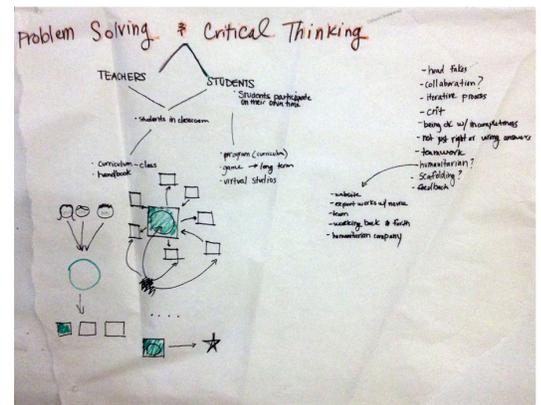
- Head fakes ("tricking" them into learning new things without being aware)
- Collaboration
- Iterative process
- Critique
- Acceptance of incomplete work
- Understanding there are more than right or wrong answers
- Humanitarian design
- Scaffolding
- Feedback

## Critical Thinking

Reasons why we believe high school students are unable to achieve the critical thinking skills needed in a college environment:

### It is difficult to teach critical thinking because it is almost impossible to assess.

We believe this difficulty is the main reason many schools fail to teach students strong



critical thinking skills. According to Burgess, "Teaching critical and creative thought is challenging: First, critical thinking may mean different things to different instructors, principals, and/or districts. Second, it can be hard to know what students are taking away from lessons and curricula designed to cultivate critical thinking skills." Even though critical thinking seems vague and difficult to teach and assess, Burgess also mentions several methods to potentially test a student's ability to think critically: "One way may be to scaffold questions that increase in complexity and demand, which may allow students the opportunity to reiterate, to explain, and then to synthesize information they've gathered."

We chose to focus on this strategy in our solution. Students who have moved on to "higher levels" in our program will take part in an iterative process in which they are constantly stepping back, seeing what they have done, and applying what they've learned to redo work. Higher-level students will also help provide critiques to less advanced students, benefiting both sides.

### **Critical thinking is not effectively taught in the classroom.**

According to Bartels, "many teachers have too little time to allow students to form and pursue their own questions, and too much ground to cover in the curriculum and for standardized tests. But people must acquire this skill somewhere. Our society depends on them being able to make critical decisions, about their own medical treatment, say, or what we must do about global energy needs and demands."

In response to this information, we're creating a technological platform which provides the opportunity to create a teaching environment outside of the classroom. We're also applying it in a real world context, by allowing students to exercise their critical thinking skills by solving large-scale, complex problems that actually exist.

### **Lecture based learning is not properly fostering critical thinking for students; it is not giving students enough autonomy.**

There is always debate about how much freedom a student should have in the classroom. Yanklowitz also claims that, "some argue that too much autonomy is given to students in a student-centered environment. But the risk is much greater with frontal lecture education: that our students master content but do not gain the cognitive, moral, and epistemic development necessary to become autonomous critical thinkers." Many high school teens are used to lecture-based learning. Although this teaching style may be necessary due to the amount of curriculum the students need to learn, the more freedom the student has with the material, the stronger their critical thinking skills will be.

We want to create a system which pushes these students to strengthen their critical thinking skills through a variety of topics.

<http://www.scientificamerican.com/article/critical-thinking-best-taught-outside-classroom/>  
[http://www.huffingtonpost.com/rabbi-shmuly-yanklowitz/a-society-with-poor-criti\\_b\\_3754401.html](http://www.huffingtonpost.com/rabbi-shmuly-yanklowitz/a-society-with-poor-criti_b_3754401.html)  
<http://www.good.is/posts/can-we-teach-creative-and-critical-thinking>

## **Interviews**

We met with a variety of people who helped us refine our original problem statement. By this time, we realized we wanted to focus on ideation. They helped us to see what problems actually existed in the high school setting and how design could play a role.

### **English Teacher (Freshmen and AP Seniors)**

#### Critical thinking

- Tries to explore ideas outside of curriculum
- Generalizations – what makes good literature overall
- Lets AP students pick their own thesis – more interest, but doesn't necessarily turn out better because everything is so grade focused

#### High School vs. College

- Pace
- Less scaffolding
- Independent thinking, more outside of the box
- Curriculum confines – limited time for critical thinking in class because there is so much testing

## Outside of School

- Education outside of school would be useful because testing is so important in school

## Iteration

- Some students can narrow down topics, and some cannot
- Freshman reevaluate more (seniors = maturity, experience, laziness)

## Collaboration

- Opportunity for self reflection
- Helps reevaluate your own ideas
- Raises the bar because you don't want to disappoint

## History Teacher (Sophomores)

### Standardized Testing

- Lower quality of questions in class (What is on the test?)
- Content versus analysis
- Less discussion in class, and fewer connections made
- No time for creative thinking/projects
- No current events
- Must provide rubrics for everything, students are unable to think on their own
- Specialized programs (math and science students struggle the most with critical thinking because they are so grade focused)

### Problem Solving

- Apollo 11 (fix problem with things from this box)
- History is about looking for trends
- Answering questions using constraints

### Operation of school

- Testing four times a year, students must improve scores
- Teachers scores based on student test scores
- School was originally meant to teach kids obedience, and it is turning into big brother

## Art Teacher (Freshman, Juniors)

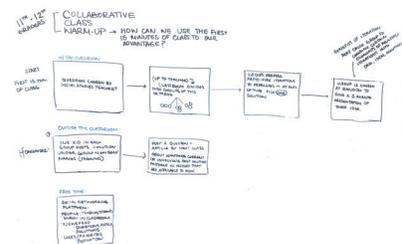
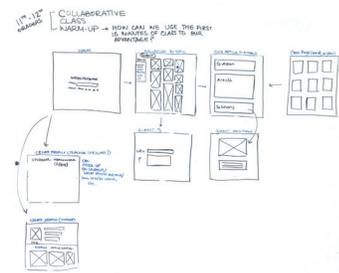
- Collaboration should be valued more in high schools because it more closely represents real-world working situations
- It's important to work with other people who have different disciplines than you
- Critical thinking is crucial in early education; it helps teach kids how to project outcomes
- Our society is not going to progress if we do not teach kids to be visionaries
- We should be integrating critical thinking more in the classroom because it fosters innovators and creators
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## Two High School Students (Seniors taking AP classes )

- Difficult to take on more activities out of school because very busy
- Do not trust working with people online
- Very focused on your life, not other peoples' problems
- Feel unprepared to solve complex global problems
- Feel prepared for college only because teachers say so

## Concept Redesign

At this point in our process, we decided to make some dramatic changes to our concept. We made the decision to teach students ideation, because it seemed more concrete. We proposed two mediums for our tool: a presentation to be used in class (in a 15 minute warm-up exercise) and a social media website, to be used outside of class. Here are our initial wireframes:



## Feedback Interview

Next, we interviewed Professor Steven Dow who completed of similar research on iteration and ideation through a collaborative design process.

- Figuring out how to accurately assess iteration
- Think about what we could use as the scaffolding for our system
- Incorporate some sort of constraint or structure in our tool
- For example, having a timed system would be a good way for students to stay on track with the exercise
- Include more serious hands-on prototyping in the curriculum, which we decided was not entirely practical for the time-constraints of our envisioned warm-up exercise
- Suggested instantly posting ideas instead of for homework

## Learning Goals

What we hope students will gain by using our system.

Our learning goals became much more focused after our interviews. We decided to focus on ideation. By teaching ideation, our eventual goal was to better prepare students to solve complex, global problems. We were trying to get students to think outside of the box, so they could apply this type of thinking in their own lives. In the classroom we also hoped they would be better able to make connections between what they are learning in class and real life situations. History is all about applying trends and analyzing the past to help decision-making in the present and future. For instance, when learning about the Great Depression, it would also be useful to look into the current recession to compare them. We also hoped students would gain the chance to improve their collaboration skills by working together, which would be a useful skill for college and beyond. We hoped students would take what they learned with our system and apply it to real life situations.

## Solution Overview

This is how our learning objectives will be implemented.

Our solution is comprised of two different components, which work together to teach students ideation. The first is a social network in which students find and read current or historical articles and post them with a summary and a complex question, which they extract by themselves, from the article. A teacher can select one of the problems with the attached summary, which can automatically be converted into a presentation with or without scaffolding, depending on what the students need at the time. It will take the question and present it to the class, for students to solve through individual and group work. The scaffolding will prompt students to ideate, which should become more natural over time. The exercise will be broken into timed steps. One group will be selected to present their solution to the entire class. The whole activity should take approximately 15 minutes, but the system is very adaptable for teachers' needs. The students will then be assigned to post their solutions online along with another article and problem, so the cycle can continue seamlessly.

## Competitive Analysis

We looked at open IDEO, which is a program set up by a large design firm. On the platform, people can solve complicated problems that are sponsored by large companies.

Open IDEO is a relatively new platform. The basic premise is crowdsource designing. Companies sponsor projects, which are facilitated through IDEO, the design firm. Users can work on many different challenges. There are phases for each challenge like research, ideas, refinement etc. The phases are shut down after a period of time, and "winners" are selected to move on to the next phase. Basically, a user posts an idea and receives applause and comments. The "good" ideas then move forward through more stages.

We created our own account to see how the system worked and found a few problems we wanted like to address in our project. We started by looking at the first challenge, which was to design the logo for open IDEO. There were relatively few applauses and comments and the ideas were unrefined, brief, and easy to look through. In later challenges, the posts were extremely lengthy and formal. Project ideas had lengthy updates. We appreciated the informality of the first challenge. It was not intimidating and we could tell that people were doing this as a side task, not as their main job. We think it is important to make people feel comfortable and not intimidated. It appears that people are making a huge time commitment to be involved in this. In our project, we need to allow people

to work quickly because this is taking place in a school environment where students and teachers are extremely busy and must meet certain standards.

There is a significant amount of information and you can filter it by “most liked” and “most recent”, but we think the hierarchy and filtering could be improved, so one can better see the information that is most interesting. The number of posts was slightly overwhelming, but we think that could be fixed with a tracking system, which would display the information of most interest. There is too much text on the site. There are character limits on the information entry page, but the option to post is offered in so many different boxes that the limits are negated. One thing that we did not think about was the integration of video. This is a great media for getting content across in a visual, more meaningful way.

The phases in Open IDEO are set up with scaffolding because the system is large, the scaffolding is never removed. IDEO employees are the ones who set the timeframe for phases. It also presents the design process in a linear way, which is unrealistic.

Open IDEO has a badge system for rewarding its users. Your “design quotient” is broken up into pieces, depending how you involve yourself in projects. We think it is an interesting idea, but its effectiveness is questionable. It only shows up when you click on someone’s profile and we think it has the potential to make some people feel superior to others. It shouldn’t matter if you’re a new member or an old one, no one’s ideas are more valid than anyone else’s. We doubt it motivates people to become involved.

## Case for Solution

This section provides summaries/notes of articles we read on iteration and ideation to better understand and support our learning objectives as valid ideas to be taught in the classroom.

### Prototyping Dynamics: Sharing Multiple Designs Improves Exploration, Group Rapport and Results

<http://www.cs.cmu.edu/~spdown/files/PrototypingDynamics-CHI11.pdf>

In this study, students were divided into three groups named: share multiple, share best, and share one. They were asked to design an ad(s) in 30 minutes, and then meet with a partner. Their collaboration was measured by word exchanges. The quality of the design was measured by how many clicks it received as a real ad online. The ads were also rated by a professional panel. The study clearly shows that there are benefits from creating and sharing multiple ideas.

- Sharing multiple ideas increased conversation between a group
- Partners had an easier time reaching a consensus
- Critiques were more efficient with multiple ideas because people were better able to separate themselves from their work
- Examples do not inhibit good ideas, but they can help people who are struggling
- Students who were in the share multiple group produced higher quality designs, had higher click rates, scored higher by the panel, explored more diverse ideas, had more verbal exchanges, and borrowed more features
- “Design organizations and educators can structure group work around creating and sharing alternative designs. For example, Stanford’s introductory HCI course revised its curriculum to more strongly emphasize creating and comparing alternatives (<http://cs147.stanford.edu>). For designers and educators who already employ a ‘share multiple’ approach, this result provides them empirical support.”

### A Pilot Study of Using Crowds in the Classroom

<http://www.cs.cmu.edu/~spdown/files/crowdInnovationCourse-chi13.pdf>

This study explored whether or not online crowdsourcing has the potential to encourage authentic interaction with people from the outside world. It also tested if input from online crowds made an impact on student learning and motivation for project-based work. In conclusion, students reported that online crowds helped them quickly uncover issues with early-stage prototypes. However, the students favored face-to-face interactions for more contextual feedback.

- Although the social media aspect of our technology is not utilizing any face-to-face online interaction techniques, students will be able to comment, favorite, and

- interact with others students' problems and solutions, which they will post online
- This study proves that crowd-based technologies have the potential to transform open ended learning by providing a link between the public and traditional isolated classrooms
- Connecting educational activity to real-world outcomes can make learning more personally meaningful to the learner
- We have to consider the risk that this research also considered, online crowds can be inconsistent, unreliable, and undereducated
- Online crowds have potential to increase the breadth and depth of ideas being used, but only if they understand the problem space and constraints

### **Parallel Prototyping Leads to Better Design Results, More Divergence, and Increased Self-Efficacy**

<http://www.cs.cmu.edu/~spadow/files/PrototypingParallel-TOCHI10.pdf>

This experiment tested whether serial prototyping (the process of receiving feedback on every single iteration), or parallel prototyping, (the process of receiving feedback on a group of iterations until the iterations are narrowed down to one final design) was more effective. Users designed graphic ads for the internet; the success of the ads was assessed by click-through data and expert ratings. In conclusion, the ads created in the parallel condition significantly out-performed those created in the serial condition.

- Independent raters found the parallel condition to produce a greater variety of solutions.
- Parallel prototyping promotes comparison because you get feedback on groups of your iterations at once. It's easier to compare and contrast your designs.
- Parallel prototyping promotes exploration because you're able to think large scale early on and worry about the feedback later.
- Time, as a constraint in our project will hopefully provide users with the ability to create multiple ideas, get feedback, and then go back and refine ideas.

### **The Efficacy of Prototyping Under Time Constraints**

<http://www.cs.cmu.edu/~spadow/files/Prototyping-Iteration-CC09.pdf>

Students were asked to design a holder for a raw egg to be dropped, without breaking. Participants were asked to design for 25 minutes, build a final holder, answer questions, and then drop the egg. The iteration group was given multiple eggs during their design phase, while the control group was only given one. The iteration group was prompted to test at specific intervals, although not required to do so. This study attempted to see if iteration had positive effects, even when it was coupled with time constraints.

- The iteration group did better than the control group
- The no-experience iteration group did as well as the group with prior experience, who did not iterate
- Self assessments were higher in the iteration group
- The iteration group utilized the experience they gained to fix problems in their subsequent iterations
- Even in the iteration group, there was a lack of diversity of ideas; they tended to stick with one and tweak that same idea throughout the design period.
- Students in the iteration group complained that the cycles were too short to make significant changes, while students in the non-iteration group complained there was too much time.
- Iteration did not lead to divergence: 'As P16 described, "I'm not a very good outside-the-box thinker, so I kinda just had one idea and I was going to try to make it work." P27, who had the best overall design, expressed a similar notion: "I went with the whole parachute idea from the beginning. So, I had one core idea." Generally participants selected an initial design direction and iterated to improve on that idea.'
- "For some reason this seems to be the only idea. There needs to be a platform and then as good of cushion as possible. I don't see any other way". Likewise P20 asserted, "This is the best approach for such a design." Despite often mediocre preliminary tests and a wide range of possibilities available, many participants appeared fixated on their initial design concept."
- "This work suggests rapid iteration yields more valuable design insights than allocating that time to a single iteration."

## Principles

This section explains how we used educational principles in our overall design to help students reach our learning objectives.

### Scaffolding

Due to the fact that ideation may be a fairly new concept for many high schoolers, we propose two versions of the presentation, one with and one without scaffolding. The scaffolding will provide guidelines to help students become familiar with the idea of producing multiple solutions. By telling them they must produce five solutions, the idea of creating many solutions should become more natural later on. When students start to feel comfortable, the scaffolding can be removed, which will help make the process smoother and faster.

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### Motivation

We are attempting to motivate students in multiple ways. Students will be solving real world problems, which provide a purpose for their work. Students want to know that their work matters. There will also be a favorite button on our social network. We hope students will be excited by their ideas being out there and appreciated by other people. Our goal with the social network is to have students go online to post their homework and "get stuck there" by seeing more interesting things. We are providing a space for them to spend free time browsing current events, history, and other people's ideas. We are offering a more educational alternative to Facebook as a "break provider" and an opportunity to randomize their grid. By viewing other peoples' solutions, we hope students will become inspired and see just how creative they can be.

### Autonomy

We discovered in our earlier research that lecture-based learning was often unsuccessful because it offered less autonomy for students in the classroom. Our audience would be preparing for college, so we wanted our exercise to introduce them to a certain level of this independence. We wanted to make sure that our system had a structure which provided students with some guidance when they were working. However, we still wanted the students to have plenty of freedom with what they created. Hopefully, they'd learn ideation through the learning structure we provided and would not feel limited.

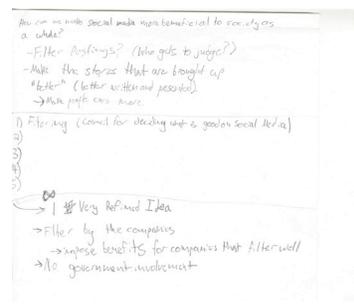
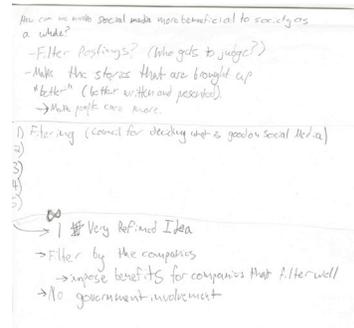
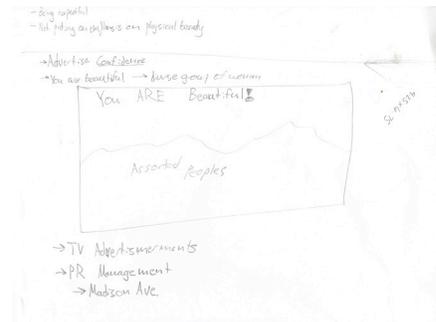
## Evaluation Part 1

We evaluated our system by using observation while running through two activities and a think aloud for user testing of the social network.

In our evaluation, we used two different methods when we tested users. Due to inaccessibility to ideal 18-year-old high school students, we evaluated two male college students, one 19-year-old and one 20-year-old. We used the methods of observation and think alouds for the evaluation of Quandary.

In the observation process, we watched as the two students worked together to solve two complex problems, first without scaffolding, and later with scaffolding. The question without scaffolding was related to women's lack of confidence. The question with scaffolding was related to making social media more beneficial. We gave them sheets of paper to take notes, while we listened to their conversation. In the first round (without scaffolding) we quickly noticed that with no obvious structure to the exercise, the students found the time constraints of five and three minutes to be too long. In the group work section, they talked in circles and got off topic. They had one main idea and quickly came up with a few expansions of the idea at the very end. They also had trouble figuring out the relationship between the summary, question, and what they were supposed to solve.

The relationship between the key components of our exercise seemed to become more clear to our participants in the second round. After a couple of questions they agreed that over time they were starting to better understand the relationship. In the second round



(with scaffolding) we found they generated a higher number of ideas. In both trials, the participants used writing and sketching as their main tools for recording their ideas. In both sections they had trouble thinking globally and did not present any wild ideas.

## Evaluation Part 2

In the second part of our evaluation, we asked the users to flip through the pages of our website as if they were accessing it online and to voice any concerns or confusion they had with the interface. Doing this on paper also allowed them to take notes on the frames themselves. Their main comments revolved around the ambiguity of some of the symbols on the page. They also believed that when a user uploads a problem, they should be restricted when uploading text or video, due to potential inappropriate content. They suggested a system which grabs the title, text, image, or video from an article on a website and stronger filtering.

