STEMS AND LEAVES

USABILITY ASSESSMENT 1

Prepared by Avery Spratt, March 2018
Prepared for James Intriligator

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The findings from my initial user research helped to better define the needs of my target users. From this research, I was able to define important factors to consider when developing my initial concepts. These factors are summarized below.

PHYSICAL SPACE

Many classrooms, especially in urban settings, have limited physical space.

+ The planter should be compact and have a minimal space requirement.

Classrooms do not have standardized interior design in terms of storage systems and furniture. Do not assume every classroom has available shelving or storage units.

+ The planter should be able to stand alone without depending on shelves or storage units.

COLLABORATION

Students succeed when given the opportunity to work with each other.

+ The app should provide students with the opportunity to compare plants with one another.

HANDS ON ACTIVITIES

Students succeed with active, minds-on learning. Integrating hands-on activities into lesson plans is a priority to teachers.

+ The planter should give students open access to their plants.

+ The planter should not be entirely automated. Students should be responsible for carrying for their plants and making decisions regarding their plants.

USER AUTHORITY AND INVESTMENT

Students are more likely to actively engage with learning-based activities when given authority over the tasks at hand.

+ The app should require students to measure and input their own data.

Students are more invested (especially in long-term projects, such as this one) when they are given ownership over their work.

+ Students should be given the opportunity to personalize their planter

+ The app should give students the opportunity to name their plant

The average primary school classroom in the US has 22 students.

+ The planter should be compact enough that each student is able to have their own planter within the available space or students are able to share planters in groups of no more than two.

SIMPLE DIGITAL INTERFACE

Highly animated and complex digital interfaces put young user populations at risk of cognitive overload and take away from user learning.

+ The app should include limited animations

+ The app should accomplish only the necessary use cases and not stray from these tasks. The necessary tasks include planter set up, data input, data analysis, and planter comparisons between students.

+ A simple interface design should be prioritized.

COMPLEMENT LEARNING OBJECTIVES OF FIFTH GRADE

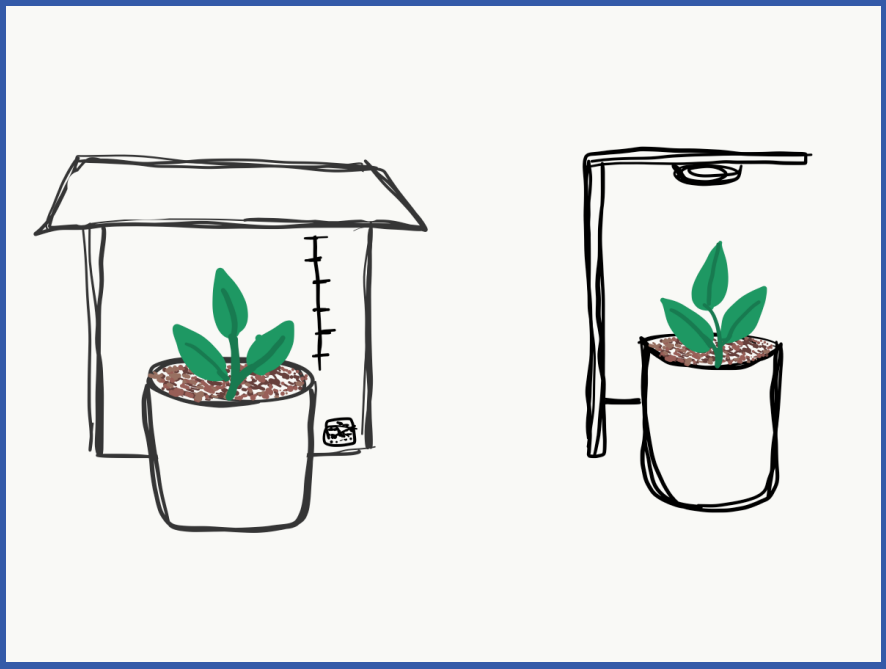
The planter & app system is not intended to replace the role teachers play in the classroom but to complement the work they do.

+ The planter & app should function as supplemental activity to lesson plans. The design of the system should allow for easy mapping between the system and Common Core education standards.

THE INITIAL CONCEPTS

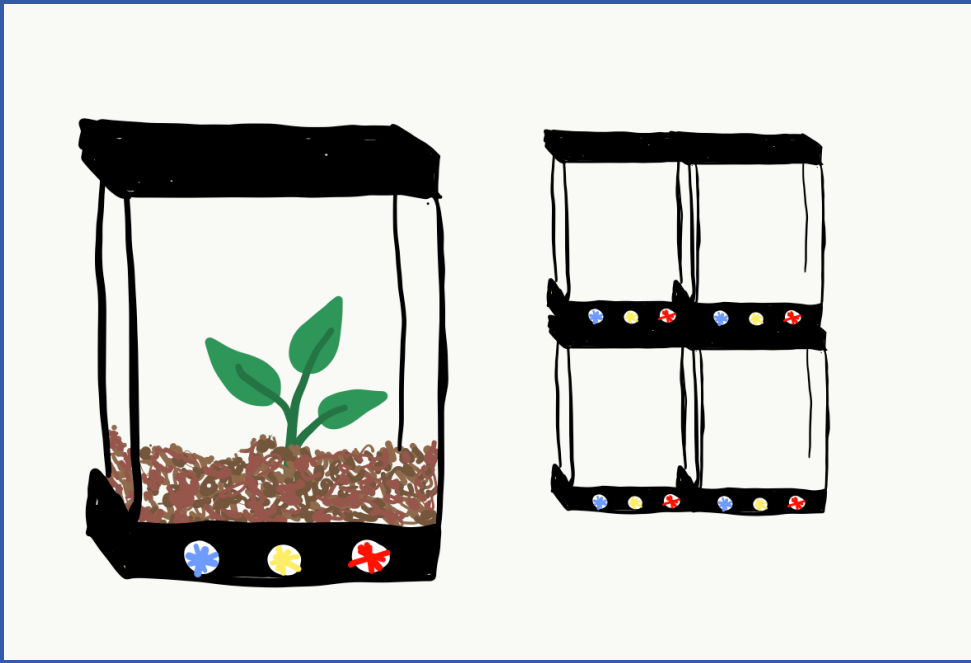
Guided by these design goals, I developed rough concepts for the physical planter and app. There are three concepts for the design of the physical planter. The app concepts are separated into a phone based design and a web based design. These designs include ideas for the tasks of set-up, data input, data analysis, and plant comparison.

PLANTER CONCEPT 1



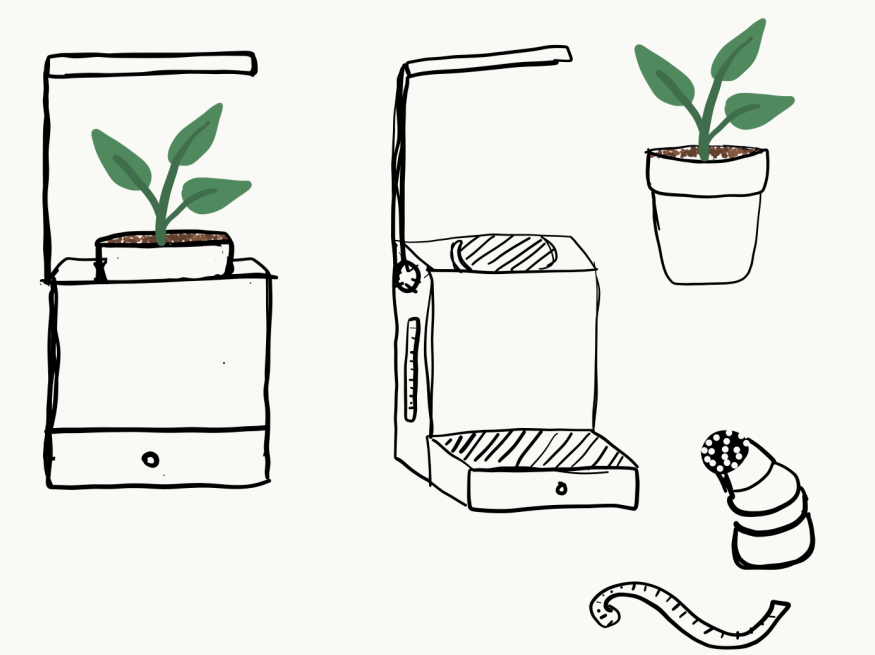
This concept features a backboard to allow for standing or hanging storage of planters, that also would limit the amount of outside light reaching the plant controlling for confounds. The backboard features includes a ruler for easy measurement of plant growth and a QR code to connect the planter to the app. This design includes an overhead lamp for consistent lighting and a holder that makes the plant pot easily attachable and detachable from the backboard.

PLANTER CONCEPT 2



This concept is a fully enclosed, making the planters easily stackable for efficient storage and easy viewing for comparing plants. The removable lid includes lights for consistent overhead lighting. The bottom of the planter features a control panel to allow students to manipulate lighting time, amounts of water and observe internal air temperature.

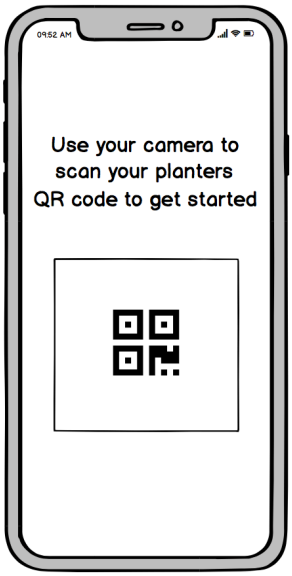
PLANTER CONCEPT 3

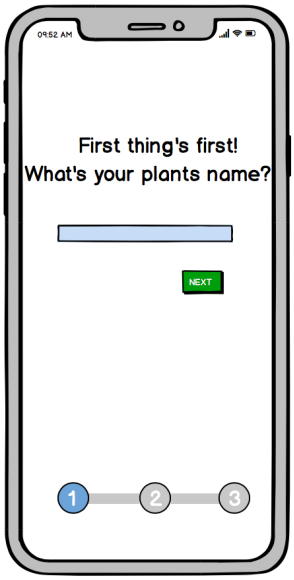


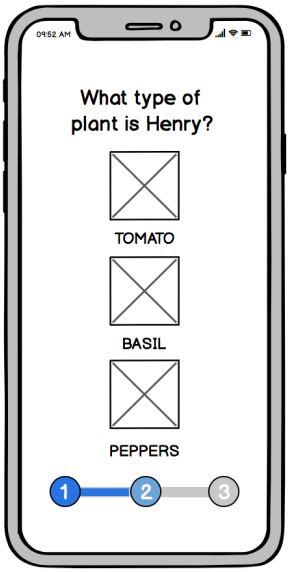
This concept includes a box-like stand that holds the plant pot. The stand features an overhead light that is extendable as to not limit plant growth and a has a timer to control the amount of time plants are lit. A thermometer of the side of the stand would indicate air temperature. The stand has an in-set spot for the plant pot to ensure safe storage and easy access to the plant. The bottom of the stand has a gardener's tool drawer to store helpful data collection tools such as a ruler to measure plant growth and a liquid measure for easy watering.

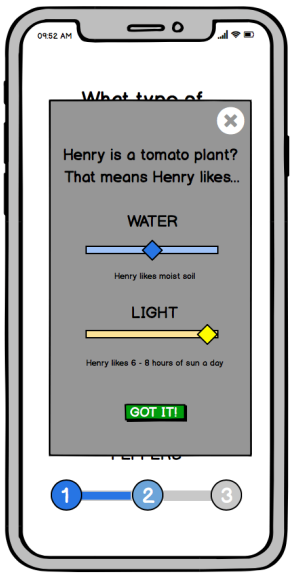
THE PHONE APP CONCEPT

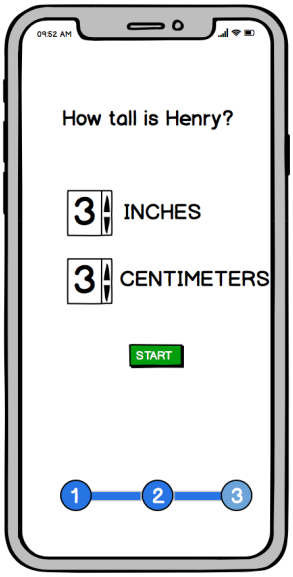
TASK: SET UP



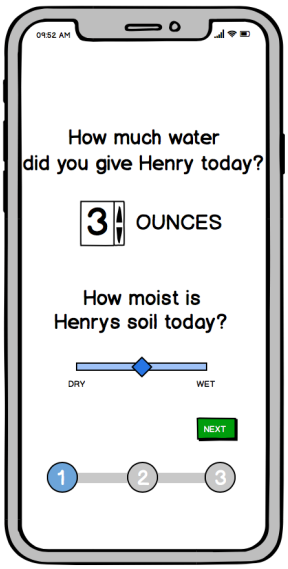


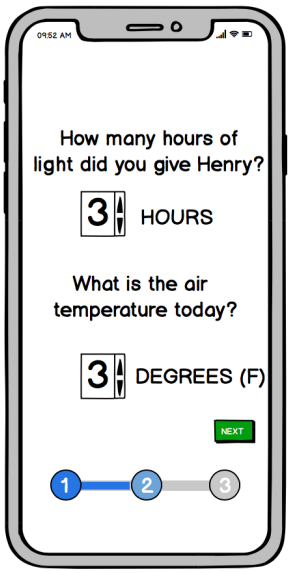






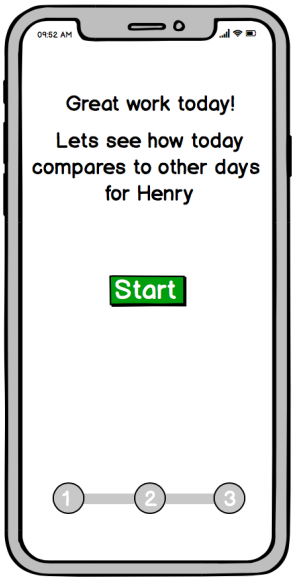
TASK: DATA INPUT

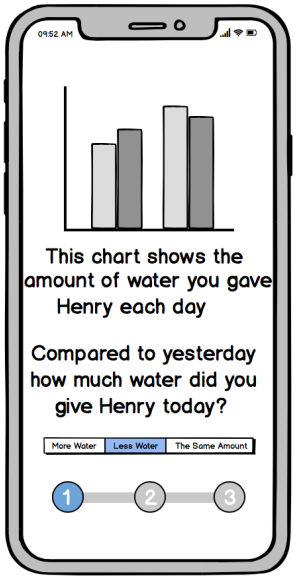


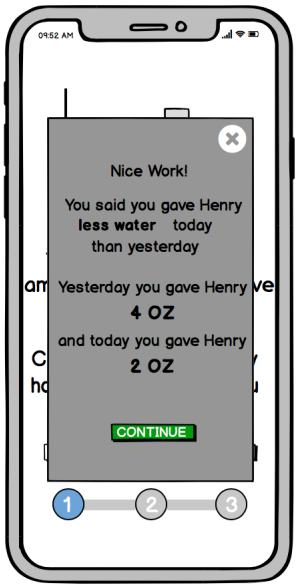


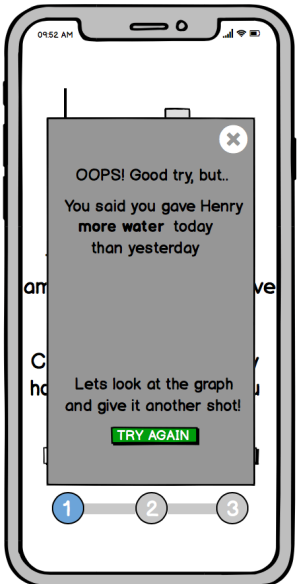
THE PHONE APP CONCEPT

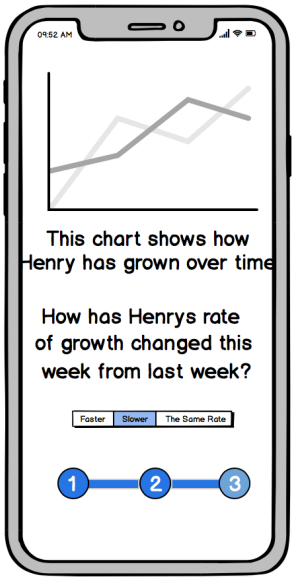
TASK: DATA ANALYSIS

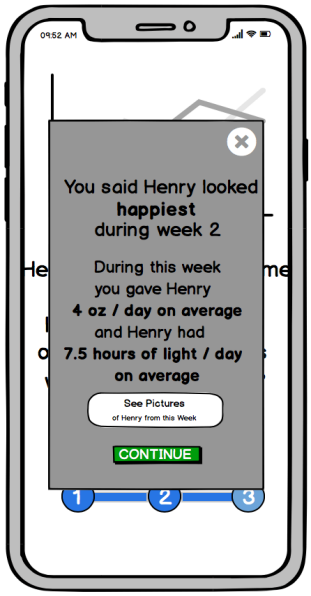




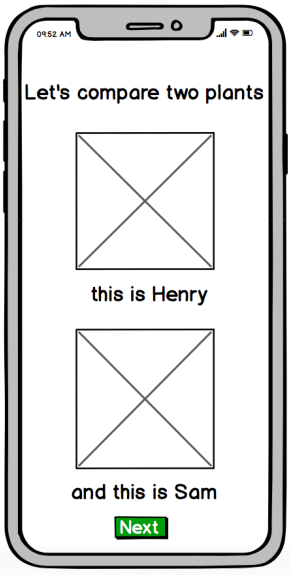


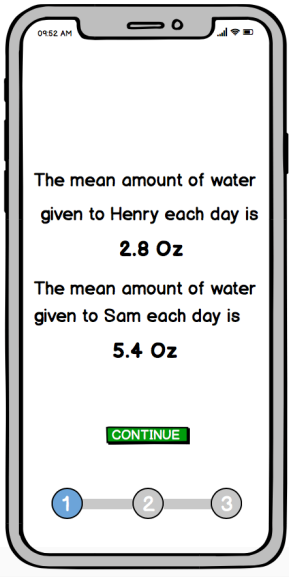


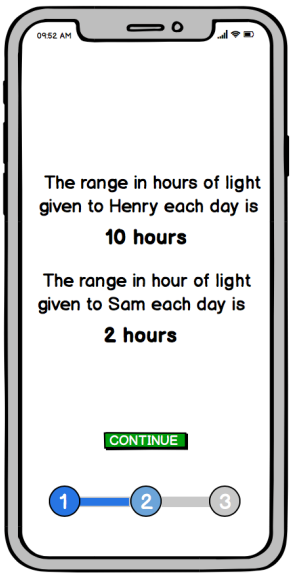




TASK: PLANT COMPARISON





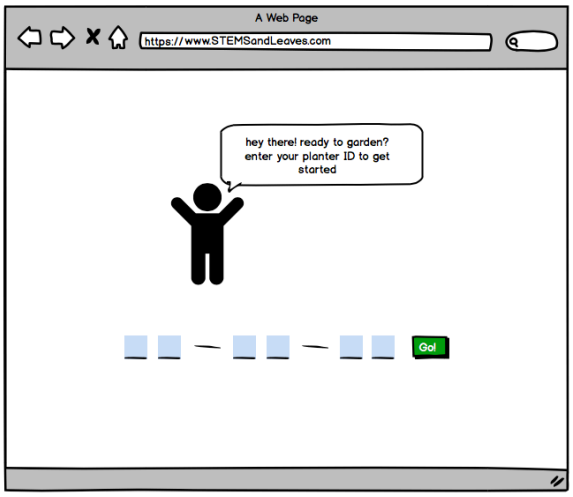


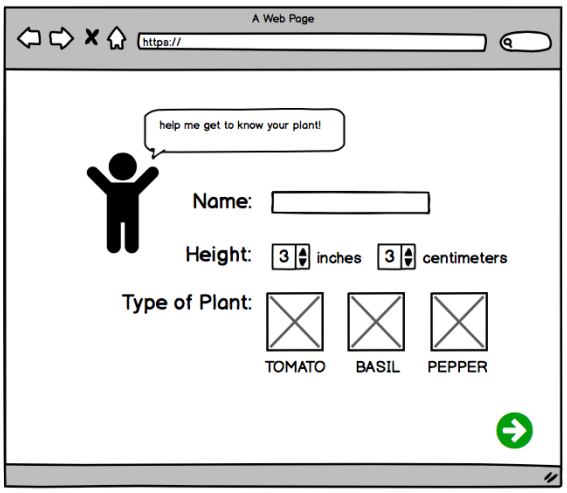
THE PHONE APP CONCEPT

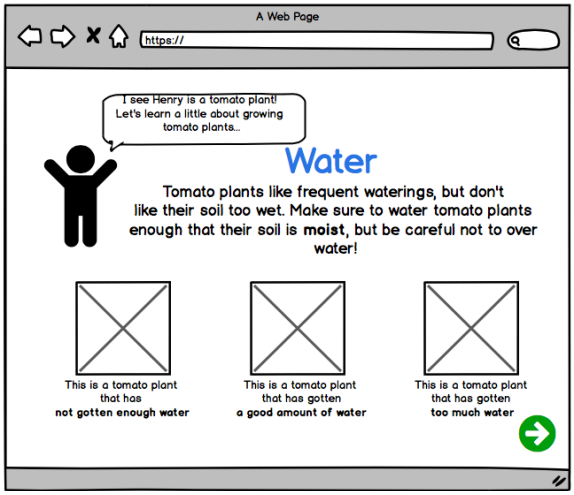
This concept is built of highly directed, sequential tasks. Each task features distinct steps and clear progress bars to track student's progress.
The first task is planter set up. Students will only have to do this task once. It is initiated by students scanning a QR code associated with their specific planter. Students are then asked to name their planter and input what type of plant it is. The selection of plant type is met with a pop up meant to inform students how much water and how much light that type of plant typically thrives in. Then, students are asked to make an initial measurement of how tall their plant is in inches and centimeters. This completes the set-up process and begins the standard, daily task flow. Each day of planter use is started with data input. In the first step of this task, students are asked to input in ounces how much water they gave their plant and rate the moistness of their plant's soil on a sliding scale of dry to wet. The next step is to input how many hours of light that day the plant is given and what the air temperature is, in degrees F. Finally students are asked to record how their plant looks that day. At this step, students record the height of their plant that day and are asked to rate how the plant leaves look on a sliding scale of "Droopy and Sad" to "Green and Happy". During this step, students are also given the opportunity to add a picture of their plant that day. Once the data input task is complete, students are presented with the task of understanding their own personal data. This task compares the day to previous days. In the example depicted in this concept, students are presented a graph of the amount of water they gave their plant on different days. Based on the graph presented, students are asked basic analysis questions. In the example, the question is "Compared to yesterday, how much water did you give Henry today?" Students choose between More Water, Less Water, or The Same Amount. If students answer correctly, a pop up congratulates the student on their good work and explains, in depth, why their answer was correct, as a form of reinforcement. If the student answers incorrectly, a pop up tells the student good try, but that their answer was incorrect. This instructs students to return to the question and try again. This flow will continue until students answer correctly and then will process to the next question. This task would integrate comparisons, rates, means, and other forms of basic statistics as a self guided study. Another task that this concept integrates is the opportunity to compare two plants. The comparison step begins with an introduction to the two plants, including names and more recent photos. Similar to the personal data analysis this task will compare how the plants have been cared for through the lens of different statistical values. In the examples displayed in this concept, the plants are compared through mean amounts of water and range of hours of light, but these metrics are expandable and can easily change each time this task is performed.

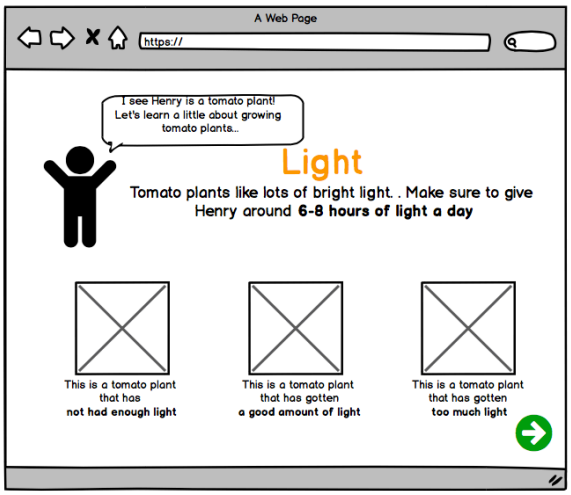
THE WEB APP CONCEPT

TASK: SET UP

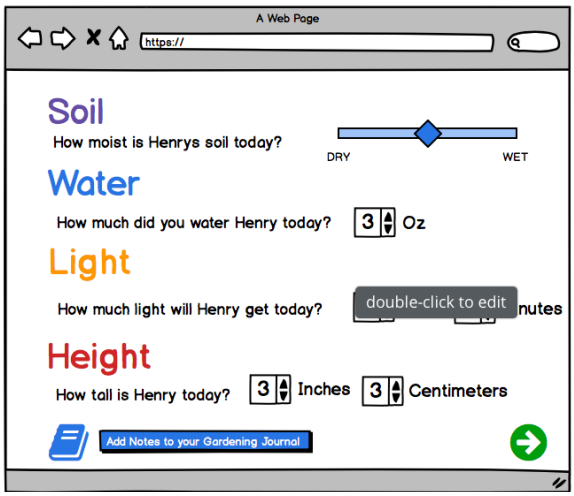






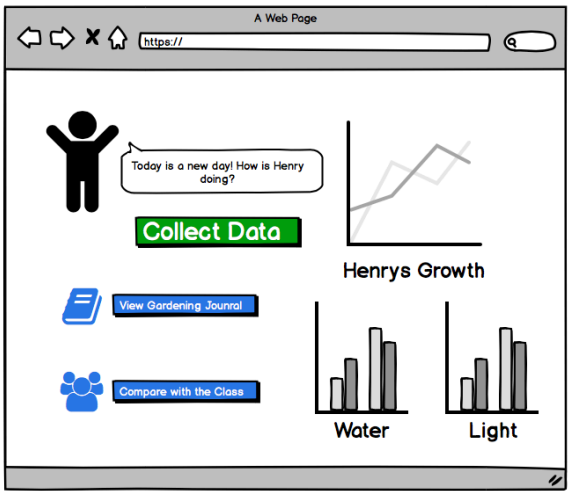


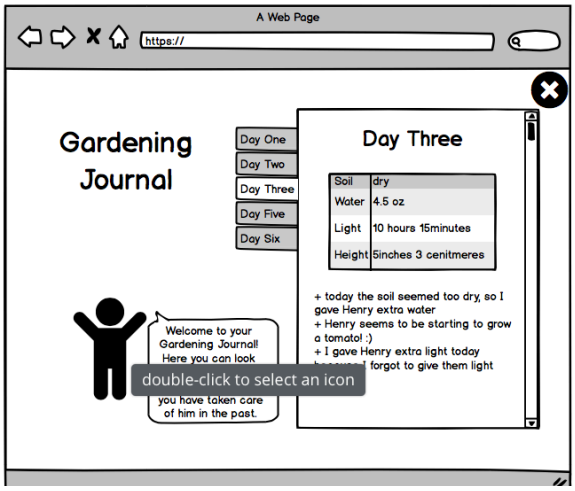
TASK: DATA INPUT



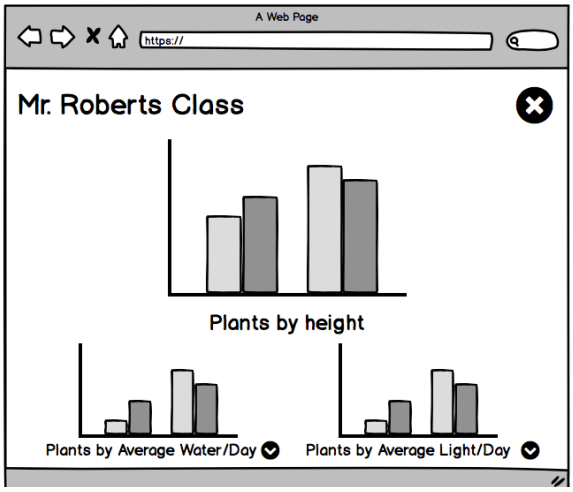
THE WEB APP CONCEPT

TASK: DATA ANALYSIS





TASK: PLANT COMPARISON



THE WEB APP CONCEPT

This concept is built of highly directed, sequential tasks. Each task features distinct steps and clear progress bars to track student's progress.
This concept features the same tasks as the other app concept - set up, data input, understanding personal data, and plant comparison. The web app features a mascot to guide students through the interface. Set up is initiated by entering a planter ID. Then, on a single page, students are asked to tell the mascot about their plant, including a name, the height in inches and centimeters, and what type of plant it is. Once students complete this step, an introduction to how to care for that type of plant. Starting with water, students are given a text description of how to effectively water their plant and then provided 3 photos - one of an underwater plant, one of a sufficiently watered plant, and one of a plant with two much water. The same page is repeated with identical structure, but in the context of lighting. That concludes the task of planter set up, which will only need to be performed once. This concept features a home page with a variety of tasks for students to choose from, under the guidance of the mascot to keep students on track. A large "Collect Data" button begins the task of data input. On a single page, students are asked to record how moist the plant soil is on a sliding scale, how much water in ounces they gave their plant that day, how much light their plant was given in hours and minutes, and the height of their plant in inches and centimeters. Students are also provided the opportunity to add notes to their gardening journal. The gardening journal is how students are able to understand their own personal data. In the gardening journal, students can look at the data associated with each data input as well as access sentences they wrote about their plant and the decisions they made when caring for them. In addition to the gardening journal, the home page features graphs of their personal metrics associated with growth, water, and lighting. The home page also features a button "Compare with the Class" that allows students to compare the various gardening techniques utilized by the class. These are graph based comparisons that display the average amount of water, for example, and students can choose to see these graphs in terms of mean, median, mode, as an introduction to basic statistics.

THE USABILITY ASSESSMENT

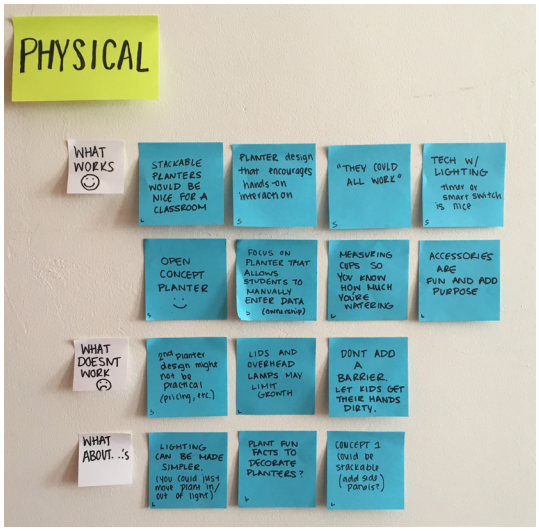
The first stage of usability testing was conducted on these initial concepts. The aim of this testing was to understand how effectively these concepts accomplished the goals defined by the initial user research, which elements of each concept are on the right track, and what needs improvement. The testing done on these concepts will be used to inform the development of a single, final design, for further testing.

EXPERT REVIEWS

The assessment of these concepts began with expert reviews. I met again with the experts who helped during the initial user research for this project to answer the question of "Am I on the right track?" Because these experts helped define the scope of this project and the needs of my user groups, their feedback is of great importance when determining the success of my designs. I did individual expert reviews with environmental education specialist Sadie Perrin, Education specialist Laura Fradin and a brief review with Human Factors expert James Intriligator. During these reviews, I presented the physical and digital concepts to the experts. We then discussed what was effective and what seemed to be missing from each concept, any preferences the experts may have between concepts, and things to focus on when getting to a finalized design to ensure the requirements of the system are met.

Overall, the expert reviews indicated I was on a good track in terms of design and general workflows. The major takeaways of these concept reviews are summarized below:

PHYSICAL CONCEPTS



+ Overall, experts felt that all three planters are feasible solutions.

+ In terms of lighting technology, simple technology such as a timer or a smart switch would add a lot of value to the design. However, lighting could also go a much simpler route - students could just move their plants in and out of light sources already in the classroom. Experts voiced concerns that overhead lighting and lids could limit plant growth.

+ The second planter concept seemed impractical and the least feasible of the solutions. The potential pricing of this unit seemed out of reach. Further, experts did not like the “control panel” aspect of this concept. It was too autonomous and the knobs controlling water and light amounts take students further from the growing process. Experts preferred planters that allowed students to manually enter data, thinking it will develop a deeper sense of ownership.

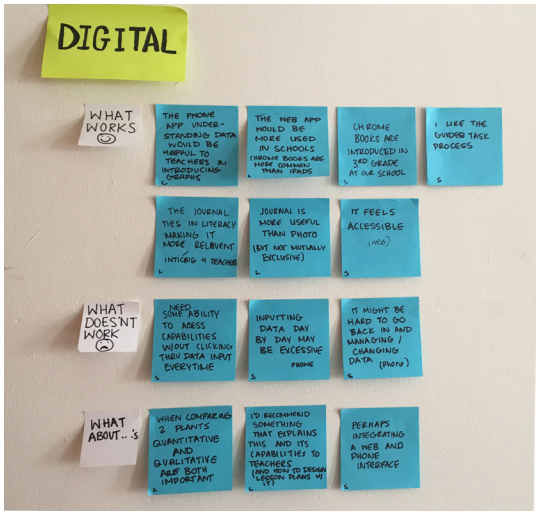
+ The second concept being stackable was the most appreciated element of this concept. In terms of space requirements, making the planters stackable is appealing. Experts suggested that the first concept could be made stackable, depending on the materials made to construct it.

+ The accessories in the third concept were perceived as fun and functional. Measuring cups and rulers are necessary to the success of the system and by providing these, the set up of the system on the teacher end becomes that much easier.

+ Experts suggested that decorating the planters with fun facts or allowing students to decorate their planters would be an engaging addition to the final design

+ By far the most talked about element of the physical concept design is focusing on an open concept design that encourages hands on interaction from the students. Concept two as an enclosed system was not well perceived because it adds a barrier between students and their plants. As one expert said “Let the kids get their hands dirty.”

DIGITAL CONCEPTS



+ The guided task process is good. While the phone app's use of sequential tasks is a more rigid way to guide student work, it is not as successful as the more subtle guiding in the web app. By having a mascot make suggestions to students regarding what task to work on, students are kept on track without taking away their freedom to explore the apps capabilities in their own way. The rigidity of sequential tasks in the phone concept would make it difficult for students to access data without inputting data first, and forcing students to input data every new day they use the app would become excessive, causing students to loose interest. To make the final concept something that compliments lesson plans, there needs to be a level of fluidity and freedom to access all capabilities of the app at any given time.

+ In the set up stage, the phone concept suggests how much water and light to give based on what type of plant they have. The web concept, on the other hand, gives students qualitative descriptions and photos of plants that received not enough water/light, the right amount of water/light, and too much water/light. Experts preferred the web concept over the phone concept in this regard because the photo anchors were more experimental than the explicit care instructions.

+ The Data Analysis task in the phone app would be helpful to teachers introducing graphs. A great way for students to independently engage with and practice graph analysis.

+ The web app felt the most accessible.

+ Because laptops are more commonly used than touch-screen devices in schools, the web concept would be more easily used in schools, but the possibility of integrating a web and phone interface to offer both solutions would be ideal.

+ The journal aspect of the web app is a valuable feature that would be appealing to teachers. The journal in the web concept is more valuable than the photo element in the phone concept, however, these two features are not necessarily mutually exclusive. The journal offers an opportunity to integrate literacy related standards. It successfully combines quantitative and qualitative data, which is a necessary element that future concepts need to further develop.

DEMO AND REACTION

Following the Expert Reviews, I met with Dana Kercheval to discuss the project and do a demo of my concepts to get her reaction. Dana currently works in a Kindergarten thru 5th grade elementary school in Boulder, CO. There she supports 3rd, 4th, and 5th graders who have been identified as gifted. Before her time in Boulder, Dana worked as an elementary school teacher, primarily 5th grade, in New Jersey, for over 15 years. Her time in New Jersey was spent largely in a self-contained classroom, meaning she was responsible for all subjects, however she has experience working in a split classroom where she was teaching double sciences with a partner doing double social studies.

I decided to reach out to Dana to get a teacher's feedback on the initial concepts. However, her expertise with this project goes much deeper than I expected.
Dana has also implemented something in line with the goals of this project in her classroom. One year, Dana was looking to come up with a creative way to teach students about controlled experiments and variables, something usually taught with pendulums. A trip to home depot inspired the use of plants as an educational tool in her classroom. She bought a tray of biodegradable cups and 2 different seeds. Each student got one type of seed to plant and grow. The plants were placed in different areas of the classroom and given varying amounts of water to help students answer the question "What might affect the growth of the plants?" What started as an introduction to controlled experiments quickly expanded beyond her original objective. As the plants grew, Dana would have students measure, with a ruler, the height of their plants, introducing another purpose - learning to read a ruler and rounding to fractional parts of an inch.
Dana said this activity was highly successful. The beginning was, reasonably, met with some frustrations, as one seed germinated and naturally sprouted faster than the other. Even though young children often want instant gratification that growing plants from seeds naturally does not provide, each student eventually ended up with a plant and at the end of the activity, the students got to take their plants home. As a teacher, Dana said "This was a kind of experiment for me because I didn't know what to expect. We were learning together, which was fun."

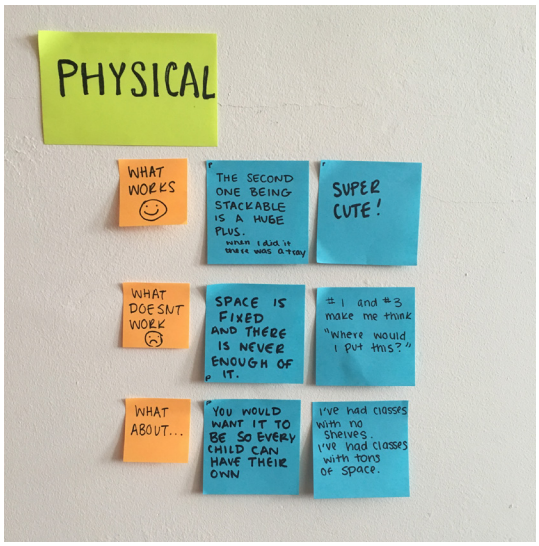
Before reviewing my initial concepts, Dana and I also discussed the general scope of the project. She had a lot of helpful insight about the system from a teacher's perspective.

She highlighted the diverse potential use cases for a system like this. Depending on curriculum objectives, there are a lot of tangential use cases beyond STEM and plant growth. Things like photography and literacy being a few examples.

Dana also spoke to the shifting world of teaching as technology makes its way into the classroom. Students are becoming more technically proficient earlier and young teachers are starting to integrate more apps and technology-based activities into the classroom. However, older generations of teachers remain and the shift to a technology-heavy classroom has been met with a fair amount of resistance. Dana has worked in relatively strong, well-funded school districts, where one-to-one Chrome books and iPads have become commonplace. In her experience, the older teachers in these school districts are very resistant to this 'technological revolution'. For teachers that have used a paper lesson planner for 20 years, these Chrome books aren't intuitive, or wanted. Dana voiced a concert that the main hurtle for this project is getting teachers to want to participate. As Dana described, teaching is a hard enough job as it is, but trying a new device and just seeing how it goes requires time teachers often don't have. Her biggest piece of advice to ensure the success of my system design is that it has to be "Easy. Easy. Easy. and Intuitive."

Following this big picture discussion I did a demo of the concepts for Dana to get her reactions. Her feedback is summarized below:

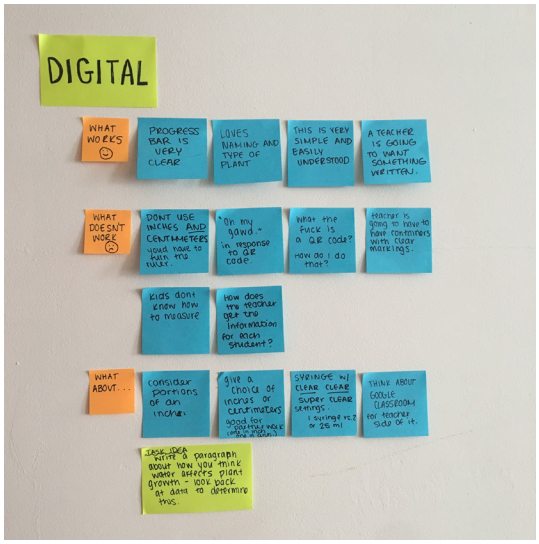
PHYSICAL CONCEPTS



+ All concepts were perceived as "super cute!"

+ Storage was a primary concern. The second concept being stackable was a big plus, where concepts one and three were met with the question of "Where would I put this?" Dana highlighted the importance of ensuring that every child could feasibly have their own plant and being aware of the great variance in physical classroom layouts.

DIGITAL CONCEPTS



+ Dana found both concepts simple and easily understood.

+ The progress bar in the phone concept served a very clear purpose

+ Naming the plant and identifying the type of plant in both concepts was a well received addition.

+ The journal feature in the web concept was well received and made the system more appealing to teachers.

+ The QR code in the set-up portion of the phone concept was met with a certain level of disgust. QR codes increase the learning curve required for teachers far too much.

+ The input of plant height being a combination inches and centimeters is too confusing for 5th graders. Consider doing portions of an inch or giving students a choice between measuring in inches or centimeters.

+ In terms of measuring the amount of water given to the plant, containers with very clear measurements would be necessary. Students would be learning how to measure with this system, so making that as clear and easy as possible is required. Syringes were suggested as possible solutions to this issue

+The most glaringly obvious element missing from these concepts was the teacher-side of the interface. Teachers would need to be able to access each individual student's information clearly. Dana suggested looking at Google Classroom to see this successfully implemented.

CONCLUSION

Both the physical and digital concepts were generally well received during this first usability assessment. The feedback received during this testing will be used to develop a single concept for further testing.
Based on these usability tests I have developed a list of design elements to guide the design of the single testable concept.

GENERAL SYSTEM

+ The system must be easily mapped to lesson plans based on Common Core standards.
+ The system should come with information for teachers on how to successfully use the system within their classrooms.

PHYSICAL PLANTER

+ The physical planter *must* allow students direct hands-on access to their plant (to “get their hands dirty”).
+ The physical planter *must* include accessories for data collection, such as containers to control the amount of water given and a ruler to measure plant growth.
+ The physical planter *should* be stackable
+ The physical planter *should* be designed to be space efficient, making it feasible for each student to have their own planter.
+ The physical planter *should* have simple technology to control lighting.
+ *It would be nice* if the physical planter was customizable, allowing students to decorate their planter.

DIGITAL INTERFACE

+ The digital interface *must* be simple in design
+ The digital interface *must* work in a standard web-browser
+ The digital interface *must* allow students to access previous data and compare with other students plants without having to input data.
+ The digital interface *must* include a feature for written data.
+ The digital interface *must* include both quantitative and qualitative data relating to the plants.
+ The digital interface *must* allow students to manually enter data relating to their plant care, at any given interval.
+ The digital interface *must* include a page for teachers that allows teachers to track individual progress and see the work done by each student in their class.
+ The digital interface *must* allow students to connect to a class page without a QR code.
+ The digital interface *should* provide a self-guided task for understanding personal data with basic activities relating to understanding and analyzing graphs.
+ The digital interface *should* allow students to track their progress as they complete certain tasks.
+ The digital interface *should* allow students to name their plant.
+ The digital interface *should* have a mascot or guiding feature to keep students on track without inhibiting personal exploration of the app capabilities.
+ *It would be nice* if the digital interface allowed students to include photos of their plants.
+ *It would be nice* if the digital interface worked on touch-screen devices such as iPads or smart phones.