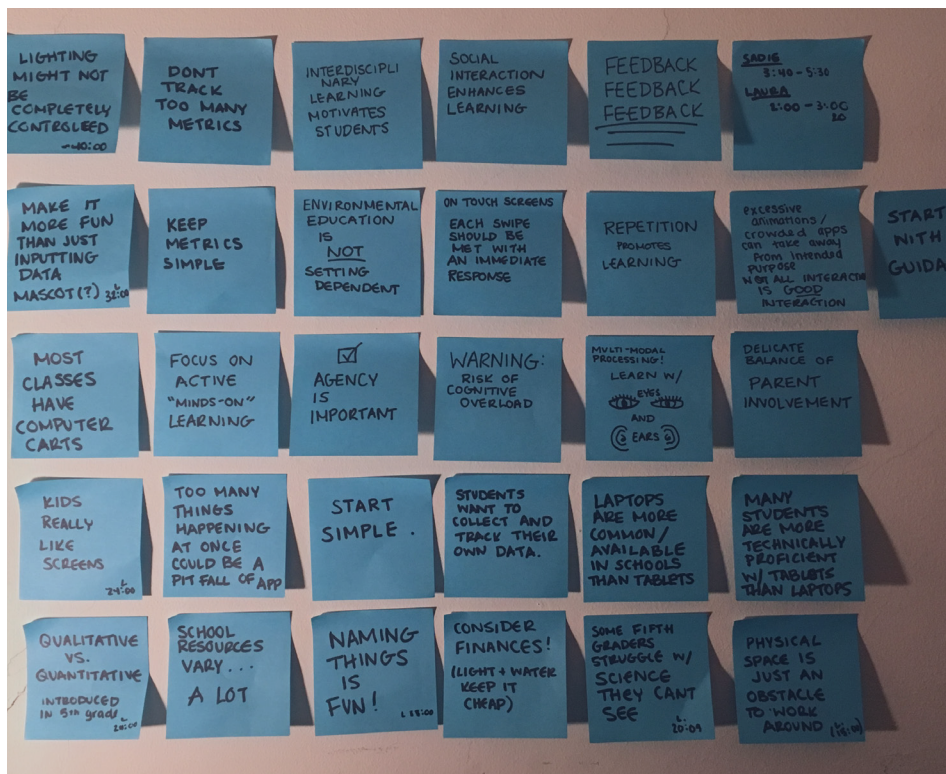

STEMS AND LEAVES

USER RESEARCH REPORT

Prepared by Avery Spratt, February 2018
Prepared for James Intriligator

TABLE OF CONTENTS

INTRODUCTION	3
METHOD	4
LITERATURE REVIEW	5-8
COMPETITIVE ANALYSIS	9-12
SURVEY	13-14
EXPERT INTERVIEWS	15
DISCUSSION	16-18
REFERENCES	19



INTRODUCTION

This project aims to develop a product that productively utilizes technology in a classroom setting to enhance STEM education for elementary school students. The research outlining the benefits of plants in our daily life, especially in educational settings, is undeniable. STEMS and Leaves strives to develop an app-connected planter to compliment STEM education with hands-on projects tailored for elementary school students.

I hope to develop a connected planter that creates simple data visualizations based on user and planter recorded data. These metrics will function as an entry point into learning just about anything when paired with teacher-guided lessons, group activities and collaboration, and individual exploration. In order to design for accessibility and sustainability, the planter will also be developed with the minimization of physical space requirements and production costs in mind.

METHOD

In order to understand the needs and desires of my target user groups and better design a product that satisfies these needs I have conducted extensive preliminary user research. This research primarily explored the themes of school curriculum, use of technology amongst the user groups, and finding the right metrics to track. It is important to keep in mind that, due to limited access and safety regulations, this research did not include direct interaction with my primary user group, late elementary school aged students. Instead, I depended heavily on previous studies conducted with this user group and on people who interact with this user group frequently. Elementary school students will be incorporated in later stages of research and will play a key role in future usability testing

The research methods employed included the following:

LITERATURE REVIEW

COMPETITIVE ANALYSIS

QUESTIONNAIRE

EXPERT INTERVIEWS

LITERATURE REVIEW

A literature review was conducted to give insight into technology as an educational tool and environmental education for younger populations. Many of these articles were found on online digital libraries for academic journals, including JSTOR, and some were provided by researchers in cognitive development. The articles read were narrowed down to six of the most relevant to this project. The findings and takeaways are summarized here:

“Affordances and Limitations of Electronic Storybooks for Young Children’s Emergent Literacy” *Adriana G. Bus, Zsofia K. Takacs, Cornelia A.T. Kegel*

An extensive review exploring the positive and negative effects of electronic storybooks.

Important Takeaways

- Parent/Supervisor interaction is important in enhancing student learning, but should not interfere with the student’s ability to independently and actively interact with the app.
- Learning is optimized when information is presented visually and audibly
- Students invest less mental effort to activities that are perceived as entertaining
- The benefits of electronic presentations of information drastically decreases once presentations become extraneous - too many animations, etc. distract students, and divergent tasks cause cognitive overload. Electronic presentations are effective when they relate directly to the task (a single task) at hand and do not require ‘switching’ between tasks

“Putting Education in “Educational” Apps: Lessons From the Science of Learning”

Gabrielle A. Cayton-Hodges, Gary Feng and Xingyu Pan

An examination of work on the Science of Learning, which examines how children learn best, to develop a set of principles to guide development in evidence-based app development.

Important Takeaways

- It is important to give students agency over what they are doing.
- Promote active, minds-on learning.
- Extraneous effects distract learners and take away from the experience.
- Each touch or swipe should be met with an immediate response to maintain focus and encourage continued interaction
- Feedback is necessary! Do not praise children for being smart, praise for their hard work to motivate them to persevere through potential difficulties. (par for the course when growing plants.)
Develop a growth mind-set
- Social interaction enhances learning! Allow students to collaborate with others
- Repetition is an important element of learning

“Now we have an app for that”

Richard J. Schaen, Garry Hayden and Janet M. Zydney

A project that paired first and third graders to work together to create apps that would be used by the schools kindergartners to learn mathematics concepts.

Important Takeaways

- “In addition to incorporating mathematics, engineering, and technology, the project gave young students a real-world purpose for planning and creating collaboratively.”
- Students thrive when given authority and are motivated with an interdisciplinary approach to learning.

“Tablet-Based Math Assessment: What Can We Learn from Math Apps?”

Kathy Kirsch-Pasek, Jennifer M. Zosh, Roberta Michnick Golinkoff, James H. Gray, Michael B. Robb, and Jordy Kaufman

A survey of mathematics education apps in the App Store reviewed on four pillars 1) quality of mathematical content, 2) feedback and scaffolding, 3) richness of interactions, and 4) adaptability of the applications.

Important Takeaways

- “The initial sample of sixty-four applications, as well as the sixteen-app subset reviewed, covered a wide range of mathematics topics, including numbers and operations, algebra, geometrics, and statistics and probability.”
- “This review culminates in the formulation of four recommendations for researchers and assessment developers on designing tablet-based mathematics assessments: (1) Thoroughly review the mapping between concepts/operations and objects/actions early in the task design stage; (2) Start with what evidence is needed to make inferences about student performance, and design the interactions to collect the necessary data; (3) Create opportunities for students to self-reflect or explain their problem-solving process; and (4) Adopt the mindset of app developers to keep the user engaged, on task, and moving forward to ensure that students are “in the game” enough to accurately assess content knowledge.”

“Greening Early Childhood Education”

Nancy Rosenow and Patti Bailie

Important Takeaways

- “Nature was a part of every major philosophical approach to early childhood education. However, in recent years, children’s access to nature has waned due to many factors including children’s increasing use of technology, diminishing wild spaces for children to roam, helicopter parenting, and as an unintended consequence of human progress.”
- It is important that children: “have daily access to nature-based outdoor and indoor environments in their early childhood programs and schools; be respected as competent, powerful learners and risk-takers who have a voice in what they create and learn through nature; be supported in developing life skills through holistic, nature-based learning”

“A Comparative Study of the Effectiveness of a Local Environmental Center’s Program for Urban Sixth-Graders Environmental Knowledge and Attitudes”

Aline Euler

A study that examined the effectiveness of environmental education programs on the environmental knowledge and attitudes of 267 sixth graders in New York City. The study broke participants up into three groups and compared results. Formal treatment group (school setting) , conformal setting (environmental center) and a control.

Important Takeaways

- Education, regardless of setting, is a necessary tool for promoting environmental awareness in students, especially at young ages.
- Outdoor hands on educational programs and traditional in-classroom education both have benefits to promoting educational awareness.

COMPETITIVE ANALYSIS

A competitive analysis was done looking at related products on the market today. This analysis looked specifically at smart, connected planters. Three different smart planters were analyzed, GROWS's automated, learning outdoor planter, Click and Grow zero-effort indoor planters, and the Biopod self-contained indoor ecosystems. Each product was analyzed in terms of it's intended use cases, included technologies, accessibility (specifically in the case of size and price), and customer opinions, if available. The finding of these analysis' are summarized here.

GROW

hellogrow.com



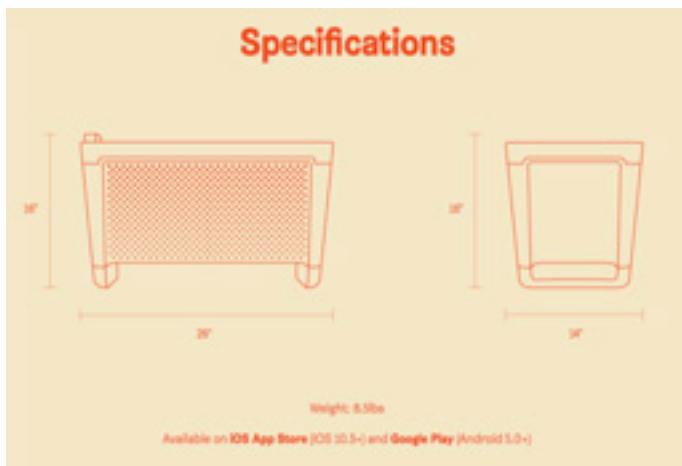
A sensor-powered learning garden.

GROW's mission is to "make food growing accessible and ubiquitous"

HOW IT WORKS

- 1) Connect your GROW to a water supply and to your phone
- 2) Select plants based on personalized recommendations from the app based on location and season.
- 3) Plant your seeds guided by instructions from the app. The app ensures the plants grow healthy by tracking the microclimate of the yard (air temperature and light), planter conditions (soil moisture and temperature), historical weather data, and plant variety profiles, to tell you when its time to harvest.)

At each harvest season, GROW recommends plants to grow next, helping you improve as a grower, but the GROW planter learns as you use it based on environmental data and user preferences.



**Note: GROW planters are set to be released in early 2018. No customer reviews are available at this time.*

GROW planters are priced at \$249 for pre-order. This purchase includes a single planter, hose connector and tube, a bag of organic soil, 2 AA batteries, 2 watering heads, and 2 starter plant kits.

CRITIQUES

- GROW requires a hose connection
- GROW cannot be used indoors
- At 26in (L) x 13.8in (W) x 16in (H) the GROW planter has a substantial space requirement
- The price point of a single planter is steep, especially for educational settings
- Beyond set-up, the user does not play a very active role in the gardening
- The learning aspect of GROW is not for the user, but for the app's AI

CLICK AND GROW

clickandgrow.com

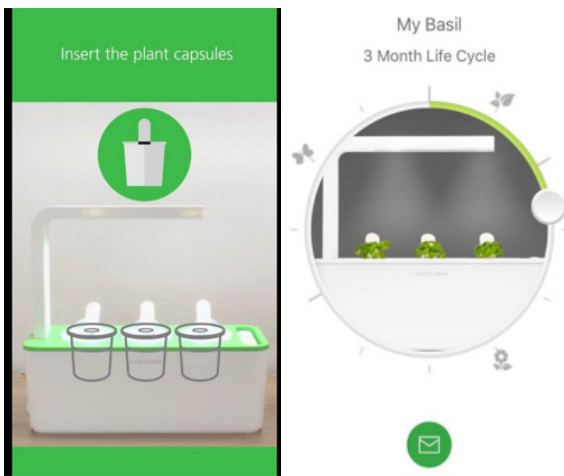
A zero-effort gardening solution perfect for urban homes.

Click and Grow's mission is stated as "we create transformative technologies that allow growing fresh, vitamin-packed food locally and sustainably."



HOW IT WORKS

- Built in timer provides 16 hours of light every day
- LED light - 10000 lux
- A Smart soil " automatically releases the nutrients , oxygen, and water your plants need to thrive" - the smart soil does all the work
- Professional grade seeds with 100% germination rate
- Refillable reservoir to hold one month of water
- Seed pods that act as a mini greenhouse
- Retail at \$99
- Plants typically sprout in 1-2 weeks and reach full size in 1-2 months
- Requires 6 watts on energy - to run for a full year, costs ~\$5
- Dimensions: 13.9 x 4.96 x 12.1 in



CUSTOMER FEEDBACK

- Click and Grow planters have 239 reviews on Amazon with an average of 3.8/5 stars.
- Positive reviews rave about the no hassle plants and the automated system.
- Negative reviews complain about the price of the system and the add-ons needed for use. Many criticize the over-head light for limiting plant growth.

CRITIQUES

- The Click and Grow app offers users little control or authority over their plant. It seems to be purely instructional
- The Click and Grow system is an easy indoor gardening solution that gives users fast-growing herbs, however there is little educational opportunity
- While the design is space efficient, the price point is not accessible and the overhead light has some problems.
- The smart soil and seed pods are very engineered and take away from the sustainable agriculture potential of growing food inside.

BIPOD

biopod.com

*A self-contained ecosystem that replicates real environments
"Biopod is an app controlled microhabitat that automatically
regulates temperature light, humidity, ventilation and rainfall."*



- Biopod is sold under "infinite uses" including environments for animals, herb and & veggie gardens, home and office decor, but most importantly - an educational tool and a way to enhance the classroom experience.
- "To enhance the classroom experience. Biopod makes a great educational tool for visual and hands-on learning in classrooms. Teachers and students can see different aspects of their environment including soil conditions, gas levels and moisture- all in real time. Classrooms can share their Biopod data with other classrooms from around the world and collaborate on observations and best practices."

HOW IT WORKS

- The smallest model, eden, is listed online at various retailer sites for \$549
- The technology: integrated misting, Biopur air injection, UVB CCFL lights, Sunlight Panel, integrated heating for both the air and soil, advanced sensory feedback that monitor and regulate temp, humidity, rainfall, and ventilation, biopod cloud to analyze user settings, an HD camera for viewing and sharing from anywhere via App, and wifi connection.

THE APP

Automatic Mode: only based on starting info (ie tips of plants or animals)

Custom Mode: for hobbyists, with custom lighting schedules, air and ground temp, daytime and nighttime settings, ventilation aeration, irrigation and rain.

Dashboard shows: Light - time, UVA/UVB, IR, Air temp, Ground temp, humidity, and daily rain (regulated by irrigation system), Irrigation, Arigation, Ventilation

CRITIQUES

- The price is not accessible.
- When used in an educational setting, the ecosystem is meant to be shared by the class and includes limited opportunity for hands-on activities as opposed to observational learning.
- The capabilities in terms of metrics are too complex for my intended use.
- The biopod, while rooted in environmental education, is not connected sustainable agriculture.

SURVEY

I developed a survey to understand school resources and teaching techniques from elementary school teachers' perspectives. This survey was developed and revised before sending it out. The survey was sent to all elementary school teachers of various school districts in 3 different states. With only 12 responses, this survey clearly suffered from a low-response rate. It is important to take into consideration that while the survey was sent to schools in varying locations with various demographics - urban to rural and wealthy schools to a schools with limited budgets, most of the responses came from teachers in the Somerville area, especially well-funded Montessori schools, where space is not particularly limited.

58.3% 4th grade teachers
16.7% 5th grade teachers
16.7% 3rd grade teachers
8.3% kindergarten teachers

50% said they incorporated electronic devices weekly and 50% said daily

83.3% said students had access to outdoor environmental education services at school
8.3% said students may have access to outdoor education but not in school and
8.3% said confidently that students did not have access to environmental education

On a scale of 1 to 4, how important is it to you to introduce your students to concepts pertaining to the environment, agriculture, and sustainability?

8.3% said 1
33.3% said 3
58.3% said 4

When planning in-class activities, how much do you consider physical space as a factor?

33.3% said 2
16.7% said 3
41.7% said 4
8.3% said 5

When asked about the most effective teaching style:

50% said hands on in class activities
41.7% said some combination of both hands on activities and teacher led lectures
8.3% said small group hands on activities

On a scale of 1 to 4, how important is it to you to provide students time to collaborate with each other into your lesson plans?

8.3% said 1
8.3% said 2
33.3% said 3
50% said 4

When asked to describe the physical space in a classroom

50% said spacious
33.3% said sufficient
and 16.7% said limited

When asked about lesson plans

66.7% described their lesson plans as interdisciplinary
33.3% described them as single-subject

SURVEY QUESTIONS

14

What grade do you teach?

Kindergarten 1st 2nd 3rd 4th 5th 6th

During the 2017-2018 school year, how many times were electronic devices such as computers, iPads, or smartphones incorporated in your curriculum?

Never 1 to 2 times 3 to 5 times more than 5 times
weekly daily

Do your students have access to outdoor, environmental education services such as school gardens?

yes perhaps, but not at school no

On a scale of 1 - 4, 1 being not at all and 4 being very important, how important is it to you to introduce your students to concepts pertaining to the environment, agriculture, and sustainability?

1 2 3 4

When planning in-class activities, how much do you consider space as a factor?

1(not at all) 2 3 4(it is the first thing I think about)

Which teaching style do you find most effective?

Teacher-led lectures Hands-on, in-class activities Some combination
of both

Other: _____

On a scale of 1 - 4, 1 being not at all and 4 being very important, how important is it to you to provide students the opportunity to collaborate with each other into your lesson plans?

1 2 3 4

How would you describe the physical space in your classroom?

Limited Sufficient Spacious

Which kind of lesson plan do you more commonly use, interdisciplinary lessons that incorporate a variety of topics or single subject lesson plans that focus on a specific field?

interdisciplinary single-subject Other: _____

Thank you for responding to this questionnaire.

If you are willing to participate in interviews or focus groups in the future, please provide your name and email here _____

EXPERT INTERVIEWS

To help understand my target user group, I turned to the people who know them well. I reached out to experts in Human Factors, Early Education, Environmental Education, Cognitive Development, and Developmental Psychology. Three experts responded and were able to meet for an interview.

The important takeaways from these interviews are summarized below.

SADIE PERRIN

Environmental Education Specialist

- Some combination of student-recorded data and system-recorded data
- Limit the metrics! Consider simple things like light, water, soil moisture, temp, etc.
- Starter plants over seeds to avoid students having to wait for a plant to sprout.

PAUL MUENTENER

Assistant Professor of Psychology and
Director of the Cognitive Development Laboratory

- Children forget the task at hand with too many side tasks to distract them
- Keep the app as simple as possible
- Constrain app capabilities, especially in the beginning

LAURA FRADIN

Education Specialist, STOMP Program Manager

- Physical space in a classroom is an obstacle to work around
- Students are more technically proficient with touch-screen devices, but laptops are more accessible in classrooms
- Children don't understand science they can't see
- Financial cost is vital to consider
- Make students more invested in their plants with names and perhaps a mascot
- Keep data visualizations simple

DISCUSSION

My initial user research provided an important overview of the needs of my users and helped to better define the goals of my final product. The literature review conducted validated a lot of my preliminary assumptions, specifically the importance of environmental based education at an early age regardless of the location it is conducted in. The literature review also extensively covered how to effectively design a technological interface for such young user groups. This idea was also reviewed during my expert interview with developmental psychologist Paul Muentener. My other expert interviews, one with education specialist Laura Fradin and the other with environmental educator Sadie Perrin, played huge roles in defining the goals of the final product. Both Sadie and Laura gave valuable insight into how young students might interact with such a product as well as possible ways to better design the product to teachers' needs. The competitive analysis provided an interesting takeaway. Each device reviewed had powerful capabilities and interesting use cases, but none of the products were directly in line with the goals of my product. The products reviewed, although they do not satisfy the goals of my project, will function as a great source of inspiration as I move into concept development.

In my project proposal I defined two target user groups - late elementary school students as my primary users and teachers and parents as a secondary user. One of the greatest takeaways from my initial user research is the need to redefine my target user groups. While late elementary school students and teachers remain my target users, I have recognized that one group does not come before the other. I have two primary user groups that come hand-in-hand with one another. It remains true that I must design with late elementary school students in mind, but it has become evident that designing for late elementary school educators is equally necessary to the success of the final design. This does not change the timeline of my project.

The findings of my initial user research have highlighted some important factors to consider when developing design concepts.

Physical Space

While the survey showed that teachers do not find physical space to be particularly limited, it is vital to remember who the survey respondents were. With responses largely from Montessori school and Somerville school teachers, it is a safe assumption that physical space is not as important of a factor for these teachers as it would be for teachers in more urban schools. During my expert interview with Laura Fradin, she stated that “space is just an obstacle [educators] have to work around.” As someone who spends time working at numerous schools in a variety of areas, Laura mentioned that in some schools space is a non-issue, but there are schools that she teaches at, such as one in Chinatown in downtown Boston, where space plays a large role in deciding the success of a hands-on activity, like the ones the STOMP program specializes in. To ensure the successful design of my product, physical space requirements will need to be minimized and used efficiently, without leaving out any necessary elements.

Collaboration

The importance of student collaboration and team work was reinforced by nearly every element of my user research. Students succeed when given the opportunity to work with one another. Providing the space for students to collaborate will be a necessary element to my final product design.

Hands-On Activity

“Putting Education in “Educational” Apps: Lessons From the Science of Learning” outlined the importance of “active, minds-on learning”. This was reiterated throughout the literature review, from survey responses, and even in my expert interviews. It is important that my final design embrace a hands-on approach to learning to help keep students engaged and optimize their learning.

User Authority and Investment

Keeping students engaged throughout the growing process has been a primary goal (and perhaps challenge) since the conception of this project. The initial user research has suggested the some effective ways to maintain such engagement. The literature review specifically underlined the importance of providing users authority over the tasks at hand. My expert interviews suggested that a great way to create this sense of authority is having students collect their own data. User input and data collection will be one of the most important elements of my final design. Further, my expert interviews suggested simple steps, such as including the opportunity to name your plant, to promote prolonged student engagement.

Simple digital interface

When meeting with Paul Muentener, one of his greatest concerns with the project was the risk of cognitive overload. This concern was validated by the findings of the literature review. When designing educational apps for young user populations the risk of cognitive overload is high. That is why designing an interface with clearly defined tasks and limited animations is important to the design of my final product.

Complement learning objectives and curriculum of fifth grade

One of the greatest “big picture” takeaways reinforced by my user research is the need for the final product to complement the education standards already in place for late elementary school students. My final product will not be a stand-alone educational device but a tool that supplements the crucial role played by educators. The survey, despite a low response rate, gave important insight into the general practices and priorities of teachers. This, in addition to takeaways from the expert interviews, provided great insight into how to better design a product for present day classrooms. In my next steps, deeper research into the specific learning objectives and standards of late elementary school will be a center point to ensure the final design can be mapped to these objectives.

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