2.1 Problem Statement

How might **Seattle-area students in age 8-12** achieve **learning about debris' impacts on marine wildlife while contributing to citizen science projects** so that they can **develop a sense of connection to the natural world through active learning while meaningfully contributing to science research**?

Old...

How might elementary school students achieve learning about science so that they can be informed and excited about STEM fields in their future academics?

How might elementary school students achieve learning about humanities and world culture through a hands-on interactive experiences so that they can gain important life skills and have understanding of different cultures?

How might elementary school students in the U.S. achieve contributing to participatory citizen science projects so that they can learn science through active and engaged learning, feel connected to and responsible for nature, and meaningfully contribute to science research?

How might elementary school students in the U.S. achieve contributing to participatory citizen science projects so that they can learn science through active and engaged learning and meaningfully contribute to science research?

2.2 Problem Background

Context

Why does this problem matter? What is the need not being met? What is the impact of inaction?

Citizen science are projects where ordinary people collaborate with professional researchers to facilitate the research process. Citizen science projects can be at four levels of participation: "crowdsourcing" where volunteers submit data, "distributed intelligence" where volunteers complete tasks, "participatory science" where volunteers are involved in problem definition, and "collaborative science" where volunteers are involved in many stages of the research process (Haklay, 2018, p. 54). All of these levels of engagement have their own unique strengths, and each level provides volunteers with an opportunity to learn and contribute.

Although citizen science has been growing, it is not engaging across all sectors of society, and gamification may attract new participants. The majority of participants are already-highly-educated people: 56%-78% of contributors to citizen science projects including Galaxy Zoo, Folding@home, and FoldIt have tertiary degrees (Haklay, 2018, p. 55-56). Bowser (2013) found that integrating gamification and social components into a citizen science project motivated volunteers to participate (p. 6-7). A citizen science project developed with these considerations in mind could attract a broader audience.

Collaborating with schools is a potential opportunity for growing citizen science which also benefits the children participating. Children are naturally "exploratory, inquiry-oriented, [and] evidence-seeking," making citizen science participation an engaging, tangible extension to science curriculums (Makuch, 2018, p. 393). Childrens' participation in citizen science projects also helps students inspire a sense of connection to the environment, develop a feeling of responsibility for the environment, improve self-confidence, and develop practical skills involved in the project (Makuch, 2018, p. 394). Partnering with schools could also improve access to STEMM fields for marginalized groups that have been historically excluded (Makuch, 2018, p. 395). Providing actual value to a research project also inspires interest in science (Harlin, 2018, p. 412)

Partnering with schools also benefits researchers by providing students as interested volunteers, teachers as leaders and data quality filters, as well as increased public awareness of their research area (Harlin, 2018, p. 411). Kosmala (2016) found that quality of data collected by volunteers for citizen science projects is "at the same level" as that of professional ecologists (p. 553), and there are a number of strategies that researchers can use to increase accuracy through iterative development of volunteer tasks, volunteer training and testing, replication across volunteers, and statistical methods including weighting results based on volunteer skill (p. 554-557). Additionally, scientists communicating concepts in ways that are understandable by children also helps this knowledge be shared within communities to further scientific literacy (Makuch, 2018, p. 393).

A project that gamifies citizen science and targets a child audience would benefit research, improve community engagement with local scientific research, and help children connect with nature and be inspired by science.

Information Problem

What aspects of the problem can you solve through an information solution?

Teachers and parents would benefit from engaging activities that connect students/children to authentic science, and professional researchers would benefit from volunteers supporting the project. However, it is not entirely straightforward to engage schools in citizen science projects.

Successful citizen science projects involving collaborations with K-12 schools must balance scientific and educational goals and must provide teachers with relevant curriculum and additional training (Harlin, 2018, p. 413-414). Tasks must also be designed in a way that recognizes childrens' developing strengths and unique competencies (Makuch, 2018, p. 404). Gamification would help maintain student engagement in citizen science projects (Bowser, 2013, p. 6-7). There must also be strategies implemented to ensure high-quality data is collected (Kosmala, 2016, p. 554-557).

These are many considerations to juggle. An information solution would solve these challenges of creating engaging age-appropriate activities, connecting classrooms to scientists, providing appropriate training to teachers, and providing appropriate support to students.

References

What evidence (articles, statistics, research, data etc.) supports the problem you have identified?

Bowser, A., Hansen, D., He, Y., Boston, C., Reid, M., Gunnell, L., & Preece, J. (2013, October 2). Using gamification to inspire new citizen science volunteers. Proceedings of the First International Conference on Gameful Design, Research, and Applications. Gamification '13: Gameful Design, Research, and Applications. https://doi.org/10.1145/2583008.2583011

Bowser (2013) is a case study in the results of gamifying a citizen science project.

Haklay, M. (2018). Participatory citizen science. In Haklay M., Hecker S., Bowser A., Makuch Z., Vogel J., & Bonn A. (Eds.), Citizen Science: Innovation in Open Science, Society and Policy (pp. 52-62). London: UCL Press. Retrieved January 21, 2021, from http://www.jstor.org/stable/j.ctv550cf2.11

Haklay (2018) shares examples and categories of citizen science projects, as well as best practices and current issues.

Harlin, J., Kloetzer, L., Patton, D., Leonhard, C., & Leysin American School high school students. (2018). Turning students into citizen scientists. In Hecker S., Haklay M., Bowser A., Makuch Z., Vogel J., & Bonn A. (Eds.), Citizen Science: Innovation in Open Science, Society and Policy (pp. 410-428). London: UCL Press. Retrieved January 21, 2021, from http://www.jstor.org/stable/j.ctv550cf2.35

Harlin (2018) shares examples of how citizen science can be integrated into school classrooms.

Kosmala, M., Wiggins, A., Swanson, A., & Simmons, B. (2016). Assessing data quality in citizen science. Frontiers in Ecology and the Environment, 14(10), 551-560. Retrieved January 21, 2021, from http://www.jstor.org/stable/24891216

Kosmala (2016) assesses the accuracy and bias of volunteer-collected datasets, and shares strategies for improvement.

Makuch, K., & Aczel, M. (2018). Children and citizen science. In Hecker S., Haklay M., Bowser A., Makuch Z., Vogel J., & Bonn A. (Eds.), Citizen Science: Innovation in Open Science, Society and Policy (pp. 391-409). London: UCL Press. Retrieved January 21, 2021, from http://www.jstor.org/stable/j.ctv550cf2.34

Makuch (2018) describes benefits and considerations of including children in citizen science.

2.3 Research Questions

Define research questions relevant to problem statement → List hypothesis / assumptions about the question → Identify research activity → Assign members (ideally all members will do some part of each research activity)

How can elementary school kids be exposed to science at-home in a way that supports their development?

- Caveat: we will need to carefully assess what materials families' have available at-home
- Assumption: parents have the time to support their kids in learning science at-home
- But it is not necessarily imperative to have parents guide their children's' learning. Children are naturally curious and can navigate well-put-together materials on their own
- Read and analyze related research papers/articles
- Survey students to learn what they learned at-home
- Survey parents to learn if they helped their kids learn science at-home
- assigned to group

How might exposure to science through hands-on projects at a young age increase elementary school kids' interest in STEM fields in the future?

- Assumption: hands-on learning is more engaging than other types of learning
- Caveat: we will not be able to conduct a longitudinal study, rather this question can be evaluated through observing kids' immediate interest and if they applied the material they learned in their daily lives (i.e. learned why the sky is blue and repeat it to their friend when playing outside)
- Read and analyze related research papers/articles
- Conduct interviews with students and observe if they are excited when doing hands-on projects
- Have parents document the students use what they learned in the days that follow
- assigned to group

How can extending established citizen science projects to involve elementary school kids as volunteers increase kids' awareness of their surroundings and their interest in STEM fields in the future?

- Hypothesis: by learning science through examples tied to the "real world," students will appreciate their surroundings more because they "know" the science behind what happens
- By learning basic science at an early-age, kids will perceive a smaller barrier when continuing/furthering their studies in STEM in the future
- Assumption: most citizen science projects engage older/experienced people as volunteers
- Read and analyze related research papers/articles
- Meet with current researchers conducting citizen science projects to learn how kids can be helpful volunteers
- Conduct interviews with students after they participate in citizen science projects to understand what their reactions are
- assigned to group

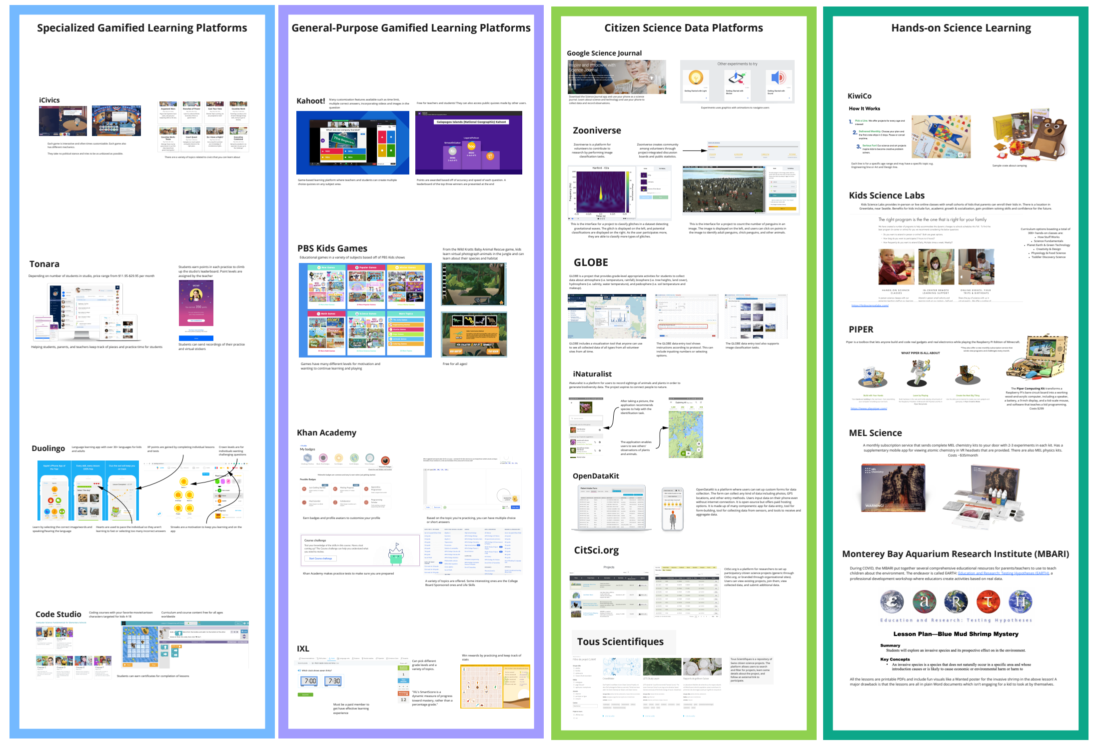
2.4 Literature Review

Present & discuss as a team → Capture insights on stickies

Key Insights

2.5 Market Research

Research existing products, services that compete or inspire → Each member finds at least 5; document by capture screens, annotating or sketch out functions → Identify specific parts, functions that are relevant → Present & discuss as a team → Capture insights on stickies



Key Insights

2.6 Initial User Research

Identify key audiences for your project → Develop interview script + questions and survey → Interview at least 5-6 users (qualitative) / survey at least 20 (quantitative) → Take notes on stickies: Group stages, and categorize (see right) → Present & discuss as a team → Capture insights on stickies

Observation | Positive | Opportunity | Quote | Problem / Pain point

Key audiences

After further considerations, our key audience are **kids in grades 3-5** and parents with children in that age range. Our initial key audiences when conducting the survey research were the following

1. Kids in grades K-12
2. Parents with children that went through grades K-12 in the U.S.
3. Kids that went through grades K-12 in the U.S. at some point

Interview script

N/A as of right now. Our first step was conducting surveys in the format of Google forms to college students who have went through K-12 in the US and parents who have children in K-12.

As a target audience of children K-12 is too broad, we have decided to narrow our audience down to children in grades 3-5. We hope to interview children in that grade range whose parents indicated in the survey that they would be interested in testing our product.

We will conduct interviews soon with key audiences.

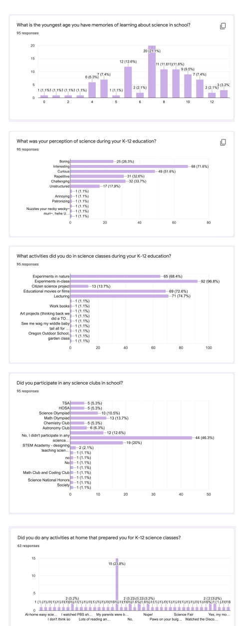
Survey questions

Survey directed towards college students (audience 3): https://forms.gle/rKJpTVDs7UnFBSBL6

Survey for parents (audience 2): https://forms.gle/jxEvoVqHKLSaUraDA

Students Survey Insights (95 responses)

- Students surveyed come from a variety of majors: Informatics, Business, Computer Science, Pharmacy, Nutritional Sciences...
- The oldest age students remember first learning science is at age 13
- Around 21.1% noted that the earliest memory of learning science was at age 7
- Overall, students are learning science at a young age
- Example of hands-on learning in their K-12 education: "In Eastern WA we also do interactive field trips like the Salmon Summit, where we went to the Columbia river and released some salmon that we had hatched earlier in the year — this was in fifth grade."
- Majority of students had positive thoughts associated with science (ex. "interesting" and "curious")
- About 26-30% students noted that science was "boring" and "repetitive"
- Great to see students experimenting in nature already
- About 37 students didn't choose to participate in science clubs (did not note that they didn't have those opportunities)
- Definitely opportunity for more citizen science projects as they seem less popular (13.7%)
- Example of at-home science learning: "Educational computer games and books about science prepared me well for younger grades"
- About 15/63 students didn't do structured or any science activities at home which shows opportunity for this product



Parents Perceptions of Learning Science Survey Insights (8 unique responses)

All parents agree that it's important for children to learn science outside of school, specifically citing ties to learning about their environment and bonding with parents

Key quotes:

"doing more at home reinforces learning and give students a chance to explore their passions. It helps parents and student bond as well."

"it helps them connect to and understand their environment better."

"Kids can dig deeper and perhaps do big projects with families that might not always be possible at school as the curriculum is set so there is more choice and freedom at home"

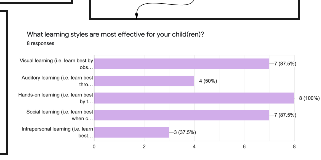
Parents have different definitions of what learning science at home looks like. 3/8 reported that they bought some sort of experiment kit. 1/8 used Youtube. 1/8 mentioned games like Jenga, legos. 1/8 mentioned "kitchen" science ("show how metals corrode, or how to prepare yogurt")

4/8 parents reported feeling unsatisfied with the engagement and effectiveness of classroom science for their child.

4/8 were satisfied. These responses included both of the 2 private school responses.

Hands-on learning was the selected by all parents as an effective learning style for their child. Social learning and visual learning were both selected by 7/8 parents. See chart below

From our survey, we have 2 parents with kids in grades 3 - 5 that are willing to help test our solution! We are continuing to look for more kids from different backgrounds to help test.



Key Insights

- Citizen science is not a fairly popular topic/project in school
- Many students didn't do any structured science activities at home, but some would watch educational TV shows or read science books
- Performing experiments in nature is quite common for students
- Definitely an opportunity for making science more interactive and interesting
- Parents all agree that it's important for kids to learn science outside of school to see their learning applied to the real world.
- Some parents also see learning outside of school as a way to bond with their child and for their child to explore their interests.
- Private school seems to engage students more in learning science, but we also had a small sample size
- Parents all have different definitions of what learning looks like at home.
- Hands-on learning is valued by all parents
- Visual and social learning were also predominant learning styles found in our sample.

2.7 Affinity Map / Research Insights

List 10 insights from your research per team member → Discuss and ask clarifying questions → Group them according to themes → Label the themes

Engagement and Learning

- Important to keep kids engaged and interactive in learning, such as through gamification methods
- Motivation for kids learning seems to revolve around gaining a prize that proves their knowledge or their time invested in an activity.
- Hands-on learning and visual learning is very engaging for kids
- Social learning is also useful for engaging kids, but there are obvious barriers for that right now with COVID-19
- Gamification motivates individuals of all ages
- Gamification has a lot of great motivators to encourage users to stay with the product
- Children are naturally curious and engaged, which is well-suited to active learning through citizen science
- Hands-on learning makes students engage with better
- Social collaboration is heightened for kids when they interact with hands on activities
- Gamification can come in a variety of forms (ex. points, streaks, leaderboard)
- Gamification has shown to keep students engaged in learning in different subjects

Parents and Teachers

- Teachers and parents need support in teaching science; parents don't want kids on screens all day
- Parents have noticed a sharp increase in screen time due to COVID
- Teachers and Parents struggle with being confident enough or prepared to teach their children.
- Something we didn't do research on, but is probably true lol: parents want to limits kids screen time
- Practically all parents think early science education achieved through activities at-home is important
- Parents and teachers require support to meaningfully support students in learning science at a young age
- When incorporating tech into education, controlling screen time is an issue that arises for parents

Theme

Educational Considerations

- There are many STEM-based tools for elementary students to learn science; important to be transparent when working with children; education access varies based on location and technology available.
- There's a variety of educational tools for elementary school kids
- STEM-based products are very popular when it comes to kids' education
- Elementary school ages are a wide range. To make an effective solution (game, kit, etc), we need to hone in on a smaller age range.
- Depending on where you live, the quality of your education may differ significantly
- Lessons that are created but rely on printers or a parent to guide the student are not as widely-used.
- Many ethical questions such as 'free data' and consent from parents/guardians need to be considered
- Important to be transparent to customer about liability/risks especially when working with children

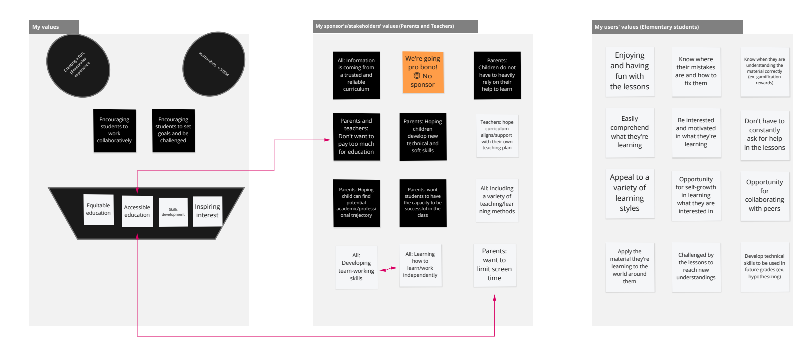
Citizen Science

- Citizen science projects help students feel responsibility for nature, feel like their learning is meaningful, understand science, and develop skills
- Most citizen science contributors are highly-educated, and participation is not equal across society
- Citizen science allows for young scientists to conduct research and science in action
- Establishing a new citizen science project requires either technical expertise to set up ODK, funding to have ODK hosted, or conforming with the format of less-customizable platforms like CitSci.org
- Citizen science projects should not limit volunteers from being involved in stages of the research process including problem definition, analysis, etc.
- Quality of data collected by volunteers is comparable to that of professional researchers, and there are strategies to maintain that quality
- Many repositories of volunteer-contributed data have many more people downloading and utilizing the system rather than contributing to it

Technology and Education

- Technology is a way to make learning interactive, and make learning resources accessible and affordable
- Technology is being integrated with children's education
- Online learning has provided personalized learning for students
- Interactive components (ex. matching and ordering) help preschoolers to develop cognitive skills
- For online platforms, they are usually free. However, for tangible items, they cost a price
- Interactive and animated graphics are seen in many learning platforms

2.8 Values & Ethics



Identify one or more ethical considerations that threaten your project's potential for positive impact.

Ethical considerations	Worst case scenario	Best case scenario
Ethical Consideration of 'Free Labour' and 'Free Data' from Participants in Citizen Science Projects As the purpose of citizen science projects is to have citizens collect data to serve a meaningful research project, there are questions concerning the idea of 'free labour' and 'free data' as raised from the book chapter "Children and Citizen Science" by Makuch and Aczel. One of the sources in this chapter mention that users are usually willing to participate and contribute the data they collect in exchange for the learning experience they are receiving during the process. With the target audience being children, another consideration to keep in mind is that parents/guardians will need to consent on behalf of them in allowing their data to be used. Issues of 'ownership of data' and the participant's role can be transparently laid out at the beginning of project so the parents/guardians are aware of the process.	What is the worst that can happen? We are sued for not being transparent with our customers regarding how ownership rights of data Citizens do not participate in the project as they feel they are not getting the learning experience they deserve in return We do not receive consent from parents/guardians in using their children's data and receive complaints	What is the best that can happen Citizens consent that the data they used are for a meaningful cause and no ownership issues arise Citizens agree in participating in the projects pro bono as they are getting an opportunity in return
Ethical Consideration of Potential Risks Over Benefits for Children Participating in Citizen Science Projects As children are the users participating in the citizen science projects, there are always potential physical and mental risks that can occur which the company does not take liability for. When reading Kiwico's terms and conditions, we noticed that they state "the site and/or the products are at your own risk" and "in no event will we or our affiliates be liable for any indirect, incidental, consequential or special damages in connection with these terms, the service, the site, or the products". This statement clearly shows that there are possible harms to using the product/service, but the company does not take any responsibility.	What is the worst that can happen? Our product/service unintentionally causes a physical harm to our customer Our product/service is teaching inaccurate information to our customer We are unclear in our policy regarding whether we take liability for risks to the customer	What is the best that can happen There are no potential risks for the customer using our product If there are risks, we are transparent about what they are and whether we take responsibility
Ethic Consideration of Volunteers' Motives and Providing Quality Data With the data coming from volunteers who are children, there is a concern about the quality and accuracy of the data they provide. According to the article "Assessing Data Quality in Citizen Science" by Kosmala, Wiggins, Swanson, and Brooke, their concern is that "science and policy might be derived from unreliable data, since the quality of data produced by volunteers has long been a concern". Therefore, many believe that citizen science projects are more about the educational experience it provides than producing high-quality and publishable results. When looking on the Zooniverse talk page, we noticed that there are questions circulating about whether children/teens should participate in online citizen science projects when done in a classroom setting. The reason for this concern is that participating in citizen science projects should be voluntary. However, when the projects are done in a classroom, the motives of the participants may change as they are instructed to do so by a teacher.	What is the worst that can happen? The data we collect from our participants are inaccurate and produce a misleading theory/result Teachers misuse our service as a mandatory assignment/project "forcing" students to participate Volunteers purposefully input inaccurate data	What is the best that can happen The participants are voluntarily participating without alternative motives/reasons We fact check the data that is being produced before coming up with conclusions to ensure for accurate results