**Project Proposal: Team BEEducated**

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**Campus Sustainability Fund Project Proposal**

**05/14/21**

**Project Name:** Establishment of a SMART Hive in a Pollinator Garden

**Project Mission:** Promote pollinator health through the accommodation of honeybees in SMART Hives placed at a designated pollinator garden space at the apiary at the UW Arboretum in partnership with the Puget Sound Beekeepers Association. Raise awareness about pollinators and the pollinator crisis through informative workshops for UW students and the larger community.

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**Executive Summary**

Our project entails the creation of a SMART Hive model based off of the Langstroth Hive design and complete with sensor technologies that allow beekeepers to monitor the hive condition, detect hive stressors, and alert beekeepers to intervene before colony collapse, a deadly environmental issue that affects thousands of hives in the United States. As part of this project, we will conduct virtual and in-person workshops to teach UW students about the pollinator crisis and how to plant pollinator gardens (see our prior work with pollinator education: [www.thebeeducated.org](http://www.thebeeducated.org)).

**Detailed Budget**

**Amount Requested**

We are requesting a total of $3910 to fund the research, development, and deployment of our SMART Hive at UW.

**Budget Breakdown**

Key:

\*Research Expenses: Related to research logistics/user research phase

\*Sensor Expenses: Related to build phase for the sensor technologies

\*SMART Hive Model: Related to build phase for the physical hive prototype

\*Beekeeping Expenses: Related to final phase of introducing bees into the hive

\*Pollinator Garden Materials Expenses: Related to final phase of building a pollinator garden

\*Education/Outreach Related Expenses: Related to the ongoing phase of conducting virtual/physical workshops on the pollinator crisis/planting sustainable pollinator gardens

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| **Purpose** | **Item** | **Cost ($USD)** |
| **Research Expenses** | Technology + Licenses (incl. Google Suite Basic Plan ($360 per year); Wix ($200 per year)) | **$560** |
| **Research Expenses** | Honorarium for research development led by principal investigator Audrey Anderson (<https://www.linkedin.com/in/audrey-m-anderson>) | **$1000** |
| **Research Expenses** | User research compensation ($25 per participant in the form of amazon gift cards; 20 participants) | **$500** |
| **Sensor Expenses** | DHT 11 sensors (4x at $5 each -- humidity, temperature) | **$20** |
| **Sensor Expenses** | Electret sensors (10x at $1.50 each -- sound, pressure) | **$15** |
| **Sensor Expenses** | Raspberry 3 Pi Computers in beehives which will use the Google Artificial Intelligence Yourself (AIY) kit (2x at $100 each) | **$200** |
| **Sensor Expenses** | GPU (likely Nvidia RTX 3070) to increase speed of training models | **$800** |
| **Sensor Expenses** | Additional necessary hardware components (incl. miscellaneous items for design and build) | **$300** |
| **SMART Hive Model/Beekeeping Expenses** | Cypress/Pine Wood Slabs for Hive Model | **$100** |
| **SMART Hive Model/Beekeeping Expenses** | Package Honey Bees | **$200** |
| **SMART Hive Model/Beekeeping Expenses** | Hive Tool | **$15** |
| **SMART Hive Model/Beekeeping Expenses** | Bee Brush | **$10** |
| **SMART Hive Model/Beekeeping Expenses** | Bee Smoker | **$40** |
| **Education and Outreach Related Expenses** | American Meadows PNW Pollinator Wildflower Seed Mix (Distribute seed packets to UW Students to encourage them to plant their own pollinator gardens) | **$100** |
| **Education and Outreach Related Expenses** | Print Educational Flyers (Flyers will advertise information about pollinators/planting pollinator gardens to UW students) | **$50** |

**Additional Funding Sources**

Our previous funding sources include a grant for $10,000 that we won out of 120 applicants from the Coding It Forward organization (2019). This grant was mostly spent on community service related efforts that included costs for pollinator garden materials, transportation, and more. There is about $2,000 remaining that will be used to compensate the other research/engineering team members. Moreover, BEEducated also won the Ashoka and GM STEM for Changemaking Challenge (2018) where we received $1,000. The majority of this grant went towards hosting our website and paying for certain website features or upgrades. Finally, BEEducated won the T-Mobile and Ashoka Changemaking Challenge out of 400+ teams and a grant for $2,000. This fund is our backup fund which we intend to use only in emergency situations as a last resort.

At this moment, we are not looking at other potential funding sources.

**Grant/Loan Status**

At this time, we are not at a stage where the grant can be fully paid back. However, should the deployment of the SMART Hive at UW prove to be successful in mitigating colony collapse, we intend to conduct a larger scale study with the hives before potentially marketing it as a low-cost solution to beekeepers in and around the U.S. Depending on the course of sales, we may be able to pay back the grant.

We will also commit to retrofitting the 20 existing beehives in the apiary with the sensor set-up at cost and providing the sensors to the beekeepers of the PSBA who also use the space at the UW at a discount.

**Organization Goals**

**Sustainability Impact**

Bees are a vital part of our agricultural and economic systems, as they pollinate 71 of the top 100 food crops—about 90% of the world’s nutrition. However, due to a combination of factors such as parasites/pathogens, pesticides, climate change, and human mistreatment, hives in the U.S. have faced the threat of colony collapse (“Colony Collapse Disorder” (CCD)) which is characterized by the mass departure of worker bees from a colony, effectively leaving the hive to die out. Based on recent studies, CCD affects sites with fewer than 5 hives at a rate of 14-17% in the U.S., resulting in the loss of thousands of hives and reduced crop viability/value. Moreover, since the pollination from bees enables genetic diversity and food production, it’s clear that bees remain a vital part of our ecosystem as they preserve nature’s biodiversity.

For our project, we’re building a SMART Hive complete with sensor capabilities that help beekeepers monitor the conditions of their hives, be it through analyzing photos of bee behavior to identify possible mite infestation, identifying abnormal behavior due to insecticides, or even simply monitoring the hive’s temperature. These, along with various other environmental factors that influence the bees’ health (symptoms of climate change and other weather concerns) pose serious concerns for beekeepers.

By establishing a partnership with the Puget Sound Beekeepers Association (PSBA) through David Zuckerman, we hope that the PSBA will sponsor our project at the UW Arboretum’s apiary (an apiary that PSBA maintains) since it is not in an enclosed area to access and it already has a public outreach component on beekeeping. Originally, we had hoped to install our SMART Hive at the UW Farm, however, installing a hive there is not possible due to public liability and safety concerns. Hence, we will focus on deploying our hive at the apiary in the UW Arboretum and work with David Zuckerman (Manager of Horticulture) to fulfill the necessary approval process.

Without bees it will be very difficult to maintain current food production and levels of biodiversity. Thus, the BEEducated project will mitigate the likelihood of colony collapse occurring by providing beekeepers with an affordable and efficient method to track the conditions of their hives.

**Education and Outreach**

Our outreach/education goals include teaching at least 100 UW students from the general student population about the importance of pollinators via virtual workshops, leading at least 2 in-person pollinator garden planting sessions at local parks with at least 20 UW students in attendance, and distributing at least 20 seed packets of a PNW pollinator-friendly seed mix to UW students who would like to start their own sustainable pollinator garden.

To advertise this event, we will coordinate with professors we have previously contacted for their support to present to their classes about the project. Moreover, we will also email other professors in the Chemistry, Psychology, and Biology departments who may have students interested in learning more about bees.

To expand our reach, we will create events for the Pollinator Garden Planting Sessions (In-Person Workshops) where we will present an informative guide on how to create a sustainable pollinator garden ([BEEducated\_ Launch Kit for Community.pptx](https://drive.google.com/file/d/1PR0X7Esxp4J4qR4LCVXjeaNhHnYNMykM/view?usp=sharing)). By communicating with public relations departments, we can post about our project and workshops soon after acquiring funding to promote our outreach efforts. We will also draft up a press release to facilitate the coordination process with the PR department.

Finally, to take advantage of other resources and communication channels UW students are likely to use, we will make a post on the UW Reddit as well as send in similar press release blurbs and photographs to Smirk and The Daily to both recruit volunteers and share information on the project. We will also create informational flyers ([PgK Flyer\_Check-In.pdf](https://drive.google.com/file/d/199g-OUPszyUTn1lDcoe8UQd4BOHgDKkI/view?usp=sharing))  that could potentially be distributed through the residence halls.

To measure the impact of our efforts, we intend to have all student participants fill out a survey after each virtual workshop and in-person gardening session. We will also have students who take home a set of pollinator-friendly seeds to build their own pollinator garden fill out this form that documents the progress of their garden: <https://forms.gle/epys7g2gaDSpdne96> .

**Student Involvement**

We are currently wrapping up the User Research portion of our project. Our UX Team recently sent out a survey to beekeepers, receiving around 40 responses from around the world. They are now in the process of conducting interviews with these beekeepers to finalize insights for our sensor/hive model. As they complete that stage, Audrey Anderson, our principal investigator, is continuing her research into the causes for colony collapse. Her report detailing her findings will be presented by the end of June.

Our next steps are to invest more time into the build process for a device that will run a Computer Vision algorithm to monitor the hive population/condition and contain sensors that relay data about measurable factors such as humidity or temperature back to an app such that the user can interact with their SMART Hive. As part of these next steps, the SWE (Software Engineering) team will begin building the app prototype in React Native. In order for the Electrical Engineering team to begin assembling the microcontrollers and such though, we will need the grant in order to purchase the necessary hardware. Without the grant, we will be unable to engage with the build process for the sensor and hive itself.

If this project were to be fully funded though, we could continue with the build phase for the sensor device and physical hive prototype. To advise us on this process, we reached out to UW EE professor Shyam Gollakata who previously worked on innovative research pertaining to a sensor that could be placed on a bee to track it. He agreed to advise us on this project. We are also reaching out to pollinator research labs across the country to visit them (virtually) and gather their advice or insight for our hive design. Once we finish the build stage for both the sensor device and hive model, we intend to deploy the single SMART hive at the UW arboretum. Since the weather is not optimal during the summer and winter for planting, we cannot immediately plant a pollinator garden before introducing our hive model. Thus, we would return at a later date, early next year, to begin adding the flowers to the space. In the meantime, we would focus on our education and outreach efforts by hosting virtual workshops in the summer about the pollinator crisis and in-person workshops in the late summer/fall to introduce UW students to sustainable pollinator gardens.

In terms of opportunities for student involvement, although we currently have a team of 8 UW students working on various research efforts within this project, we are actively looking to recruit more volunteers. Through our incubator program Dubhacks Next, we have a hiring page in order to recruit more UW students to join the project. These positions include Recruitment Coordinator, Business Team Lead/Member, Environmental Science Researcher, and SWE Lead/Member to name a few.

Another way in which UW students can be further involved, besides our outreach efforts, is through volunteering with us to build the pollinator garden at the apiary once we reach that stage. Furthermore, once we add the bees to the hive, through a partnership with the Puget Sound Beekeepers Association, we can create a program to train UW students to become beekeepers and have them maintain the SMART hive for the foreseeable future.

To track student involvement, we will have volunteers and workshop participants fill out brief surveys to keep a record of their participation.

**Organization Goals**

**Project Timeline**

**Timeline:**

Now - End of May (Finalize Recruitment)

Now - July (Research & Design Phase)

* Now - End of May: Select sensors + microcontroller (EE)
* Now - End of May: Continue creating partnerships with UW faculty, staff, and resources
* Now - June: Create flyers and digital outreach materials
* Now - June: Complete training a model to ID varroa mite; CE)
* Now - June: Compile research and data lists (Research)
* May - June: Select cloud service (EE)
* May - July: Core experience (UX)
* June - July: Conduct virtual pollinator crisis education workshops and recruitment of volunteers
* June - August: Implement sensors into hive design (EE)
* Early July: Secondary Items (UX)
* Late July: Usability Study (UX)

July - September (Build Phase/Secure Additional Investments as Necessary)

* June - August: Improving models (adversarial training etc; CE)
* July - August: Final design handoff (UX)
* August - September: Installation of first edition for senors/smart hive

September - January (2022) (User Testing/Refining the Product)

* July - January: Train new models, specific to our Beehives (CE)
* August - January: User testing and further design iterations (UX)
* September: Host in-person sustainable pollinator garden workshops highlighting other sustainable points on campus (perhaps even a DawgDays event?)
* December - March 2022: Collect data from customers, refine model monthly (CE)