Supplemental Material 2
Guide for students developing a microscope-based outreach project

Objectives

Use outreach events as a mode to convey science to others and collect data for your project
Learn how to organize and analyze data
Explain and interpret the results and conclusions

Methods and Data Collection

Part A: Planning

In carrying out a research project, you will have the opportunity to ask questions, create methods, and conduct experiments to gather data. You will then be able to analyze this data and interpret the findings to answer your research question. In preparation for a research project, you should be aware of the timeline and the resources available to you. You, your mentor, and other collaborators should work together through the planning aspect of the project. What is your primary question? How can you gather data that is applicable to your question? What methods of data collection are necessary and reliable?

For instance, you could focus on discovering which microscope would be the best for outreach events. You could narrow the focus of your study to image clarity and user friendliness. Methods of data collection to match your focus are also needed, such as Likert-type scales to allow outreach participants to quickly and easily provide ratings based on their experience at our activity.

Part B: Institutional Approval

The most challenging part of a project can be obtaining institutional approvals. These all need to be obtained before you start your project. If your research involves humans, such as gathering data from the people participating in an outreach event, your project plan needs to be reviewed by the Institutional Review Board (IRB). You can first submit a human determination form first to see if a full IRB protocol is necessary. If the project is not ruled exempt from IRB oversight, you will need to write and get approval for a full IRB protocol on your project. If you are using vertebrate animals, you will need to get any procedures using the animals approved by the Institutional Animal Use and Care Committee (IACUC) and everyone working with the animals will have to be on the protocol, which includes completing IACUC-required training. Finally, everyone working with chemicals should complete the relevant chemical safety training and all chemicals should be reviewed for safety.

Part C: Choosing the specimen

Taking live specimens to outreach requires extra materials and time. It is best to choose organisms that the project leaders are very familiar with. The organisms should be portable, able to withstand a lot of handling, and easy to keep alive. For example, live planaria are a good match for a microscope-based project as their size (~ 5 mm long) is appropriate for a wide range of magnifications. Live planaria can be easily wet mounted on a slide by either the people leading the activity or the participants themselves. To do this, a plastic transfer pipet, planaria, and a drop of water are placed into the depression of a glass depression slide. A cover slip is then placed on top to keep the planaria and water in the depression. The planaria should be kept on the slide for about ten minutes because the light from a microscope increases planaria activity and can dry out the slide.

Planaria are also very easy to transport and use. The planaria should be transported in a covered container with extra water. Approximately 10 planaria in 200 ml of water is a good ratio. On arrival to the outreach event, the cover or the transport container should be removed so the water remains oxygenated. This transportation container should be used as a recovery tank for the planaria that have been used on slides. To move them to the recovery tank, the cover slip should be removed and a transfer pipet full of water used to wash the planaria into the recovery container.

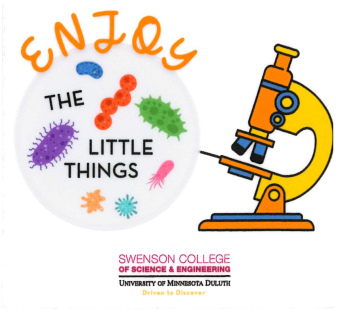
Part D: Implementing the Outreach Activity

It is important to have a plan for finding appropriate outreach events where you can host a station. If possible, build on connections with local schools, university outreach events, and FIRST Robotics, a non-profit focused on STEM education. Have a plan for how your activity is going to flow but be flexible so that you can change the plan if needed. When participants arrive, give them a brief overview of the project and what they will be doing. In addition to explaining the goal of the project, ensure you provide enough background information and share a few fun facts. Keep your introduction to five minutes or less so the emphasis is on the hands-on experience. Ensure that someone who can both ask the participant questions and answer their questions is always nearby. If you are gathering data from participants, make sure that they can easily and quickly do this before leaving your activity. Finally, consider having a souvenir your participants can take home at the end of your event, such as STEM-themed stickers (Figure).

Part E: Data Analysis

Make sure to have a system for collecting and backing up all the data collected during the outreach events. It is also important to sort the data and organize it according to the analysis you are planning to do. Another challenge is finding the correct statistical test, especially if the sample sizes are not the same across categories and if you have many sets of data to compare. There are many free online calculators and free software that can be used, many of which also include guides for finding the right test. For instance, Interactive Statistical Calculation Pages provides online calculators for many statistical tests and Real Statistics for Excel provides a free plug that brings many additional statistical methods into Excel (Zaiontz 2023)(Interactive Statistics).

Figure: Example of a STEM-themed sticker that was given to participants in an outreach-based microscope project.



CITED REFERENCES

Interactive Statistics. [accessed 2025 Aug 26]. https://statpages.info/

Zaiontz C. 2023. Real Statistics Using Excel; [accessed 2023 Aug 9]. https://real-statistics.com/