STEAMCITY CURRICULUM

FLOWER GUARDIANS
Pollinator Tracking

thematic: environment, well-being and public health

Introduction

Pollinators are **invisible yet essential actors** in our environment. They ensure the reproduction of numerous plants, including the majority of those producing our **fruits and vegetables**. However, pollinator populations are in danger - victims of **pollution, habitat destruction, and the effects of pesticides**.

In this inquiry, students will become scientists exploring the presence of pollinators in their city. Which locations are favorable to them, and why? By attempting to answer these questions, students will gain a better understanding of the **fundamental role pollinators play in biodiversity** and the concrete effects of human activities on their survival.

Additionally, they will explore how this ties into global challenges, aligning their efforts with the SDGs to foster a more **sustainable future**.

Students will examine the distribution, identify factors that either support or hinder their presence, and learn how to **interpret environmental data**. This activity will help them develop a scientific mindset while exploring a crucial issue: the **survival of our pollinators, essential to life on Earth**.

Protecting pollinators is directly linked to several United Nations Sustainable Development Goals (SDGs), including **SDG 2 (Zero Hunger), SDG 13 (Climate Action), and SDG 15 (Life on Land)**. Supporting pollinators contributes to **food security, climate resilience, and the preservation of terrestrial ecosystems**.

Interdisciplinarity

biology

geography

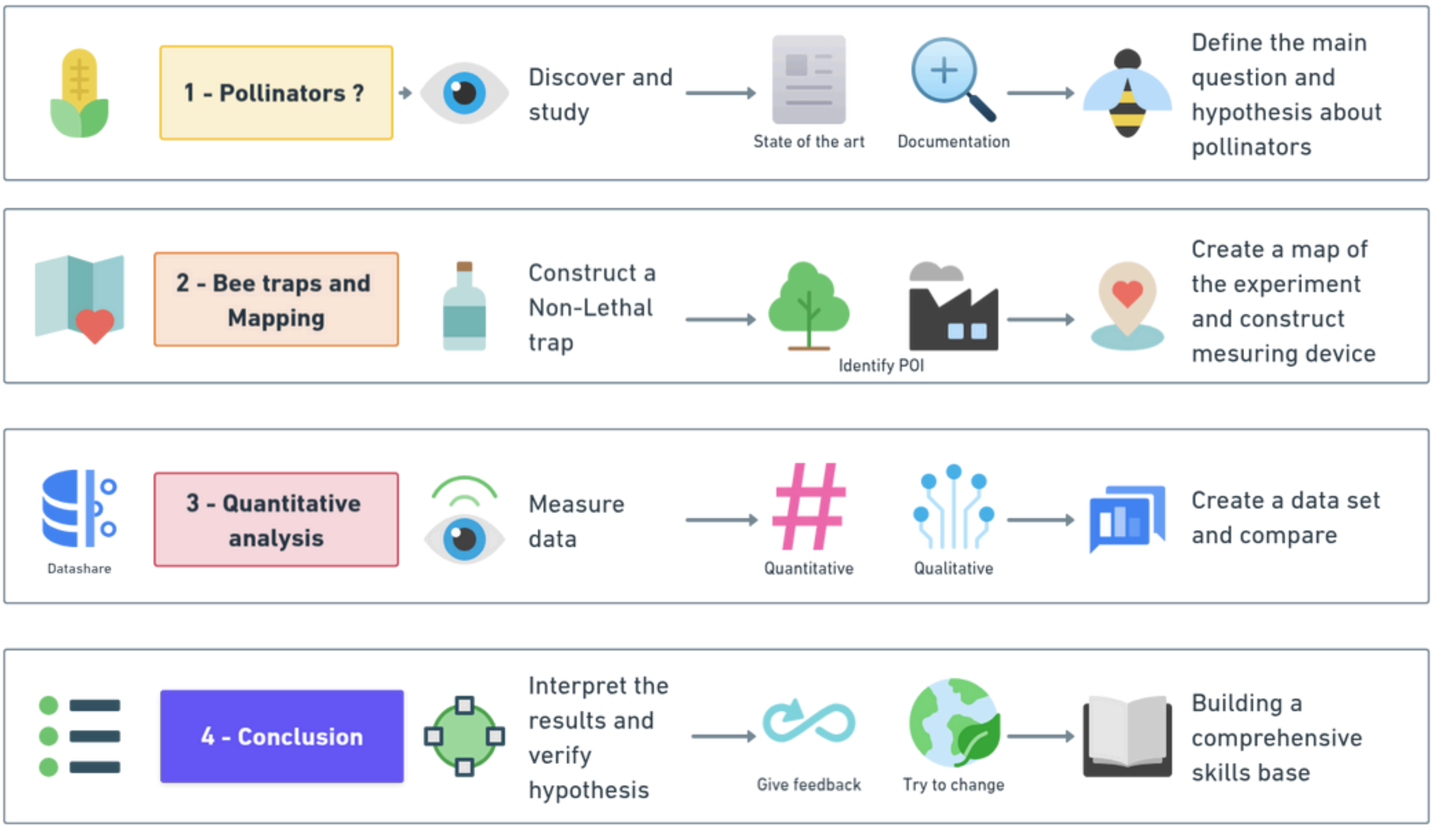
Sustainable Development Goals

Overview

Protocol Structure

The experimentation consists of three key steps, allowing students to fully engage with the scientific process, from forming hypotheses to analyzing the collected data. Below is the outline of the course:

1. **Formulating Hypotheses, Mapping, and Background Research**: Students will begin by discussing and formulating hypotheses regarding where they expect to find pollinators within the urban environment. This phase will also include a bibliographic research element where students explore existing literature on pollinators, their habitats, and the factors affecting their populations. Using a printed map, they will mark areas they believe are suitable habitats. This activity encourages critical thinking, group discussions, and justifications of their choices, while also grounding their hypotheses in scientific knowledge.
2. **Constructing and Placing Non-lethal Pollinator Traps**: In this step, students will work collaboratively to create non-lethal traps using basic materials like plastic bottles and sugary solutions. Once the traps are ready, they will place them at the selected locations on the map. They will note the specific conditions of each location, such as nearby vegetation or sources of pollution. After a set period, students will return to check their traps and record the number and type of pollinators captured. The goal is to attract pollinators without harming them, allowing students to observe the design aspects that attract insects and understand their behaviors. All insects will then be safely released.
3. **Data Analysis and Reflecting on Bias**: Back in the classroom, students will analyze the collected data to identify patterns in pollinator presence. They will calculate basic statistics such as averages and medians to better understand the distribution. Visual tools like graphs and maps will be used to represent findings, helping students communicate their results effectively. During this phase, students will also reflect on the experiment's potential biases and limitations. They will discuss specific factors such as weather, human activity, and habitat conditions that might have influenced their results. Additionally, they will consider how the experimental design could be improved to increase rigor, such as by including more diverse sampling locations, repeating measurements, or controlling variables more effectively. This step is crucial for developing critical thinking, understanding the complexities of environmental research, and learning about the importance of robust experimental design.



Getting started

Duration: The activity will be conducted over two lessons. The first lesson will focus on formulating hypotheses, constructing traps, and strategically placing them on the map for data collection. The second lesson will be dedicated to data collection, analysis, drawing conclusions from the research, and conducting a consolidation phase where students discuss biases in the experiment and consider how the experiment could have been made more rigorous.

Level of difficulty: *The activity involves both theoretical thinking (formulating hypotheses) and practical tasks (trap building and data analysis).* ★★★☆☆

Material needed: Printed map of the experiment locations, pins to mark the map, two plastic bottles per group, syrup or sugar-water solution, scissors, adhesive tape, and optionally a compass to assist with trap placement.

Glossary

Keywords & Concepts	Definitions
Ecosystem	An ecosystem encompasses a community of living organisms, such as plants, animals, and microorganisms, interacting with each other and their physical environment. This interconnected system involves the flow of energy, nutrient cycles, and ecological processes that sustain life within a specific habitat.
Biodiversity	The variety of plant and animal life in a particular habitat, crucial for maintaining ecosystem stability and health.
Pollinators	Pollinators are organisms, such as bees, butterflies, birds, and insects, that play a crucial role in the reproduction of flowering plants by transferring pollen from one flower to another. This process facilitates fertilization and the production of seeds, contributing to the diversity and sustainability of plant life.
Non-lethal Trap	A type of trap designed to capture organisms without causing them harm, used for scientific study.
SDGs (Sustainable Development Goals)	A set of 17 global goals established by the United Nations to address issues like poverty, inequality, and climate change.
Scientific Studies	Scientific studies refer to systematic and organized investigations conducted by researchers to gather empirical evidence, analyze data, and draw conclusions about specific phenomena. These studies adhere to rigorous methodologies and aim to expand knowledge in various fields, ensuring the reliability and validity of the findings.
Citizen Science	The involvement of the general public in scientific research, allowing for larger data sets and increased community engagement.
Hypothesis	A proposed explanation made on the basis of limited evidence, serving as a starting point for further investigation.
Experimental Protocol	A detailed plan that outlines how an experiment will be conducted, including the materials used, the procedures followed, and the variables measured.
Statistical Analysis	The process of collecting, organizing, and interpreting data to discover patterns and relationships.
Data Integrity	The accuracy and consistency of data throughout its lifecycle, ensuring that it remains reliable and valid for analysis.
Biases	Biases represent systematic errors or deviations from objectivity in the way information is collected, interpreted, or presented. In scientific research, biases can influence outcomes and conclusions, compromising the reliability of the study. Awareness of biases is essential for researchers to minimize their impact and ensure the integrity of their findings.
Sampling Bias	A type of bias that occurs when a sample is not representative of the population being studied, leading to incorrect conclusions.

Protocol

Step 1 - Formulating Hypotheses, Mapping, and Background Research

Background and description of the problem to be solved in this step: In this step, students work on understanding where pollinators are likely to be found in their local environment. They will define the conditions that could favor pollinator presence, such as proximity to flowers, low human disturbance, and availability of nesting spots.

Learning Objectives: Understanding biodiversity, gaining knowledge of the role of pollinators, and using the experimental approach to formulate hypotheses and propose solutions to address them. Conducting bibliographic research, constructing indicators for analysis, and developing critical thinking skills.

Conceptualisation

In this phase, students will work on defining key concepts related to pollinators and the factors that influence their presence. To help them formulate strong hypotheses, it is important to clarify the fundamental ideas involved, such as biodiversity, pollinator behavior, and human impact on ecosystems. The teacher will guide students in understanding these concepts through discussions and simple definitions.

Next, the students will work on generating a specific research question. A research question is a clear, focused question that guides the investigation by identifying what the study aims to discover. It is important to formulate a research question before proposing a hypothesis because it sets the direction for the entire study and ensures that hypotheses are relevant and targeted. Examples of research questions could be:

- Does human activity tend to reduce the presence of pollinators?
- Do gardens and naturalized spaces help attract pollinators to urban areas?
- Is the urban environment more favorable to pollinators compared to rural areas?

Once a research question is established, students will collaborate in small groups to brainstorm and explore factors that impact pollinator populations using books, scientific articles, and online resources. Based on their research, they will formulate hypotheses. An hypothesis is a statement that needs to be verified through experimentation (or calculation in fields like mathematics).

The goal of an hypothesis is to provide potential answers to the research question. Validating or invalidating a hypothesis can lead to reformulating the research question to either refine or modify it. Even if the question is not fully answered, all hypotheses should help to better frame the potential answer and clarify its limitations.

Examples of hypotheses for the research questions mentioned above could be:

- For the question **'Does human activity tend to reduce the presence of pollinators?',** a hypothesis could be 'Areas with high levels of human activity will have significantly fewer pollinators compared to areas with low levels of human disturbance.'

- For the question **'Do gardens and naturalized spaces help attract pollinators to urban areas?'**, a hypothesis might be 'Gardens and naturalized green spaces will show a higher density of pollinators compared to areas without such spaces.'

- For the question **'Is the urban environment more favorable to pollinators compared to rural areas?'**, a possible hypothesis could be 'Urban areas with managed green spaces will have a comparable or greater number of pollinators compared to rural areas due to diverse flowering plants and less pesticide use.' An hypothesis is a statement that needs to be verified through experimentation (or calculation in fields like mathematics). The goal of an hypothesis is to provide potential answers to the research question. Validating or invalidating a hypothesis can lead to reformulating the research question to either refine or modify it. Even if the question is not fully answered, all hypotheses should help to better frame the potential answer and clarify its limitations. Each group will then mark their hypotheses on a printed map, using different colors to indicate areas they expect to see high or low pollinator activity. This collaborative process will also involve discussions on how to spatialize the study area and choose appropriate locations for data collection.

Each group will then mark their hypotheses on a printed map, using different colors to indicate areas they expect to see high or low pollinator activity. This collaborative process will also involve discussions on how to spatialize the study area and choose appropriate locations for data collection.

Additionally, students will be encouraged to apply critical thinking by confronting different points of view during the conceptualisation phase. They should consider and debate various factors that may affect pollinator populations and discuss the most logical choices for their study. This will help them make more informed decisions, weigh evidence, and understand that scientific research often requires balancing competing perspectives.

This step will help students understand not only the importance of hypothesis formulation but also how to effectively map and spatialize their study. By combining theoretical knowledge with practical mapping, they will be better prepared to conduct data collection during the subsequent phases of the experiment.

Students Investigation

In this phase, students will learn how to establish an experimental protocol to validate their hypotheses. The teacher will guide students through the steps necessary to design a rigorous investigation, encouraging them to think systematically and critically about each aspect of the experimental process.

Preliminary Documentary Research: Before moving on to setting up experiments, students will conduct a literature review to determine if there are existing research articles that address similar questions or the same subject of study. This research will allow them to build a foundational understanding, familiarize themselves with key concepts, and review existing evaluation methods. This preliminary phase will help shape the students' approach, ensuring their work is informed by established knowledge.

Experimental Protocol Development: Once the literature review is complete, students will use what they have learned to design a simple but rigorous experimental protocol aimed at evaluating the impacts of human activity on pollinator presence. The protocol will follow the scientific method and will include several key steps:

- **Formulating a Clear Research Question**: Define what the study aims to discover.
- **Elaborating a Testable Hypothesis**: Propose a hypothesis that can be tested through experimentation.
- **Designing Controlled Experiments**: Establish how the experiment will be conducted, including how the traps will be placed, the conditions that will be monitored, and the duration of the experiment.
- **Data Collection**: Identify the data that will be gathered, such as the number and type of pollinators captured at each location.
- **Data Analysis**: Plan how to systematically analyze the data collected, including the use of statistical tools.
- **Interpretation and Evaluation**: Describe how the results will be interpreted to evaluate the initial hypothesis.
- **Sharing Results**: Plan how to present the findings and conclusions to the rest of the class.

Creating the Experimental Protocol: Students will work collaboratively in small groups to create their experimental protocols. Each group will take into account the specifics of their chosen locations and hypotheses. The teacher will facilitate discussions and guide students to ensure that their protocols are feasible and scientifically sound. The use of tools such as maps, notes from the literature review, and group brainstorming sessions will aid in refining the details of the protocols.

Tips for Teachers: In an active learning approach, it is interesting to let students carry out this protocol design exercise by themselves.

However, the teacher will play a crucial role as a guide, adopting a semi-directed approach to ensure that the final protocol incorporates the essential components of the study: **the use of pollinator traps for objective measurements, and the creation of a survey journal including qualitative analysis of presence of pollinators during at leat a week**.

This approach will ensure scientific rigor while promoting students' autonomy and creativity in their investigative process.

Example of protocol

1. **Study objective**: Highligth the impact of human activity on pollinators by examining if areas with high levels of human activity have a lower presence of pollinators compared to less disturbed areas.

2. **Hypothesis**: Areas with high levels of human activity will have significantly fewer pollinators compared to areas with low levels of human disturbance.

3. **Study duration**: A two-week period, with data collected three times per week.

4. **Data collection method**:
   - **Quantitative measurements**: Use non-lethal traps to capture pollinators at each chosen location (e.g., parks, urban streets, quiet gardens). Count the number and type of pollinators collected after each session.
   - **Environmental observations**: Record relevant environmental factors, such as the type of surrounding vegetation, noise levels (using a decibel meter if available), temperature, and presence of flowering plants.
   - **Qualitative Measurements**: Observe and note human activity levels (e.g., the number of pedestrians or vehicles) during each data collection session.

5. **Data usage**:
   - **Data storage**: Store quantitative data (pollinator counts) in a CSV file, including information about the date, time, location, and environmental conditions.
   - **Data analysis**: Calculate averages and medians for pollinator counts across different locations. Create graphs to visualize the presence of pollinators in relation to human activity levels and other environmental factors. Identify trends and discuss any notable differences.
   - **Comparison of factors**: Visually compare pollinator presence with noise levels, types of vegetation, and other recorded factors. Use simple graphs to highlight general trends between pollinator numbers and these indicators. Discuss any deviations from these trends.
   - **Correlation analysis**: Calculate correlation coefficients between the level of human activity and pollinator presence. Interpret these coefficients to determine how strongly human activity is related to the decline in pollinator numbers. Discuss which factors may be the most influential.

6. **Presentation of results**: Present the findings in the form of graphs showing the correlation between human activity and pollinator presence. Document the entire protocol in an infographic that can be shared with the class, the school, or on social media.

At the end of this step, students will have a well-developed experimental protocol that they can use to conduct their investigation.

This structured approach will give them the tools to explore the impact of human activity on pollinators methodically and rigorously.

Conclusion & Further Reflexion

- **Knowledge Mobilized**: At the end of this phase, students will have a deeper understanding of the factors that contribute to pollinator habitat selection, the importance of pollinators, and the various elements that may impact their presence. They will also recognize the value of bibliographic research in supporting scientific investigation.
- **Classroom Implementation Reflection**: Students will have learned how to conduct preliminary research, engage in collaborative discussions, and create a structured experimental protocol. This step also highlights the importance of teamwork, critical thinking, and decision-making during the research process.
- **General Learning Outcomes**: The students will have developed skills in bibliographic research, formulated well-grounded hypotheses, and collectively structured a study protocol. They will also have improved their critical thinking skills, particularly in evaluating different perspectives and making informed decisions.

To conclude this phase, students will engage in a discussion centered on open-ended questions. These questions are designed to encourage deeper reflection on the study and its broader implications. Several questions can be opened for discussion:

- How could different types of human activities impact pollinators differently?
- What other environmental factors could influence pollinator presence that we did not consider?
- How might seasonal changes affect the availability of pollinators?
- Are urban environments always less suitable for pollinators compared to rural ones, or can some urban areas be beneficial?
- How could climate change potentially affect pollinator populations in the future?
- What actions could communities take to enhance pollinator habitats?
- How does biodiversity relate to the health of pollinator populations?
- Can small changes in our local environment have significant impacts on pollinator survival?
- What challenges might researchers face when trying to study pollinators in the wild?
- How can the data we collect inform public policy on urban planning and pollinator conservation?

Step 2 - Constructing and Placing Non-lethal Pollinator Traps

Background and description of the problem to be solved in this step: During this step, students will learn how to create and strategically place non-lethal traps to collect data on pollinator populations. The aim is to gather evidence that will allow them to validate or invalidate their hypotheses.

Learning Objectives: Understanding the practical aspects of setting up experiments, specifically designing traps, and understanding the ethical implications of non-lethal data collection. Gaining experience in following a detailed protocol, adapting it to real-world environments, and monitoring the experiment effectively. Developing problem-solving skills by assembling traps with limited resources, practicing teamwork and collaboration, understanding spatial organization, and recording relevant environmental observations.

Conceptualisation

In this phase, students will engage in hands-on activities to build the traps that will be used to capture pollinators. It is crucial to first define what makes an effective trap, including the need to avoid harming pollinators while still attracting them effectively. Teachers should introduce students to concepts such as attractants (like sugar water) and safe trap design (non-lethal components).

The importance of careful trap placement will also be discussed, emphasizing the need to select locations that align with their previously defined hypotheses. This means students should think critically about how their hypothesis influences the selection of trap locations on the map, such as choosing areas with different levels of human activity or specific types of vegetation, based on their predictions. The link between hypothesis and spatial placement will help students understand how to create a meaningful experimental design that effectively tests their assumptions.

Students Investigation

Constructing Non-lethal Traps: Students will use simple materials—plastic bottles, scissors, adhesive tape, and a sugar solution—to construct non-lethal traps. The teacher will provide step-by-step instructions on how to build the traps, ensuring each group understands the importance of the non-lethal aspect. Key considerations include:

- **Materials**: Two plastic bottles, syrup or sugar-water solution, scissors, and adhesive tape.
- **Trap Design**: The trap design should include a funnel made from the bottle top, with a perforated bottom to allow insects to breathe. The traps will be baited with sugar solution to attract pollinators.

Detailed instructions are available in the section "Practical Implementation - Building a Non-Lethal Insect Trap" below.

You can also consult videos such as: https://www.youtube.com/watch?v=15B9VCKg-qs

Placing the Traps: Once traps are constructed, students will place them at locations identified during the mapping phase. The placement should consider proximity to flowering plants, human activity levels, and other relevant environmental factors, ensuring alignment with the hypotheses formulated in Step 1. Each group will need to:

- **Identify Variables**: Note environmental conditions such as vegetation type, noise level, human activity, and nearby infrastructure. Consider how these variables align with the hypotheses, for example, if the hypothesis relates to the impact of human activity, choose locations with varying levels of activity.
- **Record Locations**: Document the specific coordinates or location descriptions for each trap using a map. This should be accompanied by photographic evidence of each trap, including the surrounding environment. Photos should include timestamps and the name of the person placing the trap to ensure traceability. This will be

essential for accurate data analysis and to verify that the placement adheres to the designed protocol.

- **Collect Initial Observations**: Make initial observations of each site—such as sunlight exposure, temperature, and presence of specific flowering plants—which might influence pollinator behavior. Photos should also be taken during initial observations to capture environmental conditions visually.

To ensure high-quality and reliable data collection, students should establish a regular schedule for monitoring the traps. This includes:

- **Frequency of Data Collection**: Data should be collected consistently at the same times each day to reduce variability due to diurnal changes in pollinator behavior. A logbook should be maintained to document when and by whom the data was collected.

- **Traceability of Collectors**: Each student collecting data should record their name, the date, and the time of the data collection, along with a photo of the trap site, to ensure complete traceability.

- **Photographic Evidence**: Photos should be taken each time data is collected, showing the condition of the trap, the surrounding area, and the release of pollinators. This helps validate the location, timing, and integrity of the data collection process.

- **Release of Pollinators**: Students should record the release of pollinators through both written notes and photos, ensuring no harm is done to the insects and providing proof of ethical handling.

Example Logbook for Trap Placement and Data Collection: Below is an example of a logbook format that students can use to ensure traceability and data quality:

Date	Time	Trap ID	Location Description & Coordinates	Collector Name
2024-09-15	10:00 AM	Trap A1	Park, near central flower bed	John Smith
2024-09-15	10:15 AM	Trap B2	Residential area, backyard garden	Jane Doe

Environmental Conditions	Pollinator Count	Notes*	Photo Reference	Pollinator Release
Sunny, 22°C, Low Noise Level	5	Moderate human activity, children playing nearby	Photo_101	Yes
Cloudy, 18°C, No Noise Level	8	Low activity, birds observed	Photo_102	Yes

In which:

- **Date and Time**: Document the date and time of each collection to track consistency and any temporal variations.
- **Trap ID**: Assign a unique identifier to each trap for easy reference.
- **Location Description/Coordinates**: Provide a detailed description of each trap's location or precise GPS coordinates for traceability.
- **Collector Name**: Note who collected the data to ensure accountability.
- **Environmental Conditions**: Record key conditions such as weather, temperature, noise levels, etc.
- **Pollinator Count**: Count and record the number of pollinators captured.
- **Notes**: Add any observations regarding the surrounding activity, notable environmental changes, or anything that might affect the results.
- **Photo Reference**: Note the photo ID that shows the trap and its surroundings for visual confirmation.
- **Pollinator Release Confirmed**: Indicate whether the pollinators were safely released, ensuring ethical treatment.

Using this logbook format, students will maintain detailed records that help ensure the quality and reliability of their data, while also providing a basis for analyzing patterns and validating their findings.

Conclusion & Further Reflexion

- **Knowledge Mobilized**: Students will have learned about designing and setting up a non-lethal experimental tool to collect scientific data. They will understand how to adapt a general protocol to specific environmental conditions.
- **Classroom Implementation Reflection**: The trap construction and placement activities are ideal for fostering collaboration. Students will need to share tasks effectively and work as a team to ensure traps are safely built and deployed. They will also learn practical considerations when implementing field studies, such as ethical data collection and controlling environmental variables.
- **General Learning Outcomes**: At the end of this phase, students will understand how to translate a research question and hypotheses into a tangible experiment. They will also gain experience in designing, constructing, and placing experimental tools, understanding the challenges of real-world experimentation.

For conclusing on this step, you can use the following questions which will lead to open discussion regarding the knowledge mobilised and the feeling of the students regarding this experiment:

- How do different environmental factors (like sunlight, nearby human activity, or temperature) influence the effectiveness of traps?
- Why is it important to design non-lethal traps when studying pollinators?
- What potential sources of error could influence the results of this phase of the experiment?
- How could the location of a trap influence the type of pollinators captured?
- Are there ethical considerations that need to be kept in mind while capturing pollinators? How do we ensure their well-being?

These questions will help students reflect on their experiment, consider variables they might not have accounted for, and think about how they might improve their experimental protocol in future iterations.

To enhance the knowledge provided for your pollinator counting campaign, you can add information about the observed species using the identification sheets from the Great Sunflower Project (https://www.greatsunflower.org/)

Step 3 - Data Analysis

Background and description of the problem to be solved in this step: In this final phase, students will analyze the data collected from their traps and use it to evaluate their initial hypotheses. The goal is to identify any observable patterns in pollinator distribution and determine whether these align with their hypotheses.

Learning Objectives: Data analysis, identification of trends, critical evaluation of experimental results, interpretation of data in the context of the formulated hypotheses, and understanding limitations and confidence levels in the results. Developing skills in statistical analysis, visual data representation, effective communication of results, and fostering critical thinking by identifying biases. Students will also learn to evaluate the reliability of their findings, considering factors such as experimental design, sample size, and how to minimize the impact of limitations.

Conceptualisation

Students will consolidate the data they have gathered from all locations to begin the process of systematic analysis. This phase will involve:

1. **Data Organization**: Data from the logbooks will be organized into tables for better comparison. Students will use spreadsheet software to create these tables and maintain consistency in their data representation.
2. **Statistical Analysis**: Students will calculate averages, medians, and identify trends. Teachers should introduce basic statistical concepts like variance and range to help students understand the differences across their datasets.
3. **Visual Representation**: Graphs (such as bar graphs, scatter plots, and maps) will be used to represent findings. The visual representation will help identify any patterns regarding the presence of pollinators in different environments.

Reflecting on Bias and Limitations: After analyzing the data, students will be encouraged to reflect on the experimental process itself:

- **Identifying Bias**: Teachers should guide students to consider various forms of bias that might have affected their results, such as observational bias, environmental bias, or sampling bias. Students will also think about how subjective choices in selecting locations or timings might have skewed their findings.
- **Evaluating Experimental Design**: Students should reflect on how the experimental protocol might be improved for better accuracy or reliability. For example, they could discuss repeating measurements, conducting longer-term studies, or including additional environmental variables.
- **Understanding Limitations**: Students will discuss the limitations of their results, including the size of their sample, the duration of the study, and the potential influence of uncontrolled variables. They should consider how these limitations affect the level of confidence they can have in their conclusions and what could be done to mitigate these limitations in future studies.
- **Ethical Reflection**: Students will also discuss ethical aspects, such as the impact of their presence during trap placement and data collection on pollinator behavior.
- **Evaluating Experimental Design**: Students should reflect on how the experimental protocol might be improved for better accuracy or reliability. For example, they could discuss repeating measurements, conducting longer-term studies, or including additional environmental variables.
- **Ethical Reflection**: Students will also discuss ethical aspects, such as the impact of their presence during trap placement and data collection on pollinator behavior.

Students Investigation

1. **Organize the Data**: Collect all data from the logbooks and compile them into a spreadsheet. This will help students easily calculate summary statistics such as averages and ranges.
2. **Perform Calculations**: Calculate metrics such as the average number of pollinators per site, median counts, and overall frequency distribution. This will allow students to understand which locations were most favorable to

pollinators.
3. **Create Graphs**: Each group should generate at least two different types of visual representations (e.g., bar charts, line graphs) to effectively communicate their findings. They should also create a visual map to show the geographic distribution of pollinator presence across their selected locations.
4. **Interpret Data**: Based on the graphs and statistical analysis, students will interpret their results in the context of their hypotheses. They should look for any patterns indicating whether factors such as human activity or vegetation type had an effect on pollinator distribution.

Reflecting on the Experimental Process: Each group will present their findings to the class and discuss how their data compared to their initial hypotheses. This will provide an opportunity to identify common themes across the different groups' studies.

Teachers should lead a discussion on the limitations of the data collection process, including potential biases, the constraints of the sample size, and how these factors might influence the reliability of the results. Students should consider how limitations such as short data collection periods, unaccounted environmental changes, and observer influence could impact their findings. They should also discuss strategies for minimizing these limitations in future experiments, such as conducting the study over a longer duration, collecting more extensive data, or adding controls for environmental variables. For example, students may consider the time of day at which traps were checked or the influence of weather conditions during the study period.

Conclusion & Further Reflexion

- **Knowledge Mobilized**: Students will learn about organizing and analyzing scientific data, applying statistical methods to real-world datasets, recognizing limitations of small-scale studies.
- **Classroom Implementation Reflection**: This phase helps students understand how raw data can be transformed into meaningful information. It also emphasizes the importance of data integrity, transparency, and critical reflection on findings.
- **General Learning Outcomes**: By the end of this phase, students will have developed skills in data analysis, learned to question their own experimental designs, and understood the critical role that bias, limitations, and experimental rigor play in scientific research. They will also be able to assess the reliability of their results and articulate the level of confidence they have in their conclusions, acknowledging where limitations may impact their findings.

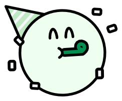
To help students reflecting on their data, their implications, and consider the broader significance of their findings, you can use the following questions.

- What environmental factors seemed to have the most significant impact on pollinator presence?
- Were there any locations where your results did not match your initial hypotheses? Why might that have occurred?
- How can observational or experimental biases affect scientific studies, and how might we reduce these biases in future experiments?
- What trends were observed regarding pollinator presence in areas with high vs. low human activity?
- How could this study be expanded or modified to produce more comprehensive results?
- If given more time, what additional variables would you consider measuring?
- Were there any surprising observations during the experiment that contradicted existing literature?
- How can the results of your experiment contribute to broader ecological studies or conservation efforts?
- How does the process of data collection and interpretation help inform public policy decisions regarding urban biodiversity?
- What improvements could be made to the trap design or placement to improve the reliability of future experiments?

They will think about how their experiment might be improved and what future studies could build on their work to help protect pollinators and promote biodiversity.

Practical Implementation

Building a Non-Lethal Insect Trap



This activity sheet presents a practical activity focused on constructing a non-lethal insect trap.

This project is designed to enhance your understanding of environmental conservation and the essential role that pollinators play in our ecosystem.

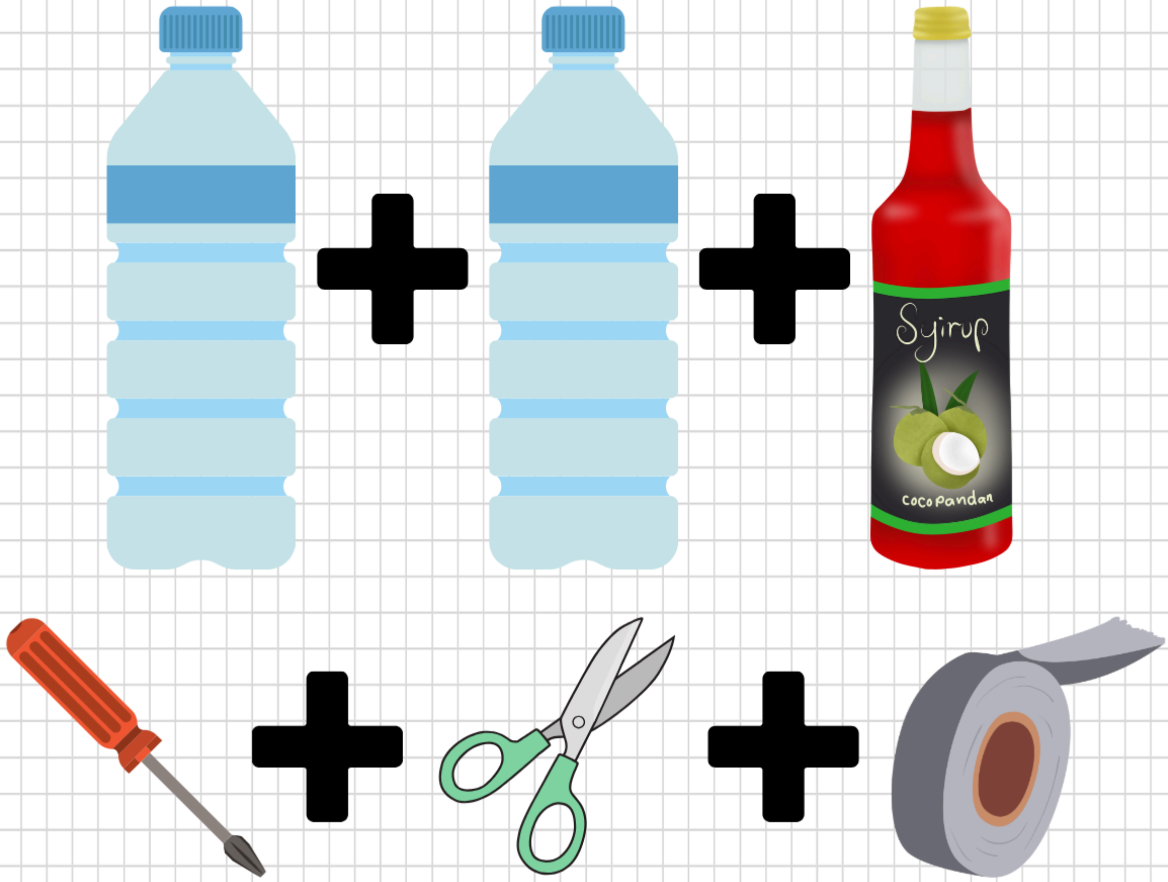
You will utilise basic materials such as plastic bottles, a sugar-water solution, branches and leafs, scissors, and tape to create your traps. Throughout this process, you will gain insights into the significance of protecting insects and explore humane methods for managing them.

Let’s follow the instructions given below to easily build the trap, caring for the well-being of the pollinators by ensuring their security and safety with our device!

INSECT TRAP

Build a liquid bait trap that doesn't kill the insect

NECESSARY MATERIAL

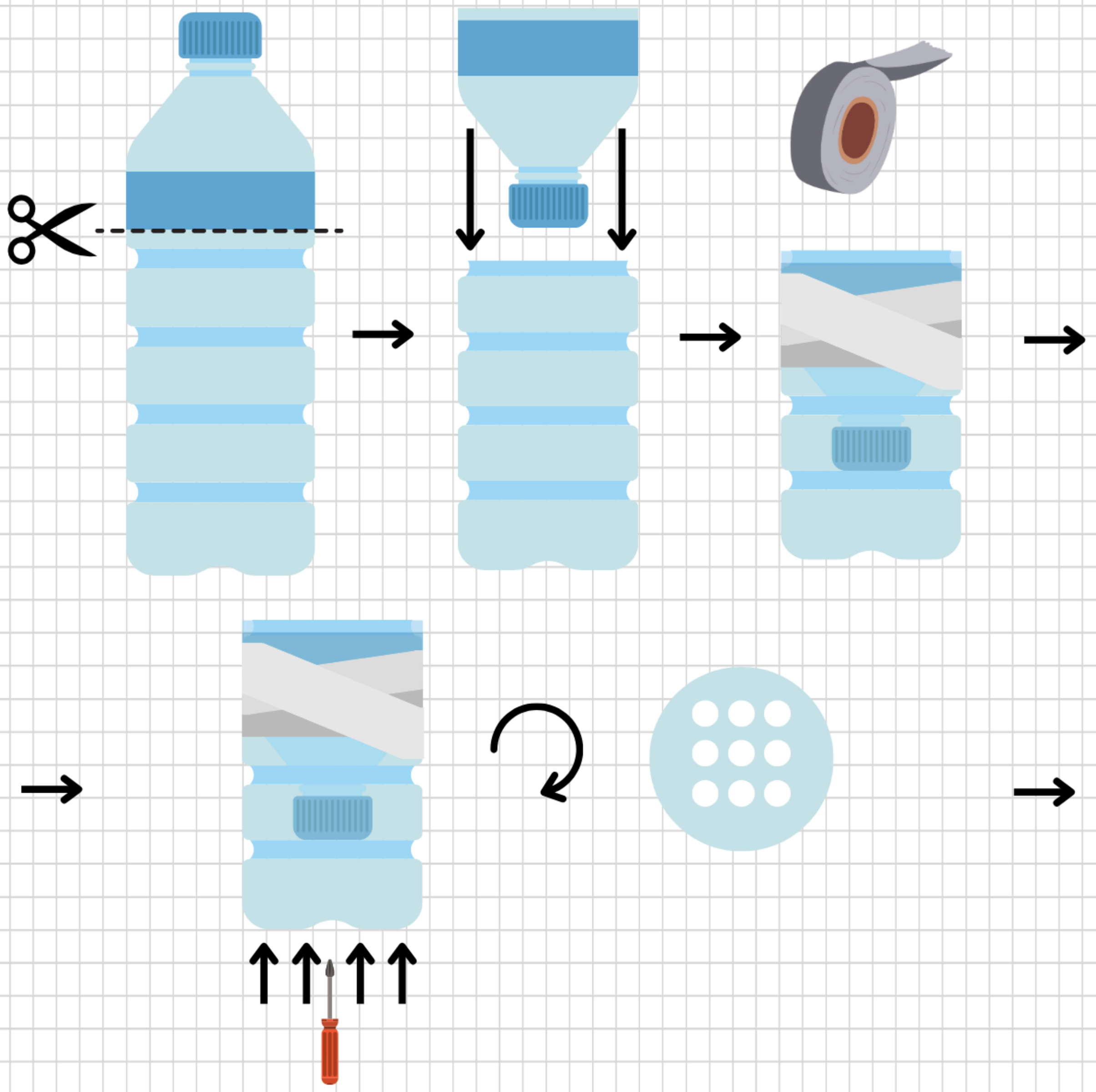


2 plastic bottles of any kind Syrup or other sweet liquid A tool capable of piercing the plastic bottle (screwdriver type) A tool capable of cutting the plastic bottle (scissors type) Adhesive tape

Our advice: add branches and/or leaves to the trap to allow pollinators to get out of the water if necessary.

FLOWER GUARDIANS POLLINATOR MONITORING

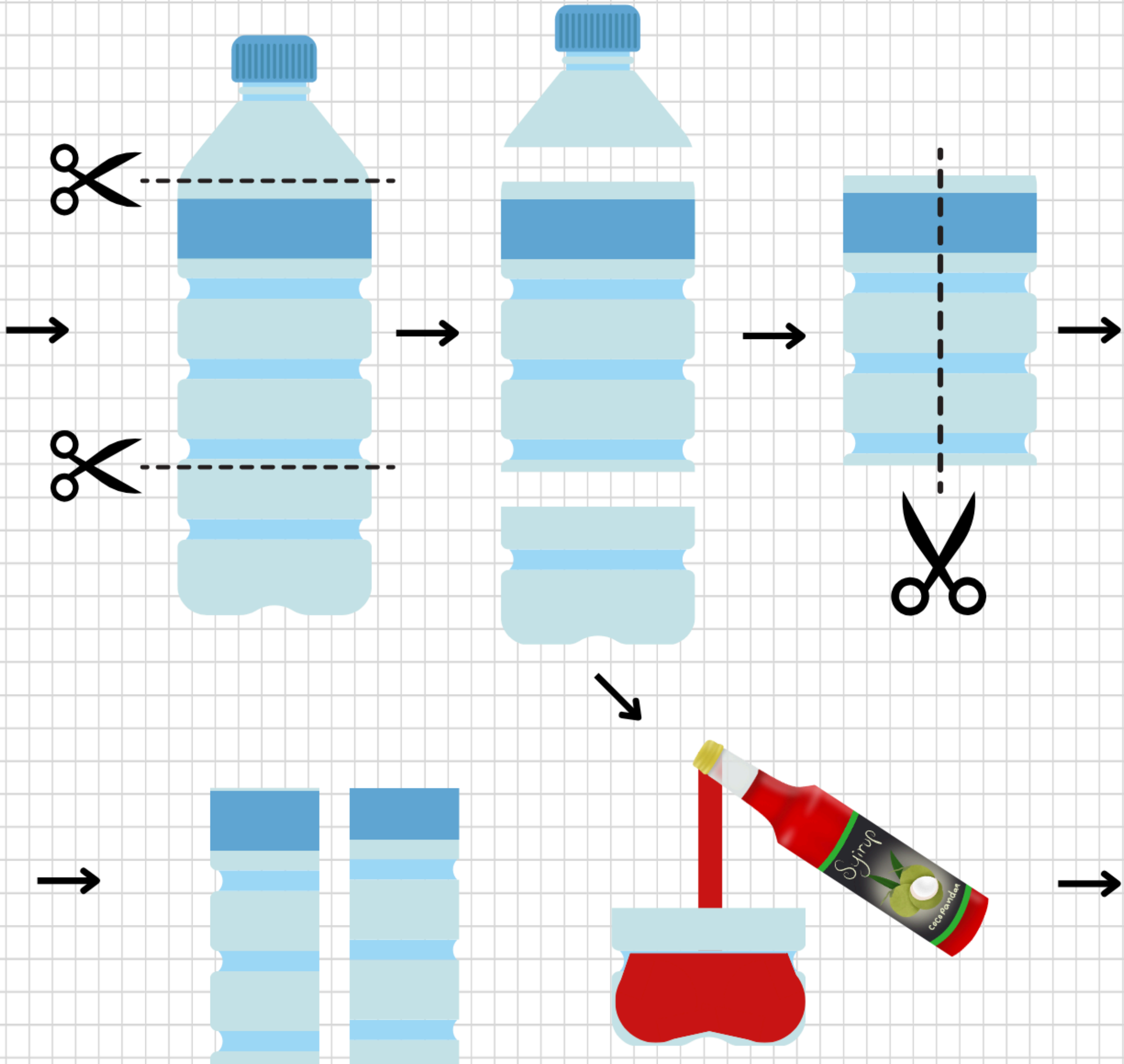
STEP 1



Cut the top off the first bottle to create a funnel. Attach the funnel to the top of the first bottle with adhesive.
Pierce the bottom of the bottle to prevent insects from drowning.

FLOWER GUARDIANS POLLINATOR MONITORING

STEP 2

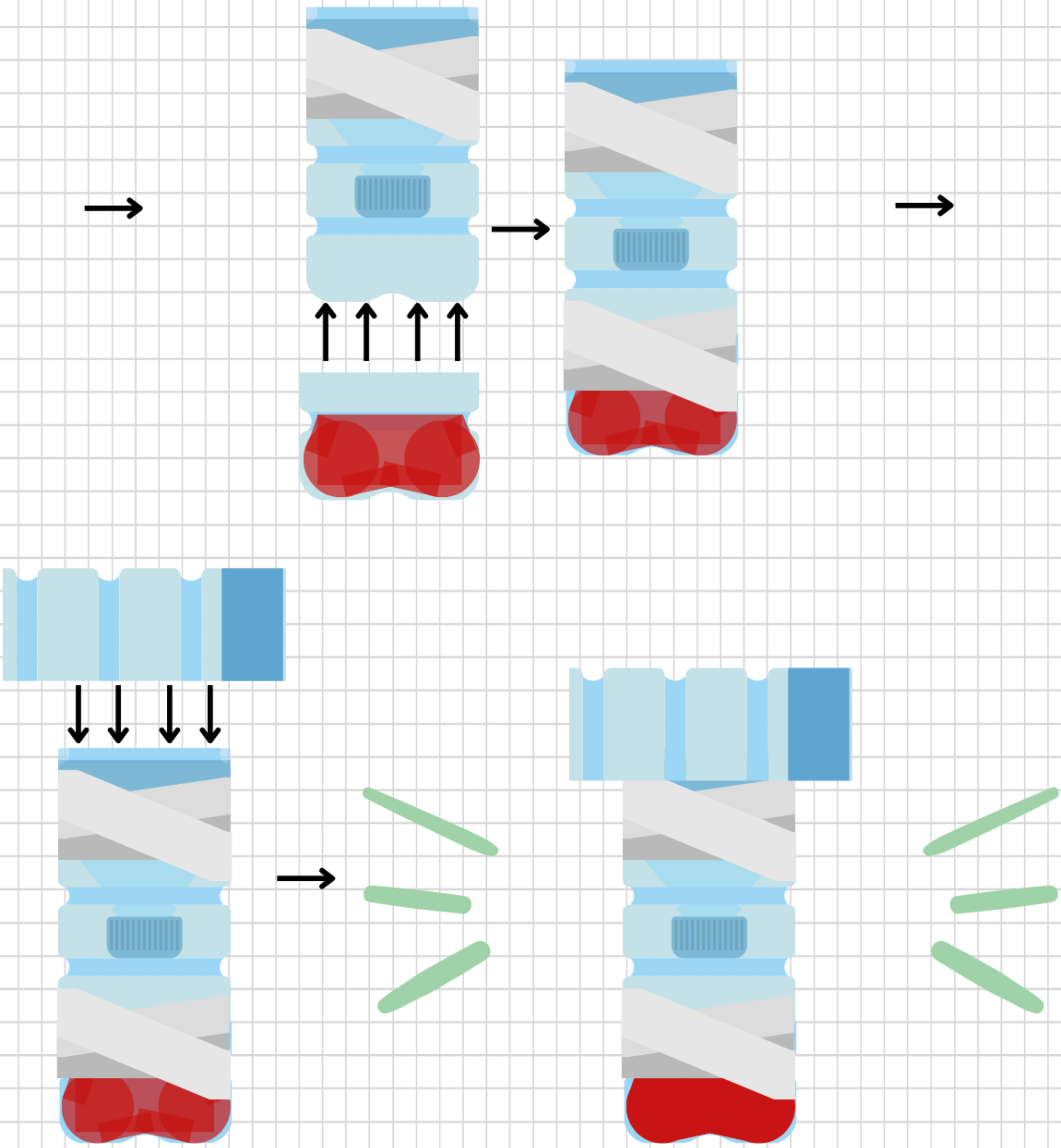


Use the remaining part of the second bottle to create a rain cover, by cutting it in half.

Cut the bottom off the second bottle and fill it with syrup.

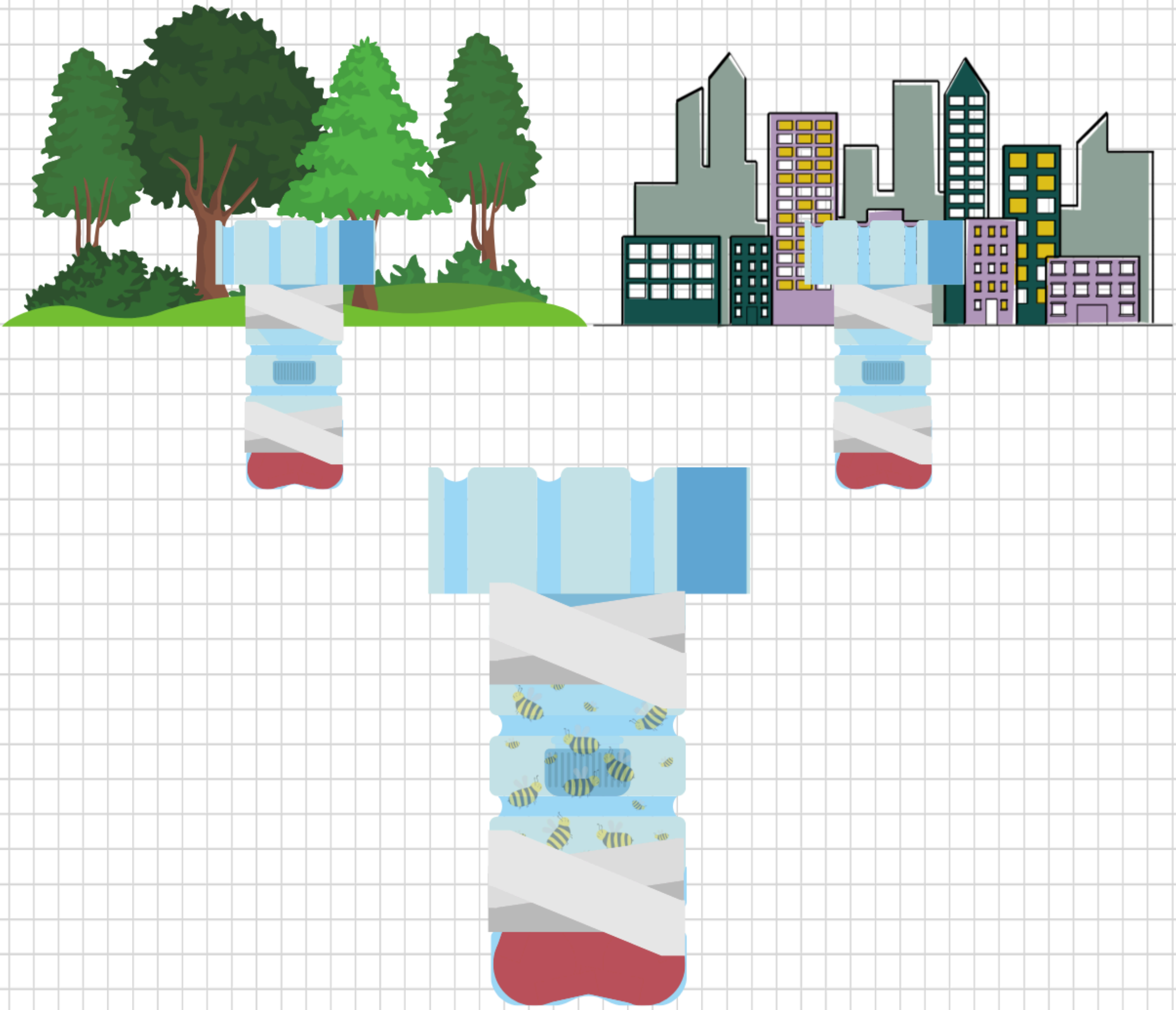
FLOWER GUARDIANS POLLINATOR MONITORING

STEP 3



Secure the bottom part filled with syrup under the first bottle using adhesive.
Attach the rain cover to the funnel.

STEP 4



Place the traps in different environments.
Wait a few hours.
Count how many insects were caught.
Release the captured insects.

Exploring the issue through other initiatives

1. **Community Pollinator Gardens**: Expand the experiment by involving the local community in creating pollinator-friendly gardens. Students can work with residents to plant flowering species that attract pollinators, and then monitor the impact on local pollinator numbers.

2. **Artistic Representation**: Use the data collected to create artistic visualizations, such as murals or sculptures of pollinators and their habitats. This could help raise awareness in the school or community about the importance of pollinators.

3. **Mobile Pollinator Tracking App**: Develop a simple mobile app to help track pollinator observations. Students could use the app to log sightings, photos, and environmental conditions, making data collection more engaging and allowing for easier long-term monitoring.

4. **Longitudinal Study**: Extend the duration of the experiment to several months to track seasonal variations in pollinator activity. This could help students understand the influence of different weather conditions and flowering cycles on pollinator populations.

5. **Collaboration with Other Schools**: Partner with other schools to compare pollinator data from different geographic locations. This could introduce students to more advanced data analysis techniques and highlight how environmental factors vary regionally.

6. **Pollinator-Themed Festival**: Organize a school festival celebrating pollinators. Include exhibitions of student findings, art projects, and even hands-on workshops where participants can build their own pollinator traps or plant pollinator-friendly flowers.

7. **DIY Pollinator Hotels**: Have students build "pollinator hotels" to provide nesting habitats for bees and other insects. Monitor which insects use the hotels and compare these data with the data collected from the traps.

8. **Citizen Science Project**: Transform the experiment into a citizen science project where students invite community members to participate in data collection. This could expand the data pool and provide a more diverse set of locations to study pollinators.

9. **Comparison Between Urban and Rural Areas**: Add a comparative aspect to the experiment by examining pollinator presence in rural versus urban settings. Students can then discuss the impact of urbanization on pollinator populations.

10. **Storytelling and Pollinators**: Encourage students to write creative stories or poems about the journey of a pollinator through the city. This artistic exercise can help deepen their understanding of pollinator behavior and the challenges they face in urban environments.

Bibliography

Books and Guides:

- "The Bees in Your Backyard: A Guide to North America's Bees" by Joseph S. Wilson and Olivia Messinger Carril – This book is an excellent guide for learning to identify bees and understanding their importance in biodiversity.
- "Our Native Bees: North America's Endangered Pollinators and the Fight to Save Them" by Paige Embry – An accessible and educational overview of native bees and the importance of their preservation.

Scientific Articles:

- **Global pollinator declines: trends, impacts and drivers**
- **How urbanization is driving pollinator diversity and pollination–A systematic review**

Websites and Online Resources:

- **Pollinator Partnership** (https://www.pollinator.org/): A site offering educational resources on pollinators, including guides and activities.
- **BeeSpotter** (https://beespotter.org/): A citizen science platform where users can submit their observations to help monitor pollinator populations.
- **National Wildlife Federation - Pollinators** (https://www.nwf.org/Educational-Resources/Wildlife-Guide/Pollinators): A source of practical information on how to create pollinator-friendly habitats in gardens.

Educational Videos:

- **"The Importance of Bees"**: These talks examine why they're crucial to the earth and worth saving.
- **"Ever wanted a bees-eye view of the world? Get closer to nature with the National Trust"**: Discover how bees see the world through a day in the life of a bee.

Citizen Science Projects:

- **The Great Sunflower Project** (https://www.greatsunflower.org/): The largest citizen science project focused on pollinators
- **iNaturalist** (https://www.inaturalist.org/): Students can use iNaturalist to identify pollinators and contribute to a global database.