The web of inquiry: urban black widow behavior as a tool to teach the scientific process

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Introduction

Hands-on inquiry is a major emphasis in K-12 science education, but how often do students design and conduct tests of their own ideas in the classroom?

Animal behavior researchers can collaborate with K-12 science classrooms by bringing authentic investigations of their study subjects into schools.

Here we present a collaborative effort using the behavior of arthropods. Our specific curriculum utilizes the Western black widow spider (*Latrodectus hesperus*).

As a familiar, and often feared species in residential areas, black widows capture the imagination of students and illustrate the importance of animal behavior to understanding urban ecology.

However, this pedagogical framework can be used with any arthropod, such as crickets, mealworms and pill bugs.

Classroom Methods

Through a series of four lessons, students ask their own questions about spider behavior in small groups; then come to a consensus on one class hypothesis and design methods to test it, each group performing one replicate per treatment.

Students arrive at conceptually relevant hypotheses through a series of structured steps.

1) observing spider behavior,
2) brainstorming questions,
3) identifying independent variables to be manipulated
4) modifying initial questions to more testable hypotheses (see Figure 1)

Ultimately, the class designs methods to collect data and presents their experimental process in scientific posters.

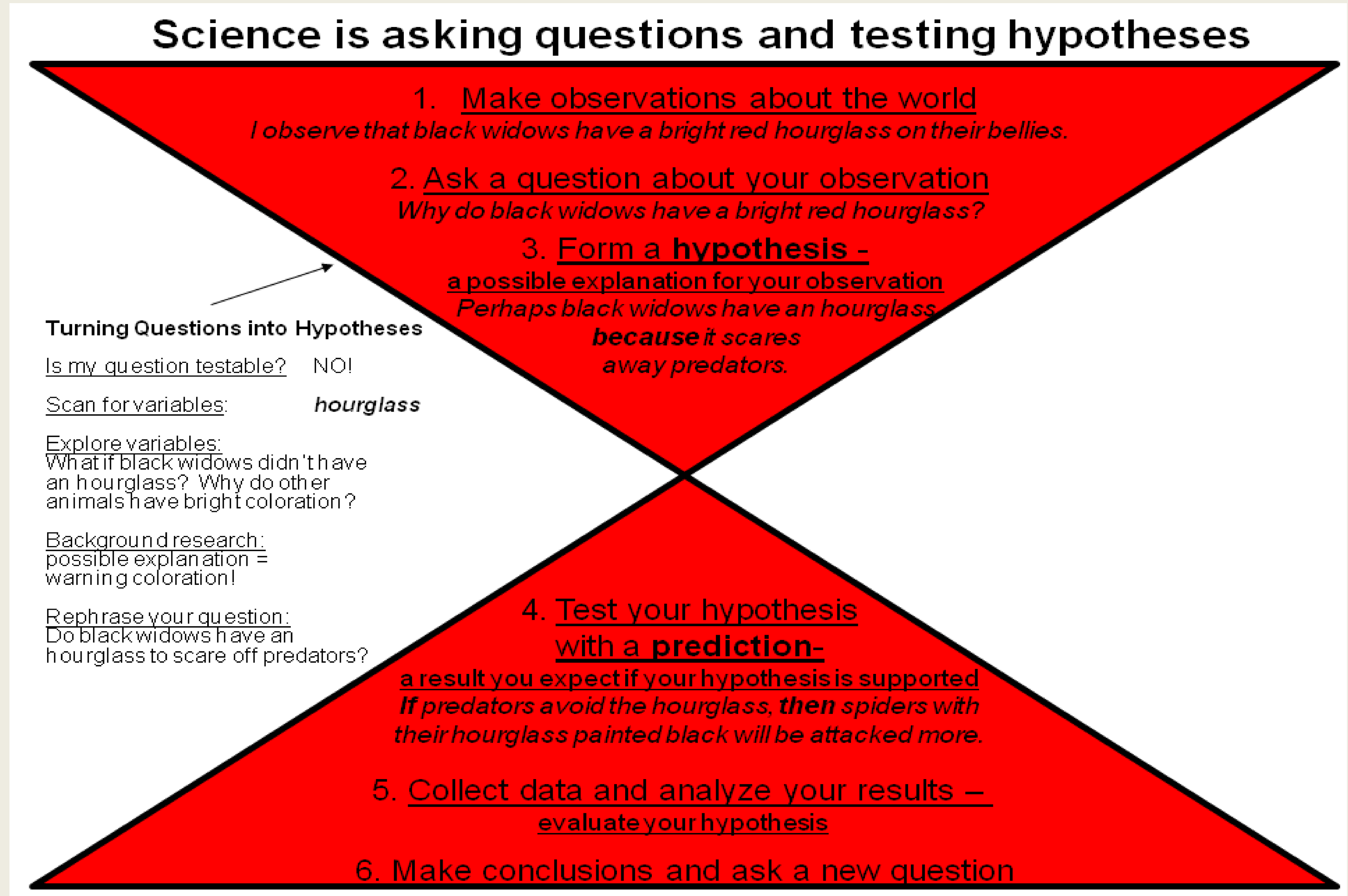

Figure 1. The hourglass shape emphasizes science as a process that cycles from **broad** (observation), to **narrow** (hypothesis testing), back to **broad** (extrapolation of findings), resulting in better-informed questions.

Classroom Results

Below are excerpts from several student's worksheets and final posters illustrating their experience over four weeks.

Observations: *the female is much bigger than the male; the spider is upside down in the web; the spider stalks the cricket.*
Questions: *Is the spider going to kill the cricket? How hungry would the spider have to be to kill the cricket, or kill each other?*
Variables of interest: *Independent=spider's hunger level; Dependent=time before it sinks its fangs into the cricket.*

Title: *Which black widow eats more, starved or fed?* ☺ *We have the answer!*
Hypothesis*: Black widow aggression is affected by how hungry the spider is.*
Prediction*: Fed spiders will not be as aggressive as not fed spiders*
Methods*: There were 12 spiders in our class experiment. 6 were starved and 6 were well fed. We fed each spider 2 crickets and watched for 30 minutes to see who would eat. Then we checked every day to see if they ate later on.*
Results & Implications: *We found support for our hypothesis that starved spiders will eat faster than well-fed spiders. The reason why is because the well fed spiders don't have any more room to fit in their stomach.*
…it was really surprising because we found out that spiders are really important…, and spiders feel the same way as we do about food.

Discussion

Students were excited to study the behavior of black widows and encountered some difficulties that are common even for college students. For example, this collaboration helped them distinguish observations from inferences and hypotheses from predictions.

Perhaps the greatest challenge for novice researchers is to turn questions into testable hypotheses. We facilitated this by encouraging students to explore independent variables and then rephrase their original question.

Importantly, this lesson offered students an opportunity to focus intensively across an entire month on an engaging study species. This extended process was critical in overcoming the hurdles mentioned above.

Thus, we encourage sustained animal behavior investigations in K-12 classrooms to promote the excitement of scientific discovery and the self confidence that comes from ownership in a project.

Partnerships between K-12 classrooms and academic researchers can jump-start genuine inquiry projects.

Central Arizona-Phoenix Long–Term Ecological Research (CAP LTER)

CAP-LTER is one of only two urban LTER sites sponsored by NSF in which biological, physical, social, and engineering scientists and community partners collaborate to study an arid land ecosystem profoundly influenced by human activities.

Ecology Explorers is an outreach education program that encourages collaboration among CAP LTER researchers and the K-12 community. **http://ecologyexplorers.asu.edu**

ASU Arizona State University

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