K20 L•E•A•R•N

Getting Yourself Out There

Plant Reproduction and Seed Dispersal

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Grade Level	8th Grade	**Time Frame**	3-5 class period(s)
Subject	Science	**Duration**	200 minutes
Course	Life Science		

Essential Question

How do specialized structures affect a plant's likelihood of successful reproduction?

Summary

In this lesson, students will explore a variety of plant reproductive structures and determine differences between sexual and asexual reproduction through hands-on observations and online research. Based on their findings, students will use engineering design to create and test "seed dispersal" structures. After testing and revising their designs, students will use data from their tests and previous investigations to defend the scientific merit and biological relevance of their structures. This lesson addresses MS-LS1-5. (Funding provided by USDA Project No. 2015-08433 through the National Institute for Food and Agriculture's Agriculture and Food Research Initiative.)

Snapshot

Engage

Students observe the phenomenon of exploding seed pods to generate questions about types of plant seed dispersal mechanisms and their purpose.

Explore

In small groups, students investigate the reproductive strategies of a model fruit or seed. Groups share out their findings visually to the class to create a data set for later reference.

Explain

Students compare and contrast their individual model plants. From the Explore data and Explain discussions, the whole class synthesizes a list of the most important scientific concepts.

Extend

Students design artificial plant structures for seed dispersal and test the effectiveness of their devices. The class engages in a bracket-style challenge to determine the most effective device and discusses why there is still no "best" design.

Evaluate

Using their investigative and design test data, students make a pitch to a company arguing for the merits and scientific relevance of both their design and the seed pod phenomenon.

Standards

Next Generation Science Standards (Grades 6, 7, 8)

MS-ETS1-2: Evaluate competing design solutions using a systematic process to determine how well they meet the criteria and constraints of the problem.

Oklahoma Academic Standards (8th Grade)

8.LS1.4 : Use arguments based on empirical evidence and scientific reasoning to support an explanation for how characteristic animal behaviors and specialized plant structures affect the probability of successful reproduction of animals and plants respectively.
8.LS1.5 : Construct a scientific explanation based on evidence for how environmental and genetic factors influence the growth of organisms.

Attachments

- Artificial Seed Dispersal Pitch Planning Document—Getting Yourself Out There - Spanish.docx
- Artificial Seed Dispersal Pitch Planning Document—Getting Yourself Out There - Spanish.pdf
- Artificial Seed Dispersal Pitch Planning Document—Getting Yourself Out There.docx
- Artificial Seed Dispersal Pitch Planning Document—Getting Yourself Out There.pdf
- Bracket Graphic Organizer—Getting Yourself Out There - Spanish.docx
- Bracket Graphic Organizer—Getting Yourself Out There - Spanish.pdf
- Bracket Graphic Organizer—Getting Yourself Out There.docx
- Bracket Graphic Organizer—Getting Yourself Out There.pdf
- I Notice I Wonder—Getting Yourself Out There - Spanish.docx
- I Notice I Wonder—Getting Yourself Out There - Spanish.pdf
- I Notice I Wonder—Getting Yourself Out There.docx
- I Notice I Wonder—Getting Yourself Out There.pdf
- Lesson Slides—Getting Yourself Out There.pptx
- Model Plant Design—Getting Yourself Out There - Spanish.docx
- Model Plant Design—Getting Yourself Out There - Spanish.pdf
- Model Plant Design—Getting Yourself Out There.docx
- Model Plant Design—Getting Yourself Out There.pdf
- Model Self-Evaluation—Getting Yourself Out There - Spanish.docx
- Model Self-Evaluation—Getting Yourself Out There - Spanish.pdf
- Model Self-Evaluation—Getting Yourself Out There.docx
- Model Self-Evaluation—Getting Yourself Out There.pdf
- Research Notes—Getting Yourself Out There - Spanish.docx
- Research Notes—Getting Yourself Out There - Spanish.pdf
- Research Notes—Getting Yourself Out There.docx
- Research Notes—Getting Yourself Out There.pdf

Materials

- Lesson Slides (attached)
- I Notice, I Wonder handouts (attached, one per student)
- Assorted fruits and seeds
- Research Notes handout (attached, one per group of 3-4 students)
- Assorted recyclable materials (for building seed prototypes)
- Model Plant Design handout (attached, one per pair of students)
- Model Self-Evaluation handout (attached, one per pair of students)
- Bracket Graphic Organizer (attached, one per pair of students)
- Artificial Seed Dispersal Pitch Planning Document (attached, one per pair of students)
- Devices with video recording capability or poster materials (optional)

- Student devices with Internet access

Engage

TEACHER'S NOTE: PRIOR KNOWLEDGE

This lesson assumes that students are familiar with asexual and sexual reproduction and generally understand that plants and animals (e.g., pollinators) interact in plant reproduction.

Begin the lesson by displaying **slide 3** and passing out a copy of the **I Notice, I Wonder** handout to each student. Show students the example of exploding seed pods, and have them make observations and ask questions about what they see using the I Notice, I Wonder prompts. Encourage them to think about why this phenomenon might happen and what purpose it might serve. After giving students some time to record their individual responses, ask for volunteers to share out and record class responses on the board.

Himalayan Balsam (Impatiens glandulifera) is one of many species of plants that disperses its seeds by force. As the seeds approach maturity, the seed pods begin drying up. The force that drying puts on the walls of the seed pod causes it to explode when touched.

Exploding Seeds

Instead of, or in addition to, showing the video footage of an exploding seed pod, consider bringing in actual seed pods for demonstration or student exploration. Ornamental flowering plants like jewelweed (Impatiens capensis), wisteria, and lupine produce explosive seed pods. Jewelweed in particular will explode before the seed pods dry fully. Okra will also explode if it dries out long enough.

Display **slide 4**. Review the questions that the class generated for the "I Wonder" prompt and help students select one or more to continue investigating. Students will probably wonder *how* the phenomenon works. Encourage them to explore that during their upcoming investigation to find out for themselves.

TEACHER'S NOTE: CONTENT

Describing the actual mechanism behind the exploding seed pods goes beyond middle school science content standards. However, this could be a good object lesson on forces (MS-PS2-2) and transfer of energy (MS-PS3-6) to help students understand the phenomenon at a basic level.

Explore

Display **slide 5** and organize students into groups of three or four. Give each group a copy of the Research Notes handout as well as a unique plant so that the class has examples of a variety of seed dispersal strategies.

> **Teacher's Note: Suggested Plants For Observation**
>
> Plants that you might consider include fleshy fruits or vegetables, strawberries or strawberry plants (which make seeds and can clone from stem runners), potatoes or yams (plants with no seeds), water lilies, maple or other seeds with "wings," pine cones, dandelions, or sandburs (if they can be handled safely), coconuts, and http://lawnamat.net/seed-heads-are-not-weeds/" target="_blank">grasses with seed heads. Be aware of any student allergy issues before selecting your plants.

Allow students time to investigate their plants as well as the research questions they chose during the Engage activity. Students should investigate:

- Their research questions.
- Their plant's life history (e.g., what it is, where it can be found, etc.).
- Their plant's reproductive strategy (i.e., sexual, asexual, or both).
- How their plant passes on its genetic information (e.g., seeds, runners, etc.).
- The purpose of their plant's external structures (e.g., Why does a dandelion have "fuzz" after the flower dies?).

Display **slide 6**. Now that groups have an understanding of their plant, they will prepare a visual presentation to share their findings with the class. Posters, whiteboard art, and digital slides are some options for this presentation. Feel free to customize this slide with specific guidelines. In their presentations, ask students to share the life history and reproduction information that they investigated but wait to cover the research questions until later.

> **Teacher's Note: Research Questions**
>
> Where in the lesson you choose to discuss the class research questions is flexible. Depending on their nature, it might make sense to discuss them immediately after the student presentations, during the Explain activity as relevant details are discovered, or near the end of the Explain activity before students complete the summary activity. **Slide 7** can be moved wherever you feel this discussion fits best.

As each group shares its presentations with the class, instruct students from the non-presenting group to record the data about reproduction, seeds/runners, and external structures on the second page of their Research Notes handout.

> **Crosscutting Concepts: Structure & Function**
>
> Throughout the Explore activities, be sure to emphasize the structure-function relationship with students. As they discover new information, continue to press them to explain how the shape and structure of their plant allow it to perform its survival and reproduction functions.

Explain

Display **slide 8**. Have students form new groups where they will discuss the questions on slides 9-11.

Slide 9:

- How does your plant pass on its genetic information (e.g., seed, runners)?
- How does your plant disperse seeds?
- If your plant does not disperse seeds, how does it reproduce?

Slide 10:

- How do the patterns you notice in the dispersal strategies used in asexually reproductive plants compare to those that are used in sexually reproductive plants?
- Why might those patterns exist?

Slide 11:

- Why would plants need to disperse their seeds?
- What are the costs and benefits of dispersing seeds near the parent plant? Far away from the parent?

Teacher's Note: Flow

Depending on the flow of class presentations, you might consider weaving the Explain discussion into the presentation portion of the Explore activity. Discussion questions could be posed to the class between groups' presentations or as clarifying questions for presenters.

Display **slide 12**. Have students return to their original research groups. Use the Strike Out strategy to help students develop a list of important scientific ideas they learned from their exploration and discussion. Have students start by working with their group to write down as many important scientific ideas as they can from their research and discussion.

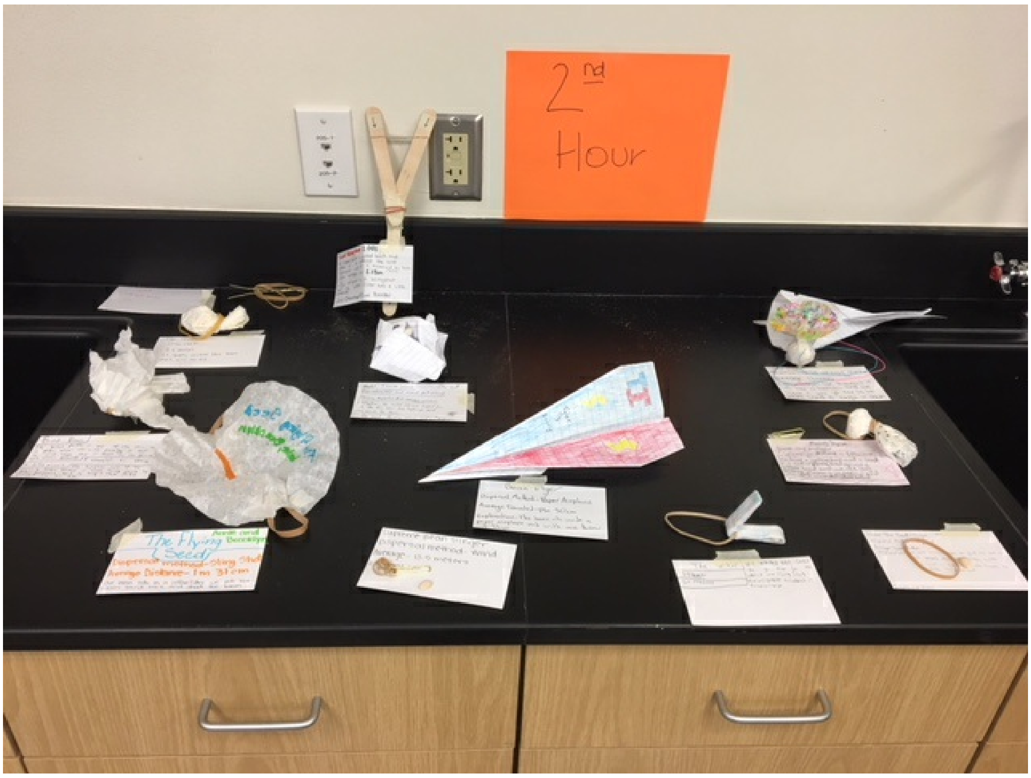
Display **slide 13**. Have groups pass their list to the group next to them. (Choose a specific direction (left, right, etc.) to avoid confusion.) When groups receive their peers' list, they should cross off one item that they feel is least relevant or least important. Repeat this step for as many groups as you have in class, time permitting. (Make sure the lists go through at least three new groups if there isn’t time for every group to evaluate every list.)

Display **slide 14**. Have groups return the lists to their original owners. When groups receive their own lists, back, instruct them to choose one of the crossed-out items to add back to their lists. Then, have them look at the items and consider if any could be grouped together into larger categories.

Display **slide 15**. Have each group share out their lists of ideas and record them as a master list. This represents the ideas the class thinks are the most important. Discuss any items that might be able to be combined. At this point, if students missed any of the important concepts referenced in the previous discussion questions, facilitate additional whole-class discussion to solicit those ideas. If there are additional concepts specific to the example plants that students did not pick up on in their research, this is the time to provide direct instruction or supplemental readings.

Extend

Display **slide 16** and pass out copies of the Model Plant Design handout. In pairs, students will create a model plant or plant part designed to disperse seeds based on the essential question: *How do specialized structures affect the plant's likelihood of successful reproduction?* Based on the scientific concepts developed in the Explain activity and the firsthand exploration of actual plant structures, pairs will 1) prototype their models, 2) build their models using recycled/recycling materials and test them, 3) evaluate their models' effectiveness, and 4) revise their models. This procedure is described in detail below and on **slides 17-27**.



Examples of some first draft prototypes of seed dispersal structures

Prototyping

Display **slide 17**. Before building a prototype, students should create a visual model of their design. This should be a technical diagram that includes different views (top-down, side, etc.) with labels for each part. Remind students that because design is the primary work of most engineers, and because there is cost associated with building and testing, they should take time to fully work out their plans before beginning any construction. Display **slide 18**. Ask students to write a claim upfront about the effectiveness of their design and justify the purpose of its features based on the scientific concepts from the lesson.

Building And Testing

Display **slide 19**. After students have designed their models, written their justification, and received approval from you, give them time to construct their seed dispersal devices using the recycled materials you have provided. Once their build is complete, **display slide 20**. Students need a measurable goal/outcome to determine how effective their models are at seed dispersal. Engage in a discussion to decide as a whole class on a measurement to use. Two possibilities are measures of distance traveled or the number of seeds dispersed. After the measure has been selected, display **slide 21**. Students should test their devices and record data during their testing to demonstrate how effective (or ineffective) their designs are at dispersing seeds. During their tests, students should record data for the selected measure.

Evaluating Designs

Display **slide 22**. and pass out copies of the Model Self-Evaluation handout. After students have tested the effectiveness of their models, they should evaluate the strengths and weaknesses of their designs in light of their test results, taking notes on their handouts. Once all pairs have completed their evaluations, the class will participate in a modified Inverted Pyramid, bracket-style comparison of their models.

Display **slide 23** and pass out a copy of the Bracket Graphic Organizer to each pair. Have pairs write their team name or design name in the top box in the first column of the bracket and then find another pair to match up with. Display **slide 24**. Have pairs write the opposing pair's name below theirs in the bracket. Then, pairs should compare and contrast the design, strengths, and weaknesses of their two models, record their observations, and determine, based on the data, which was more effective at seed dispersal. They should write this team name in the second column.

Display **slide 25**. Have the groups of four pair up to create groups of eight. In this large group, students will compare the two designs that were selected as more effective in the previous round. Again, they should compare and contrast the design, strengths, and weaknesses of the two models. Based on the data, they should determine which was more effective and write this team name in the third column.

Depending on your class size, you'll generally have 2-4 models remaining at the end of three rounds. Engage in a whole-class discussion to compare the design features, strengths, and weaknesses of these models and decide on one that is most effective. As part of this discussion, be sure to emphasize that as long as the device they created was able to disperse seeds, it was *successful,* even if it was not the most effective at the task. Guide students to understand the difference between being the most effective versus being "the best" design.

Teacher's Note: The Nature Of Science And Engineering

Students **should not** leave with the impression that there is one "best" design. Instead, they should recognize that all of their designs have merit. The design that works best in one context (e.g., water dispersal) would not be the most effective in another context (e.g., wind dispersal). It is also important for them to understand that in engineering, design solutions come with trade-offs among costs, materials, strengths, and weaknesses, among others. More than one design can accomplish the same goals, and sometimes, the "most effective" might not be the best choice in the real world.

Display **slide 26**. Through discussion, help students compare similarities across designs, strengths among them that the "most effective" does not address, and weaknesses of the "most effective" that other designs account for or solve (if applicable). Guiding questions for this discussion might include:

- What patterns in the data support the conclusion that plant structures affect the probability of reproduction?
- How might the distance that seeds are dispersed affect a plant's reproductive rate?
- How did your designed structure make it more or less effective at distributing seeds?
- Which other designs had similar characteristics? Why might two designs with similar strengths or structures not perform the same?
- What are some strengths of the other designs that the most effective did not have? How do those other designs improve upon the weaknesses we identified in the most effective?
- If all of the models performed equally effectively, how could we decide which is "the best"? (Press students here to point out that the designs are different but not better or worse than one another.)

If any devices were unable to disperse seeds, frame the discussion in terms of the design being a rough draft and as an opportunity rather than a deficit. (For example, "If this was a real plant, what would be the effect if it couldn't disperse its seeds?") This discussion will provide an excellent segue into the final portion of the Extend activity. Emphasize for students that engineering design involves improving designs before the final version is built and used.

Revising Models

Display **slide 27**. Using evidence from their tests, their design evaluation, and the class discussion, pairs should revise their original models. Depending on the changes, they could use a new color to draw the changes on top of the original design or draw relevant views of the revised parts from scratch. Display **slide 28**. Ask students to revise their original claims based on the changes they made to their designs. If time permits, allow the pairs to rebuild their models and test the changes.

Teacher's Note: Engineering Design

Don't skip the self-evaluation and redesign portions of the Extend activity, even if you won't have time to rebuild and re-test the models. The revision process is vital to engineering design and is frequently left out of lessons. For students to come to a deeper, more authentic understanding of what engineering is, they must have a chance to engage in every step of the engineering process.

Evaluate

Display **slide 29**. Pass out a copy of the Artificial Seed Dispersal Pitch Planning Document to each pair of students and introduce the scenario presented on the slide:

A company is developing artificial plants to support the reproduction of endangered species. The company wants to mimic actual seed dispersal and has asked for design ideas for structures with potential for use in this work. You have identified two possible structures, the exploding seed pod you saw earlier and the device you designed in class. Create a sales pitch for the company to argue the merits of each.

Give students time to create a pitch that they will present (as a poster, oral presentation, written proposal, video, etc.) arguing in favor of designs based on their effectiveness and scientific relevance. Student pitches should be evidence-based arguments that highlight the purpose of structures in both the exploding seed pod from the Engage section and their own designs from the Extend activity. The pitches for each example should also explain the effect of the dispersal mechanism (i.e., seeds carried away from the parent plant) and why this effect is important (i.e., how it helps the plant reproduce). Use **slide 30** to outline any specific pitch and presentation guidelines that you might have.

When students are finished working, have them present their pitches to the class and turn them in as an assessment for the lesson.

Resources

- A Bit of Botany. (n.d.). Dispersal of seeds by water. http://theseedsite.co.uk/sdwater.html
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