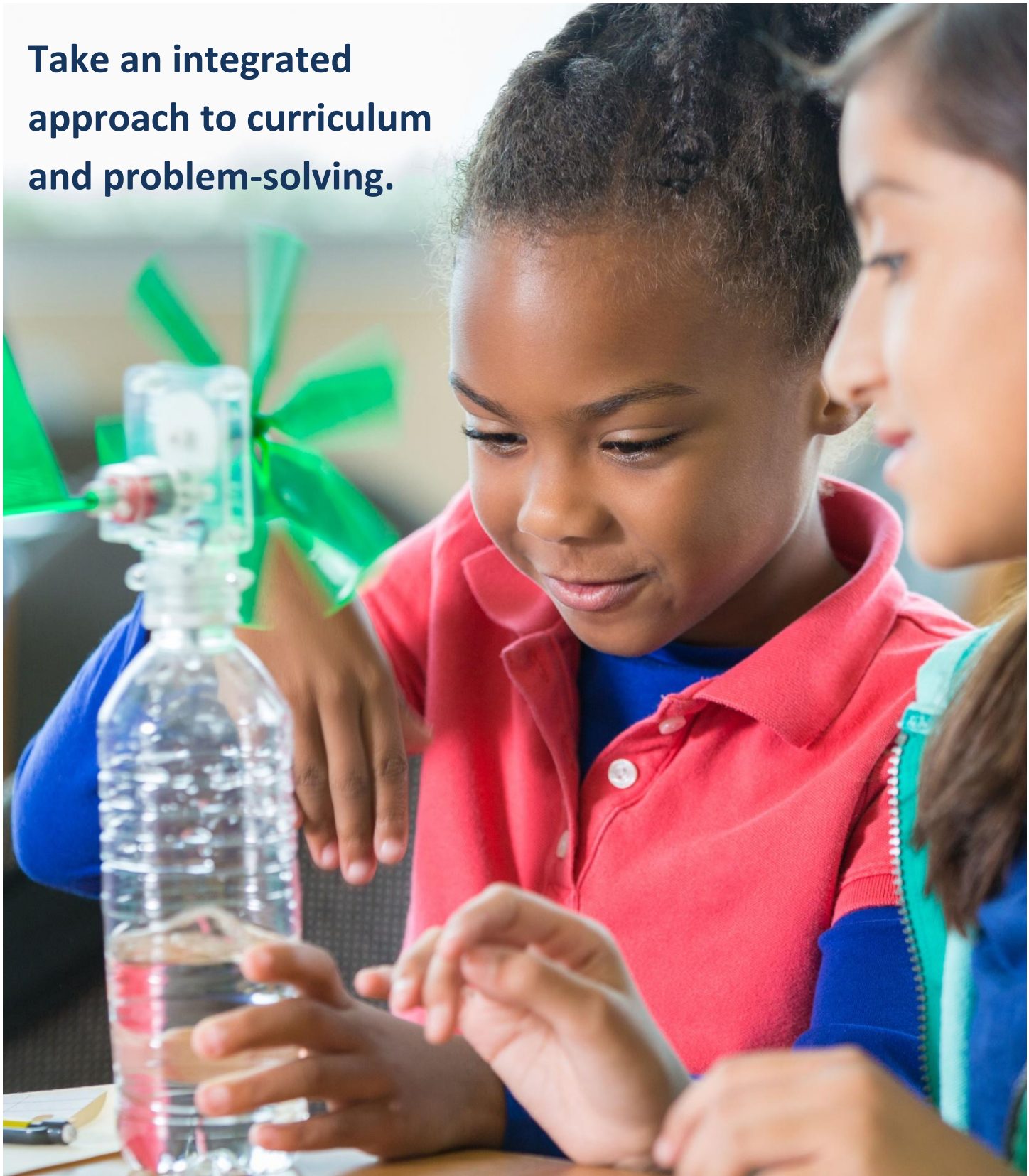
STEM and STEAM in the Elementary Classroom



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Taking Steps to STEM

Use design thinking and process to apply a STEM approach in any subject

In recent years, STEM has become increasingly popular in education. In a STEM classroom, instruction takes a unified approach to the normally separate subjects of science, technology, engineering, and math.

The STEM model is founded on the belief that the separation of these disciplines is done mainly for convenience, not for more effective learning. The more "holistic approach to curriculum" through STEM is designed to help students:

1. see how content in one subject connects to other subjects,
2. think more deeply about key ideas and issues instead of memorizing facts,
3. make connections between what they learn in school and their experiences outside of it.

STEM classrooms ask students to work on problems that blend, or blur, the lines between disciplines and require knowledge and thinking across them. It is believed that this approach better prepares them to solve problems in an increasingly complex and connected world, ensuring that they will be career-ready and globally competitive.

Some educators want to make sure the arts aren't excluded. In this broader approach, called STEAM, students share their thinking and ideas from STEM classrooms in creative ways, such as song lyrics and multimedia forms of communication.

Even if you aren't at a STEM or STEAM school, you can help students think more deeply and integrate ideas across disciplines in your classroom by:

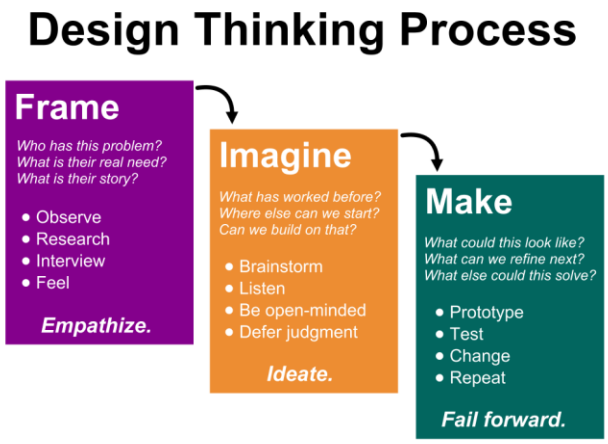
- asking questions that require knowledge and thinking in different areas.
- providing students with a design challenge connected to a topic you teach.
- using a design process during project work.

Utilize Design Thinking or a Design Process

A design thinking approach, or a design process, can help you get students questioning, thinking, and making in both STEM and traditional single-subject classrooms.

While creative designers have been using this process for almost fifty years, this process has more recently found its way into education, especially in maker spaces.

There are many models for the steps in design thinking, but they generally follow a process of defining the problem, coming up with ideas, making prototypes or designs and then improving them.



The process begins as you define, or **frame**, the problem according to the needs and desires of the people encountering it. You empathize with the audience for the problem to better identify what is actually needed and develop solutions to the issue.

Next, you work to **imagine** possibilities that address the specific needs you have defined. This part of the phase is about volume of ideas, not quality of them.

Next, you **make** your ideas real by creating designs and prototypes. You continue work by evaluating the first attempt as a prototype; testing, getting feedback, and learning from "failure" to make changes and improvements in a next version.

The process is repeated until you get a result you will use to move forward. In some models, like the Engineering Design Process used by the Museum of Science in Boston, improving is a separate step in the process.

Classroom Implementation

The goal of a STEM approach is to get students solving complex problems that require thinking across disciplines. It doesn't matter if you are a STEM school, or even which process you utilize. What matters is challenging students to think, know, and question across disciplines, building both creative and analytical thinking skills and learning when to use them.

In language arts class, you can use literature you are already reading to connect to STEM thinking. Literary characters encounter problems all the time, so ask students to design alternative paths to action for them. They may not be making something, but they are thinking both creativity and analytically about both the text and their experiences outside the classroom.

If you want to get language arts learners making, ask them to build new versions of the structures they encounter in stories, such as a better house for a fourth pig or an alternative way across the river for the Three Billy Goats Gruff. Then, ask them to present their work through written, oral, and multimedia forms of communication.

In social studies classrooms, challenge students to find new solutions to problems encountered by people in history, analyzing research and events to find creative alternatives. They can collect and analyze mathematical data to develop their own solutions to social science issues and share them using technology tools.

In the physical sciences, students can connect to engineering, not by repeating someone else's steps to build a bridge or roller coaster or boat, but by developing prototypes in response to a specific design challenge. If you are a single-subject science or math teacher, give students tasks that help them see the connections between these two disciplines.

Conclusion

No matter exactly how you deploy the ideas of a STEM approach, remember the goal is to help students connect ideas between disciplines to think more deeply about our world. Challenging students with complex problems that require ideas and information from multiple subjects can better prepare them to tackle the issues facing our world today and into the future.

Connecting Curricula for Deeper Understanding

The case for an interdisciplinary approach.

If we were going to build a house, we would expect that all its various parts would work together. We would assume that the architect shared the building plans with the plumbing, electrical, and general contractors. If these contractors did their part without regard to how their work fit in with what others were doing, the house would be inhabitable. But in a similar manner, school curricula are often disconnected; that is, we categorize subjects by disciplines and teach them separately. Why aren't we concerned in schools when the content of one subject does not relate to other subjects?

Instead of studying motion across the subject areas: what is it, where we see it, and how it affects us in our daily lives, we study the principles of motion only in a science class. In most schools, the only connection between a topic like motion taught in science to other subjects is in the minds of students. This is often by chance rather than by design.

Reasons for Separate Subjects

Most schools will say that they want students to have an understanding of their world as a whole, but they seldom look at topics with an interdisciplinary focus. Why? It is easy to find reasons why this disjointed approach to learning happens:

- Some argue that there is so much content and so many skills to be learned in each discipline that they don't have time to integrate subjects.
- Others say that the each discipline has a body of knowledge and skills that should stand on its own and not be muddied by the intrusion of other disciplines.
- Secondary educators say that there is insufficient common planning time to combine their efforts to teach an interdisciplinary course.

- Still others say that the whole system is geared toward separate subjects and to break out of this would require a monumental effort.
- Others are guided by "the tests," which are presented by separate disciplines.

Despite the norm, there are many schools, that practice cross-curricular teaching. They organize students into interdisciplinary teams and coordinate lessons so that what happens in math, science, language arts, and social studies all tie to a common theme. Many times these teachers team-teach during larger blocks of time.

Advocates of this more holistic approach to curriculum argue that it helps students:

1. see how content of one subject is interconnected with content from other disciplines.
2. delve deeper into fewer topics rather than skimming across the surface of many topics.
3. connect learning more easily with the experiences in their lives.

STEM, STEAM, and More

In recent years, curriculum developers have begun putting money and effort behind the notion of connecting allied disciplines. Linking the disciplines of science, technology, engineering, and math has been given the acronym STEM.

These disciplines have a lot in common, so their interconnection seems logical. We can find applications for each of these disciplines in the other. For example, we use science, technology, and math in the field of engineering. Similarly, we might use technology, engineering, and math in the study of a science such as genetics.

Some educators say that the arts are an integral part of STEM and shouldn't be excluded from an interdisciplinary mix, calling their approach STEAM. For example, if students are studying the transfer of energy, art could be a means to show it through music, dance, or poetry.

Still others feel that it is hard to exclude any discipline from a unified study. Everything, they say, is interconnected. One program at Spigot Science uses the large acronym STEAM GLASS + to characterize this all-inclusive approach. It incorporates more subjects than STEAM, such as geography, language arts, and social studies.

These acronym-labeled programs all recognize that the ways we divide subjects is artificial and is something that occurs mainly in schools for the convenience of the education system. The way schools work and the way scientists and others work is quite different. When scientists are studying a problem, there are often scientific, mathematical, artistic, or social elements involved. They seldom think about which discipline is at play when solving a problem.

This discipline separation in schools does not meld well with a problem or project-based approach. Nor does it help students learn to think deeply about solutions to problems that cross discipline lines.

Consider a student's day in each type of curriculum structure:

Subject Area	Separate subjects	Intradisciplinary by subject	Intradisciplinary by blended subjects
Science	Newton's First Law (An object at rest stays at rest and an object in motion stays in motion with the same speed and in the same direction **unless acted upon by an unbalanced force**).	Newton's First Law	How do we know how much force is applied to cause objects to move? Force experiments and calculations
Math	Area of a trapezoid	Force equation: F = m x a force = (mass) (acceleration)	
Social Studies	The Civil War- Battle of Gettysburg	Who was Isaac Newton?	What was happening in the world when Newton developed his laws? Research and multimedia project
Language Arts	Writing prompt: My favorite holiday	Writing prompt: Forces in our lives	
Art	Watercolor: Spring	The Art of Force: Newton Mobiles	How do forces affect us? Illustrate the effects with an art project.
Health	Avoiding disease	Forces that affect our bodies – the roller coaster	

Digging Deeper

The ultimate goal for the study of any subject is to develop a deeper understanding of its content and skills so that students can engage in higher-level thinking and higher- level application of its principles. When students dig deeper and understand content across several disciplines, they will be better equipped to engage in substantive discussion and application of the topic. They will also be better able to see relationships across disciplines.

Suppose upper elementary or middle school students were studying ecosystems. If they were studying this in science class, they might learn about how the habitats of plants or animals are interrelated. This is fine, but it doesn't push the topic as far as it could go. Students could collect and analyze data about ecosystems in the math portion of the study. They might use technology to find and represent information. They could learn what ecological engineers do and try their hand at designing a balanced ecosystem. Students could represent their findings using multimedia applications. And this study could go on to touch all the other school subjects.

Engaging in a thorough study of ecosystems would involve reading, writing, planning, designing, interacting, producing, and more. When students learn though an interdisciplinary approach, they are acting as they will in the real world—solving a problem rather than studying a subject. They are using many methods to gather, analyze, and process data.

Of course, digging deeper doesn't fit well in the time frame that most schools use. It takes time to link content across several disciplines, and it may be difficult to squeeze a learning activity into a 40-minute period. To change the method of learning will mean changing more than the curricula. The school structure, including the schedule and methodology will also need to change.

The measurement of interdisciplinary approaches does not fit well in a traditional testing format. Just as test developers have found it hard to create science tests that include hands-on experiences, they would find it very challenging to test understanding when the content crosses several disciplines. Indeed, to measure the results of an interdisciplinary, problem-based approach, we must often use rubrics and other measures that some test makers feel are "soft measurement" due to the difficulty of getting quantifiable data.

One ray of hope comes from the support offered by the Common Core State Standards initiative. This effort is embraced by 45 states and it supports digging deeper though cross-curricular teaching and its associated problem-based and project-based approaches. It supports using a variety of methods and incorporating technology to help all students learn. This initiative seeks to prepare students for college and their careers.

This type of digital storytelling uses the power of personal appeal along with voice, music, and images to create influence and impact. Authors combine their personal messages with the lessons learned to provide a compelling call to action. A popular television version of this approach is the "Above the Influence" series calling attention to the consequences of choices made or not made.

Our Challenge

To prepare our students for an integrated world, we need to break out of the separate-discipline mentality and develop more holistic and problem/project-based approaches. Many have tried to do this, and it isn't easy. Our separate-disciplinary structure is deeply ingrained in the culture of schools.

If we can ever reach the point where we view education as more than separate subjects and can begin to replicate the way problems are solved in teams in the working world, perhaps we will then be able to think outside the separate boxes that we our curriculum is squeezed into now. When we achieve this, our students will be the winners. After all, they are what this effort is all about.

Reflecting in STEM

The benefits of reflection in the STEM approach to instruction

The goal of the Science, Technology, Engineering, and Math (STEM) instructional model is to integrate the four subject areas and teach them in unison instead of treating them as individual, unrelated topics. A STEM lesson can include all four of these subjects or any combination thereof. Requiring students to work on problems that blend the STEM components prepares them to solve problems in an increasingly complex and connected world, helping ensure that they will be career-ready and globally competitive.

My school has embraced the STEM model; we are currently transitioning into a STEAM school to integrate the arts into STEM instruction. I serve as the STEM resource teacher for grade K-5; students rotate through my classroom to participate in activities that connect science, technology, engineering, math, and the arts.

Why Reflect in STEM?

Reflection in STEM is essential to both student understanding and teacher evaluation of students' learning. Reflecting helps students make connections, understand their successes and failures, and become aware of their learning. Reflections help teachers identify where different students are in their learning process.

Reflecting helps students process and organize their learning. As they reflect, students observe how successful they have been during an activity. Then, they work to identify what they learned from their experience. The reflection process gives students time away from the social and fast-paced nature of group work to think critically about their role in their own learning.

Many STEM lessons and activities are collaborative in nature. Collaborative work supports and motivates students, but it can be difficult to identify how well each student is progressing in a group setting. Individual reflections help educators accurately monitor each student's progress and guide future instruction.

After reflecting, students often gain a deeper understanding of the content because teachers are able to ask questions that prompt critical thinking that can only be accomplished after the main activity has been completed. Reflecting also helps students identify connections to previous learning.

Reflecting with the Engineering Design Process

I use a five-step Engineering Design Process developed by the Museum of Science in Boston to guide most STEM lessons and activities. In this process, students:

1. **Ask** - What is the problem? What are the constraints?
2. **Imagine** - What are some solutions to the problem? Brainstorm.
3. **Plan** - Draw out your plan. Gather your materials.
4. **Create** - Follow your plan and test it.
5. **Improve** - Does it meet the goal? How can it be improved?

The Improve step supports the reflection process as students look back on the entire engineering experience to see what they can make better. Since students cannot truly improve their product without understanding the content, this reflective step provides an opportunity to unpack their learning.

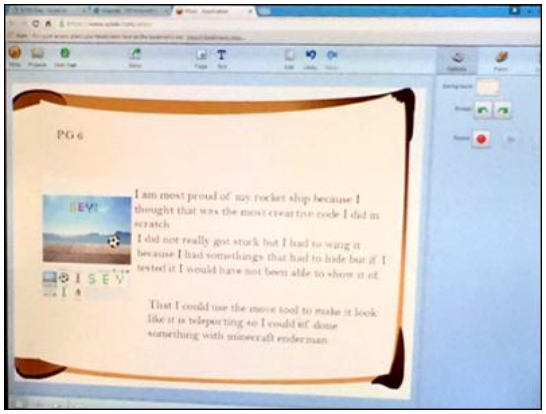
At this point, students think objectively about their product to identify whether or not they were successful in achieving their goals. They also determine what changes could be made, and then they execute the revised process to see if the changes yielded improvement.

Daily Reflection Journals

Concurrently with the Improve stage of the Engineering Design process, students complete a daily journal that includes questions to prompt reflection and a redesign space where they can illustrate new ideas. I use Wixie and Padlet to support students' daily reflection.

Wixie

Since my students are already familiar with Wixie from their project work in other classes, I used Wixie to create and assign a reflection journal. Students log in to Wixie and open their journals to type or record reflections and draw new designs.



For each day of the project, the journal has a page with questions to prompt their reflection and a page where they can use Wixie's paint tools and image library to redesign their product. I add additional reflection prompts in the instructions field on their redesign page to give them more space to work.

Padlet

When I want students to reflect in groups, I post reflection questions to Padlet and share the URL with students. Padlet works like an online bulletin board. Multiple students can edit the board at the same time, responding to the prompt and to one another by typing text, uploading files, adding hyperlinks, or adding photos.

While there are opportunities for reflection throughout the STEM process, I have found that daily reflection is the best way for students to understand and learn to value the reflecting process. Reflection becomes routine for students and expectations are always very clear.

We use a daily reflection journal in our fifth grade coding unit. In this unit, students use Scratch to complete daily coding challenges. Their experience is very exploratory; students have creative latitude as long as they are staying in line with the day's coding challenge.

I customized the scrapbook template in Wixie to create a reflection journal. Students personalized their coding journal covers to give them a sense of ownership. At the end of each class, students are prompted with questions about that day's coding experience. The students are encouraged to create drawings to go along with their reflections, add pictures of their code, and include pictures of what they actually created.

In addition to helping students to fall into a positive routine of thinking deeper on their learning, reflection journals make it easy to go back and revisit previous work. As students see their progression through a unit, they move from reflecting on what they had done to setting goals for future work.

Reflecting can be a great teaching strategy to use in the STEM classroom as it benefits the students in significant ways, can provide the teacher with powerful data, and seamlessly fits into STEM lessons.

Lesson Plans

The following lesson plans provide specific, detailed examples of the ways creative technology tools can be applied in the elementary math curriculum to engage students and improve content knowledge and retention.

Each lesson includes:

- the **task** students will perform,
- ideas to **engage** students in the content,
- a description of what students will **create** with a technology tool,
- ways to **share** student work beyond the classroom walls, and
- tips for **assessing** student work.

Animal Interviews

Students research the physical characteristics, adaptations, and habitat of an animal and share their findings through a question and answer session with the animal.

Apps: Wixie® or Frames®

Task

Everyday scientists are learning more and more about how animals "talk." For example, there is now an elephant voices dictionary that helps humans understand the meaning of elephant calls and gestures subsonic.

Students will use their powers of research, observation, and questioning to create an interview with an animal; interviewing it to help others learn more what makes it so amazing along with the issues it faces in the wild.

Engage

Inspire your student's curiosity about animal's unique characteristics by visiting the San Diego Zoo Kids web site and exploring some of the amazing animals found there. Depending on the literature you have been reading with students, you may want to start with a specific animal. For example, if you have been reading Verdi, by Janell Cannon, to your class, start with the python.

Ask your students to share what they know about other amazing animals. Help lead students to the realization that a unique physical or behavioral adaptation is what makes the animal interesting. To get them talking, ask students to share:

- What the animal looks like.
- Where the animal lives in the wild.
- What makes it interesting.

Let students know that they will become animal researchers who will inspire others about the wonders of animals, their unique adaptations, and the issues they face in the wild through an interview with the animal!

Group students together in pairs by interest in the same animal, keeping in mind work style, ability, and personality. Working together will make the research process a bit easier and provides for an easy split into interviewer and interviewee (animal) when they record the interview. If students have a team mate to question first, you will also have a bit more time to talk to different groups and identify misconceptions.

Students should begin by completing research about the animal. Graphic organizers, like clusters, may be helpful for them to organize the information they find about the habitat, food, physical characteristics, and predators of the animal they are studying.

Their research should answer questions like:

- What are the physical features of this creature?
- Why are these features needed in this habitat?
- What does this creature eat?
- What does this creature do during the day? Or is it nocturnal?
- Does this creature have any natural predators?

Create

Tell your students they will be sharing their research through an interview with their animal. Their animal will describe how it looks, what it eats, and where it lives by answering questions from a reporter.

This might be a good time to talk to your students about personification. While the goal is to share information in a fun and unique way, you can focus on writing and language skills by asking students to consider:

- How do you feel about your looks?
- What are you afraid of?
- How do you feel about what you eat and where you live?

When they have enough information about their animal, students should begin dividing up the information into questions and answers. While you can provide the questions, having students develop the questions on their own is a powerful way to have them start organizing information and thinking like scientists.

Using a tool like Wixie® or Frames®, have students enhance their interview with images and voice narration.

If your students are ready, give them flexibility to choose how many pages or slides in their interview as well as how it is organized. If they need more structure, you could suggest they create pages for:

- What the animal looks like.
- Where the animal lives in the wild.
- What makes it interesting.

Have students develop illustrations for each question and answer and record the interview. They can create original illustrations, find photographs, and even capture their image to add to the project using a digital camera or web cam.

Share

Have students present their interviews to the rest of the class or local animal expert, such as a ranger from a local park or nature center. Post interviews to your class website, a station in the school media center where other students can use for their own research purposes.

Assessment

The final interview and student work during the process will help you evaluate understanding of physical characteristics, habitats, and adaptations.

Monitor progress and encourage the use of graphic organizers as students begin their research. Work closely with students as they develop their interview questions, as their formulation of the questions will demonstrate comprehension of big ideas behind the facts they find. Their written interview may also serve as both a formative and summative assessment.

The resulting interviews serve as an artifact for a unique summative assessment of informative writing. Be sure to evaluate student recording for fluency and content accuracy.

Resources

Nicola Davies. **Extreme Animals: The Toughest Creatures on Earth.** ISBN: 0763641278

Pamela Hickman. **Animals in Motion: How Animals Swim, Jump, Slither and Glide.** ISBN: 1550745751

San Diego Zoo Kids: Animals

Shedd Aquarium: Animal Facts

Ranger Rick: Animals

National Geographic: Animals

Create a Creature

Students apply what they have learned about animal characteristics and adaptation to create a new creature and introduce it to the scientific community.

Apps: Wixie® or Pixie®

Task

Scientists are finding new species every year. While some of them live in remote environments, others have been found in large urban cities! While you can't travel to faraway lands in the hopes of finding a new species, you can use what you know about plant and animal adaptation to create a new species of your own!

Create an electronic book to introduce your species to the world, sharing its physical adaptations, daily habits (behavioral adaptations), predators, and prey.

Engage

There are lots of right ways to explore this topic. You might focus on a specific habitat and brainstorm animals and adaptations for that habitat. You might instead have students individually or collaboratively research a favorite animal and explore its habitat and adaptations. This "create a creature" project is a good culminating assessment of student understanding of animals, habitats, and adaptations and assumes they have already explored these topics.

Begin project work by reading about one of the amazing creatures in Extreme Animals: The Toughest Creatures on Earth by Nicola Davies. Share additional photos of the animal with your students from education-friendly sites like Pics4Learning.com. Penguins are a perennial favorite with elementary students and images, leveled literature, and information texts abound.

Ask your students to share what they know about other amazing creatures. Help lead students to the realization that a unique physical or behavioral adaptation is what makes the animal interesting. To get them talking, ask students to share:

- What the animal looks like.
- Where the animal lives in the wild.
- What makes it interesting.

Explain that new plants and animals are still being discovered by scientists and researchers. Share examples of some of newly-discovered species with your students. Live Science has a collection of some great examples for 2013; a search on the Web will turn up many others.

Let students know that they will become animal explorers tasked with a mission to "find" a new species. They will use what they have learned about plant and animal characteristics and adaptations to create a new species and introduce it to the world by creating an electronic book.

Create

Depending on the culture and students in your classroom, students may work individually or in small groups. If you have highly independent learners, let them show off their individuality through personal work. If you have students who must collaborate to come up with ideas, small teams provide many more opportunities to discuss and process learning. Group work also provides additional opportunities for you to identify misconceptions and help the group to focus on key understandings.

If your students have a strong grasp of characteristics, adaptations, and habitats, have students or teams begin by describing the habitat in which their new animal will live. They should include information about weather, temperature, rainfall, plants, and other animals.

Next, have students think about where their animal will live in this habitat – on the ground, in the air, water, or tree tops, etc. Share graphic organizers like t-charts, 4-squares, clusters, and storyboards to help students organize their ideas.

Ask students to create a creature with adaptations that help it survive in this environment. Encourage them to look to other creatures in similar habitats to identify features and characteristics that would help this creature thrive in its habitat. If they are creative thinkers, they can simply start designing.

If your students are just beginning to understand the idea of adaptations, have them create a creature first by combining body parts from one or more categories of animal types, including birds, reptiles, amphibians, fish, insects, and invertebrates.

Tell your students they will be creating ePubs/iBooks to introduce their amazing creatures to the world.

Books should include the features of informational text, including images, labels, photos, captions, and headings. The information students provide should answer questions like:

- What are the physical features of this creature?
- Why are these features needed in this habitat?
- What does this creature eat?
- What does this creature do during the day? Or is it nocturnal?
- Does this creature have any natural predators?

If your students are ready, give them flexibility to choose the information they will include in their project. If you want to provide direction and structure to the project, you could ask students to create a project that includes pages for:

1. Title page with name of animal and scientist(s) who discovered it
2. Image of create in habitat
3. Description of habitat and images to support description
4. Description of creature's characteristics and image with labels
5. Description of creature's predators and prey (diet)
6. Story of how the creature was discovered (narrative writing)

Have students record their voices as they read the information on each page. (Note that audio for ePub may not work on all Android devices.)

Share

Have students present their creatures to the rest of the class or to a different team. To give the project an additional air of authenticity, bring in local experts to ask questions and evaluate student work. If you do not

have a local zoo, veterinarians, park rangers, and even pet enthusiast parents may be willing to help.

Students can publish their books as ePub files and share them using a service like iTunes or Dropbox. Share the ePubs in the school library database, on computers in the library, or in a publically accessible network location where other students can access and download the publications.

If you don't have ready access to eReaders, you can export the finished work as PDF files for easy sharing. You can also print their work and share it in classroom and school media centers or post the digital files to your classroom web site.

Assessment

The final ePub and the work during the process will help you evaluate student understanding of animals, habitats, and adaptations.

As individual students or teams begin working on the descriptions of their habitats and animal features, monitor their progress and ask questions. You can also use graphic organizers as tangible check in points.

As students begin illustrating, prompt them with questions about their animals to encourage them to add more details and create accurate illustrations.

The resulting ePub or PDF can serve as an artifact for summative assessment of content and expository, or informative, writing. If their work includes a story detailing the discovery of the creature, you can also evaluate their narrative writing skills.

Be sure to evaluate oral presentations for content accuracy. Students' ability to answer questions from the audience will help you assess how well they have internalized the concepts of behavioral and physical adaptations.

Resources

Nicola Davies. Extreme Animals: The Toughest Creatures on Earth.

Pamela Hickman. Animals in Motion: How Animals Swim, Jump, Slither and Glide.

National Park Service: Our Wild Neighbors

National Geographic: Creature Feature

Dream Room Design

Students explore length, width, perimeter, and surface area, convert measurements, and work with 2-D representations of 3-D objects.

Apps: Wixie® or Pixie®

Task

Are you satisfied with the design of your bedroom? Have you seen advertisements for posters, TVs, or a bed you just have to have? Your parents are never going to give you your dream room, unless you can accurately describe the items in it and why they are necessary. Using measurement skills, create your own dream bedroom design!

Engage

Introduce the concepts of length, width, and perimeter to your students. Make sure that they know how to determine the surface area for simple rectangular shapes (width x length).

Have students practice their measurement skills in your classroom, determining the dimensions of your classroom and objects in it, such as your desk, student desks, and any chairs, tables, and bookcases.

If you are working with older students, teach them how to find the area of polygons by breaking them into component shapes and estimating.

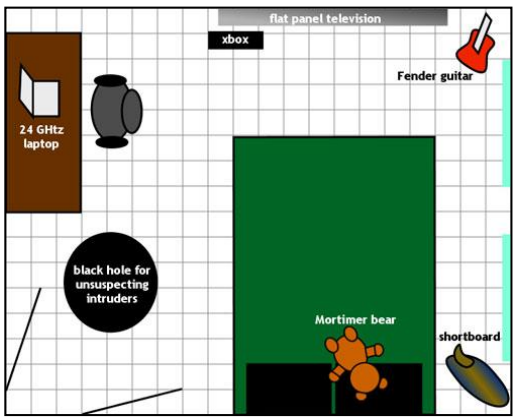
Assign students to take some basic measurements in their rooms at home and calculate the square footage. Have them measure some common bedroom elements such as beds and dressers.

Brainstorm with your class the elements a bedroom might have, such as bed, dresser, and television. Which items are needs and which are desires? What should a bedroom do for the occupant? If it contains a bed, do all beds have to be exactly the same?

Create

Have students begin by creating a paper sketch of their dream room. You might create a worksheet that has a 12 x 12 room with gridlines every 6 inches.

The designs should include major elements that make it obvious this is a bedroom, like a place to sleep and a place to store clothes. Encourage them to think about accurate or appropriate space between objects.



You may also ask them to add architectural details such as power outlets, doors, windows, cable access, and telephone access. How will they designate these items in their drawing? How will they show them to scale? Have students develop a key for their design using shapes and color.

Once students have a general idea of their room's layout, have them launch Wixie to complete their design to scale. They can begin from a grid template to more easily create accurate and appropriately sized representations of objects like rugs, dressers, beds, and desks.

Encourage them to use colors and add text descriptors for clarification. When their visual design is complete, have students add a page, or pages that includes a description of their dream room and the objects in it.

If students are new to descriptive writing, talk about putting together a descriptive paragraph. You can use the burger analogy: the meat, or main idea, of their paragraph, surrounded by juicy details, held together by the bun of introductory and concluding sentences.

Share

Have students use the text in their descriptive essay, along with a picture of their dream room, to share their design ideas with the rest of the class. After all the students have presented, discuss the ideas you liked the best. If you have adequate time, let students duplicate the page with their design and make adjustments based on other student's ideas and feedback.

Return to your brainstorm about what makes a bedroom. Compare what the students have included in their designs to the elements they came up with on their list. Have the students' opinions changed about what a bedroom should contain or be?

Assessment

Use the students' measurements of their room to determine if they understand how to take measurements and determine surface area.

Use the design sketch and finished Wixie project to evaluate students' ability to convert measurements, draw objects to scale, create 2-D representations of 3-D objects.

Evaluate their room description for the use of descriptive adjectives, voice, and organization.

Resources

Hallam, Linda. **Decorating Kids' Rooms: Nurseries to Teen Retreats**. ISBN: 069620729X.

Brunetto, Carolyn Ford. **MathART Projects and Activities**. ISBN: 0590963716

Writing with Writers

Unique Furniture Designs

Design a Polar Park

Students design enclosures for animals that live in the Arctic or Antarctic regions, reflecting the animal's natural habitat, as well as its air, water, food, shelter, and activity needs.

Apps: Wixie® or Pixie®

Task

When zoos and aquariums design animal enclosures, they make sure they are both safe and interactive for the animals. They also work hard to ensure the enclosure reflects the animal's natural habitat.

In this project, your class will work together to design a Polar Park with a variety of exhibits that showcase the animals in the Arctic or Antarctic region. It is your task to design an enclosure for a specific animal that considers the survival needs of the animal, accurately reflects their natural habitat, and helps visitors learn more about this unique species.

Engage

Begin by engaging your students in discussions about weather, climate, and animal adaptations.

Ask your students what type of weather they prefer. Do they prefer summer where the weather is warm, or winter where they bundle up to play in the snow? Ask students to explain how they do different things in different seasons and how their behavior (food, clothing, activities) changes when the temperature changes.

Ask your students which season, or weather (climate), they think animals prefer. It may take a little prompting, but students should soon see that different animals may have different preferences. Ask them to explain and elaborate using specific animals, and their characteristics, as examples.

Read a book such as Polar Bears or Penguins by Gail Gibbons. Discuss the unique adaptations and characteristics of polar animals. Discuss how the environment in which these animals live compares to the environment in which your students live.

Next, ask students if they have ever visited a zoo or an aquarium. What was their favorite exhibit? Why? What specific features made it memorable? What do they think the animals in the enclosure felt about the exhibits?

Show students a picture of a penguin, or a group of penguins, in their natural habitat.

Ask the students to describe what they see in the habitat. Which of those features could be replicated in a zoo exhibit?

Let the students know that your class will be designing a Polar Park. As a class, decide if you will focus on Arctic or Antarctic animals or if you will mix animals (but label or group them) from both regions.

Form small teams of students to design an enclosure for a specific animal. Since the focus of this project is on habitat and requirements for life, let students choose to make their exhibit any size and using any budget/materials.

Have teams begin by researching their animal. They should be encouraged to become an expert on this animal, its unique characteristics, and needs. Provide them with graphic organizers, such as clusters, to keep notes on plants and physical features that are found in this animal's natural habitat.

Create

Let the students know that they will be responsible for sharing their design through informational text and pictures, as well as formal presentation.

You may want to help provide structure to their presentation and design portfolio by establishing requirements like:

- A map of the entire enclosure.
- Textual information about what the enclosure includes.
- A detailed visual example of one part of the enclosure.
- Important things to know about the species in enclosure.
- Ways the enclosure meets these needs.
- Details about the daily routine of the animals in the enclosure.

Students can use a tool like Wixie to organize their presentation. Have them use the Paint tools to create a map, marketing important features in the animal enclosure, as well a locations where visitors can view the animal. They should also clearly mark areas that will be hidden from the guests for the caretakers to prep food, care for sick animals, and store equipment.

Students should also include a more detailed example visualizing what one area of the enclosure will look like, haring special features of that space, as well as how the animal (or animals) appear in that space.

The presentation should demonstrate their expertise about the animal itself. They should share facts about the animal as well as showcase their knowledge of its unique characteristics and adaptations that help it survive in their natural environment.

Students should also include text and pictures that describe how the enclosure reflects the animals original habitat and is uniquely suited to helping the specific animal thrive.

Share

Have student teams present their designs to "critical friends" in your classroom. After sharing feedback, teams should make tweaks to the design and edits to their presentation.

Invite a local zoologist, park ranger, or even veterinarian to evaluate student designs and the presentations of those designs. Student teams can each make an oral presentation of their design, or have them showcase their work more in the style of

science fair, where evaluators visit each booth to learn more about their enclosure.

As a class, work together to develop a map, or design, for the entire park, showing the location of each enclosure, and discussing and describing the visitor experience.

Have your entire class showcase their work at a Polar Park Faire. Invite parents, as well as community members, interested in polar animals to talk with your student experts and tour the proposed design.

Assessment

Initial discussions with your students will help you assess their prior knowledge about arctic animals, as well as how much they have thought about animal enclosures at zoos and aquariums they have visited.

As you work together to explore and research one species together, their ability to glean facts and information from the story will provide you with a sense of their research ability. This work as a whole group will provide information that will help you group students for maximum success in the project. It will also help you determine if you need to develop additional research resources and supports to help students meet the goals of the project.

Check in with students as they complete their initial animal research and organizers to clarify misconceptions before they begin the design process.

Ask students to talk about their maps, visualizations, before they present so that they have practice articulating their work. Have teams submit descriptions and other textual information to you, so you can provide comments and feedback before they add it to their design portfolio/presentation.

Support student presentation of their materials as they share their work with one other team. Use this opportunity to ask clarifying questions. You may even want to have the teams present their work to you, when they think they are finished, so you can provide feedback before final whole group presentations.

Resources

Jackie Glassman & Lisa Bonforte. Amazing Arctic Animals (Penguin Young Readers, L3).

Molly Aloian & Bobbie Kalman. The Arctic Habitat (Introducing Habitats).
Barbara Taylor. DK Eyewitness Books: Arctic and Antarctic.

Switch Zoo: Build an Online Habitat

Penguin Coast: Maryland Zoo

How Does Your Garden Grow?

Students design a functional and beautiful garden, developing a scale model, determining costs and materials, and creating a guide explaining how to care for the garden.

Apps: Wixie® or Pixie®

Task

Your local garden center wants to encourage people to plant their own gardens, and is hoping that interest in environmental issues can help boost interest in gardening. They have asked for your help in creating a variety of small garden designs that they can show to customers who are interested in saving water, cooking with foods they have grown, or just "greening up" their home environment.

Student teams will design a small garden that is uniquely suited to a specific environment. They will work together to create a scale drawing, a list of needed non-plant materials and estimated costs, a list of suggested plants and estimated costs, as well as an instruction manual with the basics of care for the garden. Teams will present their garden designs and implementation materials at a community garden fair.

Engage

From conserving water to organic gardening, environmental issues have most students talking these days. Use this interest to help engage them in the study of plants and their role in small ecosystems.

If students' families have a home or community garden plot, ask them what crops are grown. With some prompting, they may also be able to tell you different plants that are grown at different times of the year. Depending on where you live, students may also have fruit or nut trees in their yards.

If students live in apartments, prompt them to think of unique "gardens" they have seen in small spaces. You might prompt them with examples, like a cherry tomato plant on the porch, a small pot of cilantro by the sink, or a bonsai tree in the living room.

Encourage students to brainstorm other unique gardens they have seen. Botanical gardens usually have all types of plants, but students may have also heard of or visited a xeriscape garden, an aquatic garden, or even a park with a restored prairie. You might even get them interested with an excerpt of National Geographic's Pond Stars!

Depending on your goals for exploring ecosystems and movement of matter, this may be a time to bring up concepts like organic and genetically modified, as well as stories about pesticide use such as DDT and other chemicals with effects that are beneficial to plants but disastrous to animals.

You can also connect what your students are learning about American Colonial History and ecosystems in science by exploring the colonists' utilization of the "Three Sisters" style of companion planting. The Three Sisters name was coined by the Iroquois and used widely by many Native Americans groups.

In this "companion planting" style of gardening, corns, beans, and squash are grown together. Beans use the corn stalk as natural place to climb, help to stabilize the corn stalk in the wind, and boost nitrogen content in the soil, which benefits the other plants. Squash grows around the base, shading the soil and preventing both the growth of weeds and the loss of moisture. The sharp hairs on the squash also help to keep pests like mice and raccoons from eating the crops.

Once you have piqued student interest in plants and gardening, let them know that they will create a garden design and develop materials to help people interested in this type of garden implement on successfully.

Create

Form small teams of students. It will be helpful to include a science "expert" in each group to serve as the visionary who can evaluate the accuracy and quality of design.

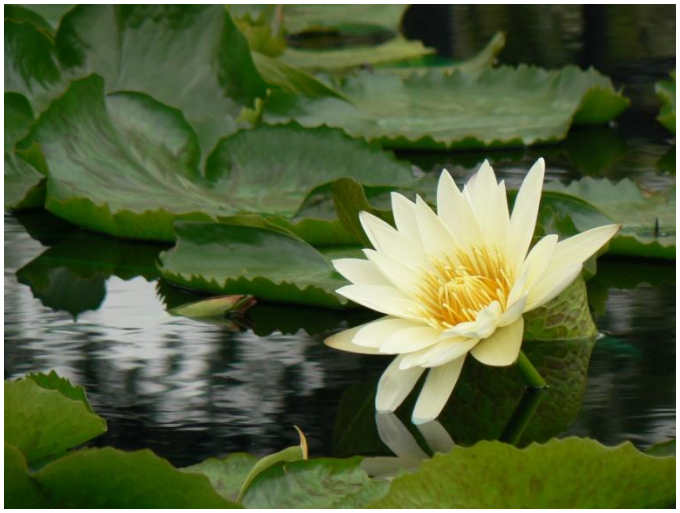
Instead of starting with a specific garden type in mind, have the team focus on the type of person they are creating the garden for. Does the person want to:

- Landscape while saving water.
- Grow their own food or herbs.
- Add a water feature to their yard.
- Create a garden inside their home or apartment.
- Create a garden habitat native to the region in which they live.

Designing with a specific user in mind makes it easier to define the problem and narrow the scope of the project.

Have students complete a cluster organizer or character trait worksheet to practice descriptive writing as they identify and define who they are designing for. Give students parameters and requirements for their work such as:

1. A scale design for a garden.
2. Suggested plants for the garden and an explanation of why these represent a healthy ecosystem or habitat.
3. A description of the design, as well as who would benefit most from this type of garden.
4. Care and maintenance instructions for the plants in the garden.



You may want to provide more specific expectations, such as choosing a particular planter size available at a typical garden center. When you share the project assessment criteria, you could also let students know that a list with three suggested plants will earn 10 points, while a list with more than 10 will earn 50 points.

Once you determine parameters for their work, let students choose how they will meet them. For example, their design description could take the form of a poster, brochure, slide show presentation, or even a video advertisement. You might want to brainstorm as a group different ways students can share information as well as the resources available to them.

You may also want to choose roles for each team member, such as lead designer, architect, researcher, writer, editor, and speaker. Depending on your goals for their learning, you might also have every team member take the role of research and writer for a day or specific component of the project.

Once student teams have chosen their audience and the type of garden they think will be most attractive to this audience, have them begin researching. They need to learn about the plants, soil, nutrients, care, and pests for a successful design.

As they explore the plants that would work in their garden, encourage them to collect research in a three-column organizer that includes the plant name, description, and pros and cons about its use. Students could also create a larger table with additional columns for size, water needs, sunlight needs, and feeding. They should not choose the first plants they find; rather, their research should help them choose the best plants from the many they learn about.

Once they have chosen plants to include, the team should work together to organize the plants into the allotted space. Encourage them to consider how the customer will access each plant for care, how it will appear (color and beauty), as well as how companion plants may be mutually beneficial.

Once they have a design created, team members need to think about how they will present a general description of their garden as well as care and maintenance instructions. They should be thinking about all of the materials they want to have available to share with potential customers at a garden fair.

Share

Have student teams present their designs to "critical friends" in your classroom. After sharing feedback, teams should make tweaks to the design and edits to their presentation.

Have students showcase their garden designs to interested community members. Host a Gardening Fair at your school or partner with a local nursery or garden center to have students present their ideas to customers at a special event. Explore additional options for distributing and displaying materials created by your students.

Assessment

Once you begin discussing the Three Sisters planting method, you will get a sense of student engagement in the topic, as well as begin evaluating prior knowledge and experience.

If you have students write about their target customers, you can evaluate their ability to empathize and write descriptively. If you implement this project more than one time, you can skip also this part and distribute/assign the first year's examples!

The research students do to develop their list of suggested plants will give you both a window into their grasp of plant needs and ecosystems as well as help you see where they need additional support in organizing research information and note taking.

The scale drawing or design of the garden is their first chance to apply the knowledge gained in their research. Evaluate their drawings' accuracy for size, complementary grouping, and maintenance. You might need to prompt the teams with questions about reaching plants to weed, prune, or pick.

Be sure to evaluate each team's overall presentation. Confirm the content accuracy and rate the effectiveness of their presentations. Did they share their ideas creatively? Were they easy to read, find, hear?

Enlist the help of gardening center staff (or parent experts) to help you evaluate the designs and the presentation of the design to potential customers.

Resources

Celebrate the Three Sisters: Corn, Beans and Squash

Companion Planting

Plant care for edible gardens

Xeriscape Plant Requirements

Plan an Event

Students plan for an event, including food, theme, and decorations, and create a proposal demonstrating how the event might look and how much it would cost for various numbers of attendees.

Apps: Wixie® or Pixie®

Task

Everybody loves a party! Well, everyone except maybe the person who has to pay for it. People hold events all the time for a variety of reasons. Businesses host events to introduce clients to new ideas or to say thank you for being a customer. Families hold events to celebrate important dates like birthdays, anniversaries, and marriages.

In this project, you will choose an event or party you would like to plan for your school. For example, you could plan a thank you dinner for volunteers, a celebration for your school's teacher of the year, or a party for your class or grade. Once you choose an event, you will write a proposal that describes the theme, decorations, and food and calculate how much the party will cost for various numbers of attendees.

Before you begin

This project engages students in a variety of activities requiring them to apply mathematics. This project isn't just about budgeting. Students will perform basic computation as they research cost of goods, practice measurement as they look at room setup and layout, and work with ratios as they calculate costs for various numbers of people and the costs for supplies.

Depending on your goals, you may want to structure the project instead of leaving it open-ended. You could establish a budget, choose 3 numbers of participants for ratio purposes, and even direct students to specific vendors for food.

To save time on research, bring in sample menus and invitations. Locate and set parameters for web sites and locations where students can find and price out party

supplies and catering. Most chain party supply stores, like Party City, have web sites. Other vendors, like Shindigz, only exist online. If you have a BYOD policy, students can research using their phones and tablets.

While students can keep track of numbers and costs on paper, this project is an excellent opportunity to demonstrate the value of a spreadsheet as a tool for tracking and analyzing data. While they should be demonstrating on paper how they solved ratios using addition and multiplication, tape diagrams, and/or coordinate plans, you may also want to encourage students who have mastered these skills to apply them to design formulas in the spreadsheet to update calculations automatically when values change.

The final proposal should be shared as an oral presentation, supported by charts, graphs, documents, and plenty of writing that both informs and persuades, using the cost analysis to achieve a goal or benefit.

Engage

To introduce the project to students, ask them about an event they attended that was fun and exciting. What was the theme? Was their music, dancing, good food, friends, new people, and/or colorful decorations?

Ask them how the goods they listed are appropriate for different kinds of events, like an awards ceremony or cultural celebration. Help guide them to the idea that a successful event has a goal and that a skilled planner minds the budget while paying attention to the needs and desires of the audience.

Let students know they will be planning an event to be held at their school. (Planning to hold the event at school eliminates the need to rent tables and chairs, helping simplify the process to focus on money and ratios.)

Divide students into teams of 3-5 members. Have them choose an event they would like to plan, such as:

- a fundraiser for a music, sports, or school club;
- a thank you dinner for volunteers;
- a celebration for the teacher of the year; or
- a cultural celebration.

Create

Once student teams choose an event, they will be responsible for developing a proposal that explains the goal of the event and describes what will happen. Proposals should include specific information about:

- Location(s) and layout(s)
- Time of event and duration
- Menu, including drinks and paper products
- Decorations
- Entertainment
- Invitations and/or advertising

The proposal should include the cost of the event for different group sizes, such as 25, 75, and 150 attendees.

You can choose the numbers of participants or have teams choose their own levels based on their particular event. If students plan a cultural celebration designed for one class, suggest that they also determine the cost to hold the event for multiple classes. If they plan a fundraiser, remind students that a larger group increases the cost, but also increases the potential for revenue.

When considering food options, students should create and show a ratio of selected menu items to the people attending to help make sure there is enough food. Do they have a plan for those who take more than their share?

The oral presentation of the proposal should include multiple forms of media, including text, voice narration, and images. The presentation is a perfect opportunity to utilize multimedia tools like Wixie and Share that include event planning templates.

As students learn to make effective proposals and persuasive pitches, encourage them to include pages or slides about:

- Event title and goal
- Theme and how it addresses the goal
- Entertainment
- Food
- Diagrams of layout/room arrangements
- Invitations and advertising
- Total cost
- Cost and budget breakdowns for different numbers of people

Pages or slides should contain text that is both informative and persuasive. Each page should contain images that also serve to inform and persuade. Images, colors, and background music are great ways to set tone and mood.

Since the presentation is meant to be live, students should work to ensure that the text they create for the presentation is concise. They may also want to write out a sample script to support their oral explanations and arguments. Practicing the presentation before giving it is a great way to identify missing information, encourage editing, and make iterative adjustments essential to the design and planning process.

If students are new to descriptive writing, talk about putting together a descriptive paragraph. You can use the burger analogy: the meat, or main idea, of their paragraph, surrounded by juicy details, held together by the bun of introductory and concluding sentences.

Share

Teams should present their proposals as an oral presentation, supported by charts, graphs, and other documents. Presentations and proposals should include expository writing and speaking that informs as well as persuasive writing and speaking that seeks to have their proposal funded.

Have students present their proposals to your school's principal, department chairs, Parent Teacher Association, or school board. Ask these stakeholders to help you evaluate the effectiveness of the idea, presentation, and proposal and share their feelings about the level at which they would fund the event.

You may want to speak with your principal or PTA to see if they would be willing to designate a certain amount of money to fund an event before you begin the project. You can use this as the way to establish a budget. This adds an element of competition, so make sure this is consistent with your goals for the project.

Assessment

This project lends itself to assessments in different areas. For math, you can evaluate accuracy of research data and measurement as well as proper application of ratios to determine cost for different numbers of participants. Require students to submit their tape designs or additional tables to demonstrate their understanding of this part of the process. This is a great opportunity for a project check-in.

The proposal project file should provide examples of both informative and persuasive writing. You can also evaluate students' writing for their ability to develop and communicate with images and diagrams.

The presentation provides an opportunity to assess speaking and oral presentation skills. You may also want to consider evaluating the project management, teamwork, planning, and organization that occurred during the process.

Resources

Judy Allen. Event Planning: The Ultimate Guide to Successful Meetings, Corporate Events, Fundraising Galas, Conferences, Conventions, Incentives and Other Special Events.

wikiHow: Plan an Event

Wixie

Wixie is an online publishing and creativity platform that lets students share what they know through **their writing, their voice, and their art.**

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