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Project-Based Units for Stem

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INTRODUCTION

As educators, we are being required to place more emphasis on science, technologies, engineering and mathematics (STEM) to ensure that today's students will be prepared for the careers of tomorrow. Additionally, practising important 21st-century skills, including collaboration, critical thinking, problem-solving and digital literacy, should be part of our daily curricula. It is imperative *and* a tall order. *Year Round Project-Based Activities for STEM* provides students with needed practice in these areas.

Project-based learning, simply put, is *learning by doing*. Project-based learning, or PBL, tends to be deeper learning that is more relevant to students and thus remembered longer. We need to educate students to be global competitors, and to do so we must require them to think creatively, to take risks and to put what they are learning into practice. After all, it doesn't do much good to know a formula if you cannot put it to use.

In STEM curriculum, project-based learning is a must! Its collaborative style guarantees that 21st-century skills are incorporated into the curriculum while supporting students' academic and socio-emotional growth. Further, PBL allows teachers to assess what students comprehend immediately, and adapt curriculum accordingly.

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WHY PROJECT-BASED LEARNING?

The classroom is the perfect place to introduce project-based learning, incorporating both traditional academic and 21st-century skills. The discovery-based activities in *Year Round Project-Based Activities for STEM* provide students, teachers and parents with the following:

Opportunities for critical thinking – open-ended questions or prompts that lead to higher-level thinking, risk-taking and investigation (solving problems versus finding the one correct answer)

Development of organisational skills – self regulation, planning and sequencing to use the information provided or researched (learning how to implement ideas and use all the information gathered)

Options for creativity – activities that allow for innovative strategies or solutions to be shared (a reminder that creativity is not for the select few – we can all be creative with practice)

Practise communicating – sharing ideas, theories, discoveries; using appropriate vocabulary; demonstrating understanding through drawings, graphs, charts, etc. (developing social skills necessary to work in groups)

Relevance – activities related to students' lives make the concepts being taught more meaningful, and thus more memorable (global awareness activities)

Time for collaboration – social learning in a classroom and via technology (helps students internalise their observations, initiate higher-level thinking and see the bigger picture)

Uses for technology as a tool to develop digital literacy – performing tasks effectively in a digital environment by incorporating interactive whiteboards; Skype; webcams and web videos; videotaping; publishing to create props such as labels, signs and charts

Use the discovery-based projects in this book to get a feel for what project-based learning is all about. Later you can develop your own PBL units with a deeper understanding of the process. Listen. What do your students want to learn about, and how can that interest be facilitated? The 21st-century vocabulary listed on the following page is a collection of action words to help motivate and direct you and your students. What are you waiting for? It's time to get started!

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WHY TEACH STEM CURRICULA?

Children are naturally curious and love to investigate. The STEM approach to teaching is inquiry-based, which is defined as the process of asking questions and trying to find answers for those questions. The components of STEM – *science, technologies, engineering* and *mathematics* – all combine to offer students a vast array of highly engaging learning experiences in which teachers are able to capitalise on students' strong desire to learn about the world around them. This resource is for the educator who recognises that the true task for a teacher is to assist students in developing a deeper knowledge of STEM subjects combined with the 21st-century skills they will need to be successful.

Utilising the philosophy of STEM allows educators to capitalise on the natural tendencies of young learners. Young students are, by nature, scientists and engineers – willing and eager to experiment, discover new things, and build and take apart anything they can get their hands on. The best way to capture and build their interest and excitement is to introduce science and engineering at an early age.

STEM-based projects are highly engaging, fun and full of natural learning opportunities. These experiences will broaden students' world views, encourage them to think critically and provide ample opportunities to connect and apply concepts learned to their everyday experiences.

Every effort has been made to include experiments and activities in this resource that use everyday materials, are easy to understand and facilitate, and ignite a desire for further learning!

Remember, an enthusiastic teacher introducing a concept is much more effective in developing successful project-based learning activities than a teacher with an extensive knowledge background who does not understand how to build the connections that facilitate learning for young students. Teachers who utilise everyday experiences and the numerous opportunities for incidental learning throughout the day understand how to best maximise those learning connections and implement project-based learning for young children.

Using the STEM approach to teach effectively requires a combination of introducing engaging materials while balancing the fun with the purposeful integration of connective activities that encourage the development of high-level, critical-thinking skills. Students are more likely to retain the knowledge gained through this approach as well as develop confidence and self-direction as they learn to work both cooperatively and independently.

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HOW TO TEACH STEM CURRICULA

The activities in this book will enable you to introduce your students to the wonderful world of project-based learning using the STEM approach!

The four learning areas of STEM are an integral part of everyday life and are naturally engaging for young students. At every opportunity, offer the following approaches to learning.

cience

- Compare and contrast different attributes of items.
- Encourage student-directed exploration using magnifying glasses, microscopes, measuring tools, scales and balances, and other scientific instruments.
- Complete experiments utilising the scientific method – *predict, observe, record* and *evaluate.*

echnologies

- Offer opportunities for students to research online using computers.
- Utilise microscopes, electronic devices, cameras, interactive whiteboards, etc.
- Investigate and present research using webcams, web videos, presentation slideshows and interactive whiteboards.

ngineering

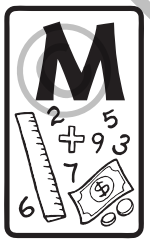
- Provide activities that require the students to solve a problem using the process of planning, designing, experimenting, making changes and sharing.

  Plan: Create a solution that best solves the problem.

  Design: Find and/or create the necessary materials and plans needed to perform the experiment.

  Experiment: Perform the experiment, redesign and experiment as necessary.

  Share: Evaluate the outcome, explain the design and discuss why it did, or did not, work. Include information regarding the process that was followed and the changes that were made in order to successfully solve the problem.



athematics

- Encourage student-directed exploration using various measurement tools, including measuring tapes, scales, balances, metre sticks and rulers.
- Provide opportunities for students to practise estimating and predicting.
- Introduce and reinforce mathematical concepts (number sense, shapes, number lines, counting, addition and subtraction, fractions, greater than and less than, etc.).

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SET UP STEM DISCOVERY CENTRES

Maximise your students' learning capabilities and further develop their higher-level thinking skills by providing year-round STEM discovery centres in addition to your music, writing and art areas. The following are some of the skills students will develop while utilising these centres:

- applying concepts introduced previously
- brainstorming
- collaborating
- decision-making
- experimenting
- predicting,observing, recording, documenting and evaluating findings
- planning (start-to-finish task skills)
- researching (in books and online)

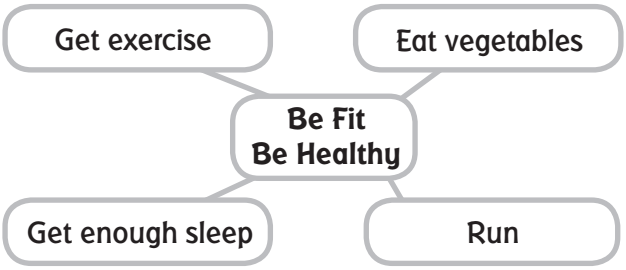
All established centres should have clipboards, different types and colours of paper, writing implements, tape and glue, staplers, scissors and appropriate book selections. Time should be scheduled *daily* to allow students the freedom to explore at self-selected discovery centres. Music of different types would make a great accompaniment at this time.

Suggestions for materials to include in these ongoing STEM discovery centres are listed on page 15. Add or switch out items as interest grows and/or materials present themselves.

Once your classroom centres are arranged, share the parent letter (page 16) with parents and prepare to immerse yourselves in discovery-based projects!

Start with one of the projects in this book that relates to your students' interests. All the information and instructions you'll need have been included for each unit, but do not limit the students to those ideas. Encourage input from students, especially during brainstorming sessions.

Initially, as the teacher, it may be necessary to reassure your students that every idea will be considered, and to provide directed times during which each student takes turns sharing an idea with the group. This will develop a foundation of acceptance and value for each member of the group that is essential to the success of project-based learning.



Consider potential outcomes from exploring the chosen unit. Images of what the discovery process should look like may begin to form in your mind. Don't become too attached to these ideas, though; your students should be the engineers. Encourage them to invent and create things as needed to solve the problems or questions presented. Remember, it is about the *process of learning, and not finding one "correct" answer.*

As your students complete these discovery-based projects, they will be developing the life skills necessary to become successful problem-solvers.

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BATS, BATS, BATS - GETTING STARTED

STEM Objectives

1. Students will conduct research about bats and share the information.
2. Students will create models of the bats they have researched and conduct an experiment to better understand the importance of bats to our environment.
3. Bat data will be collected, recorded and evaluated using charts, graphs and/or spreadsheets.

Introduce the Topic – Bats

1. Read a nonfiction book about bats. Then discuss the characteristics of bats to introduce appropriate vocabulary (see page 20).
2. Discuss the roles that bats play in our world.
3. Share nonfiction and fiction books about bats. Discuss each book after it has been read, and keep copies on display.

Suggestions

All About Bats by Caryn Jenner

Bats by Gail Gibbons

Bats by Megan Cullis, Connie McLennan and Sue King

Fly Guy Presents: Bats by Tedd Arnold

Let's Look at Bats by Ruth Berman

National Geographic Readers: Bats by Elizabeth Carney

Stellaluna by Janell Cannon

Zipping, Zapping, Zooming Bats by Ann Earle

4. Provide opportunities for students to go online for additional information and to check the suggested bat websites on page 10.

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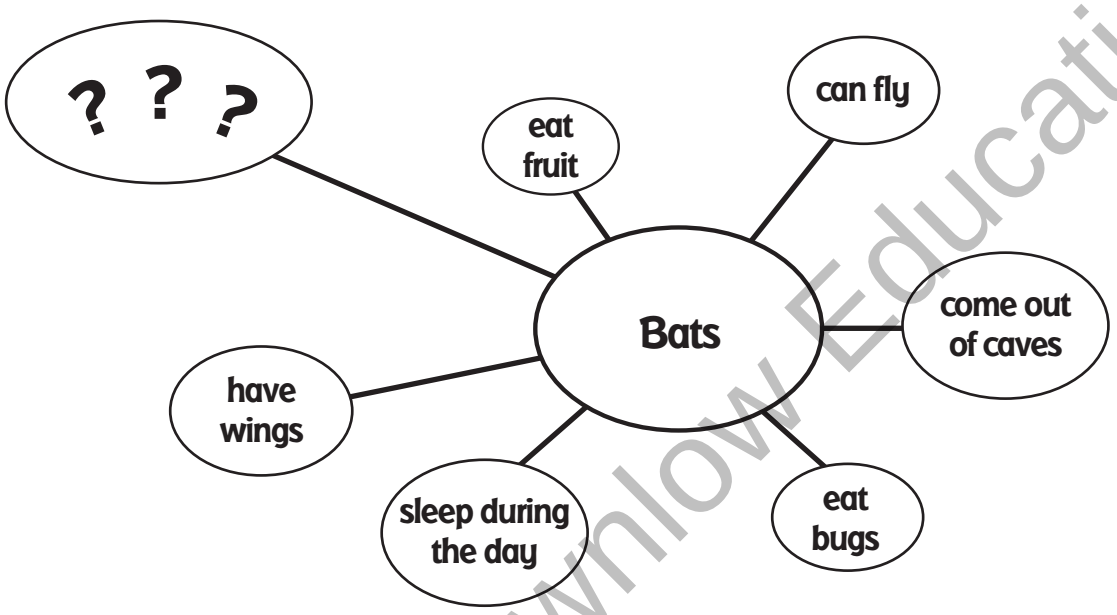
BATS, BATS, BATS - GETTING STARTED *(CONT.)*

Brainstorming Sessions

1. Help students list what they already know about bats (fact and fiction). You may wish to create a web or another type of graphic organiser, such as a KWL chart.



2. Create a list of questions to discuss related to bats. Start with these:

- How many different types of bats are there?
- Why are people afraid of bats?
- What is the difference between microbats and megabats?
- How do bats help our environment?
- How can humans help to keep bats safe?
- How can we help others to treat bats respectfully and appreciate how they help our environment?

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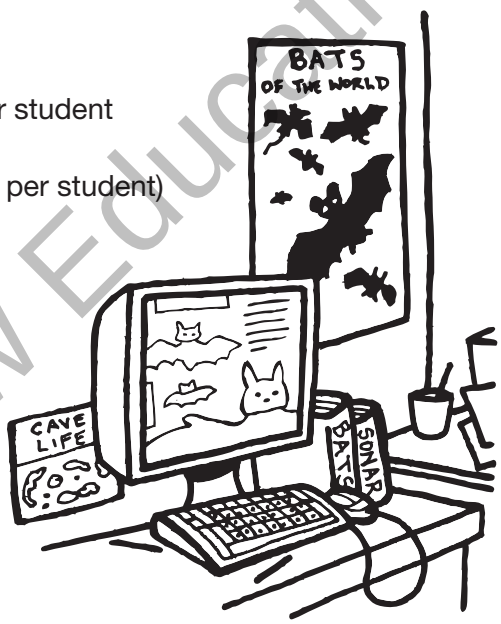
BATS, BATS, BATS

The following project-based bat activities are designed to encourage collaborative learning and discovery. Students should work in small groups (4 to 6). Encourage students to notice when they are using *science, technologies and engineering or mathematics* during their bat explorations.

Supplies

- 200 small manipulatives (counters, cubes, counting chips, etc.)
- small paper or plastic bag (one per student)
- timer or stopwatch to time 30-second increments
- whistle or bell
- modelling dough ("bat dough" recipe on page 22), ½ cup per student
- ½ cup measuring cups
- bases for sculptures – cardboard or heavy paper plates (one per student)
- plastic knives and shaping tools
- fine-tipped textas, permanent markers
- tempera paint – black, brown, white and other bat colours
- paintbrushes – variety of sizes
- crayons, coloured pencils, pencils
- *Bats to the Rescue* recording sheet (page 26)
- *Bat Fact Sheet* (page 27)
- hand washing area, soap, water and towels
- nonfiction and fiction books about bats (See page 18 for suggestions.)
- bat research websites (See page 10 for suggestions.)



Teacher Preparation

1. Consider making the modelling dough (or at least the kneading part) as another activity prior to starting this project. Display a copy of the recipe card.
2. Print copies of the *Bats to the Rescue* recording sheet and the *Bat Fact Sheet* for each student.
3. Identify a large, open area where the initial activity will take place. It will need to be large enough to spread out the 200 manipulatives and have room for all the students to move around.
4. Familiarise yourself with the characteristics of bats to guide the student discussions.
5. Set up approved bat research websites for students to view.
6. Create a sign-up sheet or checklist to insure that a variety of different bats are chosen to be sculpted. Create additional charts, graphs or spreadsheets as needed to record group responses.
7. Arrange the materials, recording sheets and writing implements near prepared student work areas and stations.

Bat Sculptures

Name of Bat	Sculptor
Brown Bat	Jennie
Flying Fox	Yan
Fruit Bat	Carrie

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BATS, BATS, BATS *(CONT.)*

Student Preparation

1. Review the characteristics of bats and the questions from the brainstorming session. Has any new information been discovered that can be added to the web or KWL chart?
2. Review the bat vocabulary on page 20. Post a laminated copy of the page in the research area.
3. Discuss and chart any additional bat facts discovered.

Introduce the *Bats, Bats, Bats* Activities

1. Explain that students will be doing an activity to see just how helpful bats can be, and how necessary they are to our ecosystems. Information from the activity will be recorded on a *Bats to the Rescue* recording sheet.
2. Outline the process of choosing a type of bat for a sculpture and how to research to discover three facts about the bat.
3. Distribute a fact sheet to each student. Model how to record the facts on the *Bat Fact Sheet* page.
4. Review the classroom rules for working with dough. Explain that one of their activities will involve making dough models of the bats chosen to research, and that their *Bat Fact Sheets* will be displayed with the finished bat sculptures.
5. Encourage students to use the new vocabulary words when completing the activities.

Bat Dough

Ingredients

- 2 cups of flour (plus 1/4 cup for kneading)
- 1 cup salt
- 2 cups boiling water
- 1 tablespoon vegetable oil
- 1 teaspoon cream of tartar

Procedure

1. Mix all ingredients together.
2. Cook on HIGH in a microwave for 1 minute.
3. Stir the mixture and return it to the microwave for approximately 1 more minute.
4. Leave to cool.
5. Knead on a floured board. Add more flour if dough is sticky.

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