WHAT IS INSPIRE?

The INSPIRE Research Institute for Pre-College Engineering is a center in the School of Engineering Education at Purdue University focused on pre-college engineering education research and integration of engineering with science, technology, mathematics, computational thinking and literacy. INSPIRE is composed of 15+ faculty, staff, and postdoctoral researchers and 40+ graduate and undergraduate research assistants on a mission to study pre-college engineering experiences and environments in order to impact educational systems. Learn more about INSPIRE and its work at purdue.edu/INSPIRE.

WHY DOES WHAT WE DO MATTER?

We know not every child will grow up to be an engineer; however, our research and work impacts children by:

- providing opportunities for them to apply their abilities to solve meaningful real-world challenges
- teaching them vital problem solving and technical skills, to prepare them for future success, no matter their profession
- educating them about the nature of engineering, so they have a better understanding of what an engineering career might hold for them

“STEM learning” has become a buzzword today in education and children’s media, which makes it all the more confusing to sort out which products can teach STEM concepts - particularly engineering. As a leader in engineering education, we assist parents, educators, and gift givers by publishing the Engineering Gift Guide, in an effort to inform them about which toys, games, books, and applications successfully promote engineering thinking and design to girls and boys ages 3-18.

WHY WAS THE GIFT GUIDE CREATED?

Within the guide, select gifts have a seal placed on them to indicate if it is the Number One gift, a Top Ten gift, or an Honorable Mention gift. These are internally decided by the INSPIRE team.

There are no fees for companies and publishers to submit their products to our guide. INSPIRE does not receive any funds directly from companies/publishers to advertise or promote any of the products included in the guide or on their website. Purdue University does not endorse such products contained herein, but only recommends them solely due to their engineering education value. INSPIRE is a participant in the Amazon Services LLC Associates Program, an affiliate advertising program designed to provide a means for sites to earn advertising fees by advertising and linking to amazon.com.

PARENTAL INFLUENCES

ROLES FOR SUPPORTING COMPUTATIONAL THINKING LEARNING

The role you take when your child participates in computational thinking activities can impact their level of engagement. Although parents often play different roles in different situations, being aware of what these roles are and how they may impact the level of learning and engagement your child may experience can be beneficial.

SUPERVISING/DIRECTING

Role description: Parent directly instructs child to act in a specific way. This role can be used by parents to fill in gaps in their child’s knowledge or help their child solve the problem quicker. However, researchers found that when parents assumed this role too often throughout the activity, children were less likely to engage in computational thinking competencies in meaningful ways. Often children mindlessly took orders from their parent.

FACILITATION

Role description: Parent makes suggestions and prompts the child to think in a specific way. This role can be used by parents to reduce stress when their child has difficulty completing a task but not remove their child from the leadership position. Parents provide assistance or share information about the task, but allow their child to make decisions and guide how to get to a solution. This role allows parents to remain engaged without getting in the way of their child’s engagement.

CO-LEARNING

Role description: Both parent and child work together on a task together; neither is the leader and no prompting occurs. Parent and child share information with each other. This role can be used by parents to reduce stress when their child has difficulty completing a task but not remove their child from the leadership position. Parents provide assistance or share information about the task, but allow their child to make decisions and guide how to get to a solution. This role allows parents to remain engaged without getting in the way of their child’s engagement.

STUDENT OF THE CHILD

Role description: Parent prompts the child to take the lead in the activity, where the parent acts as a student. The student of the child role can be used by parents to allow children to take charge of the approach to the task. Parents ask broad questions which encourages their child to think of the problem as whole and go through the problem solving process.

DISENGAGEMENT

Role description: The parent completely disengages from the activity, leaving the child to continue on their own. This role may be helpful when a child has grasped a good understanding of the activity or has practiced the competencies with their parents, and are able to engage in those competencies on their own. Parents’ decision to continue or abandon an activity can influence their child’s inclination to do the same.

ENCOURAGEMENT

Role description: Parent reassures or encourages the child while they are working on a task or after they complete a task. This role is important to a child’s engagement in computational thinking activities. Children may become disinterested if their parent does not engage in the activity with them, encourage them directly or indirectly to continue.

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Honorable Mention Voted Gift

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Baby Loves Structural Engineering, written by Ruth Spiro and illustrated by Irene Chan, is a board book for children ages two to three. Inside, it uses simple stepping-stone concepts to relate young children’s building-block creations to structural engineering thinking and design. It discusses basic concepts of designing a structure, including foundations, supports, and forces, while using simple words and illustrations to relate to a very young audience. We love how the illustrations show the child building a house for the three little pigs to protect them from the big bad wolf, which provides the book with a familiar story context. This book is an excellent way to introduce structural engineering concepts at a young age in a fun and engaging way.
This material is based upon work supported by the National Science Foundation under Grant No. DUE #1348547 and DUE #1348530 as well as the Bill and Melinda Gates Foundation to Purdue University Graduate School. Any opinions, findings, and conclusions or recommendations expressed in this material are those of the authors and do not necessarily reflect the views of the National Science Foundation.
Made by Maxine is a hardcover book meant for young readers ages 4 to 8, written by Ruth Spiro and illustrated by Holly Hatam. The story is about a little girl named Maxine, who liked to help her friends and family by taking old things and rebuilding them into new inventions. When her teacher announces the class Pet Parade, Maxine must engineer a solution that allows her to march with her pet goldfish. As an example for young engineers, she teaches perseverance and curiosity; showing them that they can build anything they want with a little imagination and the things lying around the house. Made by Maxine is a short but well-crafted picture book for children who love thinking of new ways to solve problems.

Engineering Makerspace: Terrain Walkers is a prototyping set by Thames and Kosmos, intended for children ages 6 and up. Through a mix of diagrams and words, the manual gives detailed instructions for seven different robotic creations, each of which moves in its own way. Building all of these robots one at a time encourages critical thinking and design skills, as well as spatial reasoning and perseverance. The experiment manual contains information about relevant topics so that the child learns a bit about why the robot is designed the way it is, which will aid in designing their own creations. Children (and parents) will love seeing their robot come to life when they finish! Terrain Walkers retails for $29.95.
HOW TO ENGAGE CHILDREN WITH MILD AUTISM IN ENGINEERING AND COMPUTATIONAL ACTIVITIES

When it comes to STEM, children with autism may be considered underperforming. One reason for this is that STEM concepts are often very abstracts and often complex teaching methods are used without providing enough support. Second, the means for assessing children’s learning are not aligned with the ways that children with autism can express/illustrate their learning. As a result, regardless of their potential, children with autism may never have a chance to see themselves as being capable of engaging in different STEM disciplines, particularly engineering and computer science. Therefore, parents should try engaging their children in more fun and unstructured engineering and computational thinking (and other STEM) activities at home or in other out-of-school settings. Below we have provided pedagogical techniques and tips that have been successfully used in our research.

PROVIDE PROMPTS AND SUGGESTIONS TO KEEP CHILD ENGAGED AND FOCUSED ON THE PROBLEM

Most children with autism benefit from having direct instruction to complete tasks. However, most engineering and computational thinking activities are open-ended and ill-structured, which may make solving engineering problems more challenging. They can get lost while paying too much attention to the details and variables of the problem or by spending too much time exploring the given material. Prompts and suggestions may be necessary to keep them engaged and focused on solving the problem.

TRY THIS: Use the Least to Most Prompt strategy to allow children the space to self-explore and try open-ended problems. Prior to introducing the activity create three sequenced prompts ranging from least intrusive to most intrusive. Begin the activity and as necessary provide prompts until the problem is solved.

TRY THIS: Use story/fiction books to guide children to stay on-task. Act as a “student of the children” showing that you know better than you. Remind them of their skills and accomplishments in related activities (e.g. LEGOs) and encourage them to keep up the good work.

LET CHILDREN TAKE THE LEAD

Children with autism may benefit from having their parents initiate the activity, by telling them how a toy works, what the game is and what children are required to accomplish/achieve. However, letting children lead the activity helps them think deeply and try different solutions by themselves.

TRY THIS: Use prompting questions to encourage parents to try to limit distractions for their children when they engage in engineering and computational thinking activities and try to limit the moments of frustration by offering help and involvement, and by choosing appropriate pedagogical strategies.


This material is based upon work supported by the Bilkent Dissertation Fellowship given by the Purdue University Graduate School. Any opinions, findings, and conclusions or recommendations expressed in this material are those of the authors.
MODELING

The **Eureka Crate** is the most advanced line of KiwiCo’s monthly subscription crates, intended for ages 14 and older. Don’t worry if the builds look daunting at first, as everything (even tools) is clearly laid out for the builder. Starting with a brief history of the product in that month’s box to explain its importance and usage over time, the instructions are easy to follow and do a good job of explaining how to use and troubleshoot the product. But most of that is to be expected by modeling toys. The Eureka Crate sets itself apart by explaining some of the engineering concepts and thinking that went into the design, so that the builders can incorporate some of that thinking into their own design process in future projects. The Eureka Crate retails for $24.95 a month.

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**Eureka Crate Mechanical Lock Box**
www.kiwico.com
$24.95/month
14+ SR, CreaT

**Gumball Machine Maker**
www.thamesandkosmos.com
$39.95
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**Excellent Engineering**
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www.quartoknows.com
$16.95
7+ CriT, D

**Sticks and Stones: A Kid’s Guide to Building and Exploring in the Great Outdoors**
Written by Melissa Lennig
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$19.99
8+ CreaT, WC

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**Pepper Mint in the Great Treehouse Engineering Adventure**
www.thamesandkosmos.com
$39.95
8+ PS, MS

**Tinker Crate Walking Robot**
www.kiwico.com
$16.95/month
9+ SR, D

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**Curious Creatable Creatures: 22 STEAM Projects That Magnetize, Glide, Slingshot, and Sometimes Scootch** by Sam Hayor is an arts and crafts book containing cute art projects for children 8-12 years old. Some of these projects are directly related to traditional engineering topics, like electricity, and all of them promote engineering thinking in some capacity. By using materials in imaginative and unexpected ways, children are encouraged to think about their other designs in different ways. What materials could be substituted for other, more easily accessible materials? The extreme customizability of the given projects allows kids to get creative and design their own Curious Creature, functional or otherwise. Curious Creatable Creatures retails for $17.99 at www.quartoknows.com
SimpleRockets 2 by Jundroo is the second game in the SimpleRockets line; intended for ages 4+ and available on Google Play, the Apple App Store, and Steam. True to its name, this is a game in which the player creates rockets with a simplified control scheme and basic physics. After a quick tutorial, players can either pursue provided challenges or set their own goals in a sandbox environment. Each challenge presents a problem to solve with clear criteria and constraints, which requires multiple iterations, well-planned designs, some fairly creative thinking, multiple test flights, and a few math concepts. SimpleRockets 2 is a standout for its easy-to-grasp interface and clear design requirements, which make it available to a wide range of audiences. SimpleRockets 2 retails for $4.99.
ArchiTECH: Electronic Smart House by SMARTLAB Toys is a building and circuitry kit intended for ages eight and over. There are 20 projects utilizing a modular building system to create a floor plan, then a frame, and finally electrical wiring and components. When the projects from the manual are exhausted, the user has complete freedom to get creative and design their own unique architecture or draw inspiration from previous projects. The entire design process makes an appearance, from idea generation to implementation to improvement, aided by the manual’s explanation of not just what works, but why it works like that. The ArchiTECT Smart House is an early introduction to physics and circuitry while retaining the players’ freedom to experiment with and build any type of architecture. The Smart House retails for $49.99.

Snap Circuits Motion by Elenco is a toy that emphasizes circuit design, containing instructions for more than 165 different projects. The kit requires 4 AA batteries and contains over 50 electrical and mechanical parts used to make learning about circuits fun and hands on. Projects increase in difficulty and younger users may require help from adults on the more difficult ones. A detailed manual hosts the instructions for each project and guidelines to safety while constructing circuits. Adults should go over safety instructions with younger users to avoid damage to circuit components. Each project in the manual includes a visual diagram for constructing the circuit and written instructions to help guide the user. Explanations of the functions of each component are given in easy to understand language so that children can understand the role of each component. Snap Circuits Motion teaches users some of the basic concepts governing electronic systems. Many of the circuits require perseverance to properly construct but upon completion children have the chance to explore the circuit further by playing with lights, motors and sounds. Once children have grasped the concepts and physics that play a crucial part in the creation of circuits they can use their own knowledge critically to design circuits of their own, introducing them to the world of electrical engineering! Snap Circuits Motion serves as an open-ended circuit building toy, with plenty of places for kids to explore new concepts, experiment, and develop their engineering thinking skills.
EL10T: My First Coding Robot by Elenco is an interactive programming toy featuring the titular EL10T robot, and targeted at children ages three and up. Challenges are presented at multiple difficulty levels, beginning with the basics of programming the robot. As difficulty increases, players have the flexibility to work through different paths and see what works best, encouraging experimentation and iterative learning. In the most advanced challenges, the player has to analyze the roadblocks and constraints on the board in order to develop their own unique solution, and their problem solving skills. What we love about EL10T is that it turns coding into a physical, engaging game without sacrificing functionality. EL10T retails for $89.95.

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Potato Pirates is a potato-themed coding game for 3-6 players, ages 7 and up. The object of the game is to gather all 7 “potato kings” or to be the last player standing. On a player’s turn they have the choice of programming/modifying code or attacking an opponent by “running” code. When programming a section of code, a player lays down up to three cards in some combination of action cards and control cards. Action cards state how many potatoes the opponent’s ship loses while control cards state loops and conditional statements. Control cards include while loops, if-else statements, for loops, and variable dependent statements. The game also includes surprise cards that allow a player to complete actions such as “block an attack,” “take more potatoes,” or “hijack a ship.” The player uses their surprise cards and code segments to outwit and defeat fellow players.

Potato Pirates introduces the simple concepts of coding, while also teaching problem solving and strategy skills. The instruction manual explains how the different cards relate to real coding principles, which is a great stepping stone to more complex programming projects.
Companies and publishers choose to submit toys, games, books, and applications for evaluation by INSPIRE. These submissions are reviewed by INSPIRE’s team, outside engineering/STEM experts, parents, and children. This happens not only in the lab, but also in homes and at events we host throughout the Purdue University campus and the Greater Lafayette community. Products receive feedback about whether or not they promote engineering thinking and design, and are rated on their value, fun factor, potential for educational impact, and usability. Altogether, this feedback determines which toys, games, books, and applications are included in the Engineering Gift Guide.

To learn how selected gifts support engineering thinking and design go to purdue.edu/INSPIRE/EngineeringGiftGuide