STEM/STEAM
FORMULA FOR SUCCESS

the toy association™

Inspiring Generations of Play

INTRODUCTION

In 2017, The Toy Association began to explore two areas of strong member interest:

- **What is STEM/STEAM and how does it relate to toys?**

- **What makes a good STEM/STEAM toy?**

PHASE I of this effort tapped into *STEM experts* and focused on the meaning and messages surrounding **STEM** and **STEAM**. To research this segment, The Toy Association reached out to experts from scientific laboratories, research facilities, professional associations, and academic environments. Insights from these thought leaders, who were trailblazers in their respective field of science, technology, engineering, and/or math, inspired a report detailing the concepts of **STEM** and **STEAM** *(which adds the "A" for art)* and how they relate to toys and play. Toys are ideally suited to developing not only the specific skills of science, technology, engineering, and math, but also inspiring children to connect to their artistic and creative abilities. The report, entitled **"Decoding STEM/STEAM"** can be downloaded at **www.toyassociation.org**. In **PHASE 2** of this effort, The Toy Association set out to define the key unifying characteristics of **STEM/STEAM** toys.

Before diving into the characteristics of **STEM/STEAM** toys, we wanted to take the pulse of their primary purchaser—parents of young children. The "Parents' Report Card," is a look inside the hopes, fears, frustrations, and aspirations parents have surrounding STEM careers and **STEM/STEAM** toys.

Lastly, we turned to those who have dedicated their careers to creating toys by tapping into the expertise of Toy Association members. A survey was launched to explore what makes a good **STEM/STEAM** toy. In-depth interviews with toy experts at companies that focus on the **STEM/STEAM** toy category *(see Appendix B for the list of companies with which interviews were conducted)*. Also, to add to this narrative of what makes a good **STEM/STEAM** toy, two expert panels were convened, and opinions and insights were gathered.

EXECUTIVE SUMMARY

This comprehensive report delivers best practices for developing and marketing **STEM/STEAM** toys that truly prepare kids for careers in science, technology, engineering, and math. Inside you will find:

- Parental perspectives about **STEM** careers and the role of toys in helping their kids master concepts necessary for their successful pursuit

- 14 unifying characteristics of **STEM/STEAM** toys

- Examples of good **STEM/STEAM** toys to illustrate the above characteristics

- A worksheet to help evaluate a toy as **STEM/STEAM**

The difference between the use of the terms
"STEM" vs. "STEM/STEAM"
in this report:

• The term **"STEM"** refers specifically to *careers and/or opportunities* in science, technology, engineering, and math.

• The extended term **"STEM/STEAM"** is used when talking about *toys* that facilitate interests and passions that may lead to these careers or **the** *skills* required to pursue them. The "A" in STEAM stands for "Art" and it represents the need to develop creativity, imagination and innovation within STEM careers and beyond.

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PARENTS' REPORT CARD

Parents are the gatekeepers of toys for their kids, especially for younger children. Their attitudes and appreciation of toys and play are paramount to providing kids with playful opportunities to grow, learn, and explore their ever-changing world.

The Toy Association asked parents to share their understanding and insights about how science, technology, engineering, art, and mathematics skills relate to toys, play, and their children. Here's a summary of what was revealed by investigating the thoughts, fears, and beliefs of 2,000 parents.

ASPIRATIONS

Parents recognize STEM/STEAM skills as advantageous for their kids' future. Here's what they disclosed …

PARENTS GET THAT STEM/STEAM IS IMPORTANT with an impressive 91 percent recognizing the value of encouraging the development of science, technology, engineering, art, and math skills in their kids. That's why a whopping 88 percent either have encouraged or plan to encourage the development of these skills in their children.

GO FOR IT – A majority of parents —76 percent—want their child to end up in a STEM-related career. An engineer, doctor, web developer/programmer or scientist are some of parents' top career aspirations for their children.

FRUSTRATIONS/HESITATIONS

There is some confusion for parents when it comes to technology and their child. How much technology should kids use, where can they learn it from, and how can parents help? Here's what parents divulged.

THE BIGGEST CHALLENGE parents face in fostering STEM/STEAM skills is competition with screen time (50 percent), followed by time constraints (45 percent), and lack of fun learning options (39 percent).

HALF OF A WORKDAY – Forty percent of the parents acknowledged that their child spends between three to four hours a day using technology. Thirty percent of the parents revealed their child spends one to two hours, while 19 percent of parents confessed their children spend as much as six hours a day looking at a screen.

ENOUGH! Therefore, it was not surprising that 72 percent of parents reported having taken steps to limit their child's screen time.

A DIGITAL DIVIDE – With all this screen time, 45 percent admitted their kids knew more than they did about technology, with only 28 percent of parents saying they were more tech savvy than their kids. Collectively, 73 percent of the parents who admitted their kids knew more about technology than they did confided that their kids surpassed them as young as four years old.

OLDER PARENTS = LESS TECH – Predictably, the older the parents, the more likely their children know more about technology than they do.

THE MOST TROUBLING STATISTIC was that 72 percent of parents agreed that their child's better understanding of technology made it difficult for them to help their kids learn. While not all STEM/STEAM toys are high-tech, many are, which could present a potential barrier to parental involvement when using these toys.

YES, NO, MAYBE SO – Buried within parents' aspirations for their children to learn STEAM skills, nearly half—48 percent—admitted that they might stay away from purchasing STEM/STEAM toys for their child because they worry they won't be able to help their children play with it. Yet, there are some opposing forces at work as a parent considers a STEM/STEAM toy, because the majority of parents (55 percent) acknowledged that labeling a toy as being STEM/STEAM actually makes it more attractive. The conundrum that parents confessed is that they are both drawn to STEM/STEAM toys and a bit tentative at the same time.

HELP ME IF YOU CAN – To deal with this frustration, 75 percent of parents believe that STEM/STEAM toys should include directions geared towards parents.

PREPARATION/EDUCATION

Parents want to support their kids learning STEM/STEAM skills and provide the tools they need to succeed. Here's what parents feel is required in preparing their child for the 21st century.

GET 'EM WHEN THEY'RE LITTLE – Parents believe it's better to introduce the concepts of science, technology, engineering, and math at an early age – with the ideal age between four and five years old.

TOYS AS TEACHING TOOLS – It makes sense that the younger the child, the more effective toys can be as learning tools. The majority of parents (67 percent) believe STEM/STEAM-focused toys are the primary way to encourage development of science, technology, engineering, and math in their child, followed by at-home experiences (57 percent).

TOP 3 SKILLS – Three specific skills topped parents' lists of what kids should master and were pretty evenly rated. They include written and oral communication (60 percent), tech/computer literacy (58 percent), and mathematics (57 percent).

FOR THE MAJORITY, PLAY IS A PRIORITY – Seventy-nine percent of parents agreed STEM/STEAM-focused toys played an important role in skill development—with 82 percent acknowledging that they look for ways to encourage their child's learning through play.

HALF OF PLAYTIME DEDICATED TO LEARNING – Most parents believed between 41 to 50 percent of their child's playtime should be dedicated to learning.

GET CREATIVE – Ninety-four percent of parents encouraged or hope to encourage their child in creative endeavors such as music, drawing, painting, sculpting, etc. The majority think children should begin to express themselves creatively between two and five years old.

EARLY CODERS – Coding is a skill set parents would like their kids to acquire with 85 percent having encouraged or plan to encourage their child to learn to code. The majority feel the ideal age to begin developing these skills is between six and seven years old.

LOOKING FOR STEM/STEAM – Eighty-five percent of parents have specifically looked for STEM/STEAM toys when purchasing new toys for their child, which makes sense because 82 percent agree that playing with STEM/STEAM toys will lead their child to develop an interest in science, technology, engineering, and math subjects.

EXPECTATIONS

Consumers demand a lot these days. This is what parents told us they expect from a STEM/STEAM toy.

CREATIVITY, PROBLEM-SOLVING, FUN, AND CONFIDENCE – Parents considered the most important characteristic of a STEM/STEAM toy be encouraging creativity. This was followed by fostering problem-solving, being fun, engaging, and finally building a child's confidence.

SUMMARY

Parents know STEM/STEAM skills are key to their child's success and overwhelmingly want their child to end up in a STEM career. The majority acknowledge that toys are the primary way to encourage these skill sets. The major obstacles to these efforts are their kids' appetite for screen time and parents' own anxiety that they won't be able to help their child connect to these increasingly crucial concepts.

Here is what parents say…

9 out of 10
said it's important to foster & encourage the development of **STEM/STEAM skills** in their kids

50%
cite competition with screens as primary challenge in encouraging these skills

5 ½
the ideal age to get kids started on their future career path
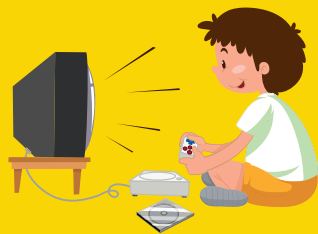
More than half
have a specific career in mind for their child

Kids average
3 ½
hours of screen time per day

42%
of a child's play should be dedicated to education and learning
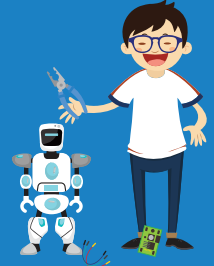
82%
look for ways to encourage their child's learning through play

72%
take steps to limit their child's screen time

76%
want their child to end up in a **STEM-related** career or field. Top jobs: engineer, doctor, web developer, or scientist

UNIFYING CHARACTERISTICS OF A GOOD STEM/STEAM TOY

Having probed parents for their feelings on STEM/STEAM, we now turn to toy experts for their perspectives on what makes a good STEM/STEAM toy. This section consists of input from a survey in which 67 Toy Association members and toy experts participated. This was followed with 26 in-depth phone interviews along with insights gathered from two expert panels hosted at both the 2019 Consumer Electronics Show (CES) and at the 116th annual North American International Toy Fair.

Based on the above input, we identified 14 unifying characteristics of STEM/STEAM toys, including 2 mandatory and 12 strengthening, all of which are detailed below.

MANDATORY CHARACTERISTICS

Research resulted in determining two mandatory must-haves for the product. The first defining characteristic is self-evident in that the product promotes an aspect of STEM. A product should lead a child into exploring an area of science, technology, engineering or math, or engage in the scientific method. The scientific method involves investigation through experimentation and observation to acquire new knowledge, solve problems, and answer questions. If one asks the question, ***does this product get kids thinking about STEM and/or the basics of the scientific method,*** and the answer is yes, then it qualifies for the "STEM" part of a good STEM/STEAM toy.

The second mandatory must-have is that the product needs to be fun. Does this toy engage the child, captivate interest, fuel exploration, and entertain? This prerequisite is a more subjective trait and is frankly more elusive. To qualify, ask the question, ***does this product feel fun to kids when they play with it?*** If the answer is yes, then this represents the "toy" part of a good STEM/STEAM toy.

UNIFYING CHARACTERISTICS OF A GOOD STEM/STEAM TOY

A good STEM/STEAM toy triggers both sides of the brain. The left-side, logical and reasoning part of the brain, is activated when the toy or play experience gets kids thinking about aspects of science, technology, engineering or math. The right side of the brain that deals with emotions is triggered when the play experience creates a fun **feeling**.

A Good STEM/STEAM Toy
is a Whole Brain Experience

LEFT BRAIN   **RIGHT BRAIN**

STEM Thinking   Fun Feeling
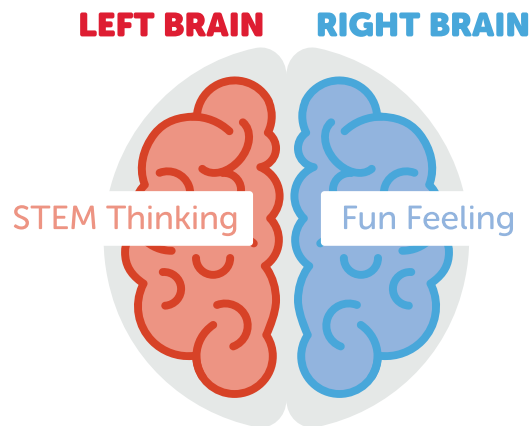
"The fundamental thing that we have to evaluate is—does it teach the method. The core method is the engineering method, the scientific method or the design-thinking method—they are all essentially the same thing... It's about coming up with a hypothesis, making a solution to the problem, watching the results of your solution, and then iterating until you get to a final end."

-**Ayah Bdeir**, CEO and Founder, littleBits

STRENGTHENING CHARACTERISTICS

After establishing the two mandatory requirements, participants identified 12 characteristics that strengthen STEM/STEAM skills and contribute to defining a good STEM/STEAM toy.

OPEN-ENDED. This refers to a toy that encourages the child to find his or her own individual way to play. After the mandatory characteristics, this was the most predominant attribute mentioned for a good STEM/STEAM toy – the ability for a product to be used in multiple manners where there is **no one right way to play**. This includes toys that offer various pathways to solving a problem, building a structure, creating a design or accomplishing a task.

RELATES TO THE REAL WORLD. Toy industry experts pointed to the need to help children and/or parents understand how a play experience with a toy relates to STEM and the surrounding environment. An example mentioned was that pushing a toy truck is teaching a child physics; but this mere act does not lead to a child ending up in an Advanced Placement Physics class in school. A good STEM/STEAM toy needs to make that association. STEM and STEAM skills should be looked at as similar to literacy and connect kids to things that are relevant to them. Children can then understand that science, technology, engineering, and math have an impact on their world and their lives, regardless of whether they pursue a STEM career or not.

"Parents know that STEM and STEAM are important, but they might not realize that it goes beyond coding. It goes beyond chemistry. There is so much more there. So, it's up to us as the toymakers to really introduce those subjects in ways that will help the kids feel comfortable."

-**Netta Rabin**, Vice President, Product Development, Klutz

ALLOWS FOR TRIAL AND ERROR. This is a trend that has been identified by several of the interviewees as one of the most misunderstood, unappreciated, and necessary elements that needs to be encouraged in relationship to STEM and life. Failing is part of the pure scientific model of testing. Experimenting presumes that kids will go through a series of trial and errors that will lead to a payoff of discovery and beyond. **Being free to fail** is one of the most significant differences between formal learning in school, where risk is seldom rewarded, and informal learning outside of the classroom where taking a chance adds to the excitement. **The ability for a child to learn to acknowledge and accept failure is paradoxically a key to success.** Eliminating the fear of failure through toys and play allows the child to have the freedom to playfully bump up against obstacles and then try out new solutions never before explored.

UNIFYING CHARACTERISTICS OF A GOOD STEM/STEAM TOY

HANDS-ON. This characteristic was identified again and again, along with the science behind it, emphasizing that there is a link between kids **using their hands and developing their brains**. We remember experiences more if we use our hands – toys are the perfect example of hands-on learning. The tactile, tangible input kids get from working with their hands is particularly relevant today where the frequency of screen time leaves less and less physical feedback flowing into a child's life. This means that some **kids' brains are literally starved for tactile sensory experiences that three-dimensional toys can provide.**

CHILD-LED. This characteristic is about building intrinsic motivation and fostering self-determination. To be a good STEM/STEAM toy, it needs to deliver on the toy part of that concept and that means the **child needs to lead the play experience**. Autonomy is a basic human drive and one that children crave in their often over-scheduled, over-controlled lives. Play is the place where kids can lead and when they do, they can tangentially learn not only about STEM subjects, but about themselves as well.

"Watching kids when they are working creatively on their own, you [can] see them actually going at a pace that they're ready for, and you see them getting to those stopping points and finding their way through it naturally."

-**Andres Garza**, Senior Design Manager, Spin Master

> *Not all STEM toys by design need a guide. It is possible to design one that is so open-ended and explanatory it doesn't need one. But in many cases, it helps both the parents and the teacher to have some fundamental instruction that can then allow them to give the basics to the child and then the child takes it and runs with it.*
>
> -**Tom Runtz**
> *Director of Product Development*
> Learning Resources

PROBLEM-SOLVING is a key element taught through toys and play. Giving children a play challenge allows them to think and figure things out for themselves. It can take the form of the product itself presenting the problem to be solved or allowing the child to choose their own problem to tackle. This encourages kids to invent and design solutions to problems they want to figure out. **Problem solving is a highly transferable thinking skill** that can be applied to other parts of a child's life. Computational thinking (thinking in ways a computer could understand), is an important aspect of problem-solving – a gateway to coding – and toys are an effective way to teach this and other mental skills.

INCLUDES CURRICULUM. There was discussion about the necessity for curriculum to accompany and even legitimize a good STEM/STEAM toy along with the need to be age appropriate. For example, the toy should not be for a four-year-old and the curriculum more appropriate for a master's degree in physics. There was also input on the need for curriculum to be parent-friendly. This can then serve two purposes. In one it allows a parent or teacher to have the confidence and competence to **guide the play experience of the child toward STEM learning objectives**. In the other, it **answers the presumed question, "Why is this a good STEM/STEAM toy?"**

UNIFYING CHARACTERISTICS OF A GOOD STEM/STEAM TOY

GENDER-NEUTRAL & INCLUSIVE. There was recognition that STEM opportunities and participation in STEM careers should be more inclusive. This included the need for gender-neutral products, toys that served children with special needs, and brands that embraced cultural differences. This inclusiveness is critically important to **harness a diversity of perspectives needed to solve the complex problems of the 21st century** and engage segments of the population previously under-represented in STEM fields.

"Technology companies are defining how we interact with the world, how we interact with data, how we interact with each other, how we interact with countries, how we interact with the environment. So, the role that technology plays is huge and when the real population is not represented, then a small group of people is making decisions for the rest of the population. This is actually very dangerous."

–**Ayah Bdeir**, CEO and Founder, littleBits

SUPPORTS PARENTS. Parents attitudes were addressed such as **familiarity with the term STEM/STEAM, and whether they found it intimidating**. Parents were referenced in Phase 1, when it was revealed that fear is contagious, and parents can pass their fear of STEM subjects on to their child. It was also recognized that parents are the **gatekeepers** of toys, especially for young children. **Supportive materials** can be delivered in different ways such as videos, etc. for parents to help them feel comfortable with STEM subjects, add value to the product, and encourage parental involvement.

BUILDS CONFIDENCE. Kids tend to label themselves just like products get labeled and that belief can be a limiting one if a child is intimidated or feels unprepared to learn STEM. STEM/STEAM toys can create confidence in exploring these subjects and that confidence is then transferable to other subjects and segments of a child's life.

"Having some toys that provide the simple steps at the beginning is extremely valuable ... not only for motor skills, but also for confidence."

–**James P. Seymour,**
Vice President & Chief Technology Officer, E-Blox

" *A good STEM/STEAM toy delivers growth through challenge— those little steps that challenge kids and gets them to get outside of their comfort zone.* "

–**Andres Garza**
Senior Design Manager
Spin Master

UNIFYING CHARACTERISTICS OF A GOOD STEM/STEAM TOY

ENCOURAGES CREATIVITY. Art, creativity, and the humanities all came up in the interviews as it relates to STEM and STEAM. The need to apply the "A" to STEM to create STEAM was touched on in the context of teaching kids to think outside of the box or to color without needing lines. Most creative people will attest to the fact that creativity demands practice and courage, and toys can deliver on both those fronts.

"...having that creativity and creative problem-solving is really important in STEAM toys."

-Netta Rabin, Vice President, Product Development, Klutz

SOCIAL/EMOTIONAL SKILLS were touched on and related to the fact that the concept of STEM/STEAM is evolving as new competencies continue to surface to succeed in these careers. Emotional IQ, Social/Emotional Learning (SEL), and Emotional Intelligence are all terms that refer to skills that kids are struggling with today. In relation to STEM/STEAM, these social skills converge with both the career aspirations and the need for collaboration to successfully solve problems.

"Innovation in the 21st century is going to be driven by collaboration ... preparing our children for the real world involves teaching them emotional quotient and social emotional learning."

-Tom Runtz, Director of Product Development, Learning Resources

UNIFYING CHARACTERISTICS OF A GOOD STEM/STEAM TOY

The following illustration highlights the two mandatory and 12 strengthening characteristics that help define a good STEM/STEAM toy. For examples of good STEM/STEAM toys, see Appendix B.

14 Unifying Characteristics of STEM/STEAM Toys

EXPLORES AN ASPECT OF STEM

FUN

Open-Ended

Relates to the Real World

Allows for Trial & Error

Hands-On

Child-Led

Problem-Solving

Includes Curriculum

Gender Neutral and Inclusive

Supports Parents

Builds Confidence

Encourages Creativity

Social and Emotional Skills

STEM/STEAM TOY WORKSHEET

This worksheet can be used as a framework to evaluate a product by answering the question:
Is this a good STEM/STEAM toy and why?

☐ **MANDATORY** *Does this toy lead a child into exploring an aspect of STEM (science, technology, engineering, and math)?*

☐ **MANDATORY** *Is this toy engaging, approachable, appealing, and fun?*

☐ Does this toy encourage *open-ended* play*?*

☐ Does this toy engage the imagination and promote *creativity*?

☐ Does this toy relate STEM to the *real world*?

☐ Does this toy encourage *problem-solving*?

☐ Does this toy spark divergent thinking to allow for *trial and error*?

☐ Does this toy build *confidence*?

☐ Does this toy promote *hands-on* play?

☐ Does this toy encourage *child-led* play?

☐ Does this toy include *supportive materials for parents*?

☐ Does this toy provide a *curriculum* for guided play?

☐ Does this toy encourage *inclusive play* appealing to boys and girls, different cultures and/or children with special needs?

☐ Does this toy offer opportunities for building *social and emotional* skills?

These questions can also be used as a guideline for new product development. It should be noted that qualifying for more characteristics does not necessarily make the product better. However, the more characteristics a product qualifies for, the more multidimensional the play experience can be; and from a child's point of view, the more the merrier.

APPENDIX A: GOOD STEM/STEAM TOY EXAMPLES

This section provides examples taken from approximately 100 members of The Toy Association who participated in a survey and/or a private interview on what makes a good STEM/STEAM toy.

It is important to note that many of these toys can relate to MORE THAN ONE category. We mention these toys in designated sections not to suggest that it is the only category this product qualifies for, rather to provide examples for each.

FACILITATES STEM-SPECIFIC PLAY

MY FIRST MIND BLOWING SCIENCE KIT
by Scientific Explorer
(SCIENCE, CHEMISTRY & TECHNOLOGY)

"Combines science and chemistry; kids can create a science lab at home. Teaches the science and technology part ."

BASIC SET **by Magformers**
(ENGINEERING)

"The Magformer set explores engineering, so a child can design and lay out a two-dimensional design and turn it into a three-dimensional build."

MECCANOID G15 **by Meccano**
(STEM & ROBOTICS)

"This robotics toy touches on all aspects of STEM— mechanics, electronics, virtual/conceptual programming work and thinking, and exposes kids to all those things."

MARBLE RUN SKYRAIL RACE **by Quercetti**
(ENGINEERING & PHYSICS)

"This exemplifies the very basic principles of engineering and physics and puts them together."

RAMI BINARY NUMBER GAME **by Quercetti**
(MATHEMATICS & CODING)

"The Rami is built to show the basic principles of mathematics, computer science, and coding."

KANO COMPUTER KIT **by littleBits**
(TECHNOLOGY & PROGRAMMING)

"This toy taps into the big emphasis on computer science and programming. Kids build their own computer to understand how it functions and works; and then they can do their own programming."

PULLEY SET FOR KIDS **by Brackitz**
(OPEN-ENDED, ENGINEERING, & PHYSICS)

"This is open-ended machine building teaches physics and essential engineering/construction practices."

ARCHITECTURAL MODEL BUILDING KIT
by Arckit
(STEM, ENGINEERING, OPEN-ENDED & INCLUDES CURRICULUM)

"This covers all STEM. Arckit is a hands-on architectural design tool that encourages open-ended play and allows children of all ages to freely and spontaneously express their ideas."

CODE AND GO ROBOT MOUSE
by Learning Resources
(CODING & SPATIAL THINKING)

"This toy takes coding down to the grade-school level – by helping to develop kids' critical thinking, problem solving and spatial recognition."

BASE INVENTOR KIT **by littleBits**
(TECHNOLOGY, ENGINEERING, & CODING)

"Explores open-ended, real-world engineering, electronics, and coding skills."

PERSPECTO 3D PUZZLE-SOLVING BRAIN BUILDER GAME **by FoxMind**
(GEOMETRY)

"A game of visual perception that makes players use and play with the concepts of perspective and geometry."

CIRCUIT BLOX LINE **by E-Blox**
(STEAM, ELECTRONICS, OPEN-ENDED)

"This line provides 59 to 800 project-based sets that teach STEM through brick-based electronic construction modules."

FACILITATES PROBLEM-SOLVING AND RELATES STEM TO THE REAL WORLD

LEGO GADGETS by Klutz
(OPEN-ENDED, CONSTRUCTION & RELATES TO THE REAL WORLD)

"LEGOs that can make all sorts of amazing gadgets. Each section has an open-ended challenge page with it. So, if you are making a unicycle, you can adjust it to make it go faster."

NEW CUBELETS DISCOVERY SET
by Modular Robotics
(CONSTRUCTION, CRITICAL THINKING & ROBOTICS)

"Kids naturally want to figure out how things work. This product asks kids to mentally deconstruct objects by asking them questions to better understand concepts. Leads kids into the computer science realm along with teaching forward and backward thinking."

BEAKER CREATURES LIQUID REACTOR SUPER LAB SET by Learning Resources
(CAUSE & EFFECT & STEM)

"Teaches cause and effect, engages kids in science— and is lots of fun to do."

META-FORMS PUZZLE SOLVING BRAIN BUILDER GAME
by FoxMind
(REASONING)

"This is a game of pure reasoning skills."

ELECTRONIC EXPLORATION KIT
by Snap Circuits
(CAUSE & EFFECT/TRIAL & ERROR)

"These are compact, easy to understand, and with instant feedback because if the circuits aren't built correctly, the propeller doesn't turn, the light doesn't come on, or the speaker doesn't make sounds."

KIDZLABS WEATHER LAB SCIENCE KIT by 4M
(UNDERSTAND THE REAL WORLD & STEM)

"This kit makes it so interesting to learn about the weather in your living area."

SENSORS ALIVE by Thames & Kosmos
(UNDERSTAND THE REAL WORLD & STEM)

"With a set of sensors – sensor pods – kids collect data like temperature, sound, light etc. Then import the data into an app. The sensor data uses the input to create creatures. Low light might have a creature with small eyes. Little sound might create a creature with big ears. It combines real work experimentation with sensory input and gamifies the real science of light, sound, temperature, etc."

DISCOVERING STEM by Engino
(UNDERSTAND THE REAL WORLD & STEM)

"These sets cover topics like solar power and Newton's law. They actually sectioned different topics out so that each set focuses on a particular STEM area."

AN INVENTION KIT FOR EVERYONE
by Makey Makey
(UNDERSTAND THE REAL WORLD & TECHNOLOGY)

"These electronics boards allow kids to connect a couple of alligator clips to various types of materials and use the resistance of those materials' inherent properties to create a play pattern. Fruit on a table can become a video controller, for example. It helps kids understand how to brainstorm, look to nature, and look around by using things out of their context to inspire invention."

FACILITATES OPEN-ENDED PLAY AND ENCOURAGES CREATIVITY

MODEL BUILDING SETS by K'NEX
(OPEN-ENDED & CONSTRUCTION)

"The things they make are amazing with their structures and gears. It's the kind of things kids can get excited about – architecture and what makes things stable – gears and what makes them move."

COLOR CHEMISTRY SET FOR KIDS by Crayola
(CREATIVITY, OPEN-ENDED, CHEMISTRY & STEAM)

"It is essentially a chemistry sets but aligned closer to STEAM and offers more open-ended outcomes that kids can explore. Rather than just 10 things you can make, this set offers kids the ability to create their own experiments and to capture their own results."

BOOST CREATIVE TOOLBOX FUN ROBOT BUILDING SET by LEGO
(OPEN ENDED & STEM/STEAM)

"Opportunity to evolve and create your own outcomes. Good example of a product that truly is STEM/STEAM."

FANTA COLOR, PIN DESIGN GAME MOSAIC by Quercetti
(CREATIVITY, OBSERVATION & HANDS-ON)

"This toy is made of little pegs that allow children to create graphics and shapes. Also, by providing the basic colors of the pegs, kids learn how to produce combinations of colors. It shows them how their eyes interpret things and these products explore the ways adults normally look at colors. This product guides kids through this process and allows them to choose some shapes to duplicate."

CARDBOARD CONSTRUCTION TOOLSET by Makedo
(CREATIVITY & CONSTRUCTION)

"This is a series of adaptors that allow you to work with cardboard. All you have to do is find the cardboard. You can make forts, mazes, airplanes, hinges for doors. It's more of a tool kit that kids can use to create whatever they want."

FACILITATES HANDS-ON PLAY

KIDS FIRST CODING & ROBOTICS by Thames & Kosmos
(HANDS-ON, CODING & ROBOTICS)

"This product is tailored to younger kids as their first coding and robotics experience, mainly K-2, that is screen free. After a child uses it they will start developing the mental pathways needed to develop this skill later in life."

HAPPY ATOMS MAGNETIC MOLECULAR MODELING SET by Thames & Kosmos
(PHYSICAL MANIPULATION, CHEMISTRY & OPEN-ENDED)

"This is a set of magnetized models that builds different atoms – each one represents a different element and you can connect them with magnets and form molecules. With an iPad, take a picture you built with DNA. It will scan it and tell you what molecule you have built."

LEGO by LEGO
(HANDS-ON, ENGINEERING & MATHEMATICS)

"These building blocks help children think creatively while incorporating engineering, mathematics, and hands-on work."

SMART ART EDUCATIONAL STEM LEARNING TOY FOR KIDS by Circuit Cubes
(HANDS-ON, TECHNOLOGY & REAL WORLD)

"This is another good example of giving kids hands-on experiences while introducing real-world concepts."

CIRCUIT BLOX LIGHTS LINE by E-Blox
(HANDS-ON, ELECTRONICS & ENGINEERING)

"It helps kids learn about circuitry, electronics, and engineering, with some guided builds. It also allows them to be creative and try to figure things out on their own."

> **❝ We know that when you are engaged and you're having fun, then you are learning. Whenever you are playing, you are learning. ❞**
>
> **-James P. Seymour**
> PhD, Vice President & Chief Technology Officer
> E-Blox

FACILITATES SOCIAL AND EMOTIONAL PLAY

VEX IQ STARTER KITS by Vex Robotics
(COLLABORATIVE, CODING & INCLUDES CURRICULUM)

"Gets kids into programming. It is so open-ended. With 80 instruction manuals you can build an alligator, dinosaur, a working farm, and then you get to program it no ceiling, no limits to what you can do and the challenges. Any kid who is into coding can zone in on it and see the physical payoff of what he or she coded. Then if they love it, they can use the same kit and go on to compete – similar to sports and group play. Kids can work together to accomplish a goal. Opens up a world of new opportunities to kids."

EVOLUTION ROBOT by Clementoni
(COLLABORATIVE, ROBOTICS, ENGINEERING, PROGRAMMING & INCLUDES CURRICULUM)

"In the process of building the robot, engineering concepts like gearing, transmitters, receivers, and levers are explored. After the robot is built, programming concepts are learned through an app; but also can be programmed without an app. Block programming is used, so sequential processes are explored, and the feedback is given when the robot carries out the commands as programmed. Open-ended. Includes collaboration in that more than one child can be involved with the building and playing – so some project management skills are taught."

FACILITATES CHILD-LED PLAY

THINK & LEARN CODE-A-PILLAR by Fisher-Price
(SIMPLE ENOUGH FOR A CHILD, HANDS-ON & STEM)

"This concept could get complicated, but they kept it simple, working with hand-eye coordination, etc."

MBOT ROBOT KIT by Makeblock
(CHILD-LED, SOLITARY PLAY & STEM)

"For a kid that wants a project, there is an incredible depth as to what you can do. With younger learners – they want to immediately drive them – but first kids have to build it. Open framework is great, you can plug in Argento. They have incredible depth of possibilities to it. Made so a single child can use the product, but it is adaptable so more than one child can play at the same time."

FACILITATES GENDER NEUTRAL AND INCLUSIVE PLAY

CRYSTAL KITS: GROW YOUR OWN CRYSTAL JEWELRY, GROW YOUR OWN CRYSTAL MINI WORLDS, AND GROW YOUR OWN CRYSTAL UNICORN, DRAGON, FOX, AND NARWHAL by Klutz
(ENCOURAGES GIRLS & SCIENCE)

"Good for encouraging girls not yet involved with Maker Labs or LEGO. Promotes learning the science of prisms, and all the related science."

FABTRONIC SEWING SET by Teknikio
(ENCOURAGES GIRLS, ELECTRONICS & STEM/STEAM)

"Combines sewing and electronics in the Maker space. Sometimes STEM can be intimidating to educators and some girls. This gets girls excited about STEM/STEAM."

AVENGER HERO INVENTOR KIT by littleBits
(CULTURALLY NEUTRAL & CREATIVITY)

"Uses superheroes from the Marvel Universe as inspiration to design your own hero. Each hero is paired with topics – like moving and jumping or how life works and depends on the hero that you build. The different heroes feature different subjects to tackle."

WONDERHOOD BUILDING SETS by Mindware
(ENCOURAGES GIRLS, ENGINEERING & PROBLEM-SOLVING)

"Engages girls in creative building and engineering concepts. Playsets also include problem-solving questions to work through as they build."

BUILDER KITS by Goldieblox
(ENCOURAGES GIRLS & CHEMISTRY)

"These toys are targeted to girls and include chemistry projects."

ROOMINATE BUILDING SETS by PlayMonster
(ENCOURAGES GIRLS & STEM)

"Empowers girls to dream, design, and build their own play structures. Girls have been underserved in STEM pursuits."

FACILITATES CURRICULUM FOR GUIDED PLAY

HOT WHEELS SPEEDOMETRY by Mattel
(INCLUDES CURRICULUM & STEM)

"Mattel partnered with University of Southern California on this concept. Research shows that the combination of Hot Wheels, along with curricula promote increased interest in STEM fields as well as achievement and improvement in STEM subjects."

TINKER CRATE by KiwiCo
(ENCOURAGES PARENTS, GUIDED PLAY & STEM)

"Developed to support STEM skills, these kits are delivered to your house every month. What makes it unique is it includes the physical product along with the supporting materials. Gives increased play value when parents have information on more than one way to play with the product and parents understand the various skills kids are experiencing."

CONSTRUCTION SETS by fishertechnik
(INCLUDES CURRICULUM & PHYSICS)

"These building sets are highly technical sets with advanced manuals – and their educational line comes with teaching curriculum. These could best be described as 'LEGOS in motion.' Could see these sets being a natural addition to a high school physics lab."

HUMMINGBIRD DUO BASE KIT by BirdBrain Technologies
(ENCOURAGES PARENTS, GUIDED PLAY, OPEN-ENDED & ROBOTICS)

"This is a programmable robot. So open-ended. Think of it as a series of small projects. Also allows for kids to do it with their parents."

FACILITATES TRIAL AND ERROR AND BUILDS CONFIDENCE

HAPPY ATOMS MAGNETIC MODELING SET

by Thames & Kosmos

(EMBRACES MISTAKES & CHEMISTRY)

"Kids snap the different bonds together magnetically and the app tells you the molecule you constructed, and you can see how they are related to other molecules, like hydro-carbon. They then show you the island of similar molecules and how they are different and then it tells you some facts. There can be games and guides to go along with them. Also teaches that mistakes can be a bridge to learning."

KIT-1, THE STEM ELECTRONIC KIT **by Mand Labs**

(BUILDS CONFIDENCE, PHYSICS, ELECTRONICS & INCLUDES CURRICULUM)

"This is a perfect example of a STEM educational toy that allows children to explore the world of physics and electronics, assemble circuits on board, and build their DIY innovative projects. It allows children to mess up with real-world components/tools and then have the confidence to learn from their mistakes. It lets children explore simple hands-on activities in a fun-interactive way."

DOC EDUCATIONAL SMART ROBOT

by Clementoni

(EMBRACES MISTAKES, OPEN-ENDED & STEM)

"Represents a good STEM toy because it has tiered learning concepts and can be open-ended. There is a real process used for programming and it shows how to do that without saying, 'This is how you have to think to do programming.' It can be used by one child and also by multiple children. The character is friendly and age-appropriate and there is feedback given for doing something right and gentle corrections for making a mistake."

APPENDIX B: ACKNOWLEDGEMENTS

The Toy Association thanks the following companies and organizations for contributing their insights to this report via an in-depth interview and/or panel participation.

Crayola	*Mattel*
E-Blox	*Modular Robotics/ Cubelets*
ETA Hand2Mind	*Nickelodeon*
Faber-Castell	*PlayMonster*
Global Toy News	*Quercetti Toys*
HueHD	*Sesame Street*
Klutz	*Spin Master*
K'NEX	*Staples*
Leapfrog	*STEM.org*
Learning Resources	*STEMfinity.com*
Liberty Science Center	*Thames & Kosmos*
littleBits	*The Toy Guy*
Magformers	*Vex Robotics/Hexbug*

14 Unifying Characteristics of STEM/STEAM Toys

EXPLORES AN ASPECT OF STEM

FUN

Open-Ended

Relates to the Real World

Allows for Trial & Error

Hands-On

Child-Led

Problem-Solving

Includes Curriculum

Gender Neutral and Inclusive

Supports Parents

Builds Confidence

Encourages Creativity

Social and Emotional Skills

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