Science, Technology, Engineering, Arts & Mathematics

Toy Assessment Framework

the toy association™

Inspiring Generations of Play

Science, Technology, Engineering, Arts, and Mathematics
(STEAM)

Toy Assessment Framework

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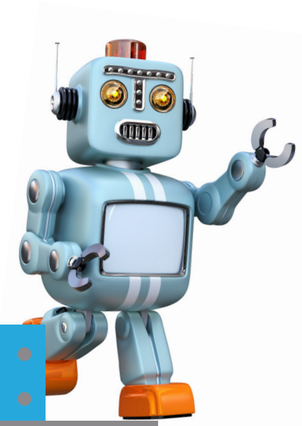
INTRODUCTION

With **STEM** principles being incorporated into school curriculum and everyday life, **The Toy Association** solicited the **Good Play Guide** and embarked on an effort to explore how toys and play can influence parents and children to embrace the concepts and understand the principles. Our studies involved interviews with over 100 experts in STEM and over 2,000 parents along with primary and secondary research which uncovered an understanding that toys and play are ideally suited to developing not only science, technology, engineering, and mathematics skills but also inspiring children to tap into their artistic and creative abilities. This expands the STEM acronym with an "A" (STEAM) to incorporate arts into the principles.

But what constitutes a **STEAM** toy? To help clarify and provide the industry with a single, consistent definition of the STEAM category, The Toy Association created the **Science, Technology, Engineering, Arts, and Mathematics (STEAM) Toy Assessment Framework** to support toy development and marketing efforts. It can be used as a checklist for toy companies to assess whether their toy can be categorized as a STEAM toy.

The assessment expands on previous Toy Association reports which tapped research and insights of key experts from in and around the Toy Industry. For example, it uses the 14 unifying characteristics of STEM/STEAM toys from **"STEM/STEAM Formula for Success"** as a foundation and takes them to the next level.

The new framework provides detailed, age-by-age criteria *(2-3 years, 4-6 years, 7-9 years, 10-12 years, and 12+ years)* for each of the STEM specific categories *(Science, Technology, Engineering, and Mathematics)*



It draws on child development milestones, a collection of US learning standards, and an independent review of existing STEAM toys.

Working within the framework to be considered a STEAM toy, the toy must have:

- all four characteristics of a 'good toy'
- all six prime STEAM attributes
- potential to support at least two of the specific STEM categories

The criteria for these are set out within the document.

The criteria in the **"Specific STEM Categories"** section provide a guide to learning goals that are appropriate for each age group. Note that some topics may be repeated across several age groups. This means children can build on the knowledge they have learned in previous years and allows for children learning at a different pace to one another.

As there is not one single US curriculum, the specific STEAM criteria have been adapted from a collection of US learning standards: The Common Core Standards Initiative standards for mathematics, The Illinois Early Learning Project learning and development standards,International Society for Technology in Education Standards for Students, and Next Generation Science Standards.

(These learning goals are not exhaustive, please refer to the sources given for additional information.)

Toy examples are given for each age and STEM category. These have been independently chosen by the authors from products that have been awarded the STEAM toy accreditation. They are given for guidance only and are not intended to cover every possible type of toy that may suit each category.

HOW TO USE THIS FRAMEWORK

To assess your toy using this framework, you will need to complete the Assessment Template *(APPX. 2)*.
Your toy must meet the requirements under each of the three sections below to be considered a STEAM toy
(see model shown on page 8 for a visual representation of the framework):

Section 1: Characteristics of a 'Good Toy'

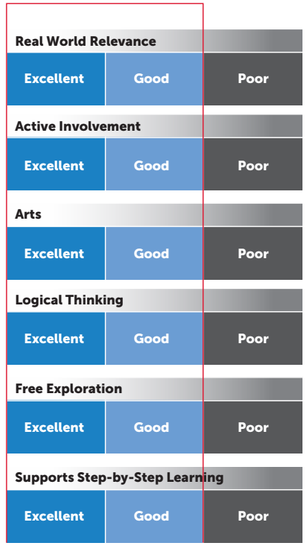
The toy is fun to play with, is accessible and inclusive, and has good play value.
Product testing and consumer reviews are useful sources of evidence for an accurate assessment.

Indicators: A rating of **'Good'** or **'Excellent'** for each of the **four characteristics:**

Section 2: Prime STEAM Attributes

The toy affords all six attributes that should underlie a STEAM toy.

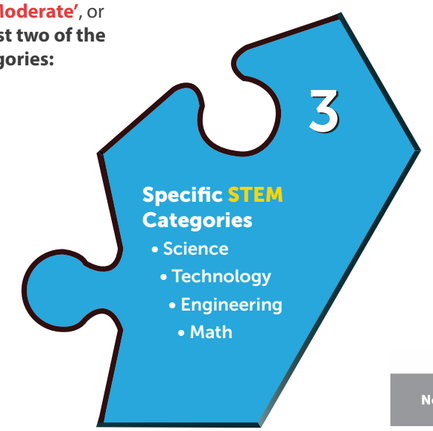
Indicators: A rating of **'Good'** or **'Excellent'** for each of the **six attributes:**



Section 3: Specific STEM Categories

The toy supports one or more learning goals in at least two STEM subjects.

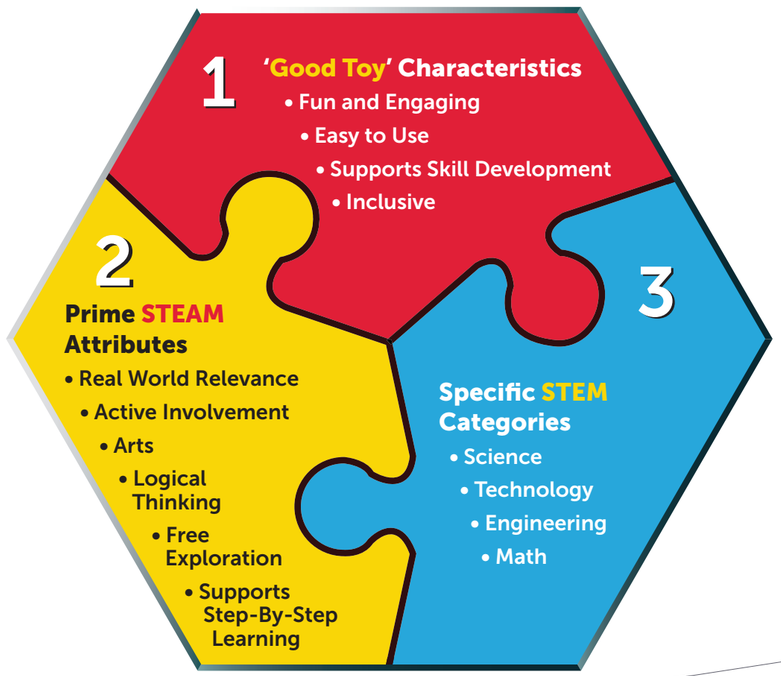
Indicators: A **'Minor'**, **'Moderate'**, or **'High'** response to **at least two of the four specific STEM categories:**



RATING CRITERIA

None	Minor	Moderate	High
Has no potential to support age appropriate learning goals in this area.	Has little potential to support age appropriate learning goals in this area. Supports one learning goal to some extent for some children.	Has some potential to support age appropriate learning goals in this area. Strongly supports one learning goal, or two learning goals to a lesser extent, for some children.	Has high potential to support age appropriate learning goals in this area. Supports two or more learning goals, or multiple learning goals to a lesser extent, for most children.

STEAM
Toy Assessment Framework Model



THE CHARACTERISTICS OF A GOOD TOY

The toy is fun to play with, is accessible and inclusive, and has good play value.

RATING CRITERIA

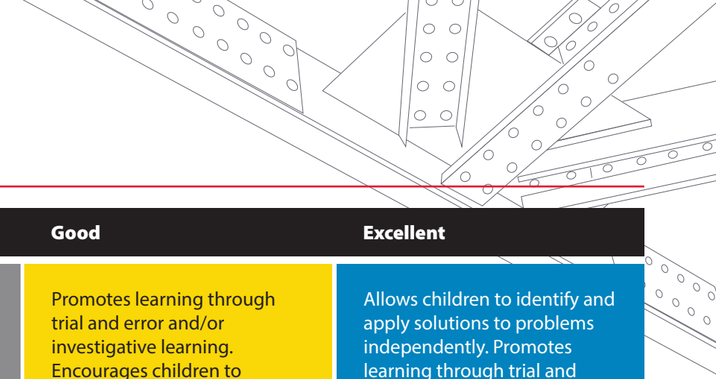
Characteristic	Poor	Good	Excellent
Fun and Engaging	Most children of the target age get bored quickly and are reluctant to play with the toy more than once.	Many children of the target age enjoy playing with the toy, and some for prolonged periods of time. It is not a favorite but still provides engagement and entertainment.	Many children of the target age enjoy playing with the toy, some for prolonged periods of time. Some children remain keen to play regularly and it may be very engaging for specific groups of children.
Easy to Use	Children of the target age are unable to use the toy without a third party (e.g. an adult does everything for them).	Children of the target age will be able to use the toy with third party support (e.g. play is largely guided by an adult).	Children of the target age will be able to use the toy to its full capacity with minimal third-party help (e.g. an adult offers some guidance when needed).
Supports Skill Development	There are no obvious age-appropriate skills developed by using the toy.	The toy has substantial benefit to a child's development in at least one age-appropriate skill area.	The toy actively encourages age-appropriate development across three or more skills (e.g. cognitive, language, or creative skills) or is particularly good at developing one or more core skills (e.g. literacy or numeracy).
Inclusive	Has barriers for children who are likely to play with it. Product packaging and marketing has a negative representation of minority groups or overly stereotyped behavior.	Is designed to be a gender-neutral product without any obvious barriers to children who are likely to play with it. Product packaging and marketing does not have a negative representation of minority groups or overly stereotyped behavior.	Is designed to be proactively inclusive, helping remove barriers for children who are likely to play with it. Product packaging and marketing positively represents diverse groups.

THE PRIME STEAM ATTRIBUTES

The toy affords all six attributes that should underlie a STEAM toy.

RATING CRITERIA

Characteristic	Poor	Good	Excellent
Real World Relevance	Has no relevance to the real world and no opportunity to practice applying knowledge.	Allows hands-on observation and use, for example: seeing real working mechanics, using measurements, or using scientific tools. Relevance to the real world isn't clear, for example: a puzzle game.	Has clear relevance and application to the real world. Allows hands-on observation and use, for example: seeing real working mechanics, using measurements, or using scientific tools.
Active Involvement	Children cannot be actively involved in the learning experience through observation or hands-on play.	Allows children to be actively involved in the learning experience, but a large amount of support from an adult is required to do so.	Allows children to be actively and independently involved in the learning experience. They can look at and physically manipulate materials to further their understanding and/or solve problems.
Arts	Gives children no opportunities to tap into their creative and imaginative skills to support divergent thinking. Children have no requirement to use the right (creative) side of their brain.	Gives children some opportunities to tap into their creative and imaginative skills to support divergent thinking. Children have some chances to use both the left *(logical)* and right *(creative)* sides of their brain, but this is limited. For example, expressing themselves through the arts such as design, drama *(including role play)*, dance, music, history, or language.	Actively encourages children to tap into their creative and imaginative skills to support divergent thinking. Children have the chance to use both the left *(logical)* and right *(creative)* sides of their brain. For example, expressing themselves through the arts such as design, drama *(including role play)*, dance, music, history, or language.



RATING CRITERIA

Characteristic	Poor	Good	Excellent
Logical Thinking	There is no need to use logical thinking when playing with the toy, for example: there are no opportunities to problem solve, no exploration or use of logic principles such as cause and effect.	Promotes learning through trial and error and/or investigative learning. Encourages children to explore logical concepts, such as cause and effect.	Allows children to identify and apply solutions to problems independently. Promotes learning through trial and error and/or investigative learning. Encourages children to explore logic principles, such as cause and effect.
Free Exploration	Children do not have opportunities to experiment repeatedly. They are unable to explore and find answers to a range of questions.	Opportunities to explore and experiment are available but limited. For example, children may only be able to carry out a science experiment once, or cannot take a model apart once built in order to rebuild it.	Gives children the freedom to repeatedly explore their own ideas, such as exploring a range of hypotheses through science experiments or designing their own codes to see what they do.
Supports Step-By-Step Learning	Has limited guided learning opportunities. It could either be too simple for the target age, thereby not helping children to grow their skills; or is too complex for the target age and tries to develop skills that are not yet achievable.	Allows children to continually extend and apply their knowledge, reinforcing learning within their comfort zone. Activities included with the toy offer different levels of challenge, gradually increasing in difficulty, to help children grow their confidence.	Includes additional guidance for adults, that can help them support the child's learning to extend their knowledge past their comfort zone. Activities included with the toy offer different levels of challenge, gradually increasing in difficulty, that may help children grow their confidence.

SPECIFIC STEM CATEGORIES: 2-3 YEARS

The toy supports one or more learning goals in at least two STEM subjects.

RATING CRITERIA

Area	Criteria	Example Toy
Science	**Scientific Practices** • Expressing curiosity by asking questions and solving problems • Creating models to represent their ideas (e.g. mix colors of paint to show the colors of leaves changing on a tree) • Planning and carrying out simple investigations (e.g. compare textures of objects using the sense of touch) • Understanding basic safety, and using nonstandard and standard scientific tools, in experiments (e.g. studying natural items under a magnifying glass) **Organisms** • Observing, investigating, describing, and categorizing living things • Understanding changes that occur in themselves and the environment (e.g. looking at photos of themselves when younger and comparing how they have grown) • Describing and comparing the basic needs of living things **Matter** • Understanding changes that occur in matter (e.g. mix substances such as baking soda and water) • Observing, investigating, describing, and categorizing physical objects; including earth/water/air **Forces** • Exploring and describing simple forces such as wind, gravity, and magnetism **Earth's Systems and Human Activity** • Understanding changes in the weather and seasons • Learning to respect nature and take care of the environment	**Magna-Tiles® Safari Animals 25-Piece Set** A magnetic construction toy that encourages children to express curiosity and explore magnetism. 

RATING CRITERIA

Area	Criteria	Example Toy
Technology	**Digital Tools** • Recognizing that a range of technology is used for different purposes • Selecting and using technology for purposes • Starting to use simple technology such as tablet devices	**TOMY John Deere Build a Johnny Tractor** A working toy tractor that children can build and take apart, introducing them to the purpose of a screwdriver. 
Engineering	**General Engineering** • Learning the concept of object permanence (that objects still exist even if they can't see them) • Using levers, buttons, or instructions (e.g. press here) to get a reaction • Showing curiosity about how thing work	**Gakken Block Advanced Set** A construction set that encourages children's curiosity by building various different designs. 

SPECIFIC STEM CATEGORIES: 2-3 YEARS

RATING CRITERIA

Area	Criteria	Example Toy
Mathematics	**Numbers and Operations** • Connecting numbers to quantities, counting objects up to five • Verbally reciting numbers one to 10, and know the next number up • Recognizing some single digit written numerals • Recognizing that numbers and quantities can be combined or separated to make another number, and identifying this new number, up to 10 • Estimating and comparing quantities using objects using "more", "less", "greater than", "fewer", "equal to", or "same as" **Shapes and Measurements** • Measuring length and capacity using non-standard measurements (e.g. a pencil) and estimations, moving onto using standard measurements • Using vocabulary to describe and compare length, height, weight, capacity, and size • Gaining a sense of time through routine • Recognizing and naming common 2D and 3D shapes • Describing, comparing, and sorting shapes by some attributes (e.g. number of sides) • Combining 2D shapes to create new shapes • Understanding how a shape might look if it changes size, rotation, or position	**Wall Stories** **LUDO** **I'm discovering numbers!** Wall stickers that children can interact with using a tablet device, to practice counting and recognizing numbers. 

RATING CRITERIA

Area	Criteria
Mathematics	**Analysis** • Describing, categorizing, and ordering objects by a single attribute, moving onto using multiple attributes • Recognizing, copying, and extending simple patterns by describing or modeling with objects or actions • Generating questions, making predictions, and gathering data to answer them with support (e.g. discussing whether trees have buds yet and going outside to check) • Organizing, representing and analyzing data with objects, with support (e.g., predict that the class collected more yellow than red leaves on the nature walk before sorting and counting them)

SPECIFIC STEM CATEGORIES: 4-6 YEARS

The toy supports one or more learning goals in at least two STEM subjects.

RATING CRITERIA

Area	Criteria	Example Toy
Science	**Scientific Practices** • Planning and investigating with guidance **Organisms** • Observing patterns and understanding what plants and animals (including humans) need to survive • Understanding how parents engage in behavior to help offspring survive **Ecosystems** • Understanding that plants need sunlight and water to grow • Understanding how animals disperse seeds and pollinate plants **Evolution, Heredity, and Genetics** • Observing and comparing plants and animals in different habitats • Observing that plant and animal offspring are similar, but not identical to, their parents **Matter** • Classifying materials by observable properties, and understanding that some materials are best suited for different purposes (e.g. plastic to float) • Understanding reversible and irreversible changes caused by heating or cooling • Understanding how an object made of a small set of pieces can be disassembled and made into a new object	**Insect Lore Butterfly Garden®** A butterfly growing kit that helps children to understand what butterflies need to survive. 

RATING CRITERIA

Area	Criteria
Science	**Forces, Energy, and Waves** • Exploring the effect of push and pull motions on objects • Observing the effect of sunlight on Earth's surface • Understanding the link between sound and vibrations • Understanding that objects in darkness can be seen when illuminated, and the effect of placing objects in the path of a beam of light **Earth and Astronomy** • Observing patterns in the sun, moon and stars • Observing how the amount of daylight changes through the year • Understanding that some Earth events happen slowly (e.g. erosion of rocks) and some happen quickly (e.g. volcanic explosions) **Earth's Systems and Human Activity** • Observing weather patterns • Understanding how plants and animals (including humans) can change the environment to suit their needs (e.g. a squirrel digging in the ground to hide its food) • Exploring how wind and water shape the land, and where water is found on Earth (as a solid or liquid) • Understanding the relationship between the needs of different plants and animals (including humans) and the places they live • Understanding the purpose of weather forecasting to prepare for, and respond to, severe weather • Understanding how to reduce the impact of humans on the land, water, air, and/or other living things in the local

SPECIFIC STEM CATEGORIES: 4-6 YEARS

RATING CRITERIA

Area	Criteria	Example Toy
Technology	**Digital Tools** • Using basic devices and software applications **Digital Citizenship** • Engaging in positive, safe, legal and ethical behavior when using technology **Innovation and Creation** • Using a deliberate design process for generating ideas, testing theories, and creating innovative artifacts (e.g. 3D printing, computer programs, robotics, simulations, virtual representations, prototypes) • Creating original works or responsibly repurposing or remixing digital resources into new creations **Computational Thinking** • Using algorithmic thinking to develop a sequence of steps (e.g. coding) to create and test automated solutions	**Learning Resources Botley® 2.0 the Coding Robot Activity Set** A programmable robot that encourages children to use a sequence of steps, teaching algorithmic thinking. 
Engineering	**Applied Science** • Exploring solutions that will reduce the impact of humans on the land, water, air, and/or other living things in the local environment (e.g. reusing paper and recycling cans and bottles) • Designing and building a device that uses light or sound to solve the problem of communicating over a distance (e.g. paper cup and string "telephones") • Designing a solution to a human problem by mimicking how plants and/or animals use their external parts to help them survive, grow, and meet their needs (e.g. clothing or equipment to protect bicyclists by mimicking turtle shells, acorn shells, and animal scales) • Testing different materials to determine which materials have the properties that are best suited for an intended purpose	**Morphun Total STEM** A construction set with unique side-joining blocks, that allows children to build and compare the strengths of two different models. 

RATING CRITERIA

Area	Criteria	Example Toy
Engineering	• Comparing solutions designed to slow or prevent wind or water from changing the shape of the land • Designing and building a structure that will reduce the warming effect of sunlight on Earth's surface **General Engineering** • Defining problems and identifying how they can be solved through the development of a new object or tool • Developing simple drawings to illustrate how the shape of an object can help it function as needed to solve a problem • Comparing the strengths and weaknesses of two objects designed to solve the same problem	*See example on page 18.*
Mathematics	**Numbers and Operations** • Counting to 100 by ones and 10s • Understanding place value, grouping in 10s and ones • Representing, adding and subtracting whole numbers with objects and numerals within 20 **Shapes and Measurements** • Identifying and describing basic 2D and 3D shapes (e.g. squares, triangles, cubes, and cones) in different sizes and orientations • Modelling and drawing 2D and 3D shapes, and composing larger shapes from smaller ones (e.g. two triangles to make a square) • Describing and comparing measurements • Understanding iterating, the mental activity of building up the length of an object with equal-sized units • Telling and writing time in hours and half-hours using analog and digital clocks **Analysis** • Counting the number of objects in categories • Representing and interpreting data with up to three categories	**Squargles Starter Set** A magnetic construction set that allows children to identify, describe, and model 2D and 3D shapes. 

SPECIFIC STEM CATEGORIES: 7-9 YEARS

The toy supports one or more learning goals in at least two STEM subjects.

RATING CRITERIA

Area	Criteria	Example Toy
Science	**Scientific Practices** • Planning and conducting investigations to produce data to serve as the basis for evidence to answer a question **Organisms** • Understanding that life cycles are diverse, but all organisms have in common birth, growth, reproduction, and death **Ecosystems** • Understanding that plants need sunlight and water to grow • Understanding how animals disperse seeds and pollinate plants • Understanding that some animals form groups to help with survival (e.g. obtaining food or defending themselves) **Evolution, Heredity, and Genetics** • Understanding that plants and animals have traits inherited from parents, and that these traits can be influenced by the environment • Observing and comparing plants and animals in different habitats • Exploring fossils to understand the organisms and the environments in which they lived long ago • Understanding how the variations in characteristics among individuals of the same species may provide advantages in surviving, finding mates, and reproducing (e.g. plants with larger thorns may be less likely to be eaten, animals with better camouflage may be more likely to survive and reproduce) • Understanding that in a habitat some organisms can survive well, some survive less well, and some cannot survive at all	**Hot Wheels® STEAM Drop & Score™** A vehicle and ramp set that helps children understand the effects of gravity and the motion of pendulums. 

RATING CRITERIA

Area	Criteria
Science	**Matter** • Classifying materials by observable properties, and understanding that some materials are best suited for different purposes (e.g. plastic to float) • Understanding how an object made of a small set of pieces can be disassembled and made into a new object • Understanding reversible and irreversible changes caused by heating or cooling **Forces** • Understanding the impact of balanced and unbalanced forces on the motion of an object • Observing and measuring an object's motion to identify a pattern, that can be used to predict future motion (e.g. swinging on a swing) • Exploring the cause and effect relationships of electric or magnetic interactions between two objects not in contact with each other **Earth and Astronomy** • Understanding that some Earth events happen slowly (e.g. erosion of rocks) and some happen quickly (e.g. volcanic explosions) **Earth's Systems** • Exploring how to slow the effect of wind and water in shaping the land • Understanding the different kinds of land and bodies of water, and where water is found on Earth (as a solid or liquid) • Describing typical weather conditions expected during a season using data in tables and graphs • Exploring information describing climates in different regions of the world

SPECIFIC STEM CATEGORIES: 7-9 YEARS

RATING CRITERIA

Area	Criteria	Example Toy
Technology	**Digital Tools** • Using technology tools to support their learning (e.g. text to speech, audio, video, highlighting) • Using technology to seek feedback to inform learning (e.g. spellcheck, online search) • Using technology to demonstrate learning (e.g. digital posters, blogs) • Using basic devices and software applications • Solving technical problems (e.g. restarting a device, installing updates) and transferring this knowledge to new technologies **Digital Citizenship** • Understanding the permanence of their actions in the digital world • Engaging in positive, safe, legal and ethical behavior when using technology • Managing personal data to maintain digital privacy and security and being aware of data-collection technology used to track their navigation online **Information Gathering** • Using effective research strategies to locate information and other resources through digital tools (e.g. using multiple sources, video and audio clips) • Curating information from digital resources using a variety of tools (e.g. note taking, citation tools) • Actively exploring real-world issues and problems using digital tools	**Elenco** **Snap Circuits** **Discover Coding** A circuit building kit that allows children to use coding to create and test automated solutions. 

RATING CRITERIA

Area	Criteria
Technology	**Innovation and Creation** • Using a deliberate design process for generating ideas, testing theories, creating innovative artifacts (e.g. 3D printing, computer programs, robotics, simulations, virtual representations, prototypes) or solving authentic problems using technology • Using digital tools to plan and manage a design process that considers design constraints and calculated risks • Developing, testing and refining prototypes as part of a cyclical design process • Creating original works or responsibly repurposing or remixing digital resources into new creations • Customizing content to suit the intended audience **Computational Thinking** • Identifying problems that can benefit from technology-assisted methods such as data analysis, abstract models, and algorithmic thinking in exploring and finding solutions • Collecting (e.g. surveys) or identifying (e.g. big data) relevant data sets and using digital tools to analyze and represent the data to facilitate problem-solving and decision-making • Understanding how technology can be used for repetitive tasks (automation) and using algorithmic thinking to develop a sequence of steps (e.g. coding) to create and test automated solutions

SPECIFIC STEM CATEGORIES: 7-9 YEARS

RATING CRITERIA

Area	Criteria	Example Toy
Engineering	**Applied Science** • Solving simple design problems by applying scientific ideas about magnets • Considering the merit of design solutions that reduce the impacts of a weather-related hazard (e.g. barriers to prevent flooding) **General Engineering** • Defining problems and identifying how they can be solved through the development of a new object or tool • Defining a simple design problem reflecting a need or a want that includes specified criteria for success and constraints on materials, time, or cost • Developing simple drawings to illustrate how the shape of an object can help it function as needed to solve a problem • Comparing the strengths and weaknesses of two objects designed to solve the same problem • Generating and comparing multiple possible solutions to a problem based on how well each is likely to meet the criteria and constraints of the problem • Planning and carrying out fair tests to identify how a model or prototype can be improved	**Red Toolbox DIY Truck Catapult Kit** A craft kit that encourages children to compare the strengths and weaknesses of equipment, e.g. nails vs. screws. 

RATING CRITERIA

Area	Criteria	Example Toy
Mathematics	**Numbers and Operations** • Counting in ones, fives, tens, and 100s • Recognizing digit place (e.g. 853 is 8 hundreds + 5 tens + 3 ones) • Addition and subtraction within 1,000 • Multiplying and dividing whole numbers within 100 • Understanding and comparing unit fractions (e.g. 1/2. 1/5) **Shapes and Measurements** • Using standard measurements in time, liquid volume, mass, and length • Describing and comparing 2D shapes by sides and angles • Building and drawing 2D and 3D shapes • Recognizing and measuring area as an attribute of 2D shapes • Partitioning circles and rectangles into two, three, or four equal shares, describe the shares using the words halves, thirds, half of, a third of, etc. • Working with time (analog and digital, to the nearest five minutes) and money (involving dollar bills, quarters, dimes, nickels, and pennies) **Analysis** • Representing and interpreting data with picture graphs and bar graphs	**Connetix Tiles 40 pc Pastel Geometry Pack** A magnetic construction set that encourages children to build 2D and 3D shapes in different sizes and orientations. 

SPECIFIC STEM CATEGORIES: 10-12 YEARS

The toy supports one or more learning goals in at least two STEM subjects.

RATING CRITERIA

Area	Criteria	Example Toy
Science	**Scientific Practices** • Investigating to produce data to serve as the basis for evidence, using fair tests in which variables are controlled and the number of trials considered **Organisms** • Understanding that plants and animals have internal and external structures that function to support survival, growth, behavior, and reproduction • Understanding that that animals receive different types of information through their senses, process the information in their brain, and respond to the information in different ways • Understanding that plants get the materials they need for growth chiefly from air and water **Ecosystems** • Understanding the movement of matter among plants, animals, decomposers, and the environment (matter that is not food - air, water, decomposed materials in soil - is changed by plants into matter that is food) **Matter** • Understanding that matter is made of particles too small to be seen • Understanding that the weight of matter doesn't change when heating, cooling, or mixing substances • Identifying materials based on their properties through observing and measuring • Experimenting with missing two or more substances, to understanding whether this results in new substances	**SmartLab Toys Ultimate Squishy Human Body** A human anatomy model with a Smart Scanner, that introduces children to the internal and external structures of the human body. 

RATING CRITERIA

Area	Criteria
Science	**Forces, Energy, and Waves** • Understanding that the gravitational force exerted by Earth on objects is directed down • Understanding how the speed of an object links to its energy (faster objects have more energy) • Understanding how energy can be transferred from place to place by sound, light, heat, and electric currents; and changes in energy when objects collide • Understanding that the energy in animals' food was once energy from the sun • Describing patterns in terms of amplitude and wavelength and that waves can cause objects to move • Understanding how light reflects from objects into the eye, so that objects can be seen **Earth and Astronomy** • Identifying patterns in rock formations and fossils in rock layers to understand changes in landscape over time • Understanding that the apparent brightness of the sun and stars is due to their relative distances from the Earth • Exploring patterns of daily changes in length and direction of shadows, day and night, and the seasonal appearance of some stars in the night sky **Earth's Systems and Human Activity** • Exploring the effects of weathering or the rate of erosion by water, ice, wind, or vegetation • Describing Earth's features using maps (e.g. land and ocean floor, mountains, earthquakes) • Describing ways the geosphere, biosphere, hydrosphere, and/or atmosphere interact (e.g. the influence of the ocean on ecosystems) • Understanding the distribution of water and fresh water on Earth using graphs (in oceans, lakes, rivers, glaciers, ground water, and polar ice caps) • Understanding that energy and fuels are derived from natural resources and their uses affect the environment • Exploring ways individual communities use science ideas to protect the Earth's resources and environment

SPECIFIC STEM CATEGORIES: 10-12 YEARS

RATING CRITERIA

Area	Criteria	Example Toy
Technology	**Digital Tools** • Using technology tools to support their learning (e.g. text to speech, audio, video, highlighting) • Using technology to seek feedback to inform learning (e.g. spellcheck, online search) • Using technology to demonstrate learning (e.g. digital posters, blogs) • Using basic devices and software applications • Solving technical problems (e.g. restarting a device, installing updates) and transferring this knowledge to new technologies **Digital Citizenship** • Understanding the permanence of their actions in the digital world • Engaging in positive, safe, legal and ethical behavior when using technology • Managing personal data to maintain digital privacy and security and being aware of data-collection technology used to track their navigation online **Information Gathering** • Using effective research strategies to locate information and other resources through digital tools (e.g. using multiple sources, video and audio clips) • Curating information from digital resources using a variety of tools (e.g. note taking, citation tools) • Actively exploring real-world issues and problems using digital tools	**Learning Resources Coding Charms** A craft set that requires children to use algorithmic thinking to follow a sequence of steps, similar to coding, to make a charm. 

RATING CRITERIA

Area	Criteria	Example Toy
Technology	**Innovation and Creation** • Using a deliberate design process for generating ideas, testing theories, creating innovative artifacts (e.g. 3D printing, computer programs, robotics, simulations, virtual representations, prototypes) or solving authentic problems using technology • Using digital tools to plan and manage a design process that considers design constraints and calculated risks • Developing, testing and refining prototypes as part of a cyclical design process • Creating original works or responsibly repurposing or remixing digital resources into new creations • Customizing content to suit the intended audience **Computational Thinking** • Identifying problems that can benefit from technology-assisted methods such as data analysis, abstract models, and algorithmic thinking in exploring and finding solutions • Collecting (e.g. surveys) or identifying (e.g. big data) relevant data sets and using digital tools to analyze and represent the data to facilitate problem-solving and decision-making • Understanding how technology can be used for repetitive tasks (automation) and using algorithmic thinking to develop a sequence of steps (e.g. coding) to create and test automated solutions	*See example on page 28.*
Engineering	**Applied Science** • Designing, testing, and refining a device that converts energy from one form to another • Generating and comparing multiple solutions that use patterns to transfer information (e.g. using Morse code to send text) • Generating and comparing multiple solutions to reduce the impacts of natural Earth processes on humans (e.g. designing an earthquake resistant building)	**Jumbo JR. Giant Tumbling Timber Toy** A giant block-stacking game that helps children learn about load, tension and compression, and rotational force.

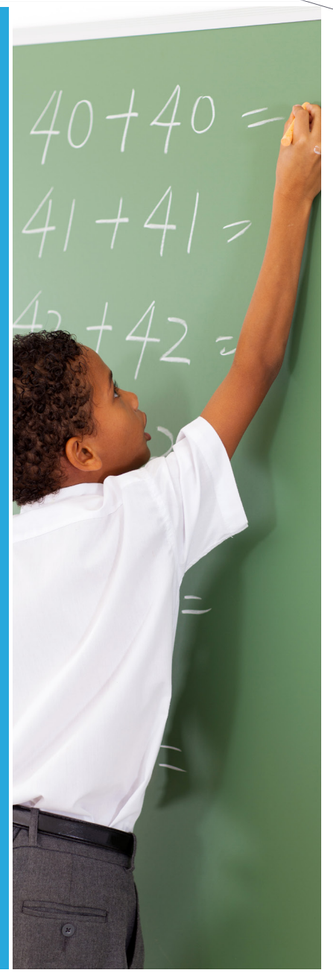
SPECIFIC STEM CATEGORIES: 10-12 YEARS

RATING CRITERIA

Area	Criteria	Example Toy
Engineering	**General Engineering** • Defining a simple design problem reflecting a need or a want that includes specified criteria for success and constraints on materials, time, or cost • Generating and comparing multiple possible solutions to a problem based on how well each is likely to meet the criteria and constraints of the problem • Planning and carrying out fair tests in which variables are controlled and failure points are considered to identify aspects of a model or prototype that can be improved	**Jumbo JR.** **Giant Tumbling Timber Toy** 
Mathematics	**Numbers, Operations, and Algebra** • Ordering negative rational numbers • Writing and evaluating numerical expressions involving whole-number exponents, and in which letters stand for numbers (e.g. express the calculation "Subtract y from 5" as $5 - y$) • Performing operations with multi-digit whole numbers • Performing operations with fractions • Understanding and using ratios, and connecting these with fractions • Dividing by two-digit numbers • Using whole number and decimal operations • Understanding and using the relationship between decimals and fractions	**ARCKIT** **Coastal Living** A model house kit that encourages children to build and draw 2D and 3D shapes. 

RATING CRITERIA

Area	Criteria
Mathematics	**Shapes and Measurements** • Recognizing volume as an attribute of 3D space and understanding how to measure this • Decomposing 3D shapes to find volume, by viewing them as layers of 1x1x1 unit cubes • Classifying 2D shapes based on their properties (e.g. all rectangles have four right angles, and squares are rectangles, so all squares have four right angles) • Converting like measurement units **Analysis** • Representing and interpreting data in a line plot • Using operations to solve problems using information from line plots • Understanding and using data distribution, median and mean • Describing and summarizing statistical data, identifying clusters, peaks, gaps, and symmetry



SPECIFIC STEM CATEGORIES: 12+ YEARS

The toy supports one or more learning goals in at least two STEM subjects.

RATING CRITERIA

Area	Criteria	Example Toy
Science	**Scientific Practices** • Investigating and evaluating the experimental design to produce data to serve as the basis for evidence that can meet the goals of the investigation **Organisms** • Understanding that living things are made of cells; either one cell or many different numbers and types of cells • Understanding the functions of a cell as a whole and how parts of cells contribute to the function, and how the body is a system of interacting subsystems composed of groups of cells • Understanding how characteristic animal behaviors and specialized plant structures affect the probability of successful reproduction of animals and plants respectively • Understanding how environmental and genetic factors influence the growth of organisms • Understanding the role of photosynthesis in the cycling of matter and flow of energy into and out of organisms • Understanding how food is rearranged through chemical reactions forming new molecules that support growth and/or release energy as this matter moves through an organism • Understanding that that sensory receptors respond to stimuli by sending messages to the brain for immediate behavior or storage as memories	**Insect Lore** **Ant Mountain™** An ant habitat that allows children to observe the life cycle of ants and understand that they form groups to survive. 

RATING CRITERIA

Area	Criteria
Science	**Ecosystems** • Understanding the effects of resource availability on organisms and populations of organisms in an ecosystem • Predicting patterns of interactions among organisms across multiple ecosystems (e.g. competitive, predatory, and mutually beneficial) • Understanding the cycling of matter and flow of energy among living and non-living parts of an ecosystem • Understanding how changes to physical or biological components of an ecosystem affect populations **Evolution, Heredity, and Genetics** • Explaining why structural changes to genes (mutations) located on chromosomes may affect proteins and may result in harmful, beneficial, or neutral effects • Describing why asexual reproduction results in offspring with identical genetic information and sexual reproduction results in offspring with genetic variation • Analyzing patterns in the fossil record that document the existence, diversity, extinction, and change of life forms throughout the history of life on Earth • Comparing the anatomical similarities and differences among modern organisms and between modern and fossil organisms to infer evolutionary relationships • Comparing patterns of similarities in the embryological development across multiple species to identify relationships not evident in the fully formed anatomy • Describing how genetic variations of traits in a population increase some individuals' probability of surviving and reproducing in a specific environment • Understanding the technologies that have changed the way humans influence the inheritance of desired traits in organisms (e.g. genetic modification, animal husbandry, gene therapy) • Using mathematical representations to explain how natural selection may lead to increases and decreases of specific traits in populations over time

SPECIFIC STEM CATEGORIES: 12+ YEARS

RATING CRITERIA

Area	Criteria	Example Toy
Science	**Matter** • Describing the atomic composition of simple molecules and extended structures • Analyzing the properties of substances before and after interaction to determine if a chemical reaction has occurred • Understanding that synthetic materials come from natural resources • Predicting and describing changes in particle motion, temperature, and state of a pure substance when thermal energy is added or removed • Understanding that the total number of atoms does not change in a chemical reaction • Understanding that the change in an object's motion depends on the sum of the forces on the object and the mass of the object **Forces, Energy, and Waves** • Determining the factors that affect the strength of electric and magnetic forces • Understanding that gravitational interactions are attractive and depend on the masses of interacting objects • Understanding that fields exist between objects exerting forces on each other even though the objects are not in contact • Describing the relationships of kinetic energy to the mass of an object and to the speed of an object • Understanding that when the arrangement of objects interacting at a distance changes, different amounts of potential energy are stored in the system • Understanding that when the kinetic energy of an object changes, energy is transferred to or from the object • Understanding that the amplitude of a standard repeating wave is related to the energy in a wave, and that waves are reflected, absorbed, or transmitted through various materials	*See example on page 32.*

RATING CRITERIA

Area	Criteria
Science	• Understanding that digitized signals are a more reliable way to encode and transmit information than analog signals **Earth and Astronomy** • Using the Earth-sun-moon system to describe the cyclic patterns of lunar phases, eclipses of the sun and moon, and seasons • Describing the role of gravity in the motions within galaxies and the solar system • Determining scale properties of objects in the solar system (e.g. crust and atmosphere) • Understanding how the geologic time scale is used to organize Earth's 4.6-billion-year-old history **Earth's Systems and Human Activity** • Understanding the cycling of Earth's materials and the flow of energy that drives this process (e.g. melting, crystallization, weathering) • Understanding how geoscience processes have changed Earth's surface at varying time and spatial scales, and how these have led to uneven distributions of Earth's mineral, energy, and groundwater resources • Exploring the distribution of fossils and rocks, continental shapes, and seafloor structures to provide evidence of the past plate motions • Describing the cycling of water through Earth's systems driven by energy from the sun and the force of gravity • Understanding how the motions and complex interactions of air masses results in changes in weather conditions • Understanding how unequal heating and rotation of the Earth cause patterns of atmospheric and oceanic circulation that determine regional climates • Interpreting data on natural hazards to forecast future catastrophic events and inform the development of technologies to mitigate their effects

SPECIFIC STEM CATEGORIES: 12+ YEARS

RATING CRITERIA

Area	Criteria	Example Toy
Science *(Continued)*	• Understanding how increases in human population and per-capita consumption of natural resources impact Earth's systems • Exploring the factors that have caused the rise in global temperatures over the past century	*See example on page 32.*
Technology	**Digital Tools** • Building networks through online connections (e.g. email) • Using technology tools to support their learning (e.g. text to speech, audio, video, highlighting) • Using technology to seek feedback to inform learning (e.g. spellcheck, online search) • Using technology to demonstrate learning (e.g. digital posters, blogs) • Using basic devices and software applications • Solving technical problems (e.g. restarting a device, installing updates) and transferring this knowledge to new technologies **Digital Citizenship** • Cultivating and managing their digital identity (e.g. social media posts, public comments/reviews) • Understanding the permanence of their actions in the digital world • Engaging in positive, safe, legal and ethical behavior when using technology, including social interactions online or when using networked devices • Understanding the rights and obligations of using and sharing intellectual property • Managing personal data to maintain digital privacy and security and being aware of data-collection technology used to track their navigation online	**Learning Resources Artie Max™ The Coding Robot** A robot that children can program using real coding languages, teaching them about automation and solving technical problems. 

RATING CRITERIA

Area	Criteria
Technology	**Information Gathering** • Using effective research strategies to locate information and other resources through digital tools (e.g. using multiple sources, video and audio clips) • Evaluating the accuracy, perspective, credibility and relevance of information, media, data or other resources • Curating information from digital resources using a variety of tools (e.g. note taking, citation tools) • Actively exploring real-world issues and problems using digital tools **Innovation and Creation** • Using a deliberate design process for generating ideas, testing theories, creating innovative artifacts (e.g. 3D printing, computer programs, robotics, simulations, virtual representations, prototypes) or solving authentic problems using technology • Using digital tools to plan and manage a design process that considers design constraints and calculated risks • Developing, testing and refining prototypes as part of a cyclical design process • Choosing appropriate digital platforms (e.g. blog, video) and tools (e.g. digital camera) for meeting the desired objectives of their creation or communication • Creating original works or responsibly repurposing or remixing digital resources into new creations • Communicating complex ideas clearly and effectively by creating or using a variety of digital objects such as visualizations, models or simulations • Customizing content to suit the intended audience

SPECIFIC STEM CATEGORIES: 12+ YEARS

RATING CRITERIA

Area	Criteria	Example Toy
Technology	**Computational Thinking** • Identifying problems that can benefit from technology-assisted methods such as data analysis, abstract models, and algorithmic thinking in exploring and finding solutions • Collecting (e.g. surveys) or identifying (e.g. big data) relevant data sets and using digital tools to analyze and represent the data to facilitate problem-solving and decision-making • Understanding how technology can be used for repetitive tasks (automation) and using algorithmic thinking to develop a sequence of steps (e.g. coding) to create and test automated solutions **Global Collaboration** • Using digital tools (e.g. virtual conferencing, multiplayer online games) to connect and engage with others from a variety of backgrounds and cultures • Using collaborative technologies (e.g. digital project sites, collaborative schedulers) to work with others, examine issues and problems from multiple viewpoints • Exploring local and global issues and using collaborative technologies to work with others to investigate solutions	*See example on page 36.*

RATING CRITERIA

Area	Criteria	Example Toy
Engineering	**Applied Science** • Constructing, testing, and modifying a device that either releases or absorbs thermal energy by chemical processes • Applying Newton's Third Law to design a solution to a problem involving the motion of two colliding objects • Designing, constructing, and testing a device that either minimizes or maximizes thermal energy transfer • Evaluating design solutions for maintaining biodiversity and ecosystem services (e.g. water purification, nutrient recycling, and prevention of soil erosion) • Designing a method for monitoring and minimizing a human impact on the environment (e.g. reducing water usage, land usage, and pollution) • Defining the criteria and constraints of a design problem with enough precision to ensure a successful solution, considering relevant scientific principles and potential impacts on people and the natural environment that may limit possible solutions **General Engineering** • Evaluating competing design solutions using a systematic process to determine how well they meet the criteria and constraints of the problem • Analyzing data from tests to determine similarities and differences among several design solutions to identify the best characteristics of each that can be combined into a new solution to better meet the criteria for success • Developing a model to generate data for iterative testing and modification of a proposed object, tool, or process such that an optimal design can be achieved.	**ARCKIT GO Eco** A model house kit that introduces children to load bearing, by trying different designs to make a structurally sound model. 

SPECIFIC STEM CATEGORIES: 12+ YEARS

RATING CRITERIA

Area	Criteria	Example Toy
Mathematics	**Numbers, Operations, and Algebra** • Using ratios and proportions to solve problems • Using linear equations • Solving problems using scale drawings • Recognizing the link between fractions, decimals, and percents • Using negative numbers in everyday contexts (e.g. temperature) • Adding, subtracting, multiplying and dividing with negative numbers, and rational numbers • Understanding, comparing and using functions **Shapes and Measurements** • Solving problems using the area, surface area, volume, and circumference of 3D shapes • Understanding congruence and similarity using physical geometric models • Using Pythagorean Theorem **Analysis** • Comparing populations in data • Understanding and using random sampling • Identifying patterns of association in bivariate data	**Elenco Simple Machines** A construction toy that encourages children to use linear equations. 

APPENDIX 1: KEY TERM DEFINITIONS

Characteristics of a "Good Toy"

FUN AND ENGAGING	To what extent children enjoy playing with the toy, how frequently, and for how long.
EASY TO USE	To what extent most children in the target age group can use the toy as intended.
SUPPORTS SKILL DEVELOPMENT	To what extent the toy helps children develop age appropriate soft and hard skills.
INCLUSIVE	To what extent the toy is designed for and marketed to children of different genders, backgrounds, and abilities.

Prime STEAM Attributes

REAL WORLD RELEVANCE	To what extent the toy relates to and/or represents real world applications.
ACTIVE INVOLVEMENT	To what extent the toy allows physical, hands-on involvement with the toy.
ARTS	To what extent the toy encourages creativity and artistic expression through arts including design, dance, music, drama, history or language.
LOGICAL THINKING	To what extent the toy requires logic, such as trial and error or problem solving.
FREE EXPLORATION	To what extent children can explore the toy on more than one occasion, thereby reinforcing their learning and promoting curiosity.
SUPPORTS STEP-BY-STEP LEARNING	To what extent the toy gradually builds confidence through guidance, parent support, and increasing levels of challenge.

The Specific STEM Categories

S	Learning to use scientific practices to carry out investigations as well as the study of biology (e.g. organisms, ecosystems, evolution, heredity, genetics), chemistry (e.g. matter), physics (e.g. forces, energy, waves), astronomy, and Earth science (e.g. Earth's systems). Does not include social sciences.
T	Developing digital literacy skills including using digital tools to create and innovate, gather information, and collaborate with others on a global scale. Also includes using computational thinking, such as coding and programming, and digital citizenship (the responsible use of technology).
E	Understanding how things work and applying this knowledge to design solutions to problems with set criteria and constraints. Learning to design, construct, test, compare, and critically evaluate solutions. Includes designing solutions to science-based problems (such as preventing erosion).
M	Learning numbers and operations including number order, addition, subtraction, multiplying, dividing, and fractions. Also includes learning the properties of shapes, how to use measurements (e.g. time, length, and volume), data analysis, and algebra.

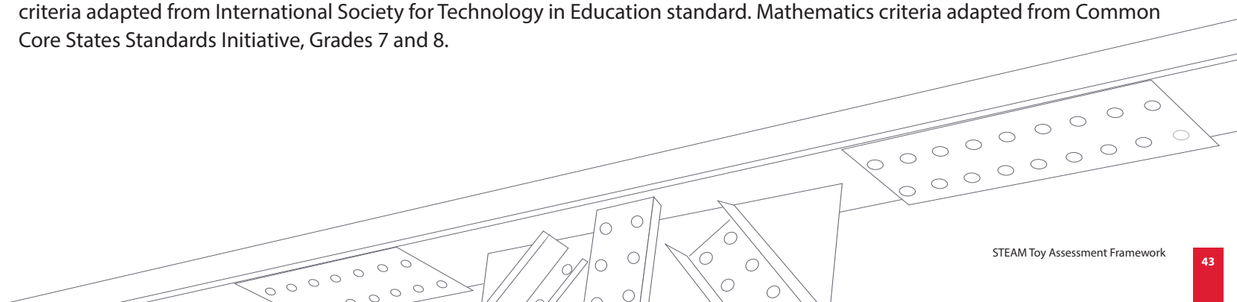
AGE 2-3 YEARS: Science and Mathematics criteria adapted from the Illinois Early Learning Project (2013) development standards. Engineering and Technology based on child development milestones only, as learning standards were not available.

AGE 4-6 YEARS: Science and Engineering criteria adapted from Next Generation Science Standards, Kindergarten (K & K-2) and Grade 1. Technology criteria adapted from International Society for Technology in Education standard. Mathematics criteria adapted from Common Core States Standards Initiative, Kindergarten and Grade 1.

AGE 7-9 YEARS: Science and Engineering criteria adapted from Next Generation Science Standards, Grades 2 and 3. Technology criteria adapted from International Society for Technology in Education standard. Mathematics criteria adapted from Common Core States Standards Initiative, Grades 2 and 3.

AGE 10-12 YEARS: Science and Engineering criteria adapted from Next Generation Science Standards, Grades 4 and 5. Technology criteria adapted from International Society for Technology in Education Standard. Mathematics criteria adapted from Common Core States Standards Initiative, Grades 5 and 6.

AGE 12+ YEARS: Science and Engineering criteria adapted from Next Generation Science Standards, Grades 6-8. Technology criteria adapted from International Society for Technology in Education standard. Mathematics criteria adapted from Common Core States Standards Initiative, Grades 7 and 8.



APPENDIX 2: ASSESSMENT TEMPLATE

Toy Name _____

Target Age _____

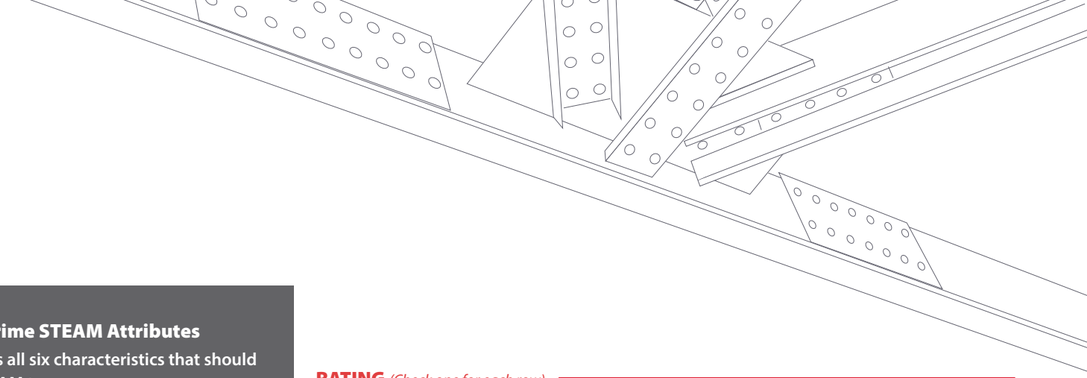
Section 1: Characteristics of a 'Good Toy'
The toy is fun to play with, is accessible and inclusive, and has good play value
(see "Characteristics of a 'Good Toy'" criteria on page 9).

RATING *(Check one for each row)*

	POOR	GOOD	EXCELLENT
Fun and Engaging	❑	❑	❑
Easy to Use	❑	❑	❑
Supports Skill Development	❑	❑	❑
Inclusive	❑	❑	❑

If all rows are checked 'Good' or Excellent', continue to Section 2.
Otherwise, skip to Section 5.

Section 1 supporting notes *(optional):*



Section 2: Prime STEAM Attributes
The toy affords all six characteristics that should underlie a STEAM toy
(see "Prime STEAM Attributes" criteria on page 10).

RATING *(Check one for each row)*

	POOR	GOOD	EXCELLENT
Real World Relevance	❑	❑	❑
Active Involvement	❑	❑	❑
Arts	❑	❑	❑
Logical Thinking	❑	❑	❑
Free Exploration	❑	❑	❑
Supports Step-By-Step Learning	❑	❑	❑

If all rows are checked 'Good' or Excellent', continue to Section 3.
Otherwise, skip to Section 5.

Section 2 supporting notes *(optional):*

APPENDIX 2: ASSESSMENT TEMPLATE

Section 3: Specific STEM Categories
The toy supports one or more learning goals in at least two STEM subjects
(see "Specific STEM Categories" criteria on page 12).

RATING *(Check one for each row)*

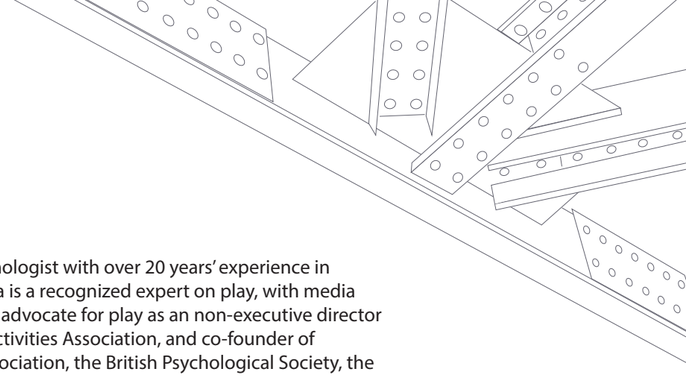
	NONE	MINOR	MODERATE	HIGH
Science	❑	❑	❑	❑
Technology	❑	❑	❑	❑
Engineering	❑	❑	❑	❑
Mathmatics	❑	❑	❑	❑

If two or more rows are checked 'Minor', 'Moderate', or 'High', continue to Section 4.
Otherwise, skip to Section 5.

Section 3 supporting notes *(optional):*

Section 4: Approved — Congratulations! Your toy meets all the requirements to be categorized as a STEAM toy.

Section 5: Failed — Unfortunately, your toy does not meet the requirements to be categorized as a STEAM toy.



About the Authors

Dr Amanda Gummer (Founder, Good Play Guide) is a PhD Psychologist with over 20 years' experience in the toy industry and working with children and families. Amanda is a recognized expert on play, with media appearances including BBC News and Sky News. She is an active advocate for play as an non-executive director for Families in Focus CIC, a founding member of the Children's Activities Association, and co-founder of Karisma Kidz; as a member of The International Toy Research Association, the British Psychological Society, the International Licensing Industry Merchandisers' Association, and Play England; and through her involvement with parliamentary policy on children's issues via All-Party Parliamentary Groups and think tanks. Her book, "Play: Fun ways to help your children develop in the first 5 years" (May 2015) has been translated into Russian and Romanian.

Anna Taylor (Researcher, Good Play Guide) holds a BSc degree in Psychology and has over five years' experience in the toy and children's media industries. She has worked with Amanda to carry out play research for the International Toy Research Association (2018), BBC Children in Need (2019), and the European Balloon and Party Council (2020).

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