KinderLab robotics

THE IMPORTANCE OF SCREEN-FREE CODING AND ROBOTICS FOR YOUNG LEARNERS

The Case for KIBO

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Summary

Early childhood is a wonderful time to spark kids' interest in coding, robotics, and engineering. Young children are curious about the world around them, and today that world includes technology. But how best to promote positive, creative, and educational engagement with technology? By introducing and integrating developmentally appropriate robotics and coding into early childhood education.

KinderLab Robotics' KIBO™, the hands-on coding robot, teaches computer science, engineering, and computational thinking to young children aged 4-7 (PreK through 2nd grade). The curriculum is standards-aligned in computer science and engineering, and supports deep cross-curricular connections to science, ELA, math, and social studies.

With KIBO, children build, program, decorate, and bring their own robot to life. KIBO is entirely screen-free, as children program their robots with "tangible code" made of wooden blocks. This approach takes advantage of years of research into providing physical manipulatives to allow young children to engage with abstract concepts like coding. KIBO is designed to be extended with craft and other building materials, providing a platform for imagination play, sturdy building, and the engineering design process.

KinderLab Robotics' mission – To offer research-based solutions for universal STEAM literacy for all children.

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About KIBO

Since 2013, KIBO has provided a platform for young students to engage and learn STEAM concepts through play and creative self-expression. KIBO brings robotics and coding to young learners and sparks their interest in STEAM. When children code with KIBO they are learning invaluable skills that will lead them on the path for success in science, technology, engineering, art, and mathematics (STEAM) skills and future careers.

STEAM learning with the award-winning KIBO is fun, imaginative, and easy. Young learners will playfully discover these concepts by creating a sequence of instructions (a program) using the wooden building blocks, creating sequences, and learning the engineering design processes. Designed for open-ended play, KIBO lets children make almost anything – a character from a story, a carousel, a dancer, a race car, a helicopter – anything that they can think of.

KIBO offers educators:

- A coding and robotic platform that can be easily integrated into existing curriculum or classroom projects, such as literacy, social studies, science, math, and art curricula.
- STEAM learning to meet your early learning Computer Science standards.
- Over 160 hours of standards-aligned STEM curriculum and teaching materials to ensure success when implementing KIBO in classrooms.
- Easy to implement lesson plans and fun play-based activities.
- Training and support in integrating robotics into classrooms with a wide range of cross-curricular connections to literacy, community, dance, science, and more!

Based on 20 years of early child development research, used in 60+ countries and tested and approved by thousands of children and their caregivers, KIBO has proven efficacy in helping kids learn STEAM, and getting them excited about it!

KIBO's Early Days

KinderLab Robotics emerged from a need to bring Dr. Marina Umaschi Bers', professor of Child Development and Computer Science, and director of the DevTech Research Group at Tufts University's Eliot Pearson Department of Child Development, research on new technologies for young children at Tufts University to a wider audience.

From this research KIBO was formed, with a dream of improving STEM education for young children with innovative and age-appropriate technology. In 2013, teaming with friend, and robotics start-up executive Mitch Rosenberg, this dream become a reality with funding from the National Science Foundation through an SBIR grant and a successful Kickstarter campaign.

Research

Why is it important to introduce coding robots for kids at a young age? Research shows that even the youngest students can learn sequencing and coding in a fun and engaging way, regardless of curriculum. Specific, powerful and positive learning outcomes for young learners when working with robotics include:

- Improved sequencing ability in early childhood
- Mastery of foundational coding and robotics skills
- STEAM success: Integration of robotics across curricula
- Positive impact on underrepresented groups in STEM fields

KIBO is the result of more than 20 years of research, led by Marina at Tufts. Her research shows specific, powerful, and positive learning outcomes for young learners (ages 4–7) when working with KIBO. Evidence of KIBOs effect exists in the form of numerous published research articles by Marina and her team. Major findings include:

Improved Sequencing Ability in Early Childhood

PreK-Grade 2 students' performance on standard assessments of sequencing ability improved from 20-35% after an 8-week robotics and coding curriculum with KIBO.

Kazakoff, E., Sullivan, A., & Bers, M.U. (2013). The effect of a classroom-based intensive robotics and programming workshop on sequencing ability in early childhood. Early Childhood Education Journal, 41(4), 245-255. doi:10.1007/s10643-012-0554-5.

Kazakoff, E.R. & Bers, M.U. (2014). Put your robot in, Put your robot out: Sequencing through programming robots in early childhood. Journal of Educational Computing Research, 50(4).

Kazakoff, E.R. & Bers, M.U. (2014). Put your robot in, Put your robot out: Sequencing through programming robots in early childhood. Journal of Educational Computing Research, 50(4)

Promote Development of Early Childhood Cognitive and Social Skills

KIBO curriculum supports development of computational thinking skills critical to foundational literacy and numeracy, as well as growth of positive character traits and pro-social behaviors.

Bers, M (2020). Coding as a Playground: Programming and Computational Thinking in the Early Childhood Classroom. Second edition. New York, NY. Routledge Press.

Mastery of Foundational Programming and Robotics Skills

As early as PreK, children master KIBO's robot parts as well as the basic syntax of KIBO's blocks. Older children can explore more complex Computer Science concepts with KIBO.

Elkin, M., Sullivan, A., & Bers, M.U. (2016). Programming with the KIBO Robotics Kit in Preschool Classrooms. Computers in the Schools, 33:3, 169-186.

Improved Computational Thinking with Concrete Tools

Children using KIBO performed 27% better on computational thinking than children using screen-based tools.

Pugnali, A., Sullivan, A., & Bers, M.U. (2017) The Impact of User Interface on Young Children's Computational Thinking. Journal of Information Technology Education: Innovations in Practice, 16, 172-193.

Counteracting Harmful Gender-Based STEM Stereotypes

After a KIBO curriculum, 2/3 of girls expressed an interest in engineering careers – a rate equal to boys. Girls who completed a 6-week KIBO curriculum were equally capable as boys at building and programming.

Sullivan (2016). Breaking the STEM Stereotype: Investigating the Use of Robotics to Change Young Children's Gender Stereotypes About Technology and Engineering (PhD dissertation).

Sullivan, A. & Bers, M. U. (2016). Girls, boys, and bots: Gender differences in young children's performance on robotics and programming tasks. Journal of Information Technology Education: Innovations in Practice, 15, 145-165.

Sullivan, A. & Bers, M.U. (2018). The Impact of Teacher Gender on Girls' Performance on Programming Tasks in Early Elementary School. Journal of Information Technology Education: Innovations in Practice, 17, 153-162.

Positive Impact on Underrepresented Groups in STEM Fields

Studies also demonstrate successful mastery of programming and computational thinking skills by disadvantaged students in underperforming schools.

Elkin, M., Sullivan, A., & Bers, M.U. (2016). Programming with the KIBO Robotics Kit in Preschool Classrooms. Computers in the Schools, 33:3, 169-186.

Kazakoff, E., Sullivan, A., & Bers, M.U. (2013). The effect of a classroom-based intensive robotics and programming workshop on sequencing ability in early childhood. Early Childhood Education Journal, 41(4), 245-255. doi:10.1007/ s10643-012-0554-5.

Sullivan, A., & Bers, M.U. (2015). Robotics in the early childhood classroom: Learning outcomes from an 8-week robotics curriculum in pre-kindergarten through second grade. International Journal of Technology and Design Education. Online First.

Evidence of Effect: The Impact of KIBO

Research by University of Chicago Economics Professor James Heckman demonstrated that the greatest return on investment in educational interventions comes when those interventions are made with the youngest learners. Following the rationale implicit in Heckman's ROI curve, policymakers and educators should intervene as early as possible to help guide children toward an interest in STEM careers. Early intervention is the reason why Dr. Bers and her team designed the KIBO program for PreK to 2nd grade.

KIBO curricula, when implemented in a developmentally appropriate way, can significantly increase girls' interest in STEM careers and may also counteract many masculine stereotypes or opinions they are beginning to form about STEM. See Sullivan & Bers, 2016; and Sullivan, 2016. Further, studies with KIBO in majority-minority, low-income, and underperforming U.S. public schools demonstrated successful mastery of programming and engineering content among all students. See Elkin, Sullivan, & Bers, 2016; and Sullivan & Bers, 2015. See the full research summary including these citations.

KinderLab has implemented KIBO successfully in many US school districts with a high proportion of low-income and minority students. One recent example is in Miami-Dade Public Schools. At four district high schools beginning in 2018, students in the early education vocational program used KIBO to teach robotics to children in the on-campus preschools. This combination of vocational career training and early childhood education represents a wonderful example of the flexibility of the KIBO program in promoting universal STEM literacy. For more information on this, see - https://districtadministration.com/preschool-coding-taught-high-schoolers/.

KIBO has also shown evidence of positive effect for children with special needs, including children on the autism spectrum (Albo-Canals, et al, 2018). In 2020, Victoria ISD in Texas began a program with KIBO teaching STEM in special education across all of their elementary schools, with early evidence of success in inclusive classrooms.

What are the Benefits of KIBO for Young Learners?

[# 1] Coding Teaches the Literacy of the 21st Century

Coding is becoming as fundamental to work, education, and culture as literacy was in earlier centuries. Not every child needs to become a computer programmer, but coding gives children the tools to create and participate in a culture, society, and working world increasingly structured by computers. Teaching children to code gives them fluency in a new set of tools for self-expression.

KIBO offers an inviting, engaging platform for children to start their journey into creating with code. KIBO's block-based coding language gives children control over the robot's movements, sounds, and sensors, allowing them to express their imaginations with code. With KIBO children can create with technology – tell stories, create characters, and explore their world.

[# 2] Coding Develops Computational Thinking Skills

How do you solve a problem in a structured way? With computational thinking, you model the problem, break it down into smaller sequential steps, invent solutions, and test them out. The term "computational thinking" grew out of work in the 1980s by Seymour Papert, a pioneer in teaching children to create with code. More recently, theorists and educators have begun to explore the connections between computational thinking and the cognitive skills developed in early childhood.

Papert, S. (1980). *Mindstorms: Children, computers, and powerful ideas*. New York: Basic books.

When children plan a sequence of actions for KIBO to perform, they assemble their program as a line of wooden command blocks. They scan the blocks with KIBO's barcode scanner, one by one in sequence. When the robot acts out the sequence, children can follow along by referring to the blocks they have scanned.

[# 3] Technology Becomes the Playground

Children's exploration of technology should be age-appropriate, safe, and creative. A technology-rich experience for children should be modeled on the idea of a playground. On a playground, children move and explore, they invent games and stories, and they collaborate with peers and negotiate conflicts. They are supervised by adults throughout, but they lead their own experience.

The best technology experiences for children are technology playgrounds, filled with creativity, exploration, and social engagement. When building and programming with KIBO, children follow their own creative interests within a technological space that has been carefully designed to support their developmental needs. They work together, they discover, and they share as they create.

[# 4] Robotics Makes Coding Tangible and Concrete… and Screen-Free!

Educational theorists have long recognized that young children think and learn best when moving, playing, building, and engaging with concrete objects. Traditional coding is often screen-based and abstract. But with robotics, children's code affects the physical world – the robot moves and reacts based on the instructions the children give it. The robot is an "object to think with," in Seymour Papert's phrasing.

Even better, with KIBO, the programming language itself is tangible and concrete. Children program KIBO by sequencing physical wooden blocks, with no screen time for these young learners. Studies with KIBO demonstrate that children benefit from connecting programming concepts to concrete, physical objects, reinforcing learning in an age-appropriate way.

[# 5] Using Technology to Break Down Engineering Stereotypes

Scientific and technical fields suffer from a gender participation gap. Research shows that even in early childhood, children are already beginning to form opinions and stereotypes about which tools

and technologies are better suited towards boys. By engaging young children in coding and robotics activities before these stereotypes begin to take root, we can help them build positive associations with technology and engineering and a self-image as a creator with technology.

KIBO is purposefully designed with a neutral aesthetic and in gender neutral colors so that it is appealing to all children. KIBO includes building platforms to allow children to extend and decorate the robot with arts and crafts materials, providing an open-ended building and design experience which draws on a wide range of children's interests.

[# 6] The Engineering Design Process Develops Grit and Perseverance

Working with robotics and coding engages with the engineering design process. This process encourages children to identify a problem, imagine and plan a solution, build and test their creation, and share their work with peers. In this process, things won't always work as intended – ask any engineer!

The process is set up to expect students to test, fix, and debug their work, so students focus on continually making changes and improvements rather than on being right or wrong – a "growth mindset." As they seek input and advice from peers, children also develop collaborative social skills around a shared project.

With KIBO, what do Children Learn?

Coding (or programming) is a new kind of literacy. When creating with KIBO, young children learn programming ideas that are directly related to foundational concepts in math, literacy, science, and humanities. These include sequencing, modularity, cause-and-effect, and patterns.

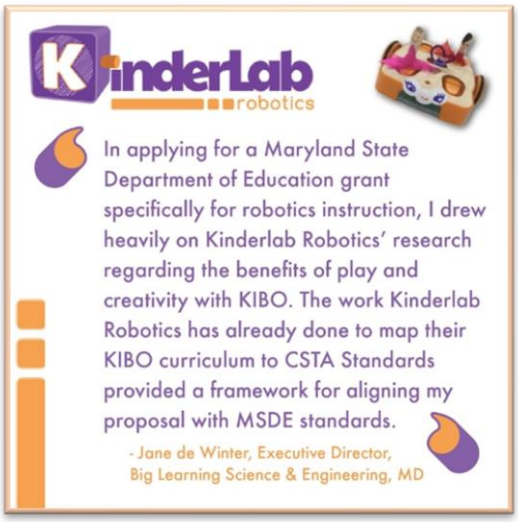
The primary benefits of the KIBO program for students are mastery of computer science content appropriate to PreK-2nd grade, development of computational thinking skills, and engagement with the engineering design process. These STEM skills are supported by a social-emotional learning framework based on collaboration and group work.

Research shows that sequencing is foundational for academic success, for math and literacy development, as well as for executive function. Furthermore, children engage in habits of mind such as:

- The engineering design process when they iteratively develop and test an idea.
- Problem solving when their KIBO programs don't work the way they want.
- Executive functions when they plan and execute their projects with different kinds of constraints such as time, resources, or materials.
- Emotional resilience when they learn persevere and learn how to manage frustration.

Our Curriculum

The KIBO robotics program curriculum, spanning PreK through 2nd grade, is built upon the work of Dr. Bers and her DevTech Research Group. Using a "spiral" scope and sequence model, each level of the curriculum engages children in the full range of powerful ideas in creative coding and robotics. After working through the curriculum, young children will be able to engage in both computational thinking and engineering design. Most importantly, children will be able to use robotics and coding to express themselves, explore their interests, and connect and collaborate with their peers.



KinderLab's core curriculum guide "*Growing with KIBO*" is designed for classroom use in school environments from PreK to 2nd grade, by teachers who are not experts in technology integration. "*Growing with KIBO*" provides 60 hours of clear lesson plans for teaching computational thinking, engineering design, and digital fluency through cross-curricular integrated STEAM lessons with KIBO. Supplemental curriculum booklets provide over 100 hours of additional optional lessons. The curriculum offers explicit scripting for teachers without an instructional technology background and a clear sequence from grade to grade to assist in fitting KIBO into a comprehensive computer science pathway from PreK to 2nd grade. The curriculum is aligned with both ISTE and CSTA standards. Full standards mappings are available from KinderLab Robotics on request.

Implementing KIBO

For classroom implementation of KIBO, a Classroom Package is recommended. Each classroom package includes 2, 5, or 10 KIBO Robot Kits. Each robot supports small group work by 2-4 children at a time, encouraging collaboration, so a Full Classroom Package (10 robots) can support simultaneous engagement by a class of 25-30 children. Classroom packages also include a complete set of curricula, teaching materials, and introductory professional development. A single classroom package can be rotated among several classrooms, but larger implementations will require multiple classroom packages. All KIBO robots, curriculum, and other materials are also available a la carte, so a customized solution can be created.

Professional development and teacher training are vital aspects of our STEM practices. Our program is delivered not by our staff but by the teachers who know their own students best. It is critical that teachers receive training in our program so that they can "make it their own," customize it to their school's needs, and understand how to pace the curriculum to allow students time to explore and experiment. Developing the skills of teachers is a critical part of our mission to develop the STEM skills of students.

Testimonials

In applying for a Maryland State Department of Education grant specifically for robotics instruction, I drew heavily on Kinderlab Robotics' research regarding the benefits of play and creativity with KIBO. The work Kinderlab Robotics has already done to map their KIBO curriculum to CSTA Standards provided a framework for aligning my proposal with MSDE standards.
- Jane de Winter, Executive Director, Big Learning Science & Engineering

"*KinderLab has created a wonderful answer to the need for early age STEAM learning. KIBO was designed for children to build and code without requiring screen time. This element really sets KIBO apart from the rest. KIBO sparked a great conversation that led my boy into associating programming, engineering, and technology with not only KIBO, but everything around him. This robot would be a wonderful addition to any STEAM classroom or a child's bedroom.*"
- Academics' Choice Evaluator, Academics' Choice

"*Look, look what I did. I made it myself!"*
- 4 year old child

"*We are totally in love with the KIBOs and all the potential learning they hold. I keep thinking of the extensive thought that went into designing them and how that is paying off in so many ways for all the children who use them*."
- Robin Ricketts, Computational Thinking and Robotics Teacher, The Steward School, Richmond, VA

"It is not a robot. It is something that you can program to do what you want. It is much better!"
- 5-Year Old

"Some of the children mastered scanning by themselves. All of the parents were so impressed, and daily children were heard on more than one occasion saying, "This is the best camp I've ever been to!!!" I had lots of great comments from parents, too."
- Nancy Kincaid, Preschool Teacher, Suncrest Primary School, Morgantown, WV

"*I highly recommend this STEAM robot. The coding adventures teach cooperation, coordination, reading, problem-solving, logic, organization, and much more! It would be a valuable asset to any classroom.*"
- Academics' Choice Evaluator, Academics' Choice

"My daughter loved it because she and her friends created a puppet show and the puppets sang and danced."
- Parent

"*Our KIBOs take on some important jobs. In one lesson, students program them to rescue baby bears that are lost in deep dark caves. (Our caves are constructed with old cardboard boxes, the imagination of the students dresses them up.) They love to train KIBO to navigate the twists and turns of our caves. Most of all, they love programming with the light sensor and the light – if the cave gets dark and scary, then KIBO should turn on her flashlight!"*

- Brian Sulkow, Teacher and Curriculum Developer, New York City Public School System, NY

"When my son tried it, I was just blown away with the kinds of things he was able to do."
- Parent

"*The students in my class couldn't wait to get their hands on the coding blocks that would make their KIBO robots go. The lessons had a true spirit of experimentation – there were no mistakes, just lots of trials, observations, and cheers to get back to work! I wouldn't be surprised if the future programmers and scientists among them remember this experience as one that sparked their interest in coding and creative problem solving.*"
- Keri Goldberg, First-Grade Teacher, PS 321, NYC

"*Using KIBO is one of the funnest and best experiences I have ever had with kids. The excitement, the total engagement is unlike anything I have ever seen before. Our young students loved learning something new, loved the challenges they faced figuring out how KIBO works and the things they might be capable of making it do. Oh, the possibilities…! I truly cannot wait to introduce KIBO to our next four pilot classes and to see where it takes us."*
- Randie Groden, Teacher Librarian, The Memorial School, Medfield, MA

"*Some of the children were so engaged that they became the "expert" and demonstrated to others! It was amazing!"*
- Cate Heroman, Vice Chair, Knock Knock Children's Museum, Baton Rouge, LA

"*KIBO supports learning in many ways at St. Pius X. Students use KIBO as a tool to think with, as a platform to make and invent, and as a medium to share the knowledge and understandings they have constructed.*"
- Cory Roffey, Learning Coach/Technology Coach, St. Pius X Elementary School, Edmonton Catholic Schools, Edmonton, Canada

"*I love introducing KIBO to young students. The design that includes familiar materials such as wood and blocks make it feel comfortable to the students while the clear bottom allows them to explore the guts of the robot."*
- Dan Riles, Technology Integration Specialist / Computer Support Specialist, Brookwood School, Manchester, MA

For More Information

We have various resources to help you get started and are always available to help answer any questions you may have.

Resources

- Research - KIBO is brought to you after more than 20 years of early childhood research led by Marina Bers and her research group at Tuft University's Dev Tech Research Group. Learn more about the research behind KIBO.
- Learn about the KIBO Difference – Constructive Play, Problem Solving, Critical Thinking, and more!
- See what is happening with Marina's current KIBO research and her team's work with early education technology at the DevTech Research Group at Tufts University
- See KIBO in action through our many Videos, including those submitted by educators.
- Download our FREE Whitepaper – 6 Key Benefits of Using Robotics with Your Youngest Students
- How Robots Bring Play to STEAM Education
- We have STEM Curriculum and Teacher Materials to ensure you're successful bringing robotics into your classroom.
- What can you do with KIBO? See some ideas of STEM Activities for Elementary Students that truly brings out fun and playful nature of KIBO.

How Can We Help?

- Request a 1:1 online demo to discuss your specific needs.
- See our Professional Development and Training Offerings
- Look for available grants and funding
- Need a quote? Contact our sales team at sales@kinderlabrobotics.com
- Ready to try KIBO out, you can purchase KIBO, go to the KinderLab Robotics website – http://www.kinderlabrobotics.com