DevTech KIBO and Robotics Publications

APA Citation and Link	Year	Author(s)	Location of Study	Participants	Instruments	Type	Analyses	Purpose of Paper	Methodology	Results
Relkin, E., Govind, M., Tsiang, J., & Bers, M. (2020). How Parents Support Children's Informal Learning Experiences with Robots. Journal of Research in STEM Education, 6(1), 39-51. Retrieved from https://j-stem.net/index.php/jstem/article/view/87	2020	Relkin, Govind, Tsiang, & Bers	Greater Boston Area	Study 1: 70 parents and 99 children Study 2: 3 parent child dyads	Study 1: Parent surveys consisting of multiple choice, likert scale, and open ended questions Study 2: Video transcription and parent surveys	Mixed Methods	Descriptives, Related Sample t-test, Chi square, video transcription analysis	To explore how parents support children's learning to code with the KIBO robot in two different informal learning environments.	Study 1: Children ages 5-7 and their parents attended a "KIBO Family Day" workshop. Parents were asked to complete a survey before and after the event. Five events were held by researchers lasting 1.5-2 hours. Study 2: Three parent-child dyads participated in 20 minute KIBO coding sessions	• KIBO Family Day events were well-regarded by parents, who reported that the events increased coding interest in their children and themselves. • Most parents reported that the event provided a collaborative experience in which adults and children took on different roles. •Parents supported their young children's exploration of new technologies by the use of cognitive, affective, and technical scaffolding strategies.
Relkin, E. & Bers, M. U. (2020). Exploring the Relationship Among Coding, Computation Thinking, and Problem Solving in Early Elementary School Students [Symposium]. AERA Annual Meeting San Francisco, CA (Conference Canceled)	2020	Relkin & Bers	USA: Norfolk, VA	271 students in second grade, ages 7-9	TechCheck KMC TACTIC-KIBO	Quantitative; Conference paper	Correlation, Simultaneous and Sequential Regression	To explore the relationship between learning to code and unplugged (non-coding) problem-solving skills.	2nd grade children from 8 elementary schools participated in a six-week coding curriculum (CAL-KIBO) utilizing the KIBO robot. Participating students were administered a battery of age-appropriate formative and summative assessments designed to evaluate three domains: KIBO coding proficiency (KIBO Mastery Challenges (KMCs), Platform Specific Coding and CT skills (TACTIC-KIBO) and unplugged CT and problem-solving skills (TechCheck).	• Participation in the CAL-KIBO was associated with improvement in unplugged problem-solving abilities. Improvement in unplugged problem-solving was related to the proficiency in coding and CT skills at the end of the curriculum.
Relkin, E., de Ruiter., L., Bers, M. U. (2020). TechCheck: Development and Validation of an Unplugged Assessment of Computational Thinking in Early Childhood Education. Journal of Science Education and Technology. DOI: 10.1007/s10956-020-09831-x	2020	Relkin, de Ruiter, & Bers	USA: Norfolk, VA	768 children in first and second grade from 1 school district	TechCheck (and TACTIC-KIBO)	Quantitative	descriptives, item response theory, classical test theory, t-tests, bayesian statistics, fliess' kappa, regression	To validate the TechCheck instrument and good psychometric properties, reliability and utility	First and second grade students recieved TechCheck over a 6 week period before during and after participating in the CAL curriculum	• TechCheck showed good reliability and validity according to measures of classical test theory and item response theory. Discrimination between skill levels was adequate. Difficulty was suitable for first graders and low for second graders. • The instrument showed differences in performance related to race/ethnicity. TechCheck scores correlated moderately with a previously validated CT assessment tool (TACTIC-KIBO). • Overall, TechCheck has good psychometric properties, is easy to administer and score, and discriminates between children of different CT abilities.
Hassenfeld, Z. R. & Bers, M. U. (2020). Debugging the Writing Process: Lessons From a Comparison of Students' Coding and Writing Practices. The Reading Teacher, 73(6), 735-746. doi:10.1002/trtr.1885	2020	Hassenfeld & Bers	USA: Boston Area, MA	3 second-grade students at a private K-8 School	Observation and ethnographic interview	Observational study, feature article for the International Literacy Association	Transcribed interviews and looked for themes	To observe the similarities and differences that exist between the composition processes of writing and coding, with a focus on four subcategories: planning/prewriting, creating/drafting, testing/evaluating, debugging/editing and revising.	Three second-grade students were observed in the classroom from the beginning of the school year to winter break. The results of two students were described in the article. The students were observed during writing and coding periods, as well as interviewed regularly by the authors of the article. During coding periods, the students worked with ScratchJr, "a block-based language designed for preliterate children."	• Both students described in the study were much more willing to debug during the coding periods than they were willing to edit and revise during the writing periods. • As such, debugging constituted a greater percentage of the coding composition time than did editing and revising of the writing composition time.
Govind, M. & Bers, M. U. (2020, Apr 17 – 21). "Coding Is Not My Thing": Fostering Early Childhood Teachers' Coding Knowledge and Attitudes [Poster Session]. AERA Annual Meeting San Francisco, CA (Conference Canceled)	2020	Mixed Methods Conference paper	USA: Norfolk, VA	24 second grade teachers	Modified TPCK survey , lesson logs, and interview	Mixed Methods Conference paper	ANOVA, transcriptions of interviews and content analysis of lesson logs	To explore teachers' knowledge and attitudes surrounding coding and robotics education in early childhood	Educators participating in the Coding as Literacy Study attended a one day training and took a modified version of the TPCK assessment before the training, after the training, before they implemented the curriclulum, and after they implemented the curriculum	• The data revealed significant increases in teachers' knowledge and attitudes over time and highlighted key factors that led to teachers' varied perceptions and classroom experiences.
Hassenfeld, Z. R., Govind, M., de Ruiter, L. E., & Bers, M. U. (2020). If You Can Program, You Can Write: Learning Introductory Programming Across Literacy Levels. Journal of Information Technology Education: Research, 19, 65-85. DOI: 10.28945/4509	2020	Hassenfeld, Govind, de Ruiter,& Bers	USA: Norfolk, VA	132 second grade students	KMCs, PALS literacy assessment	Research paper, quantitative	descriptives, t-tests, regression, bayesian statsitcs	To explore the relation between students' varying literacy levels and their level of success in mastering an introductory programming language	Eight schools received an external grant from the U.S. Department of Defense to introduce computer science in early elementary education. Standardized literacy test scores were correlated with internally developed, and age appropriate programming assessment scores from second grade students.	• The findings indicated that there was strong evidence for a weak, positive correlation between students' literacy levels, as determined by the PALS assessment, and their programming mastery, as determined by the curricular programming assessments. • The positive correlation suggests that there may indeed be underlying constructs that overlap between literacy and programming.

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Relkin, E. & Bers, M. U. (2019). Designing an Assessment of Computational Thinking Abilities for Young Children. In L.E. Cohen & S. Waite-Stupiansky (Eds.), STEM for Early Childhood Learners: How Science, Technology, Engineering and Mathematics Strengthen Learning (pp. 85-98). New York, NY: Routledge.	2019	Relkin & Bers	USA: Greater Boston area	15 elementary school children	TACTIC-KIBO, Interactive Play Session (IPS)	Book Chapter	Descriptives, pearson's correlation	To describe the design features, validation process, and experiences testing the one-on-one version of TACTIC-KIBO	15 early elementary school children between the ages of 5-7 were videotaped as they were given the TACTIC-KIBO assessment and an Interactive Play session. For criterion validation purposes, experts rated the IPS portion of the videos and those scores were correlated to the TACTIC-KIBO assessment scores.	• The assessment tool probed seven domains of computational thinking and classifies four levels of proficiency.
Govind, M. (2019). Families That Code Together Learn Together: Exploring family-oriented programming in early childhood with ScratchJr and KIBO Robotics (Master's thesis).	2019	Govind	USA	Children ages 5-7 and their family members	Pre and Post Surveys; video recorded parent-child dyads	Mixed methods thesis	Descriptives, Nonparametric t-tests (Mann-Whitney U Test, Wilcoxon Signed-Rank Test), ANCOVA, Nvivo,	To explore how children and parents jointly program using the ScratchJr app or the tangible KIBO robotics kit and to identify the roles exhibited by families at community-based Family Coding Day events and explore the affordances of ScratchJr and KIBO for promoting these roles	ScratchJr and KIBO family day events were held and secondary data analysis was conducted to compare the two. The parent- child dyads were videotaped and scored.	• Families' role engagement did not differ between ScratchJr and KIBO. Regardless of interface, children engaged highly as Planners and parents as Coaches. • Qualitative findings suggest that family-oriented programming in early childhood parallels existing literature on joint media engagement
Bers, M. U., González-González, C., & Armas–Torres, M. B. (2019). Coding as a playground: Promoting positive learning experiences in childhood classrooms. Computers & Education, 138, 130-145.	2019	Bers, González-González,& Armas–Torres	Canary Islands: Tenerife,	172 3-5 year olds from 16 Spanish early childhood centers	Questionnairs, solve-its, PTD checklist, Interview, Teacher Journal, focus groups, observations	Mixed Methods	Descriptives, Kappa	The purpose of the paper was to see how teachers integrate coding and computational thinking into their curricular activities, what programming and computational thinking skills preschool children 3–5 years old master after being introduced to robotics (KIBO)?, and what positive behaviors are developed by children in a learning environment of coding as a playground?	Teachers attended a 1 day PD and implemented an adapted version of the KIBO "Dances from Around the World" Curriculum to their classrooms. The first and last sessions of each class were observed and videotaped. Students' programming knowledge was assessed through structured observation of video recordings of their final projects in which they created a KIBO dance routine. Positive behaviors, such as collaboration, was also collected on students' engagement using the PTD checklist	• Educators were able to personalize the curriculum. The teachers exhibited autonomy and confidence as they integrated the coding and computational thinking into their curriculum, connecting these concepts with art, music, social studies, while at the same time teaching values and inclusiveness. The results showed that children achieved a high level of mastery of coding and computational thinking skills using robotics. Additionally, The PTD scores indicate that this intervention was successful in fostering communication and collaboration. Its effect on promoting content creation and creativity was moderate, and low in terms of promoting conduct choices and community building.
Sullivan, A. & Bers, M.U. (2018). Investigating the use of robotics to increase girls' interest in engineering during early elementary school. International Journal of Technology and Design Education, 29, 1033-1051. doi:10.1007/s10798-018-9483-y	2018	Sullivan & Bers	Massachusetts, MA, USA	105 children from six classrooms K-2	The Engineering is Elementary Science and Attidues Assessment and solve-its	quantitative	descriptives, Mann-Whitney U test, Wilcoxon signed-rank test, ANOVAs	To explore young chlidren's attitudes towards technology and engineering	Children completed a 7 week KIBO robotics and programming curriculum. The Engineering is Elementary science Attidues assessment was administered before and after and the solve-its assessment was administered after the curriculum.	Developmentally appropriate robotics curriculum can increase girls' interest in engineering
Elkin, M., Sullivan, A., & Bers, M. U. (2018). Books, Butterflies, and 'Bots: Integrating Engineering and Robotics into Early Childhood Curricula. In L. English and T. Moore (Eds.), Early Engineering Learning (225-248). Singapore: Springer. doi:10.1007/978-981-10-8621-2_11	2018	Elkin, Sullivan, and Bers	Cambridge, MA, USA	N/A	Vingettes	Book Chapter; qualitative	Analysis of Vingettes	How robotics can be used as a playful mediumin early childhood classrooms to learn foundational engineering and computer science concepts.	This paper describes three different classroom experiences: using robotics to bring to life the book Brown Bear, Brown Bear, What Do you See? in the context of literacy explorations; and in science, programming the life cycles of the frog and the butterfly, and using robots to model the movement of worms through different environments	• Children were able to program complex code with KIBO sucessfully by the end of the curriculum • Teachers sucessfully integrated robotics into other disciplines
Relkin, E. (2018). Assessing Young Children's Computational Thinking Abilities (Master's thesis). Retrieved from ProQuest Dissertations and Theses database. (UMI No. 10813994)	2018	Relkin	Greater Boston Area	15 children ages 5-7	TACTIC-KIBO one on one version	Quantitative Thesis	descriptives, t-tests, pearson's correlation, Cohen's Kappa	To describe a pilot study of the TACTIC-KIBO Computational Thinking instrument	Children were videotaped during one-on-one sessions with a researcher. An instrument called TACTIC-KIBO that assesses children's computational thinking skills was created and used in addition to an interactive play session with a researcher.	• TACTIC-KIBO scores correlated highly with Interactive Play Session scores rated by experts • TACTIC-KIBO was easily administered and scored and distinguished children into 4 levels of Computational Thinking (proto-programmer, early programmer, programmer, fluent programmer)
Bers, M. U. (2018, April 17-20). Coding, Playgrounds and Literacy in Early Childhood Education: The Development of KIBO Robotics and ScratchJr. Paper presented at the IEEE Global Engineering Education Conference (EDUCON), Santa Cruz de Tenerife, Canary Islands, Spain (pp. 2100 – 2108).	2018	Bers	N/A	N/A	N/A	N/A	N/A	This paper describes two programming environments explicitly designed for early childhood education, the screen-based ScratchJr; and the tangible robotic kit KIBO. Both of these tools were explicitly designed to support the learning of concepts and skills of computer science and engineering in a developmentally appropriate way. The design principles are based on the notion of "coding as playground" and "coding as literacy".	N/A	N/A

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Albo-Canals, J., Barco, A., Relkin, E., Hannon, D., Heerink, M., Heinemann, M., Leidl, K., & Bers, M. (2018). A Pilot Study of the KIBO Robot in Children with Severe ASD. International Journal of Social Robotics, 10(3), 371-383. Advance online publication. doi:10.1007 /s12369-018-0479-2	2018	Albo-Canals, Barco, Relkin, Hannon, Heernick, Heinemann, Leidl, & Bers	CASPAN center in Panama	12 students with severe ASD	Video coding, PTD Checklist, Adapted solve-its, researcher notes	Mixed methods	descriptives, correlation	To explore the feasibility of using the KIBO Robot as an engaging platform to positively impact social and emotional development in children with ASD	To assess its use in children with severe ASD, twelve participants were introduced to KIBO and engaged in a variety of activities with the robot over four consecutive days. Their interactions were observed on site by raters and simultaneously videotaped for later analysis.	Although the participants demonstrated only a limited understanding of programming principles during the study, they managed to manipulate the KIBO appropriately, engaged socially with the adults in the room and interacted positively with the robot during individual play. The findings suggest that the KIBO robot warrants further study as an engaging educational platform for children with ASD
Bers, M.U. (2018). Coding as a Playground: Programming and Computational Thinking in the Early Childhood Classroom. New York, NY: Routledge Press.	2018	Bers	N/A	N/A	N/A	Book	N/A	Coding as a Playground is the first book to focus on how young children (ages 7 and under) can engage in computational thinking and be taught to become computer programmers, a process that can increase both their cognitive and social-emotional skills. Readers will learn how coding can engage children as producers—and not merely consumers—of technology in a playful way. You will come away from this groundbreaking work with an understanding of how coding promotes developmentally appropriate experiences such as problem solving, imagination, cognitive challenges, social interactions, motor skills development, emotional exploration, and making different choices. You will also learn how to integrate coding into different curricular areas to promote literacy, math, science, engineering, and the arts through a project-based approach.	N/A	N/A
Vizner, M., Z. (2017). Big Robots for Little Kids: Investigating the Role of Scale in Early Childhood Robotics Kids. (Master's thesis).	2017	Vizner	Eliot Pearson Children's School, Medford, MA	6	Clinical Interview, Video, researcher notes, photos,	Qualitative Master's Thesis	Developmental model of programming with the KIBO platform, actions that children engage in when using the KIBO robot, and narrative examples of	Two groups spent time with KIBO and Big KIBO activities included a robotic dance party, robot mazes. and free play. During these activities clinical interviews were held in which children were asked about their thinking. Observations and alayses from videos, interviews and observatinos were then analyzed.	"Big KIBO" was created and two groups spent time with KIBO and Big KIBO activities included a robotic dance party, robot mazes. and free play.	The developmental model of programming was created to show how children progress through different stages when learning to code
Sullivan, A., Strawhacker, A., & Bers, M.U. (2017). Dancing, drawing, and dramatic robots: Integrating robotics and the arts to teach foundational STEAM concepts to young children. In Khine, M.S. (Ed.) Robotics in STEM Education: Redesigning the Learning Experience. (pp. 231-260). Springer Publishing.	2017	Sullivan, Strawhacker & Bers	Singapore; Boston, MA	Approximately 180 students	Vingettes	Qualitative Book Chapter	N/A	To demonstrate how KIBO can foster art education (STEAM) and to highlihgt strategies for child-focused robotics education	N/A	N/A
Sullivan, A. & Bers, M.U. (2017). Computational Thinking and Young Children: Understanding the Potential of Tangible and Graphical Interfaces. In Ozcinar, H., Wong, G., & Ozturk, T. (Eds.) Teaching Computational Thinking in Primary Education. IGI Global.	2017	Sullivan & Bers	N/A	N/A	N/A	Qualitative Book Chapter	N/A	To provide examples of how KIBO and ScratchJr can be integrated into the classrom	N/A	N/A
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.	2017	Pugnali, Sullivan, & Bers	Tufts University, Medford, MA	N= 60 children ages 4-7 admitted into a summer program at DevTech.	Solve-its and PTD checklist	mixed methods	Descriptives, ANOVA,t-tests	This paper examines the role that user interfaces have on children's mastery of computational thinking con- cepts and positive interpersonal behaviors.	Each program lasted five days, with approximately three hours of curricular instruction each day. Children were a part of one of two conditions, based on the program they signed up for: tangible learning using the KIBO Robotics kit; or graphical learning using the ScratchJr tablet app. The curriculum for both technologies followed the same theme, "Going on a Safari" and explored the same computational thinking concepts: sequencing, repeat loops, and conditionals. Students were given Solve-its at the end of the week long curriculum and the PTD checklist was filled out by counselors after each day.	Results suggest that type of user interface does have an impact on children's learning, but is only one of many factors that affect positive academic and socio-emotional experiences. Tangible and graphical interfaces each have quali- ties that foster different types of learning

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Sullivan, A., & Bers, M.U. (2017). Dancing robots: Integrating art, music, and robotics in Singapore's early childhood centers. International Journal of Technology and Design Education. Advance online publication. doi:10.1007/s10798-017-9397-0	2017	Sullivan & Bers	Singapore	(N = 98) from five early childhood centers ages 3-6	Solve-It assessments, PTD Engagement Checklist, Teacher Interviews and Journals,	Mixed Methods	Descriptives, t-tests	What programming concepts do preschool children master after being introduced to KIBO? 2. How engaged were children with the different aspects of Bers' (2012) Positive Technological Development framework while participating in the KIBO robotics curriculum? 3. What was this experience like for the participating teachers? What areas of this initiative did they feel were successful and what areas need improvement?	Children participated in a 7-week STEAM (Science, Technology, Engineering, Arts, and Mathematics) KIBO robotics curriculum in their classrooms called, ''Dances from Around the World.'' KIBO	Results indicate that children were highly successful at mastering foundational programming concepts. Additionally, teachers were successful at promoting a collaborative and creative environment, but less successful at finding ways to engage with the greater school community through robotics.
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. doi:10.1080/07380569. 2016.1216251	2016	Elkin & Sullivan	Rhode Island	Children (N = 64) from seven preschool classrooms, ranging in age from 3 to 5, participated in the study	Solve-It assessments	quantitative	Descriptives, t-tests, effect size	To determine what young preschool children, ages 3 to 5, can learn about foundational programming and robotics content through a short-term educational inter- vention, what types of errors do young preschoolers make when programming with KIBO, and which programming concepts are easy vs. difficult for students to master	Seven preschool classrooms completed an introductory robotics and programming curriculum taught by students from Tufts University. Solve-its were administered after the curriclum	Findings indicated that children as young as age 3 could create syntactically correct programs for the KIBO robot, although older preschoolers (closer to age 5) performed better than younger preschoolers on a standardized program- ming task. Additionally, all students generally performed better on the programming tasks that required them to manipulate less programming instructions.
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	2016	Sullivan & Bers	Massachusetts, USA	*N=45 children in Kindergarten through second grade participated in this research (n=18 kinder- garteners, n=16 first graders, n=11 second graders)*	Robot Parts Task", "Solve-Its Task", and "Gender and Technology Attitudes Protocol"	Mixed Methods	descriptives, ANOVA	To explore pre-conceived notions or gender stereotypes about technology and engineering tools such as the KIWI robot, how children master KIWI robotics and programming concepts, If children's performance on KIWI robotics and programming concepts vary by grade level (Kindergarten, first, and second grade)?	Children participated in an 8 week robotics and programming curriculum using KIWI. Qualitative pre-interviews were administered to determine whether participating children had any gender-biased attitudes toward robotics and other engineering tools prior to using KIWI in their classrooms. Post-tests were administered upon completion of the curriculum to determine if any gender differences in achievement were present.	Young children were beginning to form opinions about which technologies and tools would be better suited for boys and girls. While there were no significant differences between boys and girls on the robotics and simple programming tasks, boys performed significantly better than girls on the advanced pro- gramming tasks such as, using repeat loops with sensor parameters.
Sullivan, A. (2016). Breaking the STEM Stereotype: Investigating the Use of Robotics to Change Young Children's Gender Stereotypes About Technology & Engineering. (Doctoral dissertation).	2016	Sullivan	a public school in Somerville, Massachusetts the Arthur D. Healey School	N=105 children from six classrooms (2 Kindergarten, 2 first grade, and 2 second grade classes)	Solve-its	Mixed Methods dissertaion	descriptives, project based assessment, Mann Whitney U, Wilcoxon signed-rank tests, ANOVA, thematic analysis	1. What are children's initial attitudes and ideas about technology and engineering in Kindergarten through second grade? (2) Does participation in a seven- week robotics curriculum (taught once a week using the KIWI robotics kit) have an impact on children's attitudes and ideas about technology and engineering? (3) After receiving the same robotics curricular instruction, do boys and girls perform differently on robotics and programming tasks?	Robotics instruction was provided by two teams- one all female and one all male. Children's attitudes were assessed before and after they participated in the robotics curriculum using a modified version of the Engineering is Elementary (EiE) Science & Engineering Attitudes assessment and the newly developed Gender and Technology Attitudes protocol. Responses were compared to a Control Group who did not receive the robotics curriculum. Children's mastery of programming concepts was measured using the Solve-Its programming assessment.	Results provide preliminary evidence that young children are beginning to form gender stereotypes about technology and engineering, and that robotics may improve children's attitudes toward engineering. Girls in the Curriculum Group (but not in the Control Group) displayed a statistically significant increase in agreement that they would "enjoy being an engineer" at the posttest (Z=-2.435, p=.015). Additionally, while boys began with a significantly higher level of agreement that they would enjoy being an engineer than girls at the pretest, there was no significant difference between boys and girls after completing the robotics curriculum (U=477.5, p>.05). When taught by an all-female teaching team, there were no significant differences between boys' and girls' performance on the Solve-Its programming assessment (p>.05); however, when taught by an all-male teaching team boys performed significantly better than girls on one advanced programming task (p<.05).
Strawhacker, A. L., & Bers, M. U. (2015). "I want my robot to look for food": Comparing children's programming comprehension using tangible, graphical, and hybrid user interfaces. International Journal of Technology and Design Education, 25 (3), 293-319. doi:10.1007/s10798-014-9287-7	2015	Strawhacker & Bers	Boston, MA, USA	3 Kindergarten classrooms with 35 children ages 5-6	Solve-its , video analysis, transcripts	Mixed Methods	Descriptives, ANOVA	To explore how successfully young children master foundational programming concepts based on the robotics user interface (tangible, graphical, hybrid) taught in their curriculum.	3 Kindergarten classrooms were exposed to tangible, graphical, or hybrid programming interfaces.	Findings show little association between user interface and programming comprehension, although there may be an order-affect when introducing user interfaces.

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Sullivan, A., Elkin, M., & Bers, M. U. (2015). KIBO Robot Demo: Engaging young children in programming and engineering: Proceedings of the 14th International Conference on Interaction Design and Children (IDC '15). Medford, MA, June 21-25. New York, NY: ACM	2015	Sullivan, Elkin, & Bers	N/A	32 teachers	N/A	Demo	Data was collected on how well it 1) taught foundational engineering concepts of sturdy building and construction, 2) taught foundational programming skills of sequencing, repeat loops, and conditional branching, and 3) fostered open-ended creativity and artistic design	To describe the design of the KIBO robotics kit	Teacher and child feedback was used to improve design of KIBO	It is possible for children as young as 4 to learn foundational programming concepts
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.	2015	Sullivan & Bers	Boston, MA	N = 60 children (15 pre-K, 18 K, 16 1st grade, 11 2nd grade)	Robot Parts task, 8 Solve-It tasks (all verbally administered)	Quantitative	Descriptives, Kruskal-Wallis H Test	3) Does children's performance on KIWI robotics and programming concepts vary by grade level (Kindergarten, first, and second grade)?	An introductory robotics and programming curriculum was implemented, with one-hour lessons once each week. Students were assessed on their robotics knowledge at the end of this curriculum using the Robot Parts task, in which the researcher asks the child to identify parts of the KIWI robot and their functions, and the eight "Solve-It" tasks that each focus on one robotics/programming concept	Statisctically significant difference between grades in performance on the Hard Sequencing Solve-It. Post hoc: K, 1, and 2 each performed significantly better than pre-K on Hard Sequencing. No significant differences were found between grades in performance on the Robot Parts task.
Elkin, M., Sullivan, A., & Bers, M. U. (2014). Implementing a robotics curriculum in an early childhood Montessori classroom. Journal of Information Technology Education: Innovations in Practice, 13, 153-169.	2014	Elkin & Sullivan	Boston, MA area	19 students (6 first grade, 8 second grade, 5 third grade)	Surveys (pre- and post-), interviews, blogs	Mixed Methods Case Study	descriptive comparison	To present a case study of the integration of robotics into a Montessori classroom, grades 1-3	Two sets of surveys (comprised of two surveys each) were administered to the teacher, one before the robotics curriculum implementation and one after. One survey explored the planned curriculum and how it was implemented, while the other measured robotics knowledge and attitude. Blog entries were completed following each lesson (9 entries over 2 months), and two interviews were conducted by researchers following two robotics teaching sessions.	Self-reported measures of robotics knowledge, teaching robotics, and confidence in technology self-efficacy all went up on average in the post-survey compared to the pre-survey.
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), 553-573.	2014	Kazakoff & Bers	A laboratory setting (does not specify loaction of laboratory)	34 children ages 4-6	Sequencing assessment,	Quantitative	paired sample t-test	to examine how programming robotics impacts sequencing ability	3 1.5 hour sessions were held where children were introduced to CHERP and robotics	There was a significant increasse in children's sequencing skills which shows that children's sequencing skills can improve through learning to program
Bers, M. U. (2014). Tangible kindergarten: Learning how to program robots in early childhood. In Sneider, C. I. (Ed.), The Go-To Guide for Engineering Curricula PreK-5: Choosing and using the best instructional materials for your students (pp. 133-145). Thousand Oaks, CA: Corwin.	2014	Bers	N/A	More than 250 early childhood teachers and 2000 students have utilized the Tangible K curriclum	PTD framework, student portfolios, video journals, rubric of levels of understanding	Book Chapter	N/A	To describe the Tangible K curriculum grades pre-K-2	N/A	N/A
Bers, M.U., Flannery, L.P., Kazakoff, E.R, & Sullivan, A. (2014) Computational thinking and tinkering: Exploration of an early childhood robotics curriculum. Computers & Education, 72, 145-157.	2014	Bers, Flannery, Kazakoff, & Sullivan	Greater Boston area	3 teachers , 63 children (only 53 included in data analysis), average age - 5.7 yrs	Project based assessment, concept tests, and child interviews	Quantitative; Design Based Research	Descriptives, Repeated measures ANOVA analyses; paired-sample t-tests	To explain how young children learn computational thinking, computer programming and robotics concepts so as to inform the redesign of the Tangible K curriculum.	3 kindergarten classrooms (2 public urban, 1 private suburban schools) learned the core concepts (powerful ideas) of robotics and programming in the TangibleK curriculum. Teachers were trained and implemented the curriculum with help from research assistants. After each activity, research assistants evaluated the robot and/or program made by each child	• On average, children had a partial to complete understanding and application of debugging. • Children performed relatively better on activities involving action instructions compared to activities involving complicated control flow instructions. • As more difficult concepts were introduced, children's performance decreased compared to introductory activities which were more simple to understand.

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Lentz, T. (2014). Kids, Robotics, and Gender: a pilot study (Undergraduate thesis).	2014	Lentz	Boston, MA USA	18 1st grade students	Solve-its, happiness assessment, explicit sterotype assessment, implicit sterotype assessment	Mixed Methods Undergraduate Thesis	descriptives	How do the stereotypes that young girls hold about engi- neering differ from those of young boys, and how do these sets of stereotypes impact the children's performances with robotics in the classroom?Do performance and happiness during the robotics unit predict change in gender-based engineering stereotypes?	. The pre-testing phase consisted of a series of assessments for implicit and explicit gender-based engineering stereotypes. This was followed by a teaching phase in which robotics was taught in the classroom during eight 45-minute sessions. During the teaching phase, happiness assessments and performance assess- ments were implemented to track enjoyment and progress. Happiness assessments took place after each lesson, and "Solve-It" challenges to assess robotics knowledge and learning were conducted after the last robotics lesson. The study concluded with post-testing in which the same assessments for implicit and explicit gender- based engineering stereotypes administered during pre-testing were again given to each participant.	After 6 lessons children's gender based sterotypes decreased
Bers, M.U., Seddighin, S., & Sullivan, A. (2013). Ready for robotics: Bringing together the T and E of STEM in early childhood teacher education. Journal of Technology and Teacher Education, 21 (3), 355-377.	2013	Bers, Seddighn, & Sullivan	7 states across US	32 early childhood teachers (K-2nd grade), teachers	TPCK, Interviews	Mixed Method	Descriptives, T-test, correlation	To determine if early childhood teachers participating in a professional development institute using the KiWi robotics kit make gains in TPcK (technology, pedagogy and content knowledge)	32 educators participated in an intensive 3 day PD (18 hours) and took surveys before and after	•Overall, participating teachers showed an improvement in all areas of TPcK, particularly the technology component. •Teachers showed significant increases in technology self-efficacy and attitudes toward technology.
Sullivan, A., Kazakoff, E.R., & Bers, M.U. (2013). The Wheels on the Bot Go Round and Round: Robotics Curriculum in Pre-Kindergarten. Journal of Information Technology Education: Innovations in Practice, 12, 203-219.	2013	Sullivan, Kazakoff, & Bers	3 Pre-K classrooms in a STEM magnet school in Harlem, NY	37 children, 5 yr olds (50% African American, 12.5% Hispanic, 6.3% Mixed Race, 3.1% Caucasian, and 3.1% West Indian, 25% other/no response)	formal and informal interviews, video, photographs, and classroom observations, teacher surveys	Mixed Method	Descriptives	To examine how an intensive robotics curriculum is implemented in three Pre-Kindergarten classrooms at a STEM-focused magnet school in a developmentally appropriate way	3 day professional development workshop (18hrs total) to increase teachers' knowledge about robotics, programming	• Children had an increased understanding of the different roles of an engineer • All children were able to make a robot for recycling, with some assistance from their teachers at the end of the week. • Pre-K students required more individualized help and learnt fewer programming concepts • Participants were able to practice math, literacy and further develop their creativity skills during the engineering design process.
Flannery, L.P. and Bers, M.U. (2013). Let's Dance the "Robot Hokey-Pokey!": Children's programming approaches and achievement throughout early cognitive development. Journal of Research on Technology in Education, 46(1), 81-101.	2013	Flannery & Bers	Boston, MA	29 children(38% girls, 62% boys; 20 Kindergartners, 9 preschoolers), Mean age - 5.6yrs, 11 attend public schools and 18 attend private schools	Program completeness assessment rubric; cognitive development measure	Quantitative	descriptives, chi square, ANOVA, Kappa	To ascertain whether cognitive development influences achievement in learning to program robots.	Participants attended a small-group session for pre-assessments and introduction to the technologies, and then three individual sessions in which they constructed a robotic vehicle, learned new programming concepts, attempted a programming challenge, and reflected on their work. Post-assessments took place during the final session.	•Higher cognitive levels of development corresponded with increased understanding of programming concepts and skills. Compared to children at the pre-operational stage, children at the concrete operational stage were more likely to continue working on their program till it was complete. •All children seemed to experience similar challenges and successes with manipulating the robotics and programming materials. However, they responded quite differently to the lesson goal and format, depending on their age range and cognitive developmental stage.
Strawhacker, A., Sullivan, A., & Bers, M.U. (2013). TUI, GUI, HUI: Is a bimodal interface truly worth the sum of its parts?: Proceedings of the 12th International Conference on Interaction Design and Children (IDC '13) (pp. 309-312). New York, NY: ACM.	2013	Strawhacker, Sullivan, & Bers	Boston, MA, USA	36 Kindergarten students (from 3 classrooms in a public early childhood school) . TUI class-15 children, GUI class-7 children, HUI class- 12 children Location: Boston, MA	Solve-its	Quantitative	ANOVA	To explore the efficacy of three different computer programming interfaces for controlling robots designed for early childhood education and determine which one ensures better understanding of programming concepts.	3 classrooms completed 13 1-hour lessons with a researcher. 1 classroom used a tangible interface, one used a digital interface, and one used a hybrid approach.	•The HUI interface did not seem to provide the children with an advantage over their peers using GUI or TUI as they performed worse on the culminating task. •The TUI group developed a deeper understanding of the core concepts of sequencing a program and repeat-loop syntax, compared to the other 2 interface groups. •Users of GUI and TUI at the museum created programs that were similar in length and level of complexity.
Bers, M.U., Matas, J. & Libman, N. (2013). Livnot U'Lehibanot, To Build and To Be Built: Making Robots in Kindergarten to Explore Jewish Identity. Diaspora, Indigenous, and Minority Education: Studies of Migration, Integration, Equity, and Cultural Survival, 7(3), 164-179.	2013	Bers, Matas, & Libman	Jewish Community Day School, Boston, MA	22 Kindergarteners	Challenges, interview	Qualitative	Vingettes	To describe how kindergarteners use robotic artifacts and programmed behaviors to express their Jewish identities.	Participants recieved the tangible-K curriculum and for the Mi Ani project, children reflected on their experiences guided by their teachers during open circle times coming up with a timeline consisting of different events during the academic year that were meaningful to them. Each child chose three moments in the year as "stations" at which his or her robot would stop and perform an action.	•The robot's behavior, as programmed by children, provided greater insight into how they view themselves and the things that are important to them. •Some children used their robots to express their experiences in the form of emotions by programming them to perform commands that represented their reactions to significant moments during the year.
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.	2013	Kazakoff, Sullivan & Bers	STEM magnet sch, Harlem, NY	29 children (13 Pre-K and 16 Kindergarten students) 41.8 % African American, 25.4 % Hispanic, 1.5 % Caucasian, and 7.5 % multi-racial	Sequencing Assessment	Quantitative	Descriptives, correlation, t-tests,	; To describe the impact of programming robots on sequencing ability during a 1-week intensive robotics workshop at an early childhood stem school	Children who participated in this study were pre-tested using a standardized sequencing assessment before their participation in the 1-week robotics curriculum. On the last day of robotics week, the children were post-tested using another form of the standardized sequencing assessment.	• Improved performance on sequencing tasks in post-test after robotics instruction compared to pre-test

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Lee, K., Sullivan, A., Bers, M.U. (2013). Collaboration by design: Using robotics to foster social interaction in Kindergarten. Computers in the Schools, 30(3), 271-281.	2013	Lee, Sullivan, & Bers	A Northeastern US university	19 children (5 female and 14 male), mean age = 5.68 years	Collaboration Web, video recordings	Mixed Methods	Descriptives, t-test, cohen's d,	To determine the effect of teaching using a structured versus unstructured robotics curriculum on fostering peer-to-peer collaborative interactions	Children who participated in a summer robotics workshop and were either in a group that recieved structured instruction or unstructured (constructivist) instruction. Children filled out the collaboration web twice a day	• The use of a structured curriculum was associated with significantly less peer collaboration than an unstructured curriculum.
Sullivan, A., & Bers, M. U. (2013). Gender differences in kindergarteners' robotics and programming achievement. International Journal of Technology and Design Education, 23 (3), 691-702.	2013	Sullivan & Bers	Boston, MA	53 students from 3 different classrooms and 3 teachers	Building and programming tasks	Quantitative	t-tests, correlation, descriptives	To determine whether kindergarten boys and girls were equally successful in a series of building and programming tasks using the TangibleK Robotics Program.	Three kindergarten teachers implemented the TangibleK curriculum in their classrooms, after receiving training. During each lesson children were assessed by their teachers and a researcher.	• Girls and boys performed similarly in most tasks. • Boys scored significantly higher than girls in only two areas: properly attaching robotic materials and programming with If statements.
Kazakoff, E., & Bers, M. (2012). Programming in a robotics context in the kindergarten classroom: The impact on sequencing skills. Journal of Educational Multimedia and Hypermedia, 21(4), 371-391.	2012	Kazakoff & Bers	Greater Boston Area	58 children from 2 different schools	Picture Sequencing task	Quantitative	ANOVA	To examine the impact of programming of robots on sequencing ability in early childhood and the relationship between sequencing skills, class size, and teachers' comfort level and experience with technology.	Children in the experimental group were exposed to the TangibleK program for a period of 20 hours, taught by their classroom teacher. Children participated in computer programming activities using a developmentally appropriate tangible programming language, specifically designed to program a robot's behavior. All 54 participants' sequencing skills were assessed before and after the intervention using a picture story sequencing task	* A significant interaction was found between group assignment and test results No significant interactions were found for school assignment.
Horn, M.S., Crouser, R.J., & Bers, M. U. (2012). Tangible interaction and learning: The case for a hybrid approach. [Special Issue on Tangibles and Children] Personal and Ubiquitous Computing, 16(4), 379-389. doi: 10.1007/s00779-011-0404-2	2012	Horn, Crouser, & Bers	Museum of Science and kindergarten classrooms in Boston	260 individuals (104 being children- ie. 16 yrs or younger) GUI condition- 108 ppl and 152 for the TUI condition	Observation, notes, photographs, surveys,	Mixed Methods	Descriptives, z-test, t-test	To review 3 research studies involving tangible programming to identify situations where tangible interaction provides advantages and disadvantages	In one study, visitors of the museum either used a graphical or tangible interface to program. In other study, In another study, qualitative data was collected during an 8 week intervention at a Kindergarten. Lastly, a robotics summer camp was held where children worked together to build a city using LEGO mindstorms and surveys were given to children.	• The Tangible interface offered benefits to learning and a hybrid tangible and digital approach is reccomended.
Kazakoff, E.R., & Bers, M.U. (2011). The Impact of Computer Programming on Sequencing Ability in Early Childhood. Paper presented at American Educational Research Association Conference(AERA), 8 - 12 April, 2011, Louisiana: New Orleans. Handout	2011	Kazakoff & Bers	Tufts University	34 children, age range=4.5-6.5yrs	story sequencing task	Quantitative Confrence paper	Descriptives, t-test	The impact of TangibleK, a computer programming and robotics curriculum on sequencing ability in early childhood	Children were evaluated before and after the robotics instruction using an assessment derived from the picture-sequencing test developed by Baron-Cohen (Baron-Cohen et. al., 1986)	•Children as young as 4.5 in this study learned to program a robot to complete a variety of challenges and simultaneously improved his/her score on a sequencing assessment.
Kazakoff, E.R., & Bers, M.U. (2011). Kindergarten Robotics: Understanding and Programming Robots in Early Childhood. Poster presented at Society for Research in Child Development (SRCD) Annual Conference, 31 March - 2 April, 2011, Canada: Montreal.	2011	Kazakoff & Bers	N/A	31 participants (68% male, 32% female)	Yes/No survey of robtoics ideas	Qunatitative Confrence Paper	Descriptives	To evaluate the change in children's ideas about robots before and after participating in a robotics program	Children attended 4 sessions lasting 1.5 hours each.	• Children's ideas of the physical appearance of robots as well as their understanding of hardware/software increased after being exposed to the Tangible K robotics program
Bers, M.U. (2010). The TangibleK Robotics Program: Applied Computational Thinking for Young Children. Early Childhood Research and Practice, 12(2).	2010	Bers	N/A	N/A	PTD framework, student portfolios, video journals, SSS rubric of level of understanding	mixed methods	N/A	The first goal is to provide an evidence-based systematic account of children's learning and use of the powerful ideas identified in the curriculum, employing methods described earlier corresponding to components of the Positive Technology Development (PTD) framework. The second goal is to establish potential learning trajectories in this disciplinary context	N/A	• TangibleK draws six ideas from computer science: robotics, engineering design process, sequencing and control flow, loops and parameters, sensors, and branches and applies them to a robotics context in a structured, developmentally appropriate way. • The robotics curriculum is cross-disciplinary as it incorporates math, literacy and science concepts.
Bers., M. (2010). When robots tell a story about culture...and children tell a story about learning. In N. Yelland, (Ed.) Contemporary Perspective on Early Childhood Education. pp. 227-247. Maidenhead, UK: Open University Press	2010	Bers	N/A	(i) Educators (ii) Parents and their young children	N/A	This is a chapter in the book, Contemporary Perspectives of Early Childhood Education	Two case studies were presented one about children and their parents and the other about educators and children 1	To describe the use of robotics to tell cultural narratives using examples from two learning experiences	N/A	• Robotics can serve as a bridge that connects personal and cultural narratives to STEM fields
Bers, M. & Horn, M. (2010). Tangible programming in early childhood: Revisiting developmental assumptions through new technologies. In I. R. Berson & M. J. Berson (Eds.), High-tech tots: Childhood in a digital world (pp. 49-70). Greenwich, CT: Information Age Publishing.	2010	Bers,& Horn	2 public schools in the Greater Boston Area; one urban K-8 school and one suburban K-5 school	56 Children and 6 teachers	Observation, notes, photographs, videotapes	Design Based Research Study	Notes, analysis of video tape, DBR techniques	Are young children capable of learning how to program their own robotics projects when given access to appropriate technologies and curriculum?Can young children understand the underlying powerful ideas behind computer programming?	A two year design based research study was conducted, The first intervention was with 20 students and 2 teachers. The researchers then used that data to improve the technology and the second intervention was with 36 children and 4 teachers.	• When given access to appropriate technology, young children can program their own robotics projects without direct adult assistance • Children are able to understand the underlying powerful ideas of computer programming and robotics through the curriculum • Blocks were easier for children to use than puzzle pieces

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Horn, M., Bers, M., & Jacob, R. (2009). Tangible programming in education: A research approach. Paper presented at the Conference on Human Factors in Computing Systems, Boston, MA.	2009	Horn, Bers, & Jacob	Boston Science Museum; , 6 kindergarten classrooms in the Boston area	260 museum visitors, number of children not specified	N/A	A research approach	N/A	To compare the use of tangible and graphical interfaces in programming in a museum and describe research surrounding the use of these interfaces in classroom settings.	N/A	• Museum visitors were much more likely try the exhibit in the tangible condition and actively collaborate in small groups. • The use of tangible technology in classrooms helps children to separate the intellectual act of computer programming from the confounding factor of modern GUIs.