Handbook of Research on Innovative Approaches to Early Childhood Development and School Readiness

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IGI Global
PUBLISHER of TIMELY KNOWLEDGE

A volume in the Advances in Early Childhood and K-12 Education (AECKE) Book Series

Published in the United States of America by
IGI Global
Information Science Reference (an imprint of IGI Global)
701 E. Chocolate Avenue
Hershey PA, USA 17033
Tel: 717-533-8845
Fax: 717-533-8661
E-mail: cust@igi-global.com
Web site: http://www.igi-global.com

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Library of Congress Cataloging-in-Publication Data

Names: Betts, Anastasia L., editor. | Thai, Khanh-Phuong, DATE- editor.
Title: Handbook of research on innovative approaches to early childhood development and school readiness / Anastasia Betts, and Khanh-Phuong Thai, editor.
Description: Hershey, PA : Information Science Reference, [2021] | Includes bibliographical references and index. | Summary: "This book assembles the most current research and thought-leadership on the ways in which innovative education stakeholders are working together to impact what are perhaps the most critical years in a child's life - the years leading up to and including Kindergarten by providing key competencies needed for later success which must be pursued with intensity, creativity, and purpose if we truly wish to address learner variability and its impact on achievement overall"-- Provided by publisher.
Identifiers: LCCN 2021037983 (print) | LCCN 2021037984 (ebook) | ISBN 9781799886495 (Hardcover) | ISBN 9781799886518 (eBook)
Subjects: LCSH: Early childhood education--Research--United States. | Child development--Research--United States. | Performance in children.
Classification: LCC LB1139.225 .H365 2021 (print) | LCC LB1139.225 (ebook) | DDC 372.210973--dc23
LC record available at https://lccn.loc.gov/2021037983
LC ebook record available at https://lccn.loc.gov/2021037984

This book is published in the IGI Global book series Advances in Early Childhood and K-12 Education (AECKE) (ISSN: 2329-5929; eISSN: 2329-5937)

British Cataloguing in Publication Data
A Cataloguing in Publication record for this book is available from the British Library.

All work contributed to this book is new, previously-unpublished material. The views expressed in this book are those of the authors, but not necessarily of the publisher.

For electronic access to this publication, please contact: eresources@igi-global.com.

Chapter 19
Review on Artificial Intelligence and Robots in STEAM Education for Early Childhood Development:
The State-of-the-Art Tools and Applications

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ABSTRACT

For the last two decades, the growth of educational robots has been increasing rapidly in several sectors. The chapter aims to provide a critical assessment of artificial intelligence's (AI) impact and opportunities in early childhood education. The study used a computational kit (robotic kit) for young children from age 3-8 years old to review existing literature in robotics education. This research investigated (1) the impact of artificial intelligence devices and children, (2) computational thinking for early childhood education, (3) programming for young children using tangible blocks, (4) educational robotics in early childhood classroom learning and special education humanoid robots, and (5) existing curriculum framework for primary school children. The research was carried out by sorting through the literature published in international journals and proceedings between 2003 and 2021 (June). This chapter proposes learning of robotics at a young age as a recommendation for future research. It improves various real-life skills and computational thinking, especially at a young age.

DOI: 10.4018/978-1-7998-8649-5.ch019

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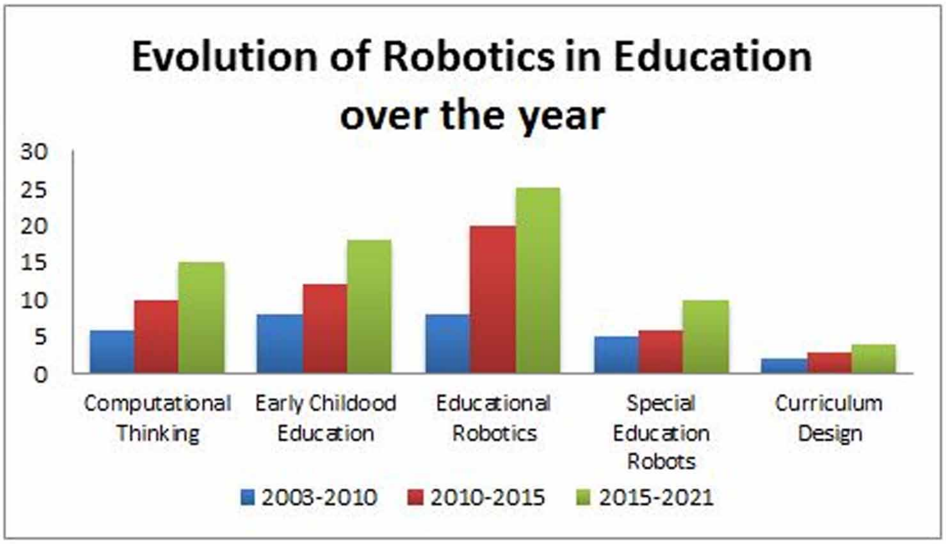
INTRODUCTION

Over the years, Artificial Intelligence (AI) technology has revolutionized the world in the daily lifestyle of the 21st century. Technology has created excellent tools and resources to gather all the information in hands within seconds. It is hard to imagine a life without technology and it has become a part of every day's life. Artificial Intelligence (AI) is one of the growing technologies that create a revolution globally by making intelligent machines. It is ubiquitous in various domains such as astronomy, healthcare, gaming, finance, social media, travel and transport, robotics, agriculture, education etc. AI plays an essential role in education, with a direct impact from early childhood and technology made education more accessible to everyone than ever. Nowadays, children use smartphone's, tablets, computers, and other internet-based devices at a young age (Prentzas,2013). Children are showing much eagerness to connect with intelligent conversational AI voice-based applications like Siri, Google Assistant, and Google Alexa (Druga et.al.,2017). Through the National Educational Policy (NEP) last year, the Indian government planned to incorporate Artificial Intelligence, Machine Learning, Internet of Things (IoT), and other related technologies into the curriculum. Schools are using several AI-based technological devices to teach children, and the purpose of robots in the classroom is to help children overcome their educational barriers. The main reason for integrating AI with the current school curriculum is that the future generation could become familiar with the technology (Ali et.al.,2019).

The early childhood STEM represents (Science, Technology, Education, and Mathematics) "STEAM" represents STEM plus arts (Science, Technology, Education, Arts, and Mathematics) educational approach gives a strong impetus and remarkable growth in learning speed. Most of the primary schools consider only science and mathematics concepts, but there is less emphasis on technology, computer science, problem solving and robotics. Art has recently been added and the integration of the arts encourages learning with more relevance to real life and unleashes children's creativity in early childhood education. It includes humanities, drama, dance, visual arts, design, music and new media. Early STEAM supports the children's overall academic growth, develops early critical and creative thinking skills, and encourages later interest in STEAM studies and careers. STEAM education develops skills in the students to become innovators and entrepreneurs of the future (Dejarnette,2018;Shatunova et.al.,2019). In a study by Microsoft, 4 in 5 STEM students (78%) said they chose to study STEM in high school or earlier, and one in five (21%) chose to go to middle school or earlier. But only 1 in 5 STEM students think that their K12 training has prepared them very well for their STEM student courses. The US Bureau of Labor Statistics (BLS) predicts 5 percent growth in non-STEM occupations between 2018 and 2028, while the number of STEM-related jobs will grow nearly 9 percent and will increase by 10.6 million jobs.

Computational thinking (CT) is a creative way of thinking and problem-solving process that enables children to identify problems and generate step-by-step solutions to this problem (García-Valcárcel-Muñoz-Repiso, &Caballero-González,2019). CT is primarily used to develop computer applications, but it can also be used to support problem solving in all disciplines, including math, science, and the humanities. For example, CT can be applied in mathematics, such as analyzing the different parts of a formula, plotting data on a chart, understanding different symbols, requires a different set of calculations and follows the formula rule. Through STEAM education, 3-5 years old children can effectively develop computational skills. When children develop numeracy skills, they can articulate a problem and think logically to break down the issues ahead and predict what may happen in the future. Additionally, a new STEM-tastic Adventures app was developed to help young children practice and learn Computational thinking (CT) skills in the context of the STEM connections "City Walk" and "Better Building" games.

Figure 1. Literature review analysis for the proposed chapter from 2003-2021



The “City Walk’’invites children to create a sequence of navigation instructions for their robot friend to deliver gifts around town. “Better Building” game application allows children to closely observe and sort objects by color, shape, size, and label groups to help the robot friend more efficiently build structure.

Google provides an artificial intelligence-based platform for young children to improve their knowledge through the AI Experiments website. AI Experiments is an open-source project containing a bunch of experiments related to artificial intelligence, virtual reality, Android, digital wellness, and Chrome experiments. It provides simple experiments that allow anyone to investigate machine learning using pictures, charts, language, music, and other mediums. Quickdraw, Teachable Machine, Sketch-RNN Demos, Rock Paper Scissors, and Cartoonify are a few of them. It helps children to learn AI concepts through fun and interactive ways. Figure 1 shows the collected documents from a variety of standard databases using key terms such as “computational thinking,” “early childhood education,” “educational robotics,” “special education robots,” and “Curriculum design” from 2003-2021 (June). In this chapter will introduce the computational kits, educational robotics, challenges and opportunities in early childhood education in the last decades one by one of the following category.

Children Curiosity with AI Devices and Robots

Young children investigate and experiment with their surroundings. They are independent learners who learn by doing, at the same time they are gathering information from others (Lovato & Piper, 2015; Kory,Jeong& Breazeal,2013). Till last decade children used only ordinary toys to engage in time to play instead of Intelligent toys, such as personal home partners (Amazon’s Echo& Alexa, Siri, Google Home Mini) and smart toy robots (Anky’sCosmo, Kayla toy), are becoming more common in children’s homes (Park et.al.,2017). These devices link to the Internet (via Bluetooth to a phone or WiF) and transmit data to the supplier. Everything a child can say to an AI toy, including their most fantastic secrets, is stored in the data. The company collects all the child’s conversation, behavior, and interest to create a great product.

The Amazon Echo Dot is a version of the Echo Dot designed explicitly for children because ordinary devices have trouble in recognizing children's voices. The child tone and accent clarity of the pitch may not be as good as those of adults. Children sometimes ask crazy questions like, "Hey Google, is it okay if I eat you?", as a question to voice assistants (Druga et.al.,2017). They are curious to use these types of voice assistants. Google has launched a free app called "Read Along" to help young children practice reading through android applications for different languages. This application is designed for elementary school students to enhance reading skills and educationally engaged at home in Covid-19 pandemic. The app has a built-in reading assistant called Diya. When children read aloud, Diya can detect if the child is having difficulty with a passage and move on with positive reinforcement or help. At any time, parents can ask the child to assist them in reading a sentence or pronouncing a word they are unfamiliar with. This Android app is based on Google's existing Polo app, which is available in English and Hindi. With support for nine languages, the updated and renamed version is now available worldwide.

A social robot is an artificial intelligence-based system that interacts with humans and other robots (Pa padakis,2020;Kory,Breazeal;2014). Social robots are also known as intelligent robots and are generally based on cognitive computation which simulate human thought processes (Ali,Moroso,&Breazeal,201 9;Prentzas,2013).This type of robots is used like a personal assistant to the child, and it helps them to learn at home. The academic success of elementary school children is predicted to be dependent on their oral language knowledge and vocabulary skills at an early age, according to research conducted over the last decade (Kory, &Breazeal,2014). The DragonBot was designed by Adam Setapen and collaborators and used as a robot learning companion for children to develop their oral skills through storytelling. The "squash and stretch" principles of animation are used to create this robot. It generates a variety of natural and organic movements, allowing children to participate in various expressive body movements while the story is being told. This robot is designed to understand nonverbal cues from children (Breazeal et.al.,2016; Setapen,2012). Artificial Intelligence based learning tools are being developed to help children with learning disabilities improve their critical thinking and problem-solving skills. Though still in its infancy, Emotional AI Assistant has the potential to provide mental health support and improve social skills for children with Autism. Through these AI devices, educators can create interest in STEM education, improve programming skills at a young age, develop problem-solving and teamwork capabilities, promote creativity in work and hands-on training experiences, create curiosity, and make learning through fun activities.

Early Childhood Education and Computational Thinking

Computational thinking (CT) has become a necessary ability for everyone, not just computer specialists, as technology advances (Chalmers, 2018). It consists of a set of abilities such as problem-solving, critical design thinking, and systematic analysis. It also refers to a type of scientific thinking that is closely related to analytical thinking (problem solving), design thinking (process design and evaluation), and logical thinking (systematic analysis). Computational thinking (CT) basic skills are required at the K-12 level where the teacher must provide adequate knowledge to the children, and they should know how to integrate them into teaching is an essential (Brennan,&Resnick,2012). Decomposition, pattern recognition, abstraction, and algorithms are the four components of computational thinking. Decomposition involves children breaking down complex issues into smaller, simpler ones. Children are taught to make connections between similar issues through pattern recognition. Children can identify important information while ignoring irrelevant details in abstraction. Finally, algorithms are a series of step-by-step procedures for problem-solving (Atmatzidou,&Demetriadis,2014).

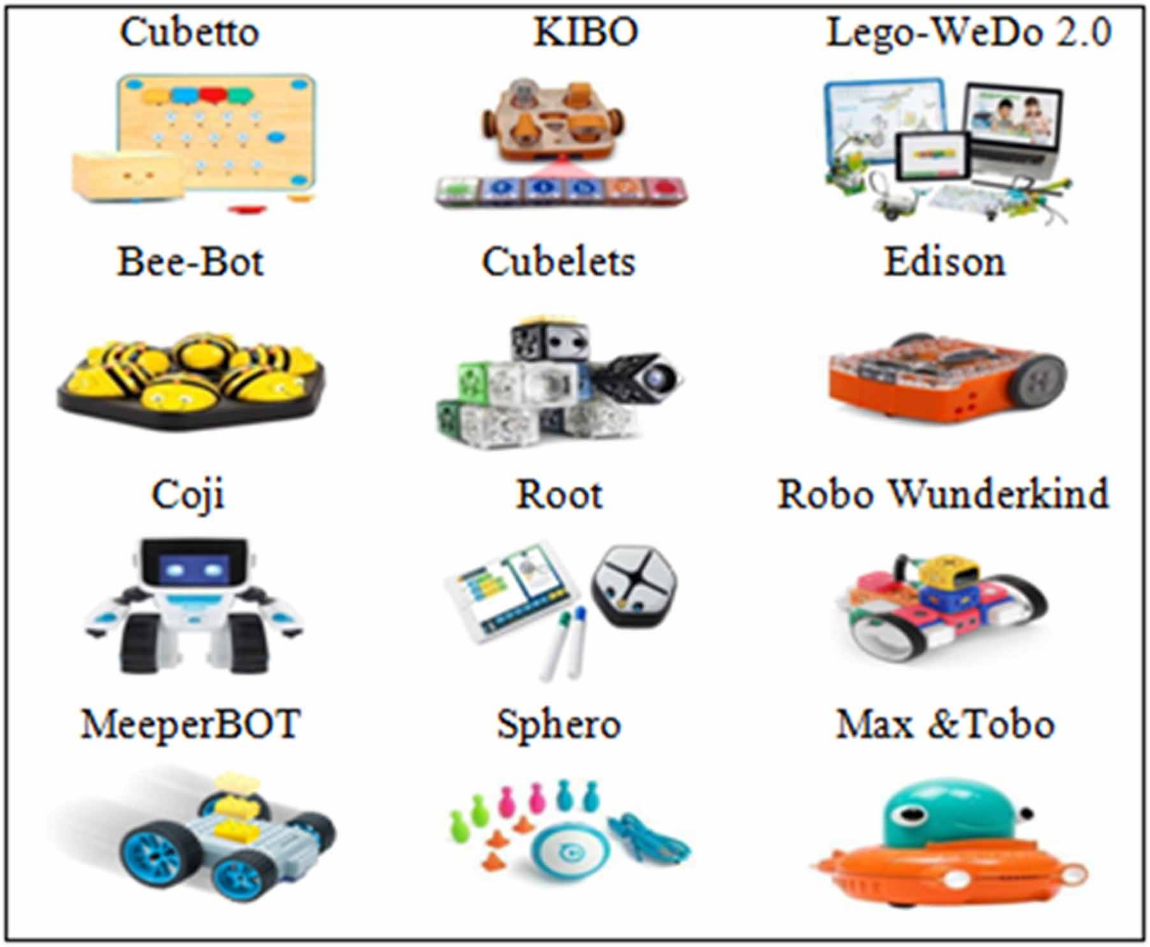
Early childhood is an important time for a kid's development, play, and exploration of new experiences. At this stage, children are busier in knowing and learning new things. One of them is to use scratch programming and robotics tools to help children understand computational thinking at a young age. Children ages 3 to 8 can play and learn various concepts with simple exercises by directly engaging in construction-based robotics learning activities. Learning activities in robotics help to develop practical maturity, computational thinking (CT), and understanding theory into successful practices (Angeli,&Giannakos,2020). The time to access technology is growing fast, but children do not understand how AI tools work. If they know at an early stage about its functionality it will enhance children's problem-solving skills and provide opportunities for futuristic research. Furthermore, hands-on project activities such as robotics assembly and simple programming engage children in learning about the operation of various motors, sensors, and electronics.

Robotic in Computational Thinking

This section author has explained some existing research work for developing computational thinking at a young age using various robotic techniques. Michael Gordon et al., (2015) has designed a programming tool kit for young children aged from 4-8 and named it as SORO (Social Robot) Toolkit. This toolkit rule is framed by reusable vinyl stickers with 22 primary school children tested using android based DrongonBot (Kory, & Breazeal,2014). As a result of this work, has described how children can learn new concepts with robots through playful learning methods. Chalmers et al., (2018) has reported how learning robotics enhances children's computational thinking and their impact. Through the LEGO WeDo 2.0 robotic kit, a study was conducted with four primary school teachers and four students. As a result, the author has summarized the significance for computational thinking concepts and perspectives. Portelance,& Bers (2015) used ScratchJr block-based programming to propose a new method for assisting the development of computational thinking in children as young as three years old. Sixty-six children were surveyed, each using iPad cameras and collected data from artifact-based video interviews. As a result of this technique, it is possible to demonstrate that ScratchJr can teach computational thinking to a broader range of young children than traditional teaching techniques (Bers,2018). With the help of ScratchJr and KIBO robot tools, investigated how user interfaces affect children's computational thinking (Sullivan & Bers, 2016). Study conducted a mixed-method approach that explored the aged 4-7 learning experience with 28 participants. Results showed the impact of computational thinking with various factors like social-emotional, prior knowledge of children.

The Logo Turtle robot and the Slot machine were the first tool kits to help kids learn about computational thinking (McKerrow,1982; Baccaglini-Frank et.al.,2020). Figure 2 shows the images of computational robot kit such as Cubetto (Anzoátegui, Pereira, &Jarrín, 2017), KIBO (Miranda-Pinto, Fernandes, &Osório, 2021), Cubelets, Bee-Bot (Stoeckelmayr,Tesar, & Hofmann, 2011), Lego-WeDorobot kit(Scaradozzi et.al., 2015), Edison, Coji, Root, Robo Wunderkind, MeeperBot, Sphero and Max &Tobo (Yu,& Roque,2019)acquires young children with computational thinking, programming, and engineering skills through construction and coding. It teaches children about patterns, loops, and parameters, as well as how to use motors, sensor systems, and crafts. It also teaches them how to redesign, limit, and analyze processes. These modules, like the KIBO robotics kit, don't really involve the use of a portable

Figure 2. Computational kit for young children (Source: Amazon, Flipkart stores)



display. To communicate a power source to a scanner and a buzzer, a combination of physical modules, a motion detector, or a motor that responds to sounds is required (Papadakis, 2020; Yu, & Roque, 2018).

Computational thinking empowers children to practice problem-solving skills through trial and error. The modern education technology debate is whether computational thinking should be taught in early childhood, and if so, which tools and curricula should be used. This discussion investigates the significance of computation thinking in the early childhood education age range of 3 to 8 years, considering all needs in the use of technology to meet the needs of individuals, along with educators' ability to comprehend, analyses, and integrate technology into their classrooms during the learning process (Umam, Budiyanto,&Rahmawati,2019).

Learning Impacts of Programming Language for Early Childhood Development

Teaching basic programming knowledge to young children allows them to thrive and play an active constructive role in the use of technology, and develop logical, problem-solving, mathematical ability, as well as creative thinking (Misirli, & Komis,2014; Sullivan,Bers,&Pugnali,2017). Learning programming allows children to see the world in new ways and develop skills that will benefit them in their current and future lives. It helps to find a meaningful way to solve the problems introduced to kids in various games, challenges, and activities. One of the advantages of learning programming at a young age is that it boosts a child's creativity, math skills, confidence, problem-solving, and writing abilities. Starting a programming concept at a young age in two ways, one with tangible blocks and the other with visual blocks-based programming applications gives them an advantage (Gonzalez-Gonzalez,2019).

Tangible Blocks

In the mid-1970s, Mr.Radia Perlman, a research fellow at the MIT Logo Laboratory, introduced the concept of tangible programming. Perlman recognized that the syntactic rules of text-based computer programming languages identified a significant barrier to teaching young children to program. Nearly two decades ago, the concept of tangible programming was revived (Gordon,Ackermann,& Breazeal,2015). Since then, concrete languages have been developed by various research laboratories. C, C++, and JavaScript are programming languages commonly used to create tangible blocks (Strawhacker, & Bers,2015;Wyeth,2008).Tangible programming is a simple computer tool.In a text-based programming language, a developer uses the phrase IF, BEGIN, END, and REPEAT. Some strict syntax and procedures to create specific tasks in traditional methods must be followed. In block-based programs are designed like image blocks where the programmer can be easily instructed on the computer screen just by arranging and combining iconic blocks physically (Sapounidis, &Demetriadis, 2016). The components functionality may include color LED light sensor, sound sensor, and motion sensor. The set of syntax rules can be replaced using visually tangible blocks. For example, a Robust User Interface (TUI) is used to decrease the cognitive burden of young children when learning to program which makes it easier for children to engage in programming languages (Idlbi,2009; Kaplancali, &Demirkol,2017).

Table 1 shows a comprehensive study of the current tangible blocks for children and their impacts on learning programming through robotic kits. This research study considers factors related to the age/number of children participating, robot type and technologies used, research approach, and theoretical structure. For decades, it has been identified that the current robust set of robots for children between ages 3 -8 developed. It helps to build and enhance the skills of children in various fields. The widely used research approaches are qualitative/quantitative, mixed methodology, empirical, experimental study approach, etc. Creativity refers to acquiring knowledge in a student-centered manner, where technology allows learners to be more interactive. As a result, they are more likely to be positive, more comfortable, and more motivated to learn new things. The research study related to children's tangible blocks enhances their programming skills and cognitive knowledge.

The AR-Maze (Jin et.al.,2018) tool is made up of augmented reality. Children could write their programming by assembling coding blocks and using mobile devices to debug and execute code. T-Maze (Wang, Zhang, & Wang, 2011) AR-Maze (Jin et.al.,2018) used tangible programming blocks and sensors to create maze maps games and give solutions to finish maze escaping tasks. T-Maze employs a camera to capture the coding sequence of the wooden blocks' arrangement in real time, and then used to assess semantic correctness and provide immediate feedback to the children. Children can learn basic programming concepts like parameters, loop logic, and debugging using this device. BRICKO (Pedersen et al.,2018), CHERP (Krieg, 2011), ElectronicBlock (Wyeth, & Purchase,2003), roBlock (Schweikardt, & Gross, 2006) made up of a microcontroller, sound sensor, light sensor. That ensures blocks are easy to arrange and connect. The blocks have pre-programmed inputs and outputs, and when connected, one

Table 1. Tangible block for young children

#	Author	Age / (No.of Persons)	Robotic Kit	Research Approach	Theoretical Framework/ skill
1	(Jin et.al.,2018)	5-8 years (8)	AR-Maze (AR Tech)	Experimental Study,Case study	-
2	(Pedersen et al.,2018)	5-7years (108)	BRICKO	Mixed Methodology	Play and learning Theories
3	(Thieme et al.,2017)	7-8 years (10)	Torino	Evaluation study	Developmental Psychology
4	(Qi et.al., 2015)	4-5 years (11)	TanProStory	Experimental Method,Case Study	Constructionism
5	(Correll,Wailes&Slaby, 2014)	4+ (45)	Cubelets	Qualitative,Quantitative Research	Constructionism
6	(Krieg, 2011)	4-6 years	CHERP - tangible block	Qualitative Research	Positive Technology Development
7	(Wang et.al., 2013)	5-8 (16)	TanPro-Kit	Experimental Study	-
8	(Wang, Zhang, & Wang, 2011)	5-8 years (10)	T-Maze	Experimental Study	Constructionism
9	(Gallardo, Julia &Jorda, 2008)	4-7 years	TurTan	Design Methodology	-
10	(Schweikardt, & Gross, 2006)	3-8 years	roBlocks	Design Methodology	-
11	(Wyeth, & Purchase,2003)	3-8 years	Electronic Block	Experimental Study	Constructionism

block's output controls the input of another.Cubelets(Correll,Wailes&Slaby, 2014) are STEM education robots are made up of various cubes with specialized actuation (drive, rotation), communication (light, sound), sensors to detect (temperature, distance, brightness, knob), and calculation (min, max, inverse) capabilities, as well as structural parts (blocker, passive, battery). Sensor data is exchanged between cubelets and one block to another block. It comes with basically three types such as the sense block are black color, action blocks are clear, and think blocks are different colors. Tornio (Thieme et al.,2017), TurTan(Gallardo, Julia &Jorda, 2008)systems support interaction such as turn right/left light on, make audibility and move forward. These are simply designed using a PIC microcontroller, Light sensor, DC motor, Arduino board with LED lights which allow children to interact with these robotic kits and learn to program interactively.

Above table 1 show tangible robotic kits designed to teach various research skills and problem-solving. These are primarily created to teach programming concepts and learning basic programming practically without a blind understanding of each concept in early childhood education. In addition, this type of tangible robotic kit is not only used to learn computer programming but also used to teach concepts of mathematics, science, and other general factors.

Figure 3. a) A snapshot from ScratchJr interface b) Blocks in ScratchJr (Source: ScratchJr)

Visual Block Based Programming

Visual block-based programming is another method of teaching computer programming for 5+ year children. Visual block-based programming offers a drag-and-drop interface for children where kids easily build an application, children able to learn basic coding without worrying about the error, syntax, and other complicated concepts. ScratchJr (Aivaloglou, &Hermans,2016;Bers,2018) is an efficient application for young children to learn programming; it is designed like block-based programming with the help of JavaScript and html. It has been translated into different languages based on the mother tongue of children. Children's problem-solving abilities, critical thinking abilities, and computational thinking have all improved in this platform.

Figure 3a) shows the ScratchJr interface of the project design page. Figure 3b) shows the various blocks available in ScratchJr such as motion block- control movements and Sprite's movement, Looks Blocks- control how a Sprite's look, Sound block- control Sprite's sound, Event Block – control events and the triggering of scripts, Control Block- control sprite's, Sensing Block –blocks detect objects, operator blocks- perform math function and string handling, Variable blocks-hold variable and list, List blocks- manage a list, and my Block- user made custom blocks(Strawhacker,Lee,&Bers,2018;Strawhacker et.al.,2015).

Another accessible programming platform for young children like Coderkids is an open-source platform for kids to begin their coding journey. To name a few, Hopscotch, Kodable, and Tynker aim to initiate basic programming skills and computational thinking to young children through simple, accessible, and enjoyable digital environments. Non-profits and other organizations have also expressed an interest in bringing computer science to nursery and primary children. Code.org, CodeComBat, LightBot, Codemonkey, Blocky games, and CoderDojo are all aimed to teach children how to code. Most of these block-based programming languages are designed by JavaScript, HTML, CSS, and Python. Children can easily create games, stories, and simple projects using block-based coding.

Computational Thinking Programmable Robotic Kits

The computational concepts of abstraction, decomposition, algorithm, generalization, and debugging were analyzed in the previous section and various computational kit outcomes explained. Robotics is an effective way for young children to build computational concepts at early childhood because it requires

Figure 4. Programmable robotic kit for nursery and primary school children

children to create step by step coding steps to programming (Brennan, &Resnick,2012; Kong, &Abelson,2019; Sapounidis, & Demetriadis,2016; Papadakis,2020). The reason for learning programming at a young age is to gain more knowledge in thinking, processing, and communicating effectively. In this section the author has explained various programmable robotic kits and their impact in the computational thinking process.

Programmable robotic kits are shown in Figure 4 for nursery and primary level children Dash & Dot is a small mobile robot from Wonder Workshop that moves around, plays music, and glows lights (https://www.makewonder.com/). Dot is a kind of sidekick. Colby resembles a mouse educational simple floor robotic kit from Generation Robots that helps children to develop logical and decision-making skills on their own in a fun and exciting way (https://www.generationrobots.com/blog/en/tutorial-robot-mouse-colby/). Finch is a robot from Birdbrain Technologies that promotes a variety of basic coding environments and provides programming options for children between the aged 5 and more. TTS Group's Pro-Bot is a turtle-like robotic kit in the shape of a race car (Papadakis,2020). The MOBOTS group's thymio robot is an educational small robotic kit containing a white box with wheels (https://www.thymio.org/). Botley is an easy-to-use remote controller and thus screen-free intelligent toy from Learning Resources. Valiant Technology's Roamer is just another educational robot designed to support the education of preschool children. It offers more flexibility to children to assemble robotic kits in a variety of ways to meet his/ her individual needs (Yu,&Roque,2019). Code-a-Pillar is a new STEAM hands-on robot caterpillar designed by Fisher-Price. The Coding Awbie is a hybrid robotic kit from Northwestern University's TIDAL Lab that combines nineteen magnetic coding blocks (walk, grab loop, jump, wonder, if, multipliers) with one mobile application. Plobot is an educational robot companion created by plobot team member ex-Google engineer Sean Purser-Haskell and NYU robotics professor Rudi Cossovich, inculcate coding concepts to fellow learners without the need for desktop computers(http://plobot.com/). Makeblock'smTiny is an educational robot that has a Tap Pen Controller and themed maps, coding card and tap-to-code interaction all these make learning fun for children (https://www.makeblock.com/mtiny). Clementoni's Mind designer robot is a car-shaped intelligent robot that children can program by tapping a set of buttons on its rear or by speaking to it through its built-in voice recognition. The Kubo robot from Kubo Robotics is also another screen-free programming solution for primary school students, designed to teach programming language and basic code using tangible cards called TagTiles. Evo – Bit from Ozobot are two small STEAM educational robots with proximity sensors, expressive LEDS and audio playback, optical sensors for detecting lines and labels, and built-in speakers for children aged five and up. Tinkerbots is a robotic construction set for kids aged 5+ (https://www.tinkerbots.de/). Tinkerbots' copyrighted Powerbrain, passive pieces, and kinetic interfaces enable kids to design an infinite number of robots with simple robotic kits. The Matatalab Coding Set is a hands-on block-based, screen-free, and words free robotic tool for children aged from 4 -8 (https://matatalab.com/en). The Matatalab robotic set uses a wireless command tower and board to guide a robot through a maze game (Yu,& Roque,2018) Programmable robotic kit enhances children's creative thinking, concentration, ability to engage and collaborate with others, teamwork, and perseverance, and a never-give-up attitude, which is crucial for any technological or scientific undertaking.

Brennan and Resnick (2012) use the computational thinking framework to support programming robotic kits for computational concepts, practices, and perspectives.Figure5, 6, and 7 shows commonly used computational concepts (Sequences, Events, Parallelism, Loops, Conditions, Operators, and Data), computational procedures (Testing and Debugging, Reuse and Remixing, Abstraction, and Limitation), and computational perspectives (Expressing, Connecting, and Questioning), and computational perspectives (Expressing, Connecting, and Questioning). The programming kit included computational thinking, seven concepts, four practices, and three perspectives that will improve the children's programming experiences along with the support of tools.

Figure 5 describes the Computational concepts concerned with programming's technicalities and includes concepts such as sequencing, parallelism, events, conditionals, operators, and loops. Sequences are most notably used in all robotics kits to make sound and light effects, such as Dash and Dot. Loops are running the particular action specified number of times. Parallelism means running multiple tasks at the same time to make some action simultaneously. Events trigger the movement one by one. When children click the blue button on cubetto, for example, actions are initiated. If-then rules are used to make decisions based on conditions that are implicitly exposed. Operators were used to perform some mathematical and logical operations. Finally, data is supported by adjusting model parameters such as movement, rotation, and loop increments.

Figure 5. Computational concepts (Source: Brennan, K., & Resnick, M. (2012))

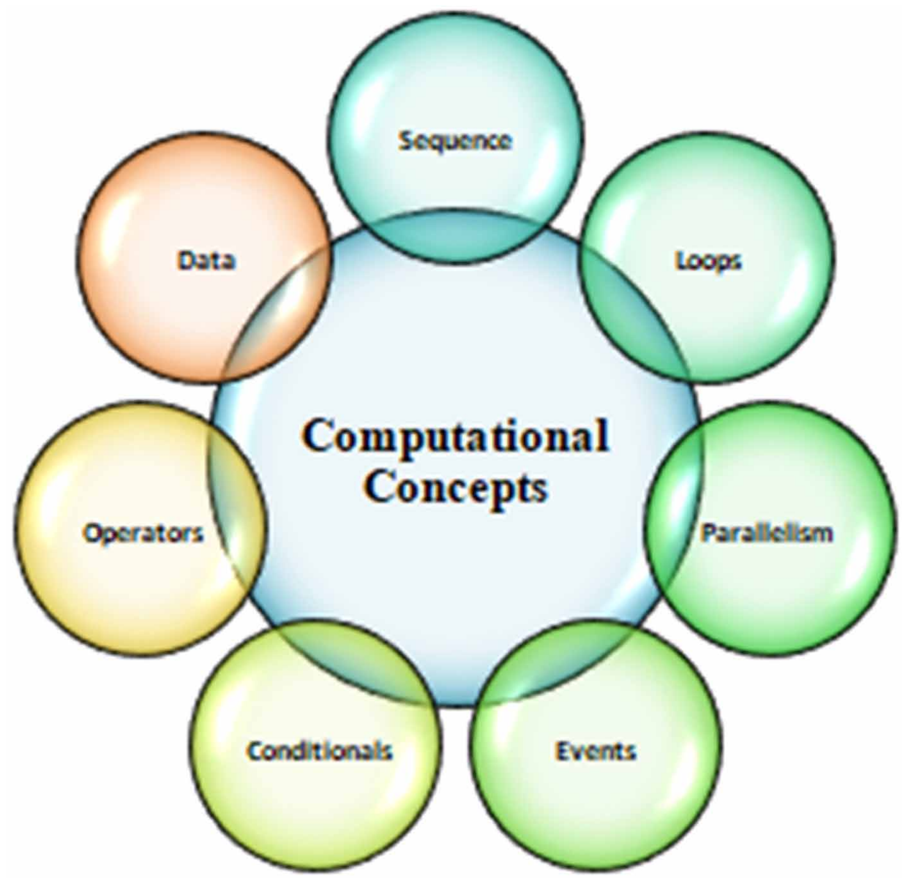
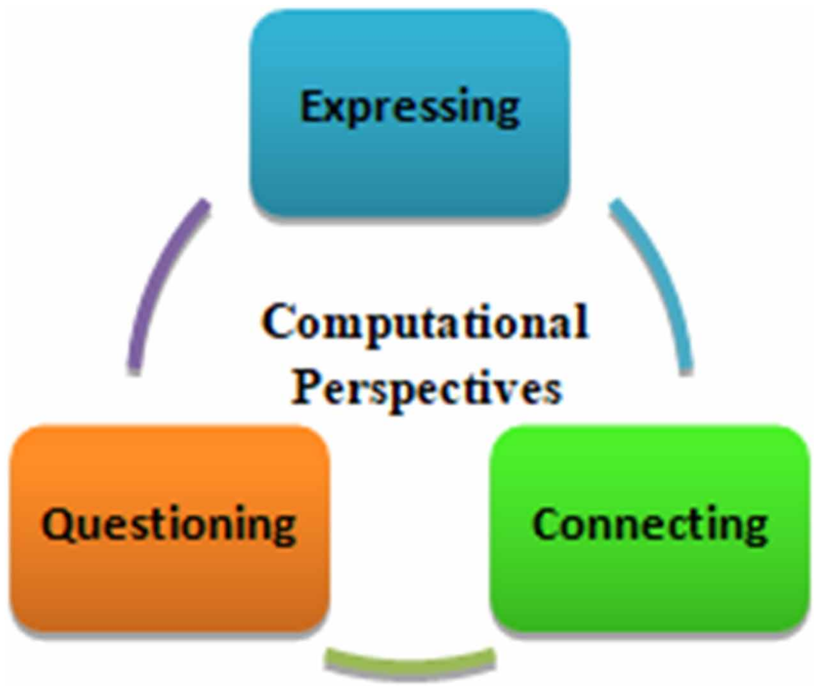


Figure 6. Computational Practices (Source: source: Brennan, K., & Resnick, M. (2012))

Figure 6 describes the decision making and refinement approaches used during programming (incremental and iteration, testing and debugging, reusing, and remixing, abstracting, and modularizing). All the kits reviewed encourage iterative and incremental development by allowing for errors and an infinite number of attempts. Children can test their code to see if it works properly and debug problems if something goes wrong during the design process. To evaluate the aspects of remixing and reusing that allowed children to share and build on each other's project activities. This feature is not explicitly supported by most of the kits tested. ScratchJr (Portelance, &Bers,2015) allows children to share their created projects across various platforms. LEGO WeDo 2.0, Cubetto, and Cubelets kit will enable chil-

Figure 7. Computational perspectives (Source: Brennan, K., & Resnick, M. (2012))



dren to develop new programming sequences, test their connected block sounds, light, and understand the concept from scratch.

Figure 7 describes Computational Perspectives (Expressing, Connecting, and Questioning) include students' ability to critically comprehend ideas and technological systems developed by understanding "the world around them and themselves" and to solve problems when things do not go as planned. After using these computational kits, children could understand their ability. They also try to figure out how to connect blocks for new work and ask questions to analyze the concept on their own. In this section given detailed study on the robotic kits, tangible blocks available for young children to learn programming in his/he early childhood, and this will help educators.

Educational Robotic in Early Childhood Education

In a classroom, an educational robot aims to provide personalized learning. In particular, numerous reports indicate that STEM education using robots as teaching aids can improve the children's motivation and heightened learning effects (Todorovska, &Bogdanova,2020; Causo,2016; Gonzalez, & Munoz-Repiso,2017). Educational robots are used in the classroom to teach programming, problem-solving, design thinking, mathematics, physics, and even art and music to children of all ages (Isnaini, & Budiyanto,2018). Humanoid, semi-humanoid, and pet-like education robots are classified into three types based on their appearance. Humanoid robots resemble humans, making them attractive for educational platforms. NaO and Asimo, for example, appear to be children and encourage them to interact. Teachers use humanoid robots as teaching assistants to provide an interactive learning experience for children (Causo,2016). Semi-humanoid robots use wheels to move around half of the body like a human. For example,Robovie(Kahn et.al.,2012), Tiro, and Papero(Osada,2005) are also classified as semi-humanoid robots. Robots that look like pets, animals, or cartoon characters are known as pet-like robots such as DrangonBot(Setapen,2012), Icat (Rios-Rincon et.al.,) and Keepon(Cao et.al.,2014), these small size robots mostly designed for special purposes. For example, the Icat robot is designed for special children to teach social values. These robots are not designed to replace the teacher but to help educators teach concepts interactively for young children.

Teaching language to children is a very complicated task in the classroom, especially in young age children. The existing tools are not customized for individuals but with the help of educational robots, teachers could easily teach a language with the help of some exercise to young children (Belpaemeet. al.,2018; Kennedy et.al., 2016; You et.al.,2006; Ozkul et.al., 2014; Kory, Jeong, &Breazeal,2013). With the advantage of this robotics children can improve vocabulary skills, and pronunciation of words in language learning. Also, some of the teaching assistant robots are used to teach programming instruction, typically basic syntax used in a programming language and exercises in the classroom (Causo,2016). However, teachers in programming class commonly spend much time correcting errors and debugging students' programs. This delay affects individual students' learning time, but it can be much easier through robots where it will rectify the problem and assist the children (Causo et.al.,2016). Thus, the teachers can give individual attention to students. Other than learning skills, children require social communicative skills and mannerism. In some situations, or due to family background some children face difficulties in communicating. To overcome this, social robots are used, and it is unique in features, focused mainly as personal assistants to children at home. It helps and suggests the children to do homework and learn new things in his/her home. Few robots such as Moxie, Misa, Roybi, and Miko robots considered educational content with storytelling, moral values, greeting, educational videos, and general knowledge. It has a brilliant facial expression, and these robots also act as best companions for kids (Han,2009). Social robots are designed to assist children enhance their social-emotional and communication knowledge by having short conversations with them and showing them demo videos to help them understand. Nowadays children show much interest towards this type of personalized robots even youngsters also using social robots as a personal assistant to control home appliances. Other social robots like Zeno (Velez,2014;Kirstein, &Risager, 2016; Park et.al.,2017) in the classroom increase the children's concentration time and concentration efficiency.

Table 2 shows the some commonly used robots in education and its developer, name of the country, year of manufacture, purpose of robots, height, sensors, software, and type of material used to develop. This kind of robot is used in various research experiments in early childhood education.

Table 3 shows a detailed study about the existing educational robots for early childhood and their impacts on learning through robots. This research study considers the factors related to age and number of children who participated, type of robot and technologies used, research approach, and theoretical framework. From the above table, it has identified that most of the existing educational robots are developed for children aged from 3 to 8 years. This helps the children to improve and enhance their capabilities in various fields such as mathematics, science, and even improve language skills. Qualitative/quantitative, mixed methodology, empirical, experimental study approach, and other research methods are commonly used. There are two different paradigms used for the studies as mentioned above are constructivism and constructionism. Constructivism refers to gaining knowledge in a student-centric method where this constructivism with technology allows the learners to be more interactive.

Several existing research studies related to STEM education enabled constructivism with technology, and for robotic social research, they did a study based on constructionism. The current era expedited

Table 2. Educational robots for young children

	Keepon	Kasper	Zeno	NaO	Jibo	Pepper	Lego WeDo 2.0	QTrobot	Misty II
Creator	BeatBots	University of Hertfordshire	Hanson Robotics	SoftBank	Jibo Inc	SoftBank	Lego	LuxAI	Mistry
Country	US	UK	US	France	US	Japan	Denmark	Luxembourg	US
Year	2003	2005	2007	2008	2014	2014	2016	2017	2018
Type	Consumer	Research	Research, Humanoids	Humanoid, Education, Research	Consumer	Humanoids, Entertainment, Consumer	Education	Education, Research, Medical	Research, Education
Height	27.5 cm	55cm | 21.6	63.5 cm | 25 in	58 cm |22.8 in	28 cm |11 in	120 cm |47.2in	Depends on creation	64 cm |25 in	35.5 cm
Sensors	Cameras, microphone Array of touch sensor	Cameras, Force-sensing resistor, capacity touch sensors	3microphones, grip load sensor, 2 cliff sensor, 2 obstacle detection, bump sensor, 21 joint load sensor, 30 joint position sensor.	5 MB OmniVision cameras, Accelerometer,4 microphone,2 infrared sensor,9 tactile, 8 pressure sensor	Stereo cameras, 6 microphone, LCD touch screen, touch sensor, HR encoders.	5-MB camera, 3D sensor,4 microphones, touch sensor,3 bumper sensor, Gyroscope	Motion and tilt sensors	Inter Real Sense D435 depth camera, Speaker, Motor rotary encoder, temperature sensor.	4K video sensor, infrared projector, touch panels, 8 flight, sensor, 6 pump sensor
Software	C and Max	Java, YARP, C++, Python	Linux Ubuntu	Linux OS, Choregraphe suite	Linux OS And JavaScript SDK	NAOqi OS, C python, Java, c++, JavaScript (Over 20 s/w)	WeDo 2.0	Ubuntu, Linux, Java, python, c++,	Android 7, WinML, TensorFlow
Material	Silicon rubber skin	Fiberglass body, silicon rubber face, aluminum frame	Frubber, plastic and aluminum	Polycarbonate-ABS plastic, Polyamide, carbon-fiber-reinforced thermo plastic	Aluminum, ABS plastic, glass	ABS resin, polycarbonate resin	Plastic	ABS plastic, Aluminum	Injection model ABS, PMMA and NBR
Picture									

Artificial Intelligence technology and autonomous robots in various domains and played an essential role in accomplishing tasks effectively and efficiently. Earlier stages of effective learning set forth the person's skill throughout his/her life. Improving the level of thinking and understanding the latest technology at the early stages of children using educational robots will build their intelligence and conceptual skills. Thus, in recent years, most research studies are highly focused on the nursery and primary-level children. The often-used robots for research purposes are KIBO (Miranda-Pinto, Fernandes, &Osório, 2021; Sullivan, Bers, & Mihm, 2017), LEGO(Strawhacker, & Bers,2015;Eck et.al.,2013; Bers,2007;Afari,&Khine,2017), Bee-Bot (Eck et.al.,2014;Stoeckelmayr,Tesar, & Hofmann, 2011), Cubetto(Anzoátegui, Pereira, &Jarrín, 2017), and NAO (Kirstein, &Risager, 2016). The basic few common sensor components constructed for the above mentioned are light sensors, sound sensors, barcode reader, ultrasonic sensor, motions sensors, tilt sensors, LEGO WeDo motors, etc.LEGO block robots are used widely where the children can make the new shapes of robots using them. Thus, they can create their character robot, which induces their creativity and imagination by play mode. Included in that, robotic programming using block coding helps the children to give commands to the robot, which makes them understand the functions of programming instructions. In (Williams, Park & Breazeal, 2019; Williams et.al., 2019), the curriculum is designed to teach artificial intelligence concepts to the kindergarten children such as supervised machine learning, rule based programming and generative AI to them using LEGO blocks robot; after post assessment the results showed necessary developments in their skills based on the technology and robot.

The most used programming platforms are open-source Python, HTML, and JavaScript to develop the applications. Robot modeling helps to make a 3D print, and it becomes most necessary in making a

Table 3. Education robot for early childhood education

#	Author	Age/ (No of children)	Name of the Robots	Research Approach	Theoretical Framework
1	(Miranda-Pinto, Fernandes, &Osório, 2021)	3-5 (13)	KIBO (Light sensors, Sound sensors, Barcode reader, ultrasonic sensor)	Qualitative Research	Positive Technological Development (PTD), Constructivism
2	(Bers, González-González &BelénArmas, 2019)	3-5 (172)	KIBO (Light sensors, Sound sensors, Barcode reader, ultrasonic sensor)	Mixed Methodology, Comparison study	Positive Technological Development (PTD), Constructivism
3	(Williams, Park & Breazeal, 2019)	4-5 (84)	PopBots (LEGO Blocks, Smart Phone, Tablet, App)	Experimental Study Comparison study(age)	Theory of Mind
4	(Park et.al., 2018)	5	ChildAR-bot Application (Augmented reality, Spatial Augmented reality)	Experimental Study	Conceptual Framework for Robotics
5	(Anzoátegui, Pereira, &Jarrín, 2017)	4-5 (21)	Cubetto	Exploratory research Evaluation study	Constructivism Joyful learning Theory
6	(Sullivan, Bers, & Mihm, 2017)	4-7 (322)	KIBO (Light sensors, Sound sensors, Barcode reader, ultrasonic sensor)	Mixed Methodology	Constructionism Constructivism
7	(Ramírez-Benavides, López, & Guerrero, 2016)	4-6 (53)	TITIBOTS, PAT (Programming Assistant Tool)	Evaluation Study	Constructionism
8	(Sullivan, & Bers, 2016)	4-7 (60)	KIWI, CHERP	Qualitative Research, Comparative Study	Conceptual Framework for Robotics
9	(Kirstein, &Risager,2016)	3-4 (29)	Zeno, NaO, Romibo	EMPIRICAL STUDY	Constructivism Constructionism
10	(Peca et.al., 2018)	9-18 month (23)	Keepon (Equipped with camera, touch sensors, and autonomous and teleoperation modes)	Experimental Research	Constructivism Constructionism
11	(Sullivan, Elkin&Bers, 2015)	4-7 (32)	KIBO (Light sensors, Sound sensors, Barcode reader, ultrasonic sensor)	Qualitative Research, Case study	Conceptual Framework for Robotics
12	(Tanaka et.al., 2015)	4-5	Pepper (Python, Java, and C++)	Qualitative, Quantitative Research, Case study	Constructivism Constructionism
13	(Gordon et.al., 2015)	4-6 (22)	SoRo (Social Robot) vinyl stickers	Qualitative Research Experimental study	Conceptual Framework for Robotics
14	(Strawhacker, &Bers, 2015)	5-6 (25)	LEGO WeDo, CHERP	Mixed Methodology, Comparison Study	Constructivism, Positive Technology Development (PTD)
15	(Scaradozzi et.al., 2015)	3-8	LEGO WeDo 2.0	Qualitative Research, Evaluation study	Constructivism
16	(Krieg,2011)	4-6	CHERP tangible block (Creative Hybrid Environment for Robotic Programming)	Qualitative Research Evaluation study	Constructivism Positive, Technology Development
17	(Eck et.al.,2014)	5 (7/10)	Bee-Bots, Cubelets, Lego Mindstorms	Quality Research Empirical Research	Constructivism
18	(Kory, &Breazeal, 2014)	4-6 (20)	DragonBot (Android phone, tablets, LEGO Blocks)	Evaluation study	Constructivism, Positive Technology Development
19	(Eck et.al.,2013)	4-5	Bee-Bot, Cubelets Lego Mindstorms	Mixed Methodology	Constructivism
20	(Liu et.al.,2013)	5	Topobo	Exploratory, Empirical research, case Study	Constructivism
21	(Setapen,2012)	4-7	Dragon Bot (Squash-and-stretch Android smartphone-based robot)	Experimental Research	Constructivism Constructionism
22	(Stoeckelmayr,Tesar, & Hofmann, 2011)	5-6 (9)	Bee-Bot	Qualitative Research, Experimental study	Developmental Psychology Constructionism
23	(Mioduser& Levy, 2010)	5 (6)	RoboGan (Neural Network,physical simulation, 3D printing, mechanical assembly, and embedded processing)	Mixed Methodology, Exploratory study	Cybernetic Theory
24	(Janka,2008)	4	Bee-Bot	Qualitative Research, Case Study	Constructivism Constructionism
25	(Bers,2007)	4-7	LEGO Mindstorms set (ROBOLAB iconic language)	Mixed Methodology, Design Experiments	Constructivism

Table 4. Humanoid robot for special education

#	Author	Year	Age / No of children	Robots & Programming language	Research Approach
1	(Yousif, 2021)	2021	6-8 (59)	NaO, (C# application)	Qualitative research method
2	(Pivetti et.al., 2020)	2020	3-8	KIBO, NAO, LEGO Mindstorms WeDo, Bee-Bot, Coding Blocks, Dash Robot	Survey Method
3	(Yousif, Kazem, &Chaichan, 2019)	2019	4-5	Nao, pepper, Milo, Aisoy, Kasper, Keepon	Survey method
4	(Amanatiadis et.al., 2017)	2017	5-8	NaO (C, C++, Python, Java, MATLAB)	Experimental Research
5	(Alemi &Basirib, 2016)	2016	5-8	NaO (C, C++, Python, Java, MATLAB)	Qualitative Research Case study
6	(Wainer et.al., 2014)	2014	6-8 (6)	KASPAR (Java software, YARP, C++, Python)	Experimental Research
7	(Miskam et.al., 2014)	2014	8	NaO Android Application	Qualitative Research Case study
8	(Kozima, Nakagawa & Yasuda, 2005)	2005	2-4	Keepon	Case study, Longitudinal research

robot. These types of robots play important role in classroom and act as teaching assistant.Some of robots like NaO(Kirstein, &Risager, 2016; Miskam et.al 2014)used in classroom to teach language for children. As a result of these children showed high interest when learning with robots. KIBO (Miranda-Pinto, Fernandes, &Osório, 2021; Sullivan, Bers, & Mihm, 2017), Cubetto(Anzoátegui, Pereira, &Jarrín, 2017) and Bee-Bot (Eck et.al.,2014;Stoeckelmayr,Tesar, & Hofmann, 2011) are used in classroom for introduce programming language at young age to improve creativity, problem solving and other academic skills. Keepon(Cao et.al.,2014)robot improvechildren's social skills and increase thinking capability at early childhood to take better decision in future. This study further shows that curriculum related to technology, AI programming, and social behaviors are required for children at the nursery level and offer their capability in learning new things.

Humanoid Robots for Special Education

Robotics is used universally in education as a learning tool, but surprisingly used mostly in special education (Amanatiadis,2017). Special education is to give special attention to those affected by genetic disorders. This kind of robot has friendly, designed, constant, and predictable behaviors like the human thought process; and reduces the natural anxiety level of many children who suffer from traditional settings.

Children are affected by various disorders at young age like Autism Spectrum Disorders (ASD) (Valadao et.al., 2016), Attention Deficit Hyperactivity Disorder, Motor impairments, Cognitive impairments, Communication impairment, Developmental disabilities, Mental impairments, and Hearing impairments. The latter tools have proven to be extremely beneficial in the education of children, particularly those with learning disabilities. Many studies have recently revealed that humanoid robots can help young children with special needs achieve learning goals and connect to the outside world(Pivetti et.al.,2020).

From table 4, Most of the researchers mainly focused on Autism Spectrum Disorders (ASD). It's a difficult neurodevelopmental disorder with strong genetic causes. Autism symptoms include difficulty talking about or understanding others' feelings, lack of facial expressions and eye contact, difficulty interacting, and sensitivity to physical contact (Kozima, Nakagawa, &Yasuda,2005). The NaO robot has been tested on children with autism and other disabilities. NaO is a 58-centimeter-tall robot that is used to play games, learn new subjects, and practice speech. The robot communicates with children by using appropriate vocabulary, speaking in a child's voice, and expressing emotions (verbal and nonverbal). The NaO robot's specifications include a Linux-based operating system, four mics, two speaker systems, and two HD cameras. C++, Python, Java, .Net, and C programming languages are used for NaOrobots.

NaO robots are also used to teach the English language to Autism children (Miskam,2104). After implanting the robot in the classroom to learn English, children show great motivation and a positive attitude towards robots. KASPER (Wood,2019) is a one-of-a-kind robot designed to help people with autism and other communication difficulties improve their turn-taking, collaborative, and tactile social interaction skills. Kasper interacts with young kids by using a wide range of generalized facial and body gestures, hand movements, and speech to break social isolation. This robot, which looks like a tiny boy baby, includes 55cm tall, cameras in the eyes, a force-sensing resistor, and a capacitive touch sensor. Programming used to design this robot Java software, YARP, C++, and Python interfaces optional. Like other unique robots Pepper, Aisoy, and Milo (Tanaka et.al.,2015) greatly help Autism children overcome their fears in his/her life. Children can learn social interaction skills such as reading feelings and communicating through role-playing and scenarios. The goal is to get the kids to step outside of their comfort zones without being afraid of exposing themselves to strangers, and the fact that they react in front of a robot that responds and reacts motivates them to not disappoint the companion robot, unlike an inanimate object such as a computer or tablet.

From this study, there is no doubt that robots will create new revolutions in the future for special children. With robotic education children can overcome their academic barrier and can learn social values. This type of special education robots is specially made for autism and Neurological disorders children. For example, robotic arms are used to provide an alternative method to engage in joint play activities of special children because which makes them lose interest in their environment.

Existing Curriculum Framework Design

The curriculum framework is the period of preparation during which instructors design the instructional units for their courses. It entails putting together activities, reading, lessons, and evaluations that will assist students in meeting their educational goals. There are three types of curriculum design: subject-centered design, learner-centered design, and problem-centered design. Subject-centered design is concerned with a specific self-control, learner-centered design is concerned with students' goals and interests, and problem-centered design is related to specific problems and solutions.

Table 5 shows the detailed study on the existing curriculum design framework for young children to learn Artificial Intelligence concept, programming and basic functionality of robots and its features. The age/number of children who participated, the study's goal, the type of robotic kit used, and the curriculum-focused activity are all factors considered in this research study. In that above table, most of the existing curriculum for children aged 4 to 8years has been based on programming kits and AI

Table 5. Existing curriculum design for young children for learning robots AI and programming

#	Authors	Age/ No. of children	Study Tool	Robotic Kits	Curriculum	Concept of Learning
1	(Miranda, Fernandes, &Osório, 2021)	3-5 (13)	Problem solving ability	KIBO	Robotic	● Sturdy Buildings ● What is a robot? ● What is a Program? ● What are repeats? ● What are sensors? ● Culminating project
2	(Williams, Park, & Breazeal, 2019)	4-7 (80)	AI Concept	PopBot (SmartPhone, LEGO blocks, Tablet, LEGO WeDo Motor)	Artificial Intelligence	● Knowledge base ● Supervised Learning ● Generative AI
3	(Nam, Kwon, & Han, 2019)	5 years (18)	Scientific Problem-Solving ability	Bee-Bot	Robotic	● Exploring ● Understanding Bee-bot's Function ● Learning Bee-bot Function ● Application Bee-Bot's Function
4	(Sullivan, & Bers, 2016)	4-7 (60)	Robotics and programming concepts	KIWI, CHERP	Robotic	● What is a robot and programming? ● What is a sound sensor? ● What are repeat loops? ● What are distance and light sensors? ● What are conditional statements? ● Final project
5	(Portelance, & Bers, 2015)	4-7 (62)	Programming Knowledge	ScratchJr App	ScratchJr Programming called ''Animated Genres''	● Programming block lessons ● Beginner blocks ● Intermediate blocks ● Advanced blocks
6	(Elkin, Sullivan, & Bers, 2014)	5-8 (19)	Learning programming Tool	LEGO® WeDo™ kits	Robotic	● The Engineering Design Process ● What is a Robot? ● What is Program? ● What are Repeats? ● What are Sensors?
7	(Sullivan, Kazakoff, & Bers, 2013)	5 (37)	Programming Knowledge	CHEPR, LEGO WeDO 2.0	Robotic	● What is the Engineering Design Process & What are Engineers? ● What is a Robot? ● What is a Program? ● Culminating Project: Robot Recyclers
8	(Bers & Flannery, 2010)	4-7	Learning with technology	LEGO RCX	Programming and Robotics	● Engineering design process ● Robotics ● Control flow by sequencing and by instructions (loops and branches) ● Parameters ● Sensors.
9	(Bers, 2010)	4-7	Learning with technology	CHERP	Programming and Robotics	● Study Building (Engineering design process) ● What is a robot? (Robots special parts and its functionality) ● What is a loop? (Loops and number parameters) ● What is a sensor? (Sensors and loops) ● The Robot Decides (sensors and branches)

concepts for decades. To be brief, these curriculums cover various concepts such as robotic curriculum designed to teach about mechanisms of robot functionality, sensors used in small robots, programming curriculum designed for teaching programming basic structure, loops, and conditional statements like if-then, if-then-else rules. ScratchJr (Portelance,Strawhacker,& Bers,2016) is a GUI based (Graphical User Interface) programming platform for young children to start their first-level coding. Bee-Bot (Nam, Kwon, & Han, 2019) curriculum has been designed to develop the scientific problem ability of children. Nowadays children use artificial intelligence-based application devices without knowing how it works. For that reason, curriculum includes and is designed to teach about artificial intelligence concepts like rule-based, supervised machine learning, generative AI, and Neural networks concepts through play way method with robotic kits (Williams, Park, & Breazeal, 2019).CHERP(Sullivan, & Bers, 2016; Bers, 2010), Bee-Bot (Nam, Kwon, & Han, 2019),PopBot(Williams, Park, & Breazeal, 2019) and LEGO WeDo 2.0 kit (Elkin, Sullivan, & Bers, 2014)are most used in curriculum development since the last decades.

KIWI is a tangible block made up of interlocking wooden blocks and various sensors known as CHERP (Creative Hybrid Environment for Robotic Programming). Users can scan barcode reader on CHERP frame and immediately send a signal to the robot (Sullivan, & Bers, 2016). Bee-Bot is a programmable floor-based robotic kit for young children learning to program using simple left, right, and rotate instruction functions. It moves and takes 15cm steps accurately, and it can remember up to 40 commands, according to the children's programming instructions. It makes a sound effect and flashes at each step to prevent it from performing (Nam, Kwon, & Han, 2019). MIT developed a PopBot (Preschool Oriented Programming) which is another android based robot teaching tool kit for young children to introduce robotics; programming and artificial intelligence by allowing children build their own design based robotsA motor, tilt sensor, motion detector, a LEGO® USB hub, wheels, and a wide range of LEGO® bricks are among the more than 150 elements included in the LEGO WeDo 2.0 robotic (Sullivan, Kazakoff, & Bers, 2013). After building a robot, kids connect it to a computer using a Power adapter and program it with the included WeDoTM software. These curriculums gave positive results on children's scientific problem-solving ability using these kinds of robotic kit and ScratchJr programming platform (Strawhacker,Lee,&Bers,2018;Strawhacker et.al.,2015).Children's ability to understand AI concepts and features was found to be positively correlated with how they could explore AI concepts and other problem-solving abilities to interacting with robots through game-based activities in this study.

CHALLENGES AND OPPORTUNITIES IN EARLY CHILDHOOD EDUCATION

Several research on early childhood education have been conducted over the past few decades. The ideal age for early childhood education is from 3-8 years old, because at this age the children tend to get to know their environment and have a high level of curiosity. Use of robotics, artificial intelligence and other technology in early childhood education is very less in developing countries due to several factors such as lack of technological, social, inadequate teaching, learning resources and economic challenges. Nonetheless, technology does not give better learning experience all the time and still has some issues like security, slow response, ambiguity and privacy in children devices.

In this 21stcentury, giving several opportunities for young children programming and robotics in early childhood education helpsto bring better learning experience and it reduces the learning time. It also develops the children's computational thinking and problem-solving ability from a youngage. The gap in the traditional classroom depends on a teacher-centred method and all children do not have the same level of background knowledge to understand the concepts in educator mindset. Robotics and adaptive learning give the solution for that gap in classroom education. Moxie, Misa, Roybi, and Miko are numerous intelligent robots that came after Logo turtle robots, these come with predefined educational content with more intelligence to interact children. Instead of robotic and artificial intelligence at home, parents can provide physical activity, fruitful mind related games, and household activity which enhances the children's thinking capability, problem-solving, decision-making skills at young age. Young children need self-confidence, motivation, discipline, positive attitude, and other valuable skills for life and these skills can be least expected at the initial stage of robotics.

CONCLUSION

Artificial intelligence and robotics play a vital role in early childhood education. This chapter has critically reviewed the importance of computational thinking, various computational and programming robotic kits, and educational and special education robots. Tangible blocks and Visual blocks-based coding is one of the best source children learn basic programming skills at a young age. Programming skills also help to understand various technologies around children and improve problem solving ability, creativity, and decision-making skills. Education robots are used in the classroom as tutor for children and monitor the kid's activity. Special humanoid robots are designed with excellent facial expressions and customized voices; with the help of these robots, Special children could overcome their academic difficulties and loneliness. In addition, this chapter has presented the existing curriculum framework design for children aged from 4-8 years old.

According to this research, robots may be able to assist children in the development of various academic skills such as science, mathematical concept development, and language improvement. Artificial intelligence, on the other hand, has been hailed as a promising educational aiding tool for all children who require a welcoming and cooperative approach to service delivery. It will be helpful for educators to implement personalized learning experiences in the classroom through robots. In the future, this research work is directed towards developing educational robots and introducing computational thinking and Artificial intelligence curriculum concepts to the nursery and primary level children in focusing on their advanced thinking and development.

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KEY TERMS AND DEFINITIONS

Artificial Intelligence: Artificial intelligence is the simulation of human intelligence process by machines, especially by computer system.

Block-Based Programing: Block based programming are using GUI interface help children to learn simple programming.

Computational Thinking: Computational thinking is a process of formulating and solving problems by breaking them down into simple steps.

Educational Robot: Educational robot designed to introduced teach programming, assist children activity and monitoring children behavior.

Machine Learning: Machine Leaning is a subset of Artificial Intelligence that enable machines to improve at tasks with experiences.

Special Education Robot: Special education robots help special children to reduce shyness, frustration, anxiety, and boost confidence.

Tangible Block: Tangible block are physical block embedded with different sensor to create simple programming.