Creating Appropriate Student Challenges for an Elementary School Robotics Curricula

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Introduction

This work describes the development of a Lego robotics curriculum by Mr. Mishler at The School at Columbia University, where he is the Director of Technology. Dr. VanEsselstyn and Mr. Mishler worked within a design research framework to articulate the development decisions at play in the curriculum development. This paper chronicles those decisions and relates them to the educational framework of "adaptive expertise" which has relevance to this work.

Classroom work with Lego robotics has its roots in the constructionist principles forwarded by Seymour Papert (Papert, 1980) which developed out of the principles of developmental psychology developed by Piaget (Piaget, 1950). Multiple efforts have been undertaken in recent history to describe the practical application of these theories and principles in curriculum development that involves Lego robotics(Bers *et al.*, 2002).

Work in the domain of "adaptive expertise" has been less frequently applied to teaching and learning with Lego robotics, and here we endeavor to apply the foundations of this work to the curriculum development effort. We believe that this novel approach will have both practical applications for the development and design of curriculum, and theoretical implications for the way in which Lego robotics and related technology-based learning approaches are considered within the K-12 curriculum.

Our Methods

This work is based in the design research framework (Collins, 1992; Edelson, 2002) which emphasizes the evaluation of design aspects of project development. Dr. VanEsselstyn and Mr. Mishler kept journals of their ideas, notes from their meetings, and occasional recordings of their conversations as the project progressed. The content of these materials were then coded and analyzed, resulting in a body of material that serves to establish the basis for hypotheses that may be pursued using more empirical techniques.

The Curriculum Development Process

The School's integrated curriculum is informed by themes, concepts, and topics propelled by important questions—all of which provide a coherent and cohesive learning experience that allows for the emergence of new knowledge, ways of thinking, and skills. For children at The School, learning promotes understanding and the growth of creative and reflective habits of mind.

Twice a year, The School at Columbia University sponsors Integrated Projects Week (IPW). During the IPWs, integrated projects often involve students from different classes and grades, teachers of different specialties and draw on the resources of The School, Columbia University, and the wider community. Their projects present rich opportunities to reflect on what they have learned, apply new-found skills, and deepen their knowledge about a particular topic, theme, or concept already embedded in The School's curriculum. Students spend approximately 40 hours focused on a collective effort, often finding new ways to work collaboratively.

During the Winter 2003 Integrated Projects Week (http://theschool.columbia.edu/home/curriculum/IPW), with assistance from Columbia Computer Science Professor Elizabeth Sklar's "Agents Lab", a group of teachers and students from The

School explored the idea of creating robots that would perform dances. Students built simple robotic vehicles of Legos and programmed their basic choreography with RoboLab. They decorated the vehicles with various art supplies to provide character consistent with the theme of the dance. The success of the week's effort prompted further interest in robotics at The School.

The most viable way to immediately further robotics in response to the great enthusiasm and interest generated from that IPW was to create an after school program focused on Lego Robotics. Mr. Mishler and one of the teachers from the IPW, began devising a program that would culminate in a competition called RoboCupJr (http://www.robocupjunior.org/). This was useful as it gave us a basis for "working backwards" to develop a curricular framework for the semester's after school program. The curriculum was developed to both encourage basic skills in Lego construction and programming, and ultimately afford the learners the ability to flexibly respond to the sorts of problems that the RoboCupJr design challenges offered.

With $2500 seed money from technology (12 Invention Systems 2.0 kits, organizing bins from Home Depot and a site license for RoboLab), Mr. Mishler purchased the requisite materials. However, the after school program was always intended to be financially self-sustaining. The school hired Columbia University undergraduates in the Computer Science Department and a Post-Doctoral assistant with extensive experience in robotics/RoboLab to assist with the program. In order to sustain these expenses, the after-school program charged parents $20 per week ($5 per hour) tuition to cover these labor costs and any additional necessary materials. This program was offered on Tuesdays and Thursday 3:30-5:30 throughout the Winter semester.

The Spring 2004 after-school effort was quite successful. It reached full capacity for enrollment and sent three students to the NorthEast Regional RoboCupJr competition at M.I.T. One student brought home a trophy for "Most Creative Design" in the primary division. Capitalizing on this momentum, we decided again to offer a robotics IPW at the conclusion of the Spring 2004 term. This IPW, however, came to be comprised of two half-day projects: the morning session was offered to 2nd graders who developed their recent curriculum investigations on emotions and the afternoon session was offered to 3rd and 4th graders who developed their recent curriculum investigations on justice. Mr. Mishler taught a separate IPW with 3 students to document these efforts (that video available at http://theserver.theschool.columbia.edu/%7Espadilla/streaming/robotics.mov). These 3 IPW projects provided a capstone experience of our first year attempts at robotics.

During the current academic year, 2004-2005, we further developed the after-school program adding a Monday/Wednesday section to the first semester due to the high interest in this program. During that semester, we were teaching robotics and RoboLab to 30 students, four hours per week! The Spring 2004 semester focused on the First Lego League competition (http://www.usfirst.org/jrobtcs/flego.htm). Again, we worked backwards to devise a framework for the curriculum to prepare for the competition to be held in NYC in early February 2005. Unfortunately, the difficulty of the challenges was underestimated by the instructors. The after-school curriculum focused on the specific skills too late in the term. The team was ill-prepared for the competition and as a result the School group did not attend this year.

In Fall 2004 we began integrating robotics into the normal curriculum with the 4th grade during their simple machines unit in trimester 1 (the school curriculum is trimester-based while after school is semester-based). The primary effort here was to investigate the physics of gears and pulleys as well as the mechanical properties of Lego parts and connectors. Following that initial investigation, a sufficient introduction to the RoboLab software was given followed by a series of challenges that drew upon both these physical and logical construction principles. These challenges provided students with a means to apply their existing knowledge to solve novel problems in a variety of approaches. Students also kept journals (blogs) documenting their experiences and produced technical descriptions of their constructions. The overriding goal was to write these descriptions so their grandmother could understand what they were communicating.

Extending, once again, a curricular theme, we created an IPW entitled "Not So Simple Machines" offered to grades 4, 5 and 6 for the Winter 2004 term. This effort looked at Rube Goldberg type contraptions (the Honda "cog" commercial (http://194.29.64.17/thecog/movie.html) served as our inspirational launching pad) with the intent that we would build such a machine, but with a twist. Instead of small groups working in parallel as we had in the past, we decided to divide the students into five groups of three students each with responsibility for a sector of the whole machine—a machine that would turn the light out. The room was divided into five corresponding sectors and each group began brainstorming their part of the machine. A video of the final project is available at http://theserver.theschool.columbia.edu/%7Espadilla/streaming/ipw3/notsosimple.mov.

Barely able to sustain the activity of the first after-school semester of 2004-05, we decided that we needed to revert back to two days per week, but Monday's roster would now be comprised of different students than Wednesday's. Though the students would now get only two hours per week, we could maintain the bottom line number of students at 30. During this semester we once again culminated our efforts at the NorthEast Regional RoboCupJr competition at M.I.T., this time with 17 students and bringing home 4 trophies!

During the final trimester of school, we again integrated robotics into the normal curriculum with 2^{nd} graders. We began the effort later than we had wanted to so we established a plan that we would focus specifically on RoboLab and the principals of logical construction; the robot vehicles were built in advance for the students. Each lesson was followed by a challenge (guided with reference) and a super challenge (guided only with verbal prompts). Students exceeded our expectations coming to a full understanding of inputs versus outputs, learning to build programmed responses to both touch and light sensors.

Once again to build on this activity we offered an IPW to 2^{nd} graders interested in designing, constructing and performing a vast robot parade. For this, we began right where we had concluded. Students modified their robots adding two light sensors and created a program that would allow the robot to follow a black line on a platform. The line served as the parade route which students decorated with a wide variety of props. Additionally, they programmed music compositions into their robots and created all the decorations for the float they had designed.

Aiming for the final objective of creating a parade of robotic floats during IPW, Mr. Mishler worked backwards to create a curriculum to scaffold that activity but to also give all 2^{nd} graders a basic understanding of RoboLab. These lessons became the routine knowledge that equipped students to become adaptive experts. Interestingly, this activity will become the basis for a more successful after school program next year for the following reasons: 1) solid base of routine knowledge among ALL 2^{nd} graders, 2) familiarity and comfort with broad, collaborative effort (see quote below), 3) established teacher-student rapport and 4) essentially all technology learning outcomes that relate to robotics have been met. After bringing the students new to robotics up to par (which is enormously easier given the peer expertise), the after school students will be engaged much quicker in adaptive expertise activities (which is exemplified by FLL and RoboCupJr).

In preparation for the 2004-2005 year, Dr. VanEsselstyn began to work with Mr. Mishler to articulate the roots of the decision making process that governed the curriculum development for the three areas in which Lego robotics would be incorporated in the curriculum: the IPW, the after-school club, and the integration into the normal curriculum. That collaboration took the shape of repeated conversations during which the student needs, educational goals and objectives, student activities and expected outcomes were recorded for each aspect of the work.

Literature Review

Subsequent to the curriculum planning, we began to examine literature related to this work. Our intention here was to uncover literature and research that might affect curriculum development in this area.

Curriculum and student activities surrounding Lego robotics meshes well with developmental psychology literature . Piaget's theories around developmental psychology came to have seminal effects on educational technology (Piaget, 1950) and has had subsequent effects on governing the integration of Lego robotics in the K-12 curriculum (Papert, 1980). This area of literature serves to provide a general guide to the cognitive development that is thought to be associated with the manipulation, assimilation, and accommodation activities made possible through the effective use of Lego robotics.

While this literature, again, provided an excellent backdrop for considering the potential gains of Lego robotics curriculum at the School, in the process of curriculum design, we became attracted to literature in the domain of "adaptive expertise". Ultimately, we have found research and writing in this area to provide a suitable framework for the sorts of development that we think the curriculum is best able to foster. Specifically, the "adaptive expertise" literature focuses on an end state in learners that is congruous with the flexible problem-solving approach that the curriculum aimed to develop.

The remainder of this section will focus on literature that informs curricular activities that encourage "adaptive expertise" and examine the Lego robotics curriculum at the School with the intention of finding curricular activities that we deem to be related to the development of "adaptive expertise.

A 1986 book chapter by the Japanese researchers Hatano and Inagaki (Hatano, 1986) differentiated between two types of human expertise. Routine expertise describes the ability to perform a skill quickly and effectively. Such activities related to routine expertise are rarely associated with breakthrough experiences in one's conceptual knowledge. Adaptive expertise describes the set of skills required to respond to changing aspects of the system in which the skill is levied. These authors made the case for the importance of each type of expertise, but emphasized “adaptive expertise” as being a desirable trait in the context of change. More recently, works such as How People Learn have identified research around expertise, including adaptive expertise, as being central to understanding learning and schooling.

Examining the curricular development structure in place in the “Lego Robotics Curriculum at the School” (Table 1) a basic structure of tasks and objectives can easily be identified. Students are to begin with activities that promote basic, routine actions that lead to comfort and familiarity with a variety of procedural knowledge. Over time the curriculum asks students to integrate that knowledge as it asks them to complete tasks that are increasingly difficult, and increasingly reliant on a variety of skills and procedures. Ultimately the curriculum offers “capstone” experiences that attempt to provide students with the sorts of challenges that one would associate with “adaptive expertise”. Specifically, students are asked to respond to challenges with multiple solutions in an innovative and efficient manner .

In uncovering literature in this area, we were struck by John Bransford’s “conjecture” that

> the development of adaptive expertise is not something that simply happens AFTER people develop routine expertise. You don’t develop it in a “capstone course” at the end of students’ senior year (Bransford, 2001)

In that work, Bransford goes on to describe aspects of educational experiences and environments that he believes to generally foster the development of expertise. We became intrigued by the possibility that the Lego robotics capstone experiences may not solely respond to the curricular desire to encourage the development of adaptive expertise. We decided, then, to examine the literature related to the question of what educational techniques are associated with the development of adaptive expertise, and compared these guidelines to the technology learning objectives and sample activities written for students in grades 2, 3 and 4 (table 2) – where the Lego robotics curriculum is in place. We believed that such a comparison would yield results that would best inform whether student technology activities are in alignment with the development of adaptive expertise.

Educational Factors Leading to the Development of Adaptive Expertise

Foster Metacognition

The practice of metacognition – or thinking about one's thinking – has been associated with the development of adaptive expertise . Adaptive experts are considered to be able to monitor on one's own knowledge and adopt a strategy for reconciling a solution strategy in the context of a domain where they have suitable knowledge. This cognitive monitoring can be described as a metacognitive act. Metacognition is also considered to be a thinking skill that is associated with life-long learning as practicing this sort of reflection has the effect of consistently comparing one's current knowledge state to other, more advanced knowledge states. Metacognitive activity begets a knowledge state that is both under consideration and in flux; the goal is not a static, end state where one is pronounced as "expert".

Journaling, reflection, and probing are all educational activities associated with bringing about metacognitive learners . Examining the School's "Technology Learning Objectives" for grades two and four, along with the associated example activities related to Lego robotics, several activities appear to be associated with supporting metacognition in learners. Activity number 3 ("Use iBlog, RoboLab, Grab and other applications for the various activities within robotics assignments."), activity number 5 ("Maintain a blog-based journal that includes screen shots, technical description and citations of resources.") and activity number 7 ("Communicate and maintain development efforts outside of classroom. Share and reflect upon process of creating robots.") are all in alignment with reflective activities associated with metacognition.

These second and fourth grade students, then, are provided with tools and experiences <u>throughout their school experience</u> that encourage metacognition, and are thus associated with the development of adaptive expertise.

Promote The Use Of External Resources, Including Interpersonal Resources

A central aspect of expertise involves acting in an environment where relevant artifacts and human resources are appropriately incorporated (Hatano, 2003). Further, development leading to expertise is thought to be best carried out in an environment where the learner has access to relevant resources of this nature (Shweder, Goodnow, Hatano, LeVine, Markus, & Miller, 1998). Interpersonal resources, such as members of a team, can be considered resources with some specific features related to inter-personal communication and collaboration habits.

The "technology learning objectives" and associated tasks related to the Lego robotics curriculum contain several activities that are relevant to this area. Activity 1 ("Demonstrate basic classroom expectations including peer interactions and treatment of equipment.") promotes appropriate behavior in the context of the learning resources. Students need to develop and exhibit respect for these resources as a prerequisite for the advanced, effective use of the resources. Activity 2 ("Utilize available programs available online and cite their source.") explicitly encourages the identification and adoption of external resources. It also establishes a protocol for appropriately acknowledging (citing) the resources. Activity 4 ("Working in groups or on shared computers, share and retrieve files for use in subsequent classes.") specifically encourages best practices related to effective computer-based collaboration and communication. Students work in an environment where they are provided with powerful electronic communications tools, and are taught to use the tools in the context of collaborative activity. Finally, Activity 8 ("Make use of available technology and resolve issues (to the best of your ability) when encountered. Consider all available support resources (eg., Help, documentation, peer, teacher, etc.") explicitly asks the students to independently seek out and incorporate resources that may help them achieve their goals. Importantly, this activity not only encourages the adoption of external resources, it places the responsibility of identifying and locating those resources on the student. This self-guided approach to knowledge acquisition and problem-definition is also central to building adaptive experts.

Promote Flexible Approaches Toward Understanding, Representing And Solving Problems

Adaptive experts are differentiated from routine experts in their ability to approach problems in a dynamic problem space with innovation and efficiency . Activities that invite students to explore multiple solution routes, consider problems from multiple vantage points, and represent problem spaces with multiple media and representations all contribute to cognitive flexibility.

Examining the list of technology learning objectives with an eye toward this domain, we can identify several tasks that are directly related. Activity 5 ("Maintain a blog-based journal that includes screen shots, technical description and citations of resources.") asks students to incorporate multiple media types as they reflect and describe their experiences. To use Spiro's term, such work "criss-crosses the knowledge domain" and results in learners who are able to move dynamically between knowledge representations and media. Activities 9 ("Use RoboLab with independent proficiency to complete a program that will successfully run in a robot and completes a specific challenge.") and 10 ("Build a Lego robot with independent proficiency to complete a program that will successfully run in a robot and completes a specific challenge.") work together to ensure that students coordinate mechanical and logical principles in their attempts to solve challenges. The construction, design, programming, and troubleshooting knowledge that are all built up through curricular activities are ultimately integrated in tasks required the sort of adaptive expertise that the curriculum hopes to establish in learners.

Encourage Student Definitions Of Learning Goals

A final educational area associated with the development of adaptive expertise concerns student definition of learning goals. Bransford describes his experience in developing curriculum for emergency medicine instruction. The curriculum asks three questions:

(1) What might be wrong with this patient?
(2) What additional information would you want in order to feel confident making a diagnosis and deciding on a treatment--and why would you want it?
(3) What are some things that you would want to learn in order to develop more expertise in this area? (Bransford, 2001)

He describes the second and third questions as being critical when considering the development of adaptive expertise. Question 2 helps the student recognize that problems do not come "pre-packaged" in real life, and that they should consider aspects of the question that do not accompany the problem. Question 3 helps the student focus on their learning goals.

As it stands, neither the Lego Robotics Curriculum nor the associated list of technical objectives explicitly addresses this type of problem definition. This is one area where the literature can provide guidance for future curriculum development and allow us to consider ways of demanding this type of inquiry. For example, as students are first introduced to the challenges inherent in the First Lego League competition each year, students could be asked questions such as "what don't we know how to do in order to solve this problem"? Such activities are certainly in alignment with the work we are attempting to achieve, but have not been explicitly included in the curriculum or technical objectives.

Conclusion

This work details the development of a Lego robotics curriculum at the School at Columbia University. Efforts to identify educational strategies related to the development of "adaptive expertise" were laid alongside the curricular approaches at work in the School.

While the "capstone experiences" inherent in the Lego robotics activities at the School provide meaningful opportunities to synthesize and exhibit student learning, they are not the primary engine for actually developing adaptive expertise. Rather, student activities associated with the School's broader technical objectives are generally aligned with the types of learning activities thought to encourage the development of adaptive expertise.

This recognition has important ramifications for future curriculum development efforts. If these technical objectives can be properly supported and realized, then curriculum development across student activities and disciplines could be designed to proceed much in the way that the Lego robotics curriculum does. That is, routine expertise across inter-related domains can be incrementally fostered and conclude in motivating, capstone experiences when introduced in the context of these technical objectives. Institutional support related to these learning objectives may enable learners to achieve foundational skills and habits associated with adaptive experts.

Resources

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TABLE 1: Lego Robotics Activities and Associated Learning Objectives

student activity/ challenge	learning objectives	evaluation	logical construction
• 1 basic instruction	basic language, basic construction techniques, identify elements involved: Legos and RoboLab	verbally poll classroom for proper names of pieces with pictures displayed.	factual knowledge
• 2 gears and pulleys	basics of gear operation. Provide builders with fundamental knowledge for further building.	tests - draw on images. take online quiz to identify that various gear names and properly explain gear ratios.	mental model knowledge
• 3 connectors and parts	Hands on tactile experience of building the elements to be used in a well-built robot	hands on mentoring and proctoring during sessions.	tactile experience. factual knowledge.
• 4 build basic robot, such as "tankbot"	Hands on tactile experience of building a well-built robot, while properly following written and graphic instructions.	check each robot against instructions	procedural and tactile knowledge to combine above.
• 5 robot control skills with RoboLab	Being able to control robot through computer. Troubleshoot accordingly when results do not match intentions or expectations.	completion of challenges	procedural knowledge. factual knowledge. systems knowledge.
• 1 Internals			
• 1 simple music playback	Using the scroll function, play a song from RCX.	demonstrate expected results for teacher	logical/procedural knowledge with troubleshooting
• 2 Outputs			
• 1 simple output functions	With basic understanding of output concept, write simple program utilizes all 3 outputs for a discreet time period.	demonstrate expected results for teacher	logical/procedural knowledge with troubleshooting

TABLE 1: Lego Robotics Activities and Associated Learning Objectives

student activity/ challenge	learning objectives	evaluation	logical construction
• 2 turning movement	Modify motor output function to cause robot to turn in a circle for a discreet time period.	demonstrate expected results for teacher	logical/procedural knowledge with troubleshooting
• 3 Recursion & Efficiency			
• 1 simple combinatio n using task split	Use task split to combine 5.1.1 and 5.2.1 to run two programs simultaneously	demonstrate expected results for teacher	logical/procedural knowledge with troubleshooting
• 2 repeat a function using a loop	Use the loop function to repeat a simple program for a discreet number of occurrences	demonstrate expected results for teacher	logical/procedural knowledge with troubleshooting
• 4 Inputs			
• 1 touch sensor input	Incorporate touch sensor into results of 5.3.1 to activate program upon 1 click (modify default input port to port 2)	demonstrate expected results for teacher	logical/procedural knowledge with troubleshooting
• 2 light sensor input	Utilize light sensor to cause robot to move forward for a discreet time period after placing a piece of white paper directly in front of sensor (modify default input port to port 3 and default Cutoff Brightness to represent reflectivity of paper)	demonstrate expected results for teacher	logical/procedural knowledge with troubleshooting
• 5 Advanced Challenge: use 2 light sensors to follow a black line that your robot will straddle	Adaptive expertise drawing on the above, which has now become routine knowledge. Being able to coordinate all learning and adapt to new situations and challenges.	demonstrate expected results for teacher	logical/procedural knowledge with troubleshooting

TABLE 1: Lego Robotics Activities and Associated Learning Objectives

student activity/ challenge	learning objectives	evaluation	logical construction
• 6 Competitions: use skills developed in section 5 to master the rescue component of RoboCupJr	Further practice for adaptive expertise, communications, negotiation skills, problem solving, trouble shooting, innovation, teamwork, planning: develop a robot that can follow a black line and locate the victims along the route.	demonstrate expected results for teacher; scored during competition	logical/procedural knowledge with troubleshooting

TABLE 2: Technology Learning Objectives and Associated Robotics Activities

	Lego Robotics Example Activity	Technology Learning Objective Grade 2	Technology Learning Objective Grade 4	School Wide Goal
1	Demonstrate basic classroom expectations including peer interactions and treatment of equipment.	Applies the classroom rules for conduct, safety and care of themselves and materials when using technology.	Applies the classroom rules for conduct, safety and care of themselves and materials when using technology.	Demonstrate the creative, ethical, and appropriate use of technologies to enhance learning
2	Utilize available programs available online and cite their source.	Identifies and gives credit when using other people's work in a project.	Uses shared hardware and software resources ethically and legally, cites sources and identifies "intellectual property."	Demonstrate the creative, ethical, and appropriate use of technologies to enhance learning
3	Use iBlog, RoboLab, Grab and other applications for the various activities within robotics assignments.	Navigates through the basic features of an operating system: locates an application, identifies the Home Directory and its sub-directories.	Applies skills learned in a familiar program or operating system to an unfamiliar one.	Understand the broad scope of application of current technologies in preparation for the effective use developing technologies
4	Working in groups or on shared computers, share and retrieve files for use in subsequent classes.	Saves, distributes and retrieves files both locally and on the fileserver.	Shows proficiency with basic features of operating system and is able to organize files and personalize environment.	Understand the broad scope of application of current technologies in preparation for the effective use developing technologies
5	Maintain a blog-based journal that includes screen shots, technical description and citations of resources.	Learns to use a variety of computer applications.	Chooses with assistance, the most effective computer application for an assignment.	Understand the broad scope of application of current technologies in preparation for the effective use developing technologies
6	Arrive to class ready to begin work on robotic creations, ensuring that all necessary materials are available and ready to use.	Exhibits prudent computer use behavior such as frequently backing up data, keeping battery charged and applying software updates.	Exhibits prudent computer use behavior such as frequently backing up data, keeping battery charged and applying software updates.	Understand the broad scope of application of current technologies in preparation for the effective use developing technologies
7	Communicate and maintain development efforts outside of classroom. Share and reflect upon process of creating robots.	Sends and receives communications from a variety of devices, in different ways, through the network, email and chatting within and beyond The School community.	Sends and receives communications from a variety of devices, in different ways especially through a school email account and publishing blogs.	Explore the utility of digital communications technology in bridging distances and creating broad-based learning communities
8	Make use of available technology and resolve issues (to the best of your ability) when encountered. Consider all available support resources (eg., Help, documentation, peer, teacher, etc.)	Identifies a computer problem and with support fixes it or carries out a plan for getting help.	Classifies a computer problem into common categories of Hardware, Software and User End problems and utilizes strategies to fix it or find the resources to get it fixed.	Use problem-solving skills to overcome gaps or failures of technology
9	Use RoboLab with independent proficiency to complete a program that will successfully run in a robot and completes a specific challenge.	Designs, programs and debugs a robot according to the rules of an iconic language to solve a specific challenge.	Designs, programs and debugs a robot according to the rules of an iconic language to solve a specific challenge.	Use problem-solving skills to overcome gaps or failures of technology
10	Build a Lego robot with independent proficiency to complete a program that will successfully run in a robot and completes a specific challenge.	Construct a simple machine.	Build a simple and complex machine using sound engineering and logical prinicpals.	Understand how and why the purposeful and wise use of technology can improve the human condition