Robotix and Mathematix: A Great Relationship

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Overview

"The meaning of 'knowing' has shifted from being able to remember and repeat information to being able to find and use it." (National Research Council, 2007)

The availability of information today is not as difficult as it once was. In fact there is much beyond our ability to even know what is available to us. It is an explosion of information. Since this sea of information is available to us at our finger tips, mere accumulation and acquisition of knowledge has become secondary to access and evaluation of information which in turn helps in being productive and creative. Logical and reasoning skills are therefore not just an asset but a necessity. In the light of this we see the shift in education toward a deeper understanding of concepts and application in real life situations. The focus of the much talked about common core is conceptual understanding.

Students today are more exposed and are more adept at using electronic devices more than ever before. They use the cell phone more than the pen. The reality is technology has arrived, and it encompasses every part of one's life, including the classroom. Not only is technology here today, but, as it continues to evolve, it will become even more of an integral part of our lives in the future. This is especially true in the classroom.

Darwin said, "It is not the strongest species that survive, nor the most intelligent, but the ones most responsive to change." Hence, when change is inevitable, it is wise to embrace it. The advantage is that today technology and resources are available and fairly affordable to enable us to implement ideas and concepts that help foster creativity and productivity. This unit focuses on developing reasoning and logical skills using flowcharting, programming, experimenting with and building robots. The tools used in this lesson, in addition to graphing calculators, smart boards and computer programs, are smart phones and robots.

Rationale

I teach Algebra 1 and Math Enrichment to ninth graders in an urban comprehensive public high school. Since students are at different levels in their math skills when they enroll it poses various challenges to prepare them for the standardized tests they must take at the end of the year. The standardized tests are based on the common core. Since the common core focuses on developing critical-thinking, problem-solving and analytical skills it becomes necessary to instill and cultivate the growth of logical and reasoning skills in students. Furthermore students need to work on activities that nurture and revolve around these skills. The curriculum for Math Enrichment, though flexible, is geared towards enabling students to be able to fill in the gaps of their learning levels and also to prepare them for the Keystone exams which implement the Common Core standards.

The Common Core State Standards Initiative (CCSSI): The CCSSI was a state led effort coordinated by the National Governors Association and the Council of Chief School Officers. The Common Core concentrates on a set of skills and concepts that students will learn in an organized way, both during the school year and through their grades. The standards encourage students to solve real – world problems. It also emphasizes the need to solve problems quickly and accurately beside its aim to foster reasoning, modeling and student engagement. Most important, the standards require students to demonstrate a deep conceptual understanding by applying them to new situations. High school standards for mathematics are organized around 5 conceptual categories: Number and Quantity, Algebra, Functions, Geometry, Statistics and Probability.

The performance of the American Students was significantly lower when compared to students from several other industrialized nations represented at the international math and science tests, and this created concern regarding the math and science education in the schools across the nation. Therefore one of the concerns for creating a Common Core was as stated by Arizona Gov. Janet Napolitano in 2006-2007 in the words of Dane Linn, Vice-President of Business Roundtable, "The more she thought about it, she came to the conclusion that America couldn't lead the world in innovation and remain being competitive if we didn't have an internationally competitive education system." As a result, one of the reasons Common Core was introduced was to raise the level of achievement in students across the nation.

“America desperately needs more STEM students” was the title of the article by Rodney C. Adkins, Senior Vice-President of IBM’s system and Technology group. In the article Rodney talks about the declining percentage of scientists in the country and the need to inspire students to pursue science and math courses to fill the need of the industry. STEM standing for Science Technology Engineering and Mathematics is the buzzword in education today. Once again the emphasis on science and technology was due to the fact that the percentage of American graduates in the STEM fields were significantly far below their peers from other countries. Since the jobs available in the future are for those in this field, the big question is, “Are we preparing our students for these jobs?” The focus of STEM is to prepare students in the required field for the jobs of tomorrow.

Since Common Core requires conceptual understanding of the subject, hands-on experience is more than just an option. Students today live in a highly visual world, and most of the students I teach use technology to a high degree. Hence it is natural for them to be more inclined towards visual and kinesthetic learning. The traditional method of teaching mathematical concepts with only the chalk and board poses many challenges in terms of stimulating the students’ interest in math. The graphing calculators were excellent as tools to enable students to visualize concepts such as linear, quadratic and cubic functions besides parametric equations and trigonometric functions. Various software such as Geometry Sketchpad and Google Sketch and the various interactive software on the net further helped in the understanding of 2 dimensional and 3 dimensional mathematics. However since technology has made such astounding strides in the last 50 years we now have resources available to even build a robot in the classroom. It is neither a distant dream any longer, nor is something we are expecting to happen in the future. With the availability of the Arduino board the possibilities for students to design, build and explore is exciting and vast. The Arduino board is the ideal toolkit to kindle and motivate their interest in the field of STEM.

Robotics is a branch of technology that deals with design, operation and construction of robots. The word “robot” comes from the Czech word “robota” meaning “slave.” It was first used in the play “Rossum’s Universal Robots,” written by the Czech playwright Karl Capek in 1921. The play was about mechanical men that were built to work on factory assembly lines, but who eventually rebel against their human “masters.”

Robotics is about action. Unlike in science fiction scenarios, most of the robots today do not resemble humans. Nor is there a standardized robotic structure. Instead, the robotic technology is embedded in common objects . Robots are used in most fields today. Medical robots are used to perform surgery and are a big success since the robots are able to use minimal invasive techniques thereby reducing recovery time and risks that are usually associated with human error, not the technique employed. Industrial robots are used to do welding, painting, ironing, assembly, pick and place, palletizing, product inspection and testing with high endurance, speed and precision. “Curiosity” was

NASA's car-sized robot rover that was launched on November 2011 to explore the Gale Crater on Mars. "Curiosity" was a part of NASA's Mars Science Laboratory Mission.

Today the commonly used cellphone is powerful enough that it could control a robot, and cellphones could also act as robots giving them the name "cellbots."

So what makes a robot? The scientific Discovery Channel has indicated that anything can be a robot if it has the following fundamental elements: (1) a moveable body – this could be in the form of wheels, limbs connected by mechanical joints or other types of moveable segments. An actuator is needed for the robot to be activated. They could use an electric motor, a hydraulic system, a pneumatic system or a combination of all three as a power source to drive its actuators. Electric robots use batteries or extension cords. Hydraulic robots need pumps to pressurize the hydraulic fluid and pneumatic robots need air compressors. An electrical circuit that powers the electric motor, solenoid or valves that control hydraulic or pneumatic systems carry the impulses to perform the various operations; and (2) a reprogrammable brain - the computer is the mastermind that controls the behavior of the robot and reprogramming the computer changes the behavior of the robot. A robot becomes powerful with a high tech sensory system to gather information about its environment and react to it.

Most robots have some level of intelligence. Some robots, however, are designed specifically as artificial intelligent machines. Artificial Intelligence and robots are closely related. For example here is an example of a robot that hit the headlines of a newspaper: "Would You Take Orders From a ROBOT? An Artificial Intelligence Becomes the World's First Company Director." This article screamed from the headlines of the Daily Mail. The news was about a Hong Kong based Japanese capital firm Deep Knowledge that named an AI to its board of directors. The robot named Vital (Validating Investment Tool for Advancing Life Sciences) was chosen for its ability to pick up market trends which is not easily picked up by humans. The news article went on to mention that the robot already helped make two major investment decisions in life science companies. When I read this article I had mixed feelings of alarm and incredulity when I considered the implications of what it meant. Whatever the implications, it is nevertheless the reality that Artificial Intelligence is the future, and we must prepare our students to use and manage it.

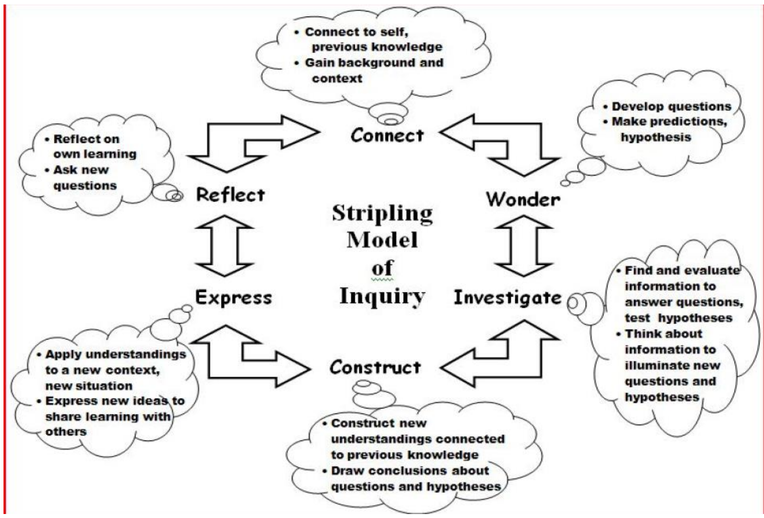
So how do we define "Artificial Intelligence (AI)"? The encyclopedia Britannica defines AI as the ability of a digital computer or computer-controlled robot to perform tasks commonly associated with intelligent beings. The Merriam Webster defines AI as the capability of a machine to imitate intelligent human behavior. Scientists are constantly working on increasing the level of intelligence in robots. The first AI software was created to play chess but today it has gone beyond this as the article above demonstrates. Machines are being created to make higher level decisions. Another intelligent software which students could relate to is Siri on Apple's 4s iPhone. Though Siri does not do complex level decision making, it could be categorized as a "lower level" artificial intelligent software.

Robotics and AI and its connection with STEM:

Since robotics requires math, science and engineering skills students develop these skills while interacting and working on robots. Robotics provides opportunities for students to apply mathematical concepts to real life problems. For example, to calculate how far the wheel of the robot car would go or how many rotations it would take to cover 2 feet, they would first have to measure the wheel's diameter in inches, calculate the circumference and therefore the distance travelled in one rotation. Next, using proportions, they would calculate the number of rotations it would take for the wheel to cover 2 feet. Students will also need to do the required conversions from feet to inches and vice versa. In doing an activity of this manner students are able to visualize the concepts, therefore accomplishing that which the standards of the Common Core hoped to accomplish.

Another reason to include robotics into the math curriculum is to promote "Inquiry Based Learning." IBL is student centered and is centered around activities that make abstract concepts more concrete and visual for students to gain a deeper understanding on the subject. This falls in line once again with the Common Core standards. We all know there is only one right answer for a math problem, but there is obviously more than one way to obtain that right answer. Inquiry math is different from traditional math in that students work with partners and whole-group instruction to construct mathematical explanations that make sense to them. Students are presented with opportunities to verbally explain their thinking processes to the teacher and class, and it is this exchange of ideas that provides the foundation for true understanding of mathematical concepts (Chapko & Buchko, 2004, p. 33).

The Stripling Model defines inquiry based learning as a cycle with six stages: connect, wonder, investigate, construct, express and reflect. The connect stage deals with previous knowledge or background and context. The wonder stage is to develop questions and make predictions or hypothesis. The investigate stage is to find and evaluate the information that answer the questions in the wonder stage. In the construct stage, new understandings are connected to previous understandings and conclusions are drawn about the questions and hypothesis. The penultimate stage is express. In this stage the understanding gained in the previous stage is applied to a new context, new situation. The final stage is reflect which is the stage where we ask new questions and reflect on our own learning.



One way to introduce robotics in the classroom is by having students work on a hands-on project using the Arduino board - the reprogrammable brain of the robot. The arduino is a simple microcontroller board with an open-source computing platform and allows writing software for the board. Hence this makes it more powerful than a desktop computer since it can sense and control more of the physical world. The arduino can be used to develop interactive objects, it can take inputs from a variety of switches and sensors and can also control a variety of lights, motors and other physical outputs. The board can be assembled or even better can be purchased preassembled at a reasonable cost.

There are many other microcontrollers available. However the Arduino has advantages for teachers and students since it is relatively inexpensive in comparison to the other models. Being a cross platform it runs on Windows, Macintosh OSX and Linux operating systems. Since it has a simple programming environment it is easy to use for beginners

My experience with the Arduino was during our seminar sessions on “Robotics for Everyone.” We did three projects using the Arduino board. The projects were a great hands-on experience for me personally. It was a long time since I did any kind of circuitry, and I have never built anything or made anything with a microcontroller board. This truly was exciting since I was getting to build something real with barely any experience or know how on its working

Introduction to Circuits and the Arduino: Our first lab was an introduction to basic electronic terms and definitions such as circuit, capacitor, resistor, inductor, light emitting diode(LED), volts, ohms, photoresistor, potentiometer. Our first task was to build a simple circuit using the breadboard. The breadboard sits on the arduino and is electrically connected by a conducting plate that runs beneath. We built a circuit with a 5V power supply connected to the LED and a 1KΩ resistor in series. The LED in the circuit light up when connected to the computer using a USB cable. Using ohms law V=IR we could regulate the flow of current I flowing through the LED in the circuit by changing the resistance R. We next uploaded the code to have the LED blink. The code was written using Arduino1.1 IDE

In part 2 of this lab we had the Boebot move forward, backward and sideways as in a dance. The Boebot is a mini robot used in high school and college labs as a learning tool for robotics. It primarily consists of a main circuit-board, microcontroller, a breadboard, 2 servo motors to drive the wheels and a chassis that different parts can be bolted onto. The servomotor (servo) is an electromechanical device in which an electrical input determines the position of a motor. Once again we learned some programming commands and logic skills to initialize and control the servo. The servo in turn being connected to the wheels of the Boebot enables it to move in different directions. Some of the commands and functions we used to accomplish this are sleft, sright, sstop , pinMode, servo1.attach, servo1.write(sleft), delay(1000), servo1.write(sright), delay(1000), servo1.write(sstop), delay(2000). In this session the programming structure was using the loop wherein a set of operations is performed for a given number of times

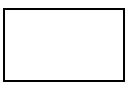
Our second lab was the flashlight follower. At this stage the Boebot has been programmed to move in all directions (from the first lab). In this lab session the Boebot should follow the beam from a flashlight. The Boebot should be able to detect the light from both sides and turn to follow the beam when needed as seen in this video link: http://www.youtube.com/watch?v=cR2SkQPjZNM . The programming structure used here is the "If-Then-Else." This structure allows the Boebot to make decisions based on a condition. As before we modified the code to perform the above task.

Our third lab session was the Minty Boost . This is a USB portable power. In other words a battery powered USB charger. Since it is portable it could be used to charge a cellphone anywhere. This session was particularly interesting: It came in a DIY kit, required no programming, and could be used whenever. Most important, it seems to be a project of interest to students since they are constantly trying to charge their cellphone in the classroom. Hence could be viable project to motivate their interests.

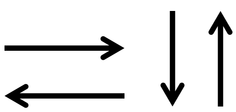
The lab sessions were extremely informative, engaging and productive. Since it had all the elements of STEM it seemed appropriate to take some of this experience into the classroom and have students work on it. I therefore developed a mini curriculum unit with this background.

Robots as we have seen cannot function without written code which is the software and functions as the brain. To appreciate and work with robots one has to be familiar with programming and flowcharts are great graphic organizers that help in writing good programs.

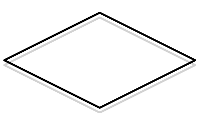
A flowchart is a diagram that shows step-by-step progression through a procedure or system especially using connecting lines and a set of conventional symbols. Merriam Flowcharts are useful when thinking about the logic in a problem. Flowcharts are universal as it is not bound by a particular hardware or software -- hence an excellent way of communicating the logic of a system. It is a good tool for students as it acts as a guide in the program development phase and helps in finding errors in the logic of the program. The basic shapes used as symbols in a flow chart are:



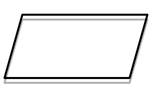
This is the process box and indicates an action done by the program such as calculating area of a circle or square



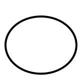
The arrows indicate the direction and sequence of process



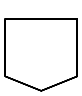
The diamond shaped box indicates the decision the program takes and the path it would take



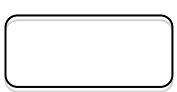
The parallelogram indicates either an input into the program or an output from the program

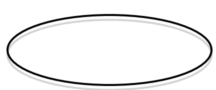


The connector connects a part of the flowchart to the other on the same page



The off page connector connects one part of the flowchart to another part but on a different page





The rounded rectangular box or an oval shape box indicates the start and end of a process

Computer Program: A computer program or code is an organized and logical set of instructions that has the computer perform a specific task. The code can be written in a language such as FORTRAN, COBOL C, C++, JAVA, Assembly language or any of the different languages for which a compiler is available. A compiler basically translates the code to machine language for the computer to execute the instruction. Coding requires good logical thinking and long tedious hours of labor, which, being the case, would not interest all students. However, to overcome this there are software and programs which are interactive and allow students to enjoy the process of coding. Some of them are SCRATCH, ALICE and SPHERO.

Scratch is a project of the Lifelong Kindergarten Group at the MIT Media Lab. The software can be downloaded free of charge. Though it was originally designed for students in the age group 8 to 16 it can be used for all ages. With Scratch students can program their own creative stories, games and animations. It is a great software for students to learn and hone their programming skills.

Another interesting programming toy is Sphero from the company Orbotix. Sphero is a robotic ball that works with IOS 4.0+ or Android devices with operating system 2.2+ which can be also controlled by a smart phone or a tablet through the blue tooth feature. There are various free apps that can be downloaded to the phone or tablet. The apps controls the movement of the ball. Sphero is a robot hence has a microprocessor besides a gyroscope and an accelerometer that communicates with the smart phone or the tablet through the app , it also has 2 little rubber wheel which allows it to roll. It also has sensors that give the yaw, pitch and roll information to whatever app that is being played so that the computer knows the position of the Sphero at any time. The yaw, pitch and roll are the 3 axis of the gyroscope that helps in keeping track of the exact position of an object in space. The outer case of the Sphero is made of high-density polycarbonate similar to Nalgene bottles, which makes it extremely strong and has been subjected to various tests to prove its strength.

Using the phone one could control its direction of movement and speed. There are a number of apps that can be downloaded to make it an extremely interesting fun toy. Besides the apps one could also write a code to make it interact creatively.

My curriculum unit includes flowcharts, programming with Scratch and understanding mathematical concepts with Sphero

Objectives

To be able to think outside the box
To be able to think logically
To break down both mathematical and non mathematical problems into steps
To organize the steps using flowchart

To be able to explain in writing the process and solution to the problem
To be able to develop a story using flowcharts and further on using Scratch to develop a digital story with animation
To develop programming skills by programming devices or toys such as Sphero

Standards

The standards listed here are as specified by the Common Core State standards
CCSSMATH.CONTENT.4.OA.B.4
Generate and analyze patterns
CCSSMATH.CONTENT.7.RPA
Analyze ratio and proportional relationships and use them to solve real-world and mathematical problems
CCSS.MATH.PRACTICE.MP1: Make sense of problems and persevere in solving them.
CCSS.MATH.PRACTICE.MP2: Reason abstractly and quantitatively.
CCSS.MATH.PRACTICE.MP4: Model with mathematics.
CCSS.MATH.PRACTICE.MP8: Look for and express regularity in repeated reasoning.
CCSSMATH.CONTENT.HSA.CED : Create equations and inequalities in one variable and use them to solve problems.Include equations arising from linear and quadratic functions, and simple rational and exponential functions. Understand solving equations as a process of reasoning and explain the reasoning.
CCSS.MATH.CONTENT.HSA.REI.A.1
Explain each step in solving a simple equation as following from the equality of numbers asserted at the previous step, starting from the assumption that the original equation has a solution. Construct a viable argument to justify a solution method.CCSS.MATH.CONTENT.HSA.REI.A.2
Solve simple rational and radical equations in one variable, and give examples showing how extraneous solutions may arise. Solve equations and inequalities in one variable.
CCSS.MATH.CONTENT.HSA.REI.B.3
Solve linear equations and inequalities in one variable, including equations with coefficients represented by letters.
CCSS.MATH.CONTENT.HSA.REI.B.4
Solve quadratic equations in one variable.
CCSS.MATH.CONTENT.HSA.REI.B.4.A
Use the method of completing the square to transform any quadratic equation in xinto an equation of the form $(x - p)^2 = q$ that has the same solutions. Derive the quadratic formula from this form.

CCSS.MATH.CONTENT.HSA.REI.B.4.B
Solve quadratic equations by inspection (e.g., for $x^2 = 49$), taking square roots,. Solve systems of equations
CCSS.MATH.CONTENT.HSA.REI.C.6
Solve systems of linear equations exactly and approximately (e.g., with graphs), focusing on pairs of linear equations in two variables.

Strategies

Math Journal: Every student will be required to keep a journal that records the date and the lesson they have learned. This helps students to keep track of lessons they have learnt and to make connections when a new lesson is taught.

The second strategy I encourage students to use is Structured Note Taking. Here students are encouraged to take notes when listening to a presentation. This strategy emphasizes purposeful reading and identifying essential information.

Writing while listening helps in sustained focus and retention of concepts. Concept Maps: It is an excellent tool for connecting and summarizing ideas around a specific topic. I encourage students to use at the introduction to a lesson and the end of the lesson as it ties up new information with previous information.

Classroom Directed:

Cooperative learning: Students will be work in groups during an activity. This helps in building group dynamic skills besides academics and also encourages peer learning and sharing. Brainstorming/ Group Discussion is something they will use after they have finished an activity and analyze the activity done to draw inferences. This activity promotes critical thinking and increases reasoning skills.

Reciprocal Teaching: Students learn and discover for themselves by posing questions based on the text, summarizing the content and predicting what will be next. The next two strategies make use of technology and I plan to use it more frequently in my classroom as I now have the resources. Internet based animation: This is an excellent methodology for abstract concepts. A single picture/animation is worth a thousand words/ expressions.

Brainstorming is great to get students involved and focused when finding solution to a word problem. As a class we discuss all the steps required to solve the problem and other ways of solving the same problem

Inquiry Based Mathematics- Instruction method where the teacher sets up a problem making sure that everyone understands it. The students are then paired or grouped according to their ability level. They work together to come up with a strategy to solve the problem and present it as a group to the class.

Since the students have access to laptops and a smart board I wish to incorporate it into the lesson and maximize its use.

Classroom Activities
Lesson 1: Flowcharts: 90-minute period

Objective: Students will learn the purpose of the various flowchart symbols. They will learn to break down a problem into a sequence of steps and place it in the appropriate box.
The symbols and what each box represents will be explained using nonmathematical examples. Students will be given the following guidelines to help develop a flowchart

Step1. Identify the input
Step 2: Identify the objective or the end result of the problem statement
Step 3: Identify the various process or list of tasks required to achieve the end result

Flowcharts can be drawn for any set of tasks. It can be a mathematical problem or even a task we do everyday or a shopping trip

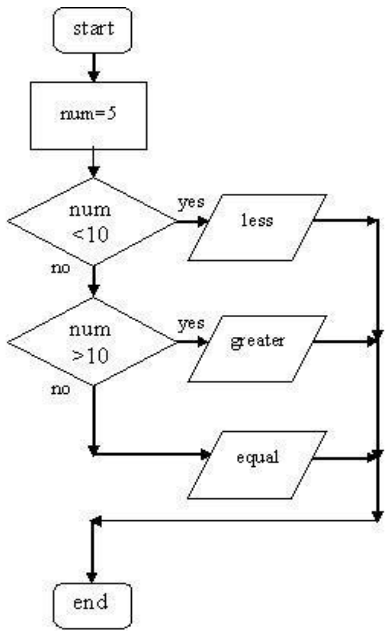
Example 1: Flow chart to shop for a pair of shoes to match the suit will be done in class

Example 2: This is a math example to print if a number is greater than 10, less than 10 or more than 10. In this example the decision box indicates the two paths of flow if the answer is true it chooses one path if the answer is false then it chooses the other path

Example 3: This example will be done to demonstrate the loop structure. To print a name entered 5 times. Through this example students will understand the concept of keeping count in a computer program. The process of printing will stop as soon as the counter has reached 5.

Example 4: To find if a number is odd or even. The focus her will be on the logic of the problem and the flow. The first step will be to accept the number –input box, the next will be to divide it by 2-process box. If the integer part of the answer multiplied by 2 results in the same number then it will be even – decision box. The decision box will have 2 paths; if it is true it will be even if not odd.

Guided Practice: Students will learn to logically order the sequence of given non mathematical operations on this interactive website for practice
http://www.cimt.plymouth.ac.uk/projects/mepres/book8/bk8i1/bk8_1i2.htm
Students will on their own develop flowcharts for the following 5 problems. They will work in groups of 3 and each group will discuss and display their work to the rest of the class.



Flowchart for Example 2

Students will work on the following problems for homework.
1. Draw a flowchart to check if a number is divisible by 5.
2. Draw a flowchart to find the sum of numbers from 1 to 100.
3. Develop a flowchart as to how you would make a peanut butter jelly sandwich
4. Draw a flowchart to accept 3 numbers a, b, c and find the mean, range
5. Calculate the distance travelled by a car in 30 minutes. The program should accept the measure of the circumference of the wheel, revolutions per minute.

Lesson 2: Programming with the software Scratch: 2 sessions: 90 minute each

Objective: a) Students will use the computer to work with the software Scratch and learn the basic tools required to create a story, game or animation
Scratch can be downloaded free from the website http://scratch.mit.edu
The following videos show the various tools that can be used to create the story. Students can use these websites to learn how to use scratch. Each of the websites shows the different capabilities of Scratch and gradually takes the students through he various levels

Video 1	http://tinyurl.com/m8vbepj
Video 2	http://tinyurl.com/lp9r7y8
Video 3	http://tinyurl.com/kbhu9vc
Video 4	http://tinyurl.com/n34xa3n
Video 5	http://tinyurl.com/n3a6z8u

b) Students will access the following websites to learn to use Scratch and further practice the use of the various functions and tools at every level to improve confidence in using the software.

c) In the second session students will use Scratch to develop a story or game of their choice. To help them organize their storyline and flow of thought they will be encouraged use the flowchart techniques discussed in the first lesson. This session might take more than 90 minutes as specified above, it might need 2 or 3 90 minute sessions for students to complete their scratch project and write a narrative on what they had learned during this activity.

Lesson 3: **Applying mathematical concepts to control Sphero the robotic ball:**
Minimum will be one 90-minute session: The sessions can be extended to an entire week or more. The lesson will be done in a small group of 3 or 4 since it requires a Sphero for each student also it allows for greater time and attention for each student. After students have completed learning the basic operations and commands they could then work independently on the programming.

Prior to having the students work on the robotic ball, the teacher needs to make sure the ball is connected to the smartphone or ipad or computer though Bluetooth. This connection is made possible by using the apps for Sphero, which can be downloaded free

The lessons plans for this lesson are available at http://www.gosphero.com/education/. Thee are 6 Macrolab lessons beginning with introduction to Sphero and goes all the way to OrbBasic programming level 2

Objective: Introduction to Sphero : Students will learn to move the robotic ball in all directions.
Students will be able to show there is a linear relationship between time, speed and distance. Students will program Sphero to move at a particular speed for a particular amount of time and then measure how far it has gone.
Students will next manipulate the 3 entities to get 3 different formula for time, speed and distance. Each in terms of the other.

Direct Instruction: Review on time, speed and distance. The relationship between the three. Define linear relationship. Simple problems on time, speed and distance. To find the third unknown when 2 others are given.

The first thing students will have to do with Sphero each time it is turned on is, to set its heading to 0 degrees . In other words it needs to be “aimed”, this means set the direction of Sphero. The heading is not relative to the ball it is relative to the user.. Aiming is done using the apps and by holding the finger on the icon to set the tail light . The tail light is a blue rectangular light inside the ball. We can direct the blue tail light of Sphero point directly to us, this indicates 0 degree heading and will go directly in the direction opposite to us or in the forward direction. Once it has been oriented it can follow the users instructions to move in the specific direction. The heading can be specified down to 1 degree.

Students will follow the step by instructions given in the lesson and complete the accompanying worksheet with this lesson. In doing this lab activity students will:
Create a one-line program that moves Sphero at a steady speed for a specified amount of time
Perform measurements to determine the distance traveled.
Perform division to compare different measurements
Create a two-line program that moves Sphero to a certain position and then moves it back to where it started.

Annotated Bibliography

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(*About STEM and the connection with Robotics)*
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(*Carnegie Mellon Robotics Academy – Mathematics applied when experimenting with Robots)*

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(All about the arduino is given here)
http://d2qrgk75cp62ej.cloudfront.net/sites/main/files/file-attachments/9.1h_-_alg_i_with_computer_final.pdf
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(a good source for beginners in programming)

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(*an article on inquiry based learning versus traditional based learning)*

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(Sphero : All the macrolab lesson plans to use Sphro in the classroom along with the worksheet and teacher guides)
http://scratch.mit.edu/about/

(*To download Scratch)*
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