

Why Robotics for Children? A Case Study on Middle and High School Students Learning Robotics in Summer Camp

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Abstract: *The rapid development in the field of Artificial Intelligence, made education sectors include robotics as part of the curriculum from the primary level onwards. It has the potential to be a game - changer for every child. A study was done on students learning robotics at the middle and high school levels. This study was carried out at the Hyderabad Institute of Excellence during the summer holidays. This school is located at Mudgula Chitampally, Vikarabad District, Telangana State, in India. The goal of the study was to analyze the importance of learning robotics in school and what skills the students will develop through learning the course and to analyze the method of teaching and learning robotics. A two - week robotic camp was organized, and students from different parts of the state attended the course. A case study was used as a method, and qualitative and quantitative approaches were used to collect data. Classroom observations enabled us to identify the effective method of teaching and learning robotics. Activities and oral questionnaires assisted us in recognizing the skill sets of Logical thinking, Analytical thinking, Conceptual Understanding, Critical Thinking, and technical thinking of students in learning robotics. Teamwork in activities boosted students' learning skills. Simultaneously formation of a team should be well - planned.*

Keywords: Robotics, Teaching and learning, Skill sets, Teamwork

1. Introduction

Robotics is becoming very popular in schools as part of the curriculum, due to the current development of AI (Artificial Intelligence) and robotics is inevitable in education, it has the potential to be a game - changer for every child (Mohan, 2021). According to (Pooja, 2023), there are ten reasons why children should learn robotics, it helps children learn to think creatively and critically, it increases their problem - solving abilities, and it helps to learn and understand coding. It helps children to learn 21st - century skills, it helps children to learn science and math concepts practically, it develops teamwork and collaboration skills in children, it encourages children to try new ideas, it teaches children to handle and overcome failure, it supports children to learn motor skills, and it assists to build self - confidence in them. The students who have critical thinking skills can think clearly and rationally according to the situation, and it allows them to perform problem - solving and decision - making more effectively (Wooll, 2022).

The Government of India launched the 'YUVAi - Youth for Unnati and Vikas with AI' program in Government Schools. It aims to foster a deeper understanding of AI by training school students from classes 8 to 12 across the nation with relevant mindsets and skill sets and empowering them to become human - centric designers and users of AI. The program offers an applied learning experience for students to understand and identify how AI technology can be used to tackle critical problems and lead to inclusive development of the nation (Government of India, 2023).

A research study was carried out at the Hyderabad Institute of Excellence during the summer holidays. This school is located in Mudgula Chitampally, Vikarabad District,

Telangana State, India. The goal of the study was to analyze the importance of learning robotics in school and what skills the students will develop while learning, and to analyze the method of teaching and learning robotics. Students from various schools participated in the summer camp activities. The robotics camp was organized for two weeks in the month of May 2023. It was conducted by ROBOMAKERS, an innovation - driven organization that presents contributions in instruction and mechanical areas and offers courses like Robotics for Beginners, App Development, 3D Design, Block Programming, Artificial Intelligence, and Machine Learning (Robomakers, 2023). The students were divided into two batches from Middle and High School. In batch one (middle school students) 14 students participated, and in batch two (high school students) 18 students participated.

The Summer Camp Robotics was planned for 14 - day sessions with a one - hour duration daily. The program was framed to develop learning outcomes and skill sets, session - wise as a case study. The session topics were 1) Introduction to Robotics, 2) Basic Electronics, 3) Basics of Arduino Uno, 5) Construction of Robot, and 6) Programming and Working of Robot. The learning outcomes of the summer camp were focused on a) Understanding Robots and human robots, and how they can help us, b) Awareness and building curiosity for further Robotics, c) Impacts of having robots in the future, d) Learning the advantages of cloud computing and Internet of Things, e) Creating a circuit using a battery, LED, switch and resistor, f) Creating a circuit using a toy motor, battery and resistors, g) Creating a circuit using Bread Board and 3 resistors, h) Learn about Arduino UNO, i) Learn how to install and setup Arduino Uno, j) Learn about programming and working of robot, k) Learn about different turns of robot. Every session was observed to identify the teaching and learning methodology.

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According to (Robomakers, 2023) the students will learn and develop skill sets like Logical thinking, Analytical thinking, Conceptual Understanding, Critical Thinking, Technical thinking, and Teamwork. The skill set logical thinking can be defined as the act of analyzing a situation and coming up with a sensible solution, which is similar to critical thinking (Great Learning, 2022). Technical thinking occurs in learning and solving technical problems and tasks (Umborg & Uukkivi, 2020). Analytical thinking is a part of problem - solving, it integrates brainstorming ideas, collecting and evaluating information, and putting it to the best use. It doesn't limit itself to the classroom, instead, it motivates the student to implement actionable plans or solutions for different life challenges (Raturi, 2021).

According to (Agnihotri, 2020) the skill set conceptual understanding refers to an integrated and functional grasp of mathematical ideas. Students with conceptual understanding know more than isolated facts and methods. They understand why a mathematical idea is important and the kinds of contexts in which it is useful. Teamwork is a very essential skill in learning robotics. It happens only when students work together toward a common goal and each team member works collaboratively brings their perspective and experiences and uses their own set of skills (Perry, 2022). These skill sets were observed during the sessions of the summer camp.

2. Methodology

First Day – the teacher started the session with an interesting question “What thoughts come to your mind when you hear the word robotics”, what is robotics? Students responded that robotics means a machine, that will do work. The teacher defined the Robot as a machine or a mechanical device that can perform repetitive tasks or activities as commanded. He also gave an example of the school bell which is programmed to ring automatically at specified times.

A video was played by the teacher to show how the students made the robot, to create awareness and curiosity in students. The video ends with a question to mention the parts of a robot. The students were able to answer the question well. To make a clear understanding of robotic parts a second video was played, which shows the conversation between a robot and a person called GEORGE DEVOL, who was the first person to make an industrial robot in 1954 that could store commands and can move parts (The Invention of the Industrial Robot, 2023). The video facilitated students, on the four main primary components of the robot, Mechanical parts, Sensors, Power supply, and Controller. The teacher also gave some more examples to the students to identify the components, and they were able to answer well.

At the end of the session, the teacher conducted an activity to make the students understand the concept of programming. He demonstrated the activity by giving instructions to the students like “Move forward by taking 9 steps, pick the bottle, and come back with 9 steps”. This activity allowed the students to understand how robots work based on the instructions, which indicates the skill set of

conceptual understanding. The teacher concluded the session by intimating the next day's topic Artificial Intelligence (AI).

Second Day–The teacher started the session by recapping the previous topic and playing a video in which different types of robots performed different tasks such as 1. Medical robots - performing surgeries, 2. Chef robots – preparing dishes in the kitchen, 3. War robots – carrying weapons and attacking, 4. Agriculture robots – helping farmers to water the plants, 5. Transport robots – transporting materials, things, and parcels, 6. Construction robots – help in construction works, and 7. Manufacturing robots – help in the production of materials. At the end of the video, the teacher asked the students to name the types of robots and then the teacher connected the topic to the present scenario like the team of Robotic Sciences in the Yashoda Hospitals which performed the largest number of successful robotic surgeries in the states of Telangana and Andhra Pradesh (Robotic Surgery Hospital in Hyderabad, 2023). The students were able to respond well and analyze the practical applications of the technology in real life.

The teacher moved to the next topic humanoid robots and asked the students about humanoid robots. Some of them were able to say that the robots work like humans. The teacher played the video of a humanoid robot called **Sofia**, which can speak like a human and give answers to the random questions of human. Sofia is the world's first robot citizen and the first robot Innovation Ambassador for the United Nations Development Programme (Sofia, 2023). To make the students think logically and critically teacher pointed out that “here the robot is giving answers to random questions”, how is it possible? Few students mentioned the concept of programs fed into the machine, which allowed students to think and answer the working process of robots.

The teacher started the next topic which is the most well-known and trending name all over the world Artificial Intelligence (AI). He played a video related to AI and asked the students have you ever observed, that when we type or talk about something in mobile apps, the content with additional text will appear, which is nothing but Artificial Intelligence. It works automatically without any commands and he concluded that robotics uses artificial intelligence. The teacher continued with the next topic **Basics of Electronics** and he asked the students about the word Electronics. The students answered that the things that work with electricity are called electronics. The teacher played a video, that showed what is electricity. how it is produced? And how it can be used? He asked the students to imagine a life without electricity and he tested their knowledge by asking questions about electricity.

As a part of experiential learning, the teacher conducted an activity by providing tools like Motor, LED, and Tyres. He demonstrated the activity and asked them to follow the steps 1) Attach the tyre to the motor, 2) Connect the LED to the motor, and 3) Rotate the tyre. Whenever the student rotates the tire, the LED starts glowing. The teacher concluded the topic by comparing the motor with a dynamite/generator, and the tire with a turbine which converts mechanical energy

into electrical energy. This activity allowed students to understand the process of energy conversion.

Third Day – The session was started by displaying a picture of an electric circuit, and the teacher asked the students about the picture, they replied as a bulb, battery, switch, and wires then the teacher explained that it is an electric circuit that can allow the current to flow. The teacher asked, what happens when the switch is on? Immediately the student replied that the bulb would glow, and then he asked how to measure the current. One of the students replied it is measured in ampere and the device ammeter is used to measure current. The teacher explained about the current and the voltage by showing a picture of two water tubs connected with a pipe in which one tub is kept at a high level and another at a low level, and he asked the students, how the water flows. The students responded that the water flows by the pressure from the tub which is kept at a higher tub to the lower tub. By comparing this activity, he made the students understand that the Current flows from higher potential to lower potential. A battery has two terminals one is positive and another is negative. The positive terminal has more potential and the negative terminal has less potential. The difference between these potentials is called Voltage, which is measured by using a voltmeter.

To develop critical thinking in students, the teacher explained how resistance works with an example of driving a car and applying the brakes to slow down the speed. Likewise, to reduce the flow of current Resistance is used. Resistance is measured in Ohms. He also conducted an activity by giving a multimeter and a 9 - volt battery to each student and asked them to measure the current, voltage, and resistance. After the activity, the teacher asked the students to explain what they had learned in the activity to test their conceptual understating. Students used the multimeter and measured the voltage by connecting it to the correct terminals of the battery.

Fourth Day – the teacher started the session by asking students, what they had learned in the previous class. They replied about the multimeter and its working methods. He conducted an activity by giving the components required to make a circuit, which included a 9 - volt battery, battery snapper, switch, fan, and a motor for each student. The teacher instructed the students to watch the process of making the circuit and he explained the steps. Students immediately started making the circuit and showed the rotating fan to the teacher and some of them connected a switch in the circuit to make it ON and OFF. This activity proved their technical and logical skill. Figure 1 given below shows a completed circuit done by the student.

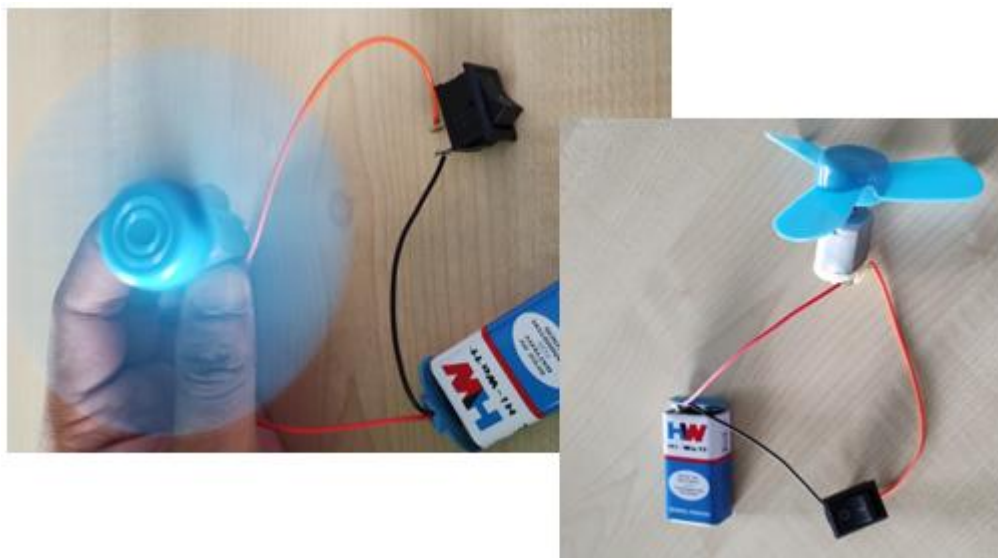


Figure 1: Circuit with fan, motor, battery and a switch

Fifth Day - The teacher started the session by showing a bread board for prototyping or building circuits, which allows to place the components and connections on the board to make circuits without soldering(What is a Breadboard?, 2019). He explained that the breadboard has 4 standing lines and 30 sleeping lines, once we connect a positive terminal to any line then the line act as a positive line. The teacher arranged the students into teams and provided them with a breadboard, 9V battery, buzzer, and battery snapper to experiment. He instructed the students to insert the positive terminal of the battery into the positive standing line and connect the negative terminal of the battery to the negative standing line of the bread board then connect the positive terminal of the buzzer to the positive line of the standing line, and check with the negative terminal by connecting it to any of the holes. When the

negative terminal of the buzzer touches the negative terminal holes the buzzer will work and if the negative terminal of the buzzer touches the positive terminal the buzzer will not work. By doing this activity the students come to know that all the holes in the bread board are connected in the respective lines. The same method is done with the sleeping lines.

The teacher conducted a demonstration to show how a low - volt component worn out when a high - volt current is applied. He connected an LED (Light - Emitting Diode) bulb to a high volt battery and found that the bulb was worn out. To overcome the challenge, we have to use resistors to reduce the flow of the current. It is used in virtually all electronic circuits and many electrical equipment. The name resistor indicates resist the flow of electricity, and this

function is key to the operation of most circuits (Resistors, n.d.).

The teacher explained another experiment using LED, he gave one resistor, LED, battery, battery snapper, and breadboard to the students and asked them to connect the positive side of the battery to the positive line of the breadboard and then connect one end of the resistor to the positive standing line and another end to the sleeping line. Then, he asked to connect the big leg of the LED to the same sleeping line, where a resistor is connected and the small leg is connected to the negative standing line. Finally, he asked the students to connect the negative terminal of the battery to the negative standing line of the breadboard. Students who had completed the circuit successfully were able to see the bulb glowing. This activity allowed students to develop their technical thinking skills.

Sixth Day—The teacher started the session with an activity to teach the students the difference between high and low resistance. He gave components like bread board, 9V battery, battery snapper, male wire, two resistors, and two LEDs for each student. He demonstrated step - by - step instructions to the students to perform the activity. Students used the breadboard to create two circuits with high and low resistance and they observed that the LED glowed brightly in one circuit, which was connected to a low resistance, and in the other circuit the LED glowed as blur which was connected to a high resistance. The teacher explained that this is because of the high resistance and low resistance, when the resistance is high then it glows with less brightness, and with less resistance, it glows brightly. This activity allowed students to think critically to understand how low and high resistance work.

The teacher conducted a competition to test the knowledge of the students by creating teams of two members. He asked them to create two circuits with LED bulbs using a breadboard, low and high resistance, battery snapper, and 9 - volt battery. He announced 10 points for the team that completed first, 5 points for the team that completed second, and 3 points for the team that completed third. He also conducted a quiz of 15 questions, related to the concepts that the students had learned in the previous classes, each question carried one point. It was observed that the students did the activities and also participated in the quiz competition enthusiastically.

Seventh Day – The class began by asking about the main parts of a robot. The students were able to answer 1. mechanical parts, 2. sensors, 3. power supply, and 4. Controller. To make the students understand the concept of the robot, the teacher asked questions, what is the controller/brain of the computer? Students replied C. P. U. (Central Processing Unit), then the teacher asked what is the controller of the human body. They said Brain, based on the response of students, the teacher compared the computer with the human body and explained that **ARDUINO UNO** is the controller of the robot. Arduino Uno is a microcontroller board, based on the **ATmega328P** (Integrated chip). It has 14 digital input/output pins of which 6 can be used as Pulse Width Modulation (PWM) outputs, 6 analog inputs, a 16 MHz ceramic resonator, a USB connection, a power jack, an ICSP header, and a reset button. It contains everything needed to support the microcontroller; simply connect it to a computer with a USB cable or power it with an AC - to - DC adapter or battery to get started(Arduino, 2023). Below figure 2 shows the details of Arduino Uno.

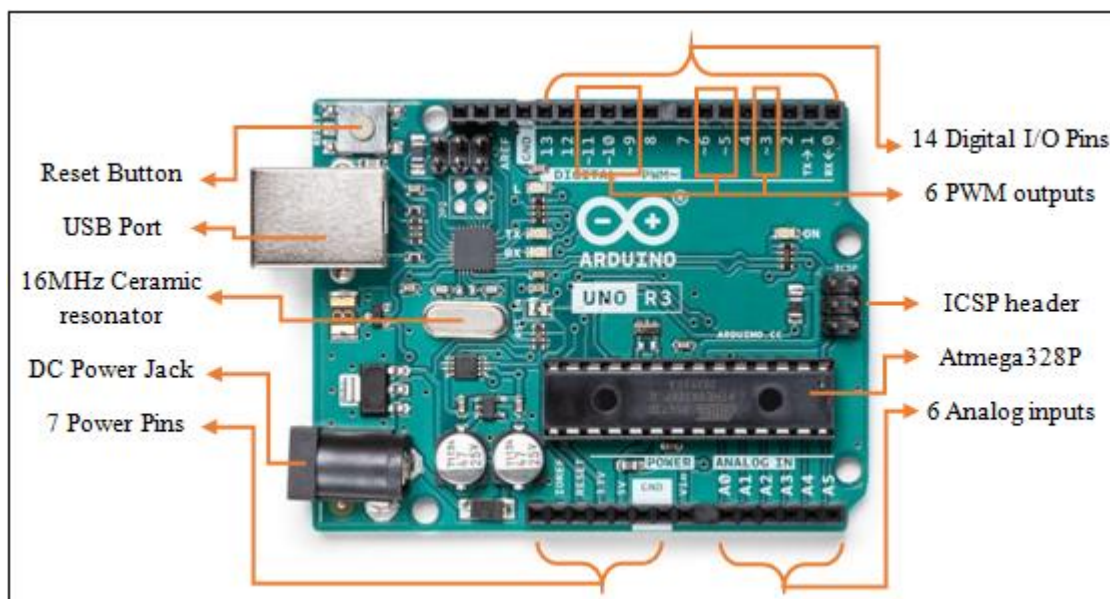


Figure 2: Arduino Uno Rev3

Source: The image is taken from (Arduino Uno Rev3, 2021)

The teacher explained Arduino Uno by showing a picture of Arduino Uno Rev3 (processor) and connected with input and output devices. He gave an example that if you want to take the water bottle to drink water as an input, then you will confirm whether water is there or not in the water bottle, this

is nothing but processing, and you will take the water bottle to drink water as an output. He gave another example by relating the human body as a robot, the brain is the controller, the eyes are sensors, and the hands and legs are output devices. When you see a bottle, your eyes give a

signal to your brain about the bottle's color, shape, size, etc. Usually, the input signals are given by the sensors, and the controller processes the signals and gives output.

The teacher asked what are the input and output devices of the computer, students responded one by one that input devices such as keyboard, mouse, and output devices are monitor, printer, speaker, etc. Similarly, Arduino Uno has input devices such as SENSORS, and output devices such as LED, MOTORS, DISPLAY, and SPEAKERS. He gave one Arduino Uno to two students as a team and explained the parts of Arduino as 1. DC jack is used to supply power to Arduino from 7V to 12V, 2. USB connector is used to connect USB cable 3. Pins – Arduino Uno has 3 types of pins, i) 6 Analog pins, ii) 14 Digital pins & iii) 7 power pins.

Eighth Day – The class began by showing the picture of coding script for glowing an LED bulb. The teacher asked the students to write the script in their notebooks. He observed whether the students were writing the script correctly, and asked them to write the script without any mistakes, then only the code would be compiled. He explained the code and defined the pins of Arduino Uno. The teacher installed the software Arduino IDE (Integrated Development Environment) for the windows platform and asked the students to type the script for glowing the LED. Next, he gave the USB cables to the students and asked them to connect the Arduino Uno to the CPU. The students connected and plugged the LED at the 13th pin of the Arduino Uno and it started glowing, the students also tried to increase and decrease the blinking of the LED by changing the script in the computer. It was observed that the students understood the installation of Arduino IDE for coding and setting up of the Arduino Uno with input and output devices.

The teacher instructed students to learn the code for 5 minutes and he conducted a competition by instructing them that whoever typed the code fast would win the game. Students completed the code within 3 to 4 minutes. The students must learn the commands and syntax to perform the task.

```
void setup ()
{
pinMode (13, OUTPUT);
}
void loop ()
{
digitalWrite (13, HIGH);
delay (2000);
}
```

```
digitalWrite (13, LOW);
delay (2000);
}
```

He explained the above code to the students like “void setup ()”, which is used to define the PIN 13 of the Arduino Uno and its functions. The command “void loop ()” is used to perform the task for PIN 13, digital Write (13, HIGH) allows the power to be ON, and digital Write (13, LOW) disables the power in PIN 13, and he also explained about the delay (2000), which will give a delay for 2 seconds for LED to blink before and after. Then the term high means ON and low means OFF, which was clarified by the students, and even they asked about changing the delay timings. The term critical thinking is important for making judgments about sources of information and forming his/her arguments, it emphasizes a coherent, objective, and self-aware approach that can help the students to identify credible sources and strengthen their conclusions (Ryan, 2023). The above activity enables the students to develop critical thinking skills.

Ninth Day – The session was focused on an activity of fixing the mechanical parts of a robot. Tool kit, which contains two wheels, one universal wheel, one chassis, two velocimetry code wheels, one battery container, two DC Gear Motors, M3*8Screw 2 bars, M3 nut 6 pieces, M3*6 Screw 8 bars, L10 spacer 4 bars, M3*30 Screw 4 bars, switch 1 piece, Fastener 4 pieces, one Arduino Uno, one Motor driver of L298N, one screwdriver, double tape...etc. were given for each team of two members. The teacher explained the construction of the robot in a step-by-step process as shown below.

Step - 1: Insert the fastener into the chassis after removing the yellow protection wrap of the chassis, the fastener, and the code wheel.

Step - 2: Fix the code wheel and the gear motor to the chassis, then insert the screws and tighten it.

Step - 3: Fix the battery container to the chassis using the screws.

Step - 4: Fix the universal wheel by inserting the spacer and tightening the screws.

Step - 5: Attach the Arduino and motor driver on the top of the chassis with the help of double tape.

The teams were able to complete the activity, their collaborative effort enabled them to achieve a common goal or to complete the task effectively and efficiently. The teacher asked the teams to identify the motor driver in the assembled kit and he explained about the motor driver and its parts.

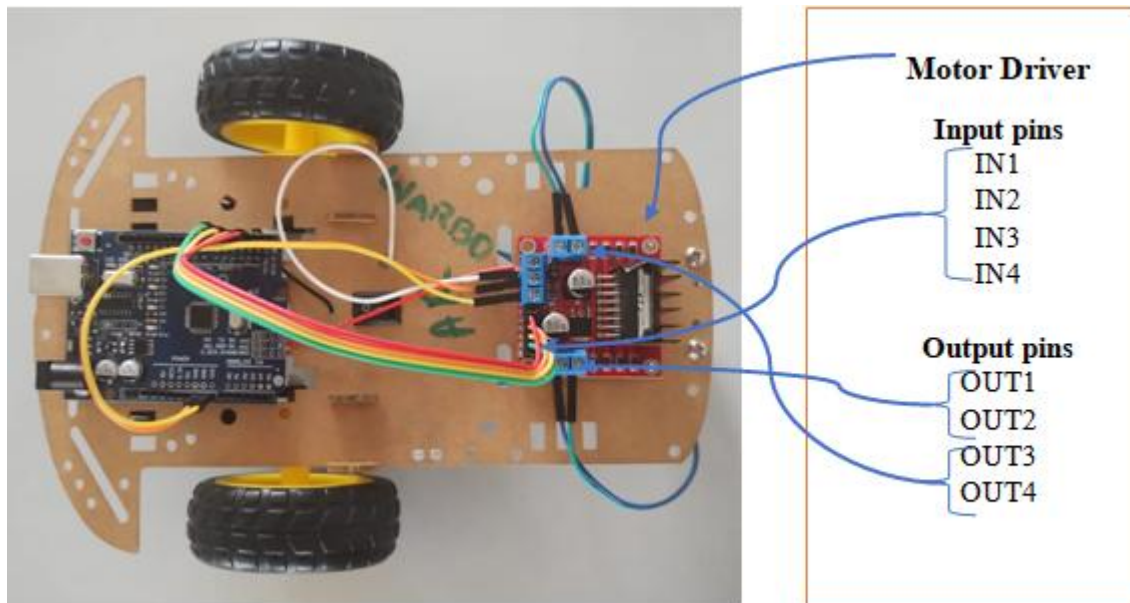


Figure 3: Assembled kit of robot

A motor driver is used to drive or control the motor. The motor driver consists of IN1, IN2, IN3 and IN4 are direction control pins, OUT1 and OUT2 pins control the right side of the motor, and OUT3 and OUT4 pins control the left side of the motor. It also has 5 Volt, 12 Volt, and ground pins. The teacher explained the importance of the motor driver, if we connect the DC motor directly to the Arduino Uno, it cannot support by giving enough power/voltage to run the motor, as a result, the motor driver is used to control the robot.

Tenth Day – The teacher started the session by asking questions such as why are we using the motor driver? The students started thinking and answered that the motor driver is used to drive and control the robot. It was observed through the interactions that the students had more doubts about the wiring between the Arduino and the motor driver. The teacher explained the two types of wires 1) Male - to - female and 2) Male - to - male by connecting the wires using Arduino and motor driver.

Conducted an activity by giving jumper cables/connecting wires, batteries of 9.3V, battery holder, chassis with Arduino, and motor driver. Using the overhead projector, the teacher showed the picture of wiring and also instructed the students as follows.

- 1) Take four jumper cables and connect them to the IN1, IN2, IN3, and IN4 pins of the motor driver and PINs 3, 4, 5, and 6 of Arduino Uno.
- 2) OUT1 and OUT2 pins should be connected to the right side of the motor and OUT3, and OUT4 should be connected to the left side of the motor.
- 3) The 5V and GND pins of the motor drive should be connected to the VIN and GND pins of the Arduino.
- 4) The teacher showed the soldering iron, lead, and stand then he explained how to hold the wire and carefully do the soldering. The teacher did the soldering of the wire on one side of the wire and asked the students to do the other side, which was to be connected to the DC motor.
- 5) Attach the battery holder down the side of the chassis, and insert the batteries into the battery holder.

- 6) Connect one of the battery wires to the 12V pin of the motor drive and the other wire to the switch.
- 7) Students ON the switch and the LED in Arduino Uno glowed, and the teacher asked the students to observe connections.

Eleventh Day – To test the students' understanding of technical skills, the teacher gave the robots to the students and provided 5 minutes to observe the wiring connection. After 5 minutes the teacher asked the teams to disconnect the wires from the Arduino Uno and motor drive, and the students showed the disconnected chassis to the teacher. On the count of three by the teacher, the teams started wiring the robot. It was observed that both the team members actively participated in the contest and the first three teams, who completed the wiring successfully received the prizes.

The session was continued by displaying a code as shown below, which is used to control the robot. The teacher asked students to copy the code in their notebooks.

```
void setup ()
{
  pinMode (3, OUTPUT);
  pinMode (4, OUTPUT);
  pinMode (5, OUTPUT);
  pinMode (6, OUTPUT);
}
void loop ()
{
  digitalWrite (3, HIGH);
  digitalWrite (4, LOW);
  digitalWrite (5, HIGH);
  digitalWrite (6, LOW);
  delay (2000);
}
```

Twelfth Day – The session was focused on programming and working on the robot. The students collected their robots and went to the computer lab, they turned on the computer and worked on the application software Arduino 1.8.1. the students typed their code and compiled it, and some of them

got error messages, immediately they clarified the errors and corrected their mistakes. Later they saved the file on the computer. The teacher explained the coding with different types of turns like axial left, axial right, radial left, radial right, stop, permanent stop, etc. Later the students connected the Arduino Uno to the CPU using a USB cable and uploaded the code to the robot. The students switched on the robot and placed it on the floor, the robot moved forward, reversed, and took different turns.

Thirteen Day –The teacher conducted a quiz competition in the computer lab by using Google Forms. Fourteen questions were given in the form of multiple choice and one question was asked to type the code for the robot to move forward. The results revealed that 94 percent of students were able to identify Arduino Uno, which was displayed as a picture in the question.93 percent of students were aware that there are 14 digital pins available in Arduino Uno, in that 6 pins are analog pins it was identified by 87 percent of the students and 77 percent of the students know that the remaining 7 pins are used as power pins.

71 percent of the students know that the resistance is measured by Ohms, and only 58 percent of the students remember the unit of current is Ampere.81 percent of the students were aware that the device Multimeter is used to measure Current, Volt, and Resistance.84 percent of the students know the components of a robot.71 percent of the students were aware of the breadboard and its sleeping and standing lines.71 percent of the students know that the resistance is measured by Ohms, and 61 percent of the students were aware that the resistance was used to control the flow of current.71 percent of the students recognize well that the 13thpin is used to glow the LED.87 percent of the students remembered that the software Arduino IDE is used to upload the program to Arduino Uno. Only 58 percent of the students were aware that the motor driver was helping to move the robot, and 58 percent of the students got the correct coding to move the robot forward.

Fourteenth Day –This day was planned for the Culmination of the Summer Camp, where the students showcased their

robots and participated in the cultural programs. In the morning session, we conducted a questionnaire orally to test the student’s understanding of the course and to analyze their knowledge about learning robotics. The following questions were asked to the teams.

- 1) What is a robot and its types?
- 2) What are the four main parts of Robot?
- 3) What is artificial Intelligence?
- 4) What components were used to create an electric circuit?
- 5) What is Arduino Uno answer any five points connected to Arduino Uno.
- 6) What are the three Arduino pins? and explain its functions
- 7) What are the main components of constructing a robot?
- 8) Explain the wiring connection between Arduino and the motor driver.
- 9) What is resistance?
- 10) What is the importance of coding?

It was not limited to the above questions, based on the students’ answers, connected questions were also asked to test their knowledge in depth. The following tables show the results of Middle school (grades 5 to 7) and High school (grades 8 to 9) teams scored in the oral questionnaire.

Table 1: Batch 1 - Students of grades 5 to 7

SINO	Team 1	Team 2	Team 3	Team 4	Team 5	Team 6	Team 7
1	5	4	5	5	1	5	5
2	4	0	5	4	2	5	4
3	0	0	3	0	1	0	0
4	2	0	5	0	0	1	5
5	5	0	5	0	1	4	4
6	5	0	4	4	0	5	4
7	5	2	5	3	0	5	5
8	4	0	4	2	0	1	2
9	5	0	5	5	0	3	5
10	5	0	5	4	0	3	2
Total	40	8	46	27	5	32	36
Percentage	80	16	92	54	10	64	72

Table 2: Batch 2 - Students of grades 8 and 9

SINO	Team1	Team 2	Team 3	Team 4	Team 5	Team 6	Team 7	Team 8
1	5	4	4	5	5	5	5	5
2	5	5	5	5	5	5	5	5
3	0	5	4	5	0	0	5	5
4	5	5	5	5	4	5	5	5
5	3	3	5	4	3	3	5	5
6	5	5	5	5	3	5	5	4
7	5	5	5	5	5	4	5	4
8	5	3	3	5	5	5	5	5
9	5	5	3	5	0	5	5	0
10	5	5	5	5	5	5	5	5
Total	43	45	44	49	35	42	50	48
Percentage	86	90	88	98	70	92	100	96

3. Results and Discussions

All sessions were conducted with activities and the sessions were interconnected with concepts. Explanations were given based on real - time examples which allowed the students to think critically. The teachers used visual aids like images,

graphics, and videos to explain the concepts, visual learning enabled students to learn and map their ideas thoughtfully and effectively. Activities enabled them to learn by doing, which is experiential learning. It allowed them to strengthen their knowledge and it improved their confidence level in assembling the robotic kits.

The results of the questionnaire reflected in the middle school that the two teams' team 2 and team 5 had scored 16 and 10 percent respectively. It was observed that the two teams scored very low percentages on the oral exam, the team 2 students are from the same school and they are classmates of grade 6. During the sessions, it was observed that they were restless and had playful behavior, even in the other activities of summer camp they were focused only on fun. The team 5 students are from the state board schools and they are from different grades 5 and 6 levels. It was observed they had challenges while interacting with the teacher, because they were only familiar with their local language 'Telugu', and even they lacked in team coordination due to different grade levels. Other teams at the middle school level were able to perform well, but some of them did not know basic electronics, due to the team coordination they were able to perform well.

High School Students performed well in learning robotics; all the teams got above 70 percent of the score in the oral questionnaire. These students have shown more interest in learning robotics, and it was observed that these students have the knowledge of basic electronics and it supported them to perform well in all the sessions. In the oral presentation, these students answered well by analyzing the question and they were able to give sensible answers. All the sessions were planned well to achieve the goals, and visual presentations and activities were conducted in each session, which allowed them to learn by doing. It is an active learning methodology based on the experience of assimilating concepts through actions. It also encourages the student to learn from mistakes and draw conclusions after analyzing the practice in a clear spirit of continuous improvement (Smowl Tech, 2022). The skill sets of Logical thinking, Analytical thinking, Conceptual Understanding, Critical Thinking, and technical thinking were observed in the session activities and it was reflected in students while answering the questions.

4. Conclusion

The study was focused on analyzing the importance of learning robotics in school, observing the skills that the students will develop through learning the course, and discovering the best method of teaching and learning robotics. Summer camp motivated students to learn robotics. The case study enabled us to identify the best method of teaching and learning, and to analyze the skill sets that the students were able to develop in learning robotics. The sessions were planned well to achieve the goals, and visual presentations and activities were conducted in each session, which allowed students to learn by doing. Teamwork in activities boosts students' learning skills. 73 percent of the students stated that learning robotics in a team, helps them to understand the concepts easily. Team formation plays an important role in learning robotics, the students who are very close friends in a team have only fun without learning. The research study enabled us to implement robotics as part of the curriculum of the Hyderabad Institute of Excellence for grades 2 to 9 in the academic year 2023 - 2024.

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