



UNIVERSITI PUTRA MALAYSIA

***STUDY ON THE STEM INNOVATION USING FLOWLOGIC 6
ALGORITHM AND ARDUINO UNO IN SMART FARMING***

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**STUDY ON THE STEM INNOVATION USING FLOWLOGIC 6 ALGORITHM AND
ARDUINO UNO IN SMART FARMING**

By

NUR FAZLIN BT MOHD MASDI

197152

**Thesis Submitted to the Department of Physics, Universiti Putra Malaysia, in partial
Fulfilment of the Requirements for the Degree of Bachelor of Science with Education
(Honours) Major in Physics**

FEBRUARY 2022

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DEDICATION

I dedicated this work to every person that has encouraged and helped me throughout the completion of this research.



ABSTRACT

STUDY ON STEM INNOVATION USING FLOWLOGIC 6 ALGORITHM AND ARDUINO UNO IN SMART FARMING

By

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FEBRUARY 2022

Supervisor: Assoc. Prof. Dr. Suriati Binti Paiman, PhD

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Plant growth is significantly influenced by their surroundings, hence proper monitoring is necessary to ensure optimal growth and distribution. As a result, the goal of this project is to develop a smart farming monitoring system that incorporates automation and internet of things (IOT) technologies, as well as auto irrigation based on real-time soil moisture data. Sensors such as soil moisture, humidity, temperature, water level, and gas sensors are utilized to create a closed-loop automated system for this purpose. When the moisture level falls below the marginal value, a signal is transmitted to the microcontroller board, which causes the pump-to-pump water into the plant. The pump is turned off when the moisture level reaches an absolute value. The level sensor is the other requirement for this operation. The level sensor detects the tank's water level. The humidity, temperature, and gas numbers indicate the conditions in which the plant can grow in a healthy state. All sensor data will be collected and delivered to an open source IOT Platform (Thingspeak) cloud server for data visualization on the web and mobile devices. The IOT platform will be set up to process all key data from the plant monitoring system and send an alarm notification to the owner if anything goes wrong.

ABSTRAK

KAJIAN MENGENAI INOVASI STEM MENGGUNAKAN ALGORITMA FLOWLOGIC 6 DAN ARDUINO UNO DALAM PERTANIAN PINTAR

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Pertumbuhan tumbuhan sangat dipengaruhi oleh persekitaran mereka, justeru untuk mengekalkan pertumbuhan dan pengedaran tumbuhan yang betul, pemantauan yang mencukupi adalah diperlukan. Oleh itu, matlamat kerja ini adalah untuk mencipta sistem pemantauan pertanian pintar yang menggunakan teknologi automasi dan internet of things (IOT) serta pengairan automatik berdasarkan data masa nyata kelembapan tanah, dan sebagainya. Untuk tujuan ini, penderia seperti kelembapan tanah, kelembapan, suhu, paras air dan penderia gas digunakan untuk membangunkan sistem automatik gelung rapat. Isyarat akan dihantar ke papan pengawal mikro apabila paras lembapan menurun di bawah nilai marginal, yang mencetuskan pengepaman air ke dalam loji oleh pam. Apabila tahap lembapan mencapai nilai mutlak, pam dihentikan. Syarat lain untuk proses ini ialah aras penderia. Penderia aras akan mengesan paras air dalam tangki. Kelembapan, suhu dan nilai gas akan diukur mengikut keadaan persekitaran supaya tumbuhan tumbuh dalam keadaan sihat. Semua data daripada penderia akan dikumpul dan dihantar ke platform IOT sumber terbuka cloud (Thingspeak) untuk visualisasi data pada WEB dan peranti mudah alih. Platform IOT akan dikonfigurasi untuk memproses semua data kritikal daripada sistem pemantauan loji untuk memberitahu pemilik jika ada yang tidak kena melalui pemberitahuan amaran.

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Lastly, to all the parties who are involved directly or indirectly, thanks for helping me throughout this project. Besides, I would like to ask for forgiveness for any mistake that I have made during my final year project throughout this one year consecutively.



APPROVAL

This thesis entitled “STEM Education Using Flowlogic 6 Algorithm and Arduino Uno in Smart farming” by Nur Fazlin Binti Mohd Masdi (Matric No.: 197152), was submitted to the Department of Physics, Faculty of Science, Universiti Putra Malaysia and has been accepted as partial fulfilment of the requirement for the degree of Bachelor of Science with Education (Honours) Major in Physics.

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DECLARATION

Declaration by student

I hereby confirm that:

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TABLE OF CONTENTS

	Pages
DEDICATION	i
ABSTRACT	ii
ABSTRAK	iii
ACKNOWLEDGEMENTS	iv
APPROVAL	vi
DECLARATION	viii
LIST OF FIGURES	
LIST OF TABLES	
LIST OF ABBREVIATIONS	
CHAPTER	
1 INTRODUCTION	
1.1 Background study	1
1.1.1 STEM Education (Science, Technology, Engineering and Mathematics)	1

	1.1.2	Arduino Technology	2
	1.1.3	Internet of Technology (IoT)	3
	1.1.4	The Fourth Industrial Revolution (IR 4.0)	4
	1.1.5	Algorithm	5
	1.2	Problem Statement	7
	1.3	Hypothesis	8
	1.4	Research Questions	9
	1.5	Research Objectives	9
2		INTRODUCTION	
	2.1	Introduction	11
	2.2	Table 1: Innovation Using Arduino Technology	12
3		METHODOLOGY	
	3.1	Introduction	25
	3.2	3.2 Software	25
	3.3	Flowlogic 6 Software	26

3.4	Algorithm	30
3.4.1	Flowchart	30
3.4.2	The Differences Between Algorithm and Computer Program	31
3.4.3	Algorithm Design	31
3.4.4	Variable	32
3.4.5	Loops and Conditional	33
3.4.6	Console Applications	35
3.5	Components	38
3.6	Arduino Uno	46
3.6.1	5V and 3.3V	51
3.6.2	GND	51
3.6.3	RESET	51
3.6.4	IOREF	51
3.6.5	Analog to Digital Conversion	52
3.6.6	PWM (Pulse Width Modulation)	55
3.6.7	Communication Protocols	56
3.6.8	Serial Communication	56

3.6.9	Input Output (IO) Pin Assignment for Flow Logic 6	56
3.7	Comparison of Arduino Boards	61
3.8	ThingSpeak (IOT)	62

4 RESULTS AND DISCUSSION

4.1	Introduction	63
4.1.1	The Flow Program of Project	64
4.2.2	The Components	65
4.2.3	The ThingSpeak Record	70
4.3	General Result for Questionnaire	72
4.3.1	Percentages and Analysis of Respondents on First Part of Questionnaire	73
4.3.2	Percentages and Analysis of Respondents on Second Part of Questionnaire (Section A)	76
4.3.3	Percentages and Analysis of Respondents on Second Part of	78

	Questionnaire (Section B)	
4.3.4	Percentages and Analysis of Respondents on Third Part of Questionnaire (Demographic Questions)	81
5	CONCLUSION AND SUGGESTION	
5.1	Conclusion	84
5.1.1	IR4.0's Educational Impact	86
5.1.2	Pedagogy	87
5.2	Suggestion	88
	REFERENCES	91
	APPENDICES	
	VITAE	92

CHAPTER 1

INTRODUCTION

1.1 Background Study

In this study, the balance involvement of students on curricular subjects and co-curricular activities has a great impact in creating a learning environment that is in line with the rapid pace of advanced technology available today. This is because, 21st century learning does not just focus to produce students who obtain excellent results on transcripts only, but they should be packaged with other soft skills that they should develop at this young age regarding to survive in the upcoming challenging days. Therefore, teachers must play a role in developing a generation of highly skilled, independent, and the ability to think critically and creatively.

1.1.1 STEM Education (Science, Technology, Engineering and Mathematics)

During this digital era, the implementation of technology is crucial for everyone who lives in a world where modern gadgets, robots, and cutting-edge technology are used to make everyday tasks such as communication, food, transportation, and learning easier. Science and technology are becoming increasingly crucial in our lives, influencing how we communicate, produce, and distribute food, water, energy, and other essential resources, among other things. Knowledge generation and application will be critical for achieving long-term progress, improving quality of life, and providing the means for innovators to address global issues such as providing high-quality food, efficient transportation, clean energy, health care, communications, waste management, and so on (Sicardi-Segade et al., 2016).

1.1.2 Arduino Technology

Arduino Uno is one of the most widely used groups of microcontrollers in robotic products. The advantages of Arduino Uno such as easy-to-use and simple programming language make them dominant in various applications including projects prototyping and the development of automation system. It has different components like serial communication with capability is desired from the crystal oscillator. The mechanical resonance of a vibrating crystal of piezoelectric material is achieved using a crystal oscillator, which is an electronic oscillator circuit. It will generate a frequency-specific electrical pulse based on (*Overview of Crystal Oscillator Circuit Working with Applications*, n.d.). High voltage protection of USB which consists of poly fuse that defends the USB port of the PC from the over-voltage. The Arduino Uno is by far the most used microcontroller for building projects; here the affordable ATmega328 relies on the central of the Arduino board due to the rise of the Arduino and the massive maker community.

More recently, Arduino systems have been developed such that inclusion of modern technology in our daily life enables a flexible way through controlling and sensing in the actual world's external electrical gadgets. Furthermore, the controller may be immediately linked to a computer through a USB connection, allowing the code to be sent. IDE (Integrated Development Environment) software is often Arduino was created to programmed. The main advantage of Arduino Uno over Raspberry Pi is that it is easier to connect to analog sensors, motors and other electronic components is overcome. Moreover, it has a minimal time to set-up, which is just plug in then the code will run. The Arduino is ideal for applications that need fast obtaining data from sensors and doing a single task with that data.

Over the past few years, Arduino technology has attracted increasing attention and has been considered for applications such as IoT sensors, simple robot controller and home automation. It enables the user to change the conversion of unit during debugging effortlessly. The library of examples present inside the software is user-friendly. For example, to measure and display the output of voltage. The process will start from learning the microcontroller for measurement, went through the learning of serial communication and will end at USB. Another essential item when handling Arduino is breadboard. This device allows users to prototype the Arduino project without having to permanently solder the circuit together.

1.1.3 Internet of Technology (IoT)

The Internet of Things notion is becoming more prevalent in daily life, and though it will take some time to fully integrate, thanks to recent technical advancements, this time frame is constantly shrinking. One of these is wireless networking technology, which has a high level of standardization in communications protocols and allows data to be collected from remote sensors from practically anyplace and there are no timing constraints. The use of new nanotechnologies in the fabrication of silicon chips resulted in new capabilities at cheaper costs. Furthermore, thanks to recent advancements in storage devices and increasing computational power made available through cloud computing, a very large-scale integration is now achievable at a lower cost. (Lung et al., 2013).

The using of Internet of Things (IoT) in the agriculture field is another intelligent alternative to collect data instantly such as temperature, volume of water in the soil and rain detector which can help the person in-charge to monitor some environmental parameters

effectively and remotely. This will boost farming production dramatically, resulting in a significant increase in people's income when they apply this technology in their daily life. The current prototype was created utilizing Arduino technology, which includes sensors as well as cloud computing, which allows for the collection of real-time data via an online way. Having immediate access to precise, accurate data aids in enhancing the efficiency level of water, pesticide, and fertilizer management. (Supervisor & Report, 2020). The study will be a significant endeavor to the researchers and bring a productive modern life for the community.

1.1.4 The Fourth Industrial Revolution (IR 4.0)

The educational landscape has transformed because of the fourth Industrial Revolution (IR 4.0). Artificial intelligence and digital physical frameworks drive IR 4.0, making the human-machine interface more general. Education 4.0 is a new paradigm of education for the future, this is because of the rapid revolution in innovation. Besides that, to prepare graduates for IR 4.0's future life and work, in which more intelligent robots will substitute humans in some activity divisions, education should focus on important information and abilities that robots will not be able to replace. This results in a suspension of innovation. In the other hand, future learning will be more tailored, hyper, intelligent, portable, international, and virtual. Education 4.0, which focuses on educational development and skill. These are beyond the powers, enhanced skill, and progress of the twenty-first century. Artificial Intelligence (AI), big data and analysis, distributed computing and portable setup, online networking, the Internet of Things (IoT), Virtual Reality (VR) and Augmented Reality (AR) with computerized pleasures are all changing the flow of education and instructional advances landscape into new types of computerized teaching methods and smart classrooms.

1.1.5 Algorithm

In this framework, the time information acquisition is carried out daily to a variety of developments, starting with analogue signals and progressing to digital signals of various types, and from a simple motion sensor to a complicated pulse train acquisition (Bachuwar et al., 2017). The method for acquiring data is known as data acquisition (DAQ) with the aid of using which physical phenomena from the real situation converted to electrical wave which might be measured and transformed directly into a virtual layout for processing, analysis, and keeping with the aid of using a computer (Bachuwar et al., 2017). The Arduino system presentation readings from sensors are inserted into the usage of the hardware.

The focus for this thesis is on developing the low-cost smart-farming kit which aided with the simplest module on handling it which involving the knowledge in Science, Technology, Engineering and Mathematics education (STEM). This kit is built by using the programmed algorithm and Arduino system in Flow Logic software. Smart farming is a self-contained, sophisticated system that uses high-tech agriculture practices to increase agricultural yields without the need for human involvement (Chandak & Agrawal, 2017). The smart-farming kit should include the different function of sensors which are eligible for farming detection, for instance, soil humidity sensor, rain sensor and temperature sensor. There are different sensors used in this project for measuring one of the physical properties like temperature, volume of water, heat transfer and conduction.

This project would require both software and hardware appliances. For data interpretation, this software employs expert systems and artificial intelligence methodologies and algorithms. It makes real-time decisions about present and future irrigation times based on this data. Arduino UNO is used in the mobile watering system (Open-source prototyping platform

depends on user friendly hardware and software which can be customized according to user need). The microcontroller on the Arduino UNO board is utilized to operate the motor. It is programmed to use a hydrometer sensor to detect moisture in the soil and alert the Arduino UNO. If the moisture level for a particular crop falls below a certain threshold, the Arduino UNO will transmit a warning to the computer system that water is required (Chandak & Agrawal, 2017).

As for software, this is a very useful technology which brings many benefits for the researchers to produce the easy-handling and time-consuming farming application especially for the local farmers and high school students. Moreover, it enables the students to develop their inquiries and enhance their interest in the main subjects of STEM. Engaging college students in excessive high-satisfactory STEM training calls for programs that include rigorous curriculum, training, and evaluation, integrate generation and engineering into the science and math curriculum, and promote clinical inquiry and the engineering design process (Kennedy & Odell, 2014).

The focus for this thesis is on developing the low-cost smart-farming kit which aided with the simplest module on handling it which includes science, technology, engineering, and mathematics (STEM) education. This kit is built by using the programmed algorithm and Arduino system in Flow Logic software. Smart farming is a self-contained, sophisticated system that uses high-tech agriculture practices to increase agricultural yields without the need for human involvement (Chandak & Agrawal, 2017). The smart-farming kit should include the different function of sensors which are eligible for farming detection, for instance, soil humidity sensor, rain sensor and temperature sensor. There are different sensors used in this project for

measuring one of the physical properties like temperature, volume of water, heat transfer and conduction. method and smart classroom.

1.2 Problem Statement

Based on the current situation, there are many new normalizations that need to be applied in daily life not least in the field of agriculture. In this field, the need to collect data systematically is high including soil moisture data, ambient temperature, and daily rainfall distribution rate. With the close monitoring of this smart system, it can help people to monitor the optimal environmental conditions for crop production through the remote-control method.

One thing we have learned so far during these pandemic times is that we can work effectively and efficiently from home, eliminating the necessity for an office in the future. (Habilelabs et al., 2016). Hence, this project would bring a positive working environment and suitable to make it our daily life activity. Farmers' dependence on the erratic distribution of rainwater which is the main source of water for crops and monitoring methods is still far behind where they still maintain less efficient methods to get better quality and healthier crops. Usually, garden workers use methods manually to control the amount of water on the plants. In turn, the level of efficiency of these existing systems complicates their movement to turn on or off the main switch of the motor.

Furthermore, the motor switch is far from control and had to go back and forth just to control it without any signal. This will cause a person working at that time to be more exposed to unpredictable weather such as scorching hot weather and sudden rain. By expanding the use of this smart system, it can indirectly benefit the public. As such an approach is in line with government initiatives that focus specifically on the agricultural sector seen from various angles

that it can provide a new ray of hope to modern gardeners, farmers, and entrepreneurs to give them the opportunity to upgrade their lives as well as be a catalyst in raising the country's economic dependence.

Science and technology are having a growing importance in our life, impacting the way we communicate, we produce and distribute food, water, energy, and other important supplies, etc. The generation and the use of knowledge will be crucial to attain a sustainable progress, to enhance one's quality of life, and the means that will allow innovators to deal with global problems such as providing high quality food, efficient transportation, clean energy, health care, communications, waste management, etc (Supervisor & Report, 2020).

As (Kennedy & Odell, 2014) point out, with the global economy "flattening" in the twenty-first century, STEM education has taken on new relevance as economic competition has become truly global. STEM education has evolved into a meta-discipline, an integrated endeavor that emphasizes creativity and the applied process of discovering solutions to complex contextual issues utilizing cutting-edge tools and technology, rather than traditional divisions between fields. Research that uses an algorithm to assess smart agricultural technologies could be able to help solve the issue.

1.3 Hypothesis

There are several hypotheses made for this project. The flow logic software is the simple method for modeling the visual hardware components in terms of its process which is user-friendly for the user to drag and decide the sequence of how the system will be running on the computer screen. Since the algorithm is stored in the software system visually, the physical hardware will be constructed on the circuit according to the command that was remotely

controlled from the computer. The chosen microcontroller is Arduino UNO which is used to apply the programmed algorithm. ((No Title), n.d.) stated that the Arduino may be used to make interactive devices that control lights, motors, and other physical outputs based on input from different switches or sensors. The Arduino projects may be used on their own or in combination with computer software (e.g., Flash, Processing, and MaxMSP.) The boards may be built by hand or bought ready-to-use. For a broad variety of users, Arduino simplifies the process of working with microcontrollers and offers certain benefits over rival systems:

1. Inexpensive
2. Cross-platform
3. Programming environment that is simple to grasp
4. Open source and expandable software
5. Open-source and flexible hardware

1.4 Research Questions

1. How far can the smart farming kit help the students to engage with the knowledge in STEM education?
2. Is this smart system model easy to use for prospective Science teachers who have a lack of technology knowledge?
3. Did every school in Malaysia afford to provide the kit for each one of the science students?

1.5 Research Objectives

The aim of this work is:

1. To design virtual projects using computational algorithm FlowLogic6.

2. To transfer virtual project into physical real project on Arduino Uno brain-board complemented with sensors.
3. To develop the smart agriculture system prototype using low-cost material.
4. To transfer physical system to microcontroller for IoT Mobile Application.



CHAPTER 2

LITERATURE REVIEW

2.1 Introduction

According to Andrew Moela [4], farming is expected to become more significant in the future decades than at any previous time in history. According to the United Nations, by 2050, the world's population would have risen to 9.7 billion people, requiring a 69 percent increase in global agricultural commodities output. Farming firms started to employ the Internet of Things for precise analysis and improved agricultural product manufacture in order to attain this goal. The Internet of Things (IoT) is a technology that was created to help in agricultural growth. Smart farming is being adopted by an increasing number of contemporary farmers, and it is gaining popularity among the new generation of educated young farmers. Sensors, drones, and other high-tech agricultural equipment are rapidly becoming the new standard in contemporary agriculture [4], as shown by (Shah & Chaudhari, 2017).

Wireless sensor network technology [5] is one of the most significant technologies in the twenty-first century. Smart electronic devices, a diverse variety of sensor types at a reasonable price, and many wireless or internet connections all provide up possibilities for monitoring and management applications. All these microsensor networks open new options for monitoring activities and other industrial and automotive applications, offering new solutions to a variety of important fields such as health and industry. Sensors may be used on the ground, in the air, underwater, on people's bodies, in cars, and even within buildings. (2013, Lung et al.)

2.2 Table 1: Innovation Using Arduino Technology

TITLE	INSTRUMENTATION	TYPE OF METHOD/ALGORITHM & etc	Sensors etc	Application and target community	Hardware	Findings	Problem	REFERENCES
Development of a Computer-Assisted Instrumentation Curriculum for Physics Students: Using LabVIEW and Arduino Platform		Graphic al-based platforms such as Scratch or LabVIEW W		Assist physics students in learning computer programming abilities such as LabVIEW W, C, and MATLAB. in the application of theoretical simulations, instrumentation, and data acquisition. in scientific and engineering	Arduino IDE	Numerical analytic methods enable physicists to investigate everything from macroscopic astronomy and aerology to microscopic particle physics, from classical Newtonian mechanics and hydrodynamics to electro-optical quantum dynamic	For freshmen in a physics department, the essential computer programming skills.	(SIAM, 2016)

				studies.		s in semiconductors and new materials.		
CODING AND COMPUTATIONAL THINKING WITH ARDUINO		Logical AND and OR connectives (if-then-else and the while statements) Coding using Arduino board.	LED	To introduce middle school students who have never programmed before to the process of creating an algorithm, beginning with basic tasks and working their way up to more	Arduino board	Coding is effective in increasing problem-solving skills, diverse thinking, creativity, communication, and group work, according to several empirical studies.	Since infancy, students have learned about the algorithm, the logical connective, the	(Choi et al., 2013, Vacacárdenas, et al., 2015, Siegle, 2017, Lye, 2014).

				difficult problems .			if-then-else, and the while expressions.	
The effect of project-based arduino educational robot applications on students' computational thinking skills and their perception of Basic Stem skill levels				Sixth grade students from two distinct Turkish secondary schools.		It has become necessary to reorganize teaching environments and teaching programmes in order to attract the attention of the Z generation, to support traditional methods , and to enrich educational environments in order to attract the attention	The student s' STEM knowledge and the effect of project-based Arduin o educati onal robot applicat	(Somyürek, 2014)

						of the Z generation, as well as to adapt to technological developments.	ions on computational thinking skill levels.	
Arduino Board in the Automation of Agriculture in Mexico		MATLAB	Farmers in Mexico	Arduino UNO	Produce d a prototype and a computer applicati on with a friendly user interface for produce rs or people who need to prepare Fertigati on solution s as part of a research project	Many farmers , particul arly in central and souther n Mexico , still survive on self-	(Osorio, 2016)	

						to automat e the process of realizing Fertigati on solution s.	consum ption agricult ure and earn money by selling surplus crops in local markets .	
LOW- COST WIRELE SS DATA ACQUIS ITION SYSTEM FOR MULTIS ENSOR APPLIC ATIONS			Mul ti- sens ors					

The implementation of a set of controls in an Arduino ATMEGA 2560 microcontroller system		LabVIEW, X-Bee based system	Sensor Nodes	For industry and not specifically stated the community target.	ATmega328 (Arduino Uno), ATmega2560 (Arduino Mega), GUI Interface	The scientific community has recently unveiled an open-source electronic platform (Arduino) for monitoring in recent years. and controlling the experimental hardware.	Automated irrigation systems for agriculture purpose. s are becoming increasingly important and popular due to a paucity of water resources and	(Joel and Sáiz, 2014)
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							rising food production demands.	
ROBOTICS AS A TOOL TO STEM LEARNING	LEGO Mindstorm robot	LEGO NXT Mindstorm programmable reconfigurable robot		Completely in a Malaysian state of Sabah's urban secondary school. A non-random, purposeful sample of forty-four sixteen-year-old Form 4 students or Year 10 students in a fully government-aided school system comprised the participants.	The runway, slotted weight, thread, and trolley are all friction corrected.	Technological innovation may help to improve learning by enhancing teachers' curriculum delivery and allowing children to learn more freely.	How robots may aid STEM education and how teacher's might establish a robotics programme in the classro	(Goh & Ali, 2014)

							om.	
An early start to STEM education among year 1 primary students through project-based inquiry learning in the context of a magnet.				Year 1 students in the Ipoh district.	Magnet	Furthermore, project participation places children in an active and interactive role in which they take responsibility and initiative in inquiring by generating questions that they would like to have answered; exploring	The Malaysian government created the Malaysian a Education on Blueprint nt 2013-2025, which	(Safiee et al., 2018)

						g by collectin g relevant data or informat ion culminat ing in a suitable design or procedu res; investig ating based on the procedu res or inventin g based on the design; and showcas ing or reportin g their work [4], which ultimate ly yields better results.	include s 11 strategi c and operati onal reforms . As a result of rising global educati on standar ds, the percent age of seconda ry school student s who	
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							do not pursue a science educati on has increas ed to over 15%.	
--	--	--	--	--	--	--	---	--

- Firstly, for physics students, the project created a computer-assisted instrumentation curriculum by using the LabVIEW and Arduino Platforms Graphical programming environments like as Scratch or LabVIEW. Physicists can use numerical analytic methods to study everything from macroscopic astronomy to microscopic particle physics.
- The coding improves problem-solving abilities, as well as diverse thinking, creativity, communication, and group work. Students have known about the algorithm, the logical connective, the if-then-else, and the while expressions since they were little. The project used the Arduino board to code.
- Students' computational thinking skills and perceptions of basic STEM ability levels as a result of project-based Arduino educational robot applications. To attract the attention of

the Z generation, sustain conventional methods, and enhance educational environments, it has become important to reorganise teaching environments and programmes.

- For producers or persons who need to prepare fertigation solutions, a project in Mexico has built a prototype and a computer application with a friendly user interface. Many farmers in Mexico still rely on self-sufficiency agriculture and supplement their income by selling surplus products at local markets.
- The focus of the research is on developing a low-cost wireless data gathering system for multi-sensor applications. The ATmega328 (Arduino Uno) microcontroller is utilised, and the software used is LabVIEW and X-Bee. This initiative said that it focuses on industry but did not specify a community target.
- The LEGO NXT Mindstorm is a robot that can be programmed and reconfigured. It has been thoroughly tested at an urban secondary school in the Malaysian state of Sabah. The participants were a non-random, deliberate sample of forty-four (16-year-old) or four and ten-year-old students.
- The Malaysia Education Blueprint 2013-2025 was produced by the Malaysian government and comprises 11 strategic and operational improvements. Through project-based inquiry learning, this programme gives year one primary kids an early start in STEM education. The number of kids who do not pursue a science education in high school has risen to above 15%.

Robotic technologies have been used in education in recent years to learn basic information and abilities in science, technology, engineering, and mathematics sectors, according to a study conducted by Karaahmetolu & Korkmaz (2019). Intelligent objects, virtual robot programming environments, and self-made sets (Numanolu and Keser, 2017) have all increased

in popularity as ways to teach students programming using a programmable real robot. Saygner, 2017; Demirkol, 2016; Yiit, 2016; Erol, 2015; Kaucic and Asic, 2011; Kert and Uraş, 2009) are just a few of the studies that indicate educational robots and block programming aid kids with many cognitive aspects. The impact of robot use in educational settings in recent years was thoroughly studied when reading the literature (Ching, Yang, Wang, Baek, Swanson and Chittoori, 2019; Simsek, 2018; Chen, at al., 2017; Leonard, at al., 2016; Noble Chaudhary, Agrawal, Sureka and Sureka, 2016; Yuen, at al., 2014). When evaluated variables were examined, Jeannette M. Wing (2006) described computational thinking capabilities for the first time.

The Internet of Things (IoT) is a technology that was created to help in agricultural growth. Smart farming is being adopted by an increasing number of modern farmers, and it is gaining popularity among the new generation of educated young farmers. In modern agriculture, sensors, drones, and other high-tech agricultural equipment are becoming more common. [4] (2020 Supervisor & Report) In the future of contemporary farming, sustaining ecosystems, and supporting growing countries like Morocco in their total output growth, collecting and analysing big data in agriculture will be vitally important. IoT technology, in fact, has a wider range of uses. This technology is undergoing more research in order to make it more publicly available and helpful (Supervisor & Report, 2020).

The goal is for students to be able to work with real hardware that, once coded, can perform real physical tasks. LEGO® Mindstorms, for example, allows you to build programmable robots out of Lego building blocks. This strategy has proven to be effective in a variety of scenarios (Haak et al. 2018, De Vries et al. 2018, Umbleja et al., 2017). Another technology commonly used in teaching and learning environments is Arduino (Plaza et al.,

2018), an open-source hardware and software for constructing digital devices and interactive objects that can sense and control items in the physical and digital surroundings. The Arduino board is made up of a number of microprocessors and microcontrollers that may be programmed in a C-like language. Microcontrollers have permanent and volatile memories, as well as I/O ports, unlike microprocessors, which only have the processing unit (CPU). Arduino is thus a self-contained system: the programme, which is stored in permanent memory, instructs the CPU, which stores data required for the program's execution in volatile memory. (Rossano and colleagues, 2018).

CHAPTER 3

METHODOLOGY

3.1 Introduction

Following the completion of the project's investigation, the design phase of the project begins, both physically and virtually. Specific sensor functions will be the foundation of this system. These functions must be capable of performing specific tasks. To ensure that all functionalities are handled properly, testing and implementation will go hand in hand. This system's automatic and efficient irrigation can benefit agricultural fields, parks, home gardens, and school's little lawns. Furthermore, when compared to other automated systems, this one will be less expensive and more user-friendly.

This study focused on using computational thinking skills and software like Flow Logic 6 to design virtual projects. Aside from that, this initiative will assist kids in becoming more motivated and interested in STEM subjects. There have been various teaching experiences that have used coding to educate pupils as young as elementary school about problem solving and computational thinking (Rossano et al., 2018).

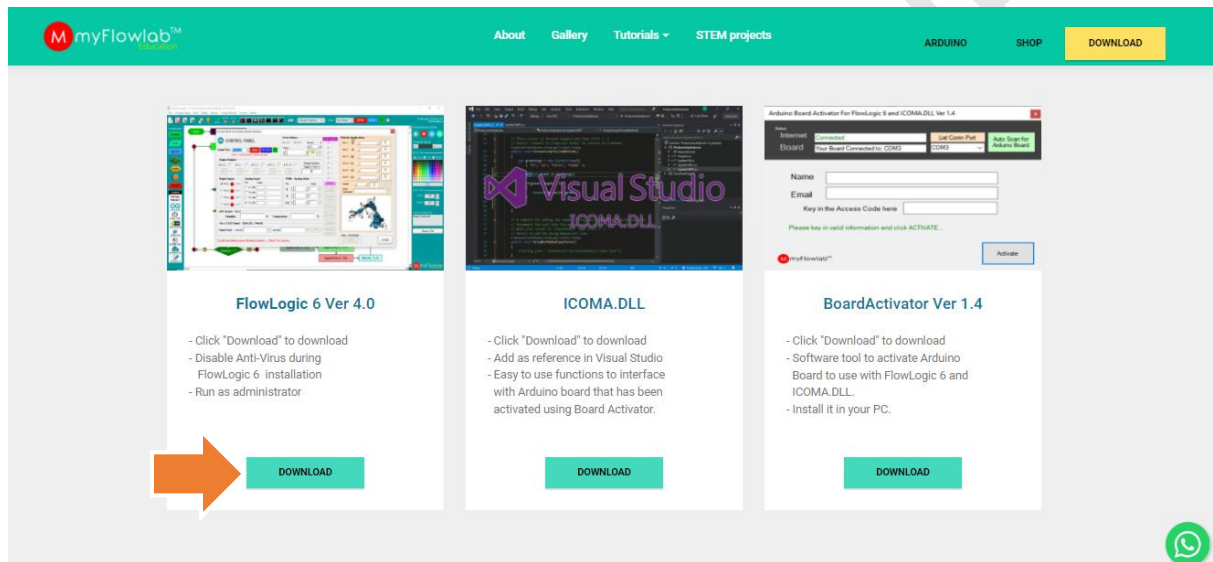
3.2 Software

The Arduino software, known as Flow Logic 6, was used to build the automated farming system. This software component will assist the researcher in developing the algorithm and transferring it to the Arduino Uno microcontroller board. It runs on Windows, Linux, and OS X.

As a result, C and C++ programming languages are used to create this environment. Flow Logic 6 software is a flowchart-based Programming IDE.

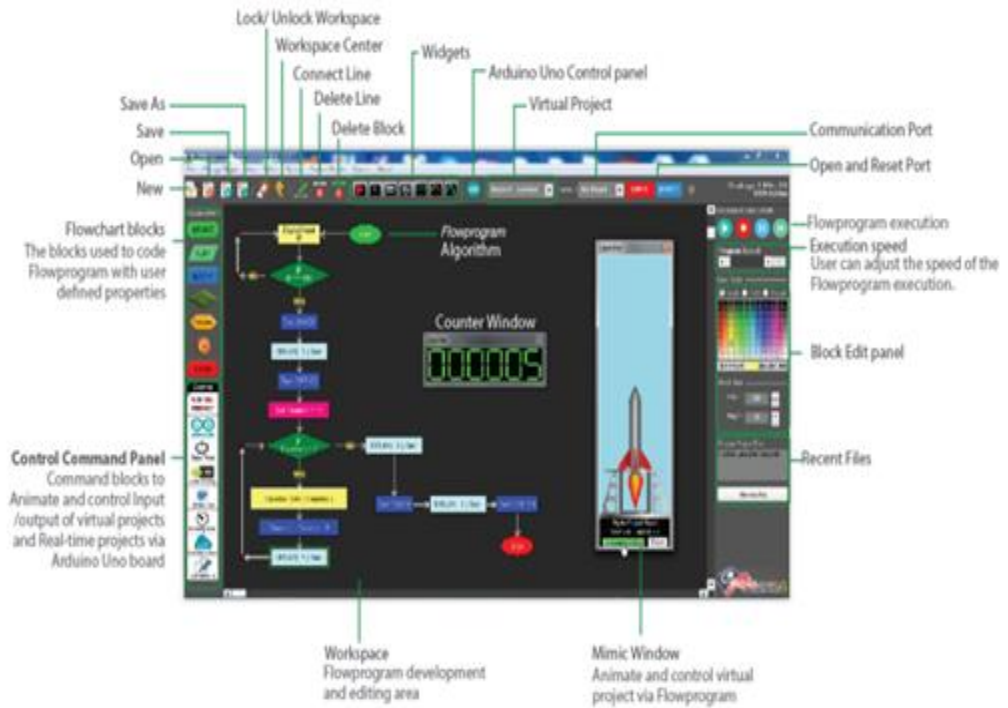
3.3 Flowlogic 6 Software

1. Download the Flow Logic 6 through to www.myflowlab.com then, click the downloaded file to install.



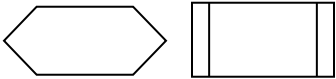
Source: <https://www.myflowlab.com/>

2. The guide of Flow Logic 6 on how to construct flow program



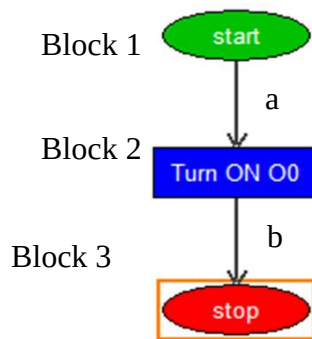
3. Flowchart blocks to develop algorithm

	Terminal (Stop/Start)	Used to represent start and end of flowchart.
	Input/Output	Used for input and output operation.
	Processing	Used for arithmetic operations and data-manipulations.
	Decision	Used to represent the operation in which there are two alternatives, true and false.

	Flow line	Used to indicate the flow of logic by connecting symbols.
	Predefined Process/Function	Used to represent a group of statements performing one processing task.
	On-page Connector	Used to join different flow line

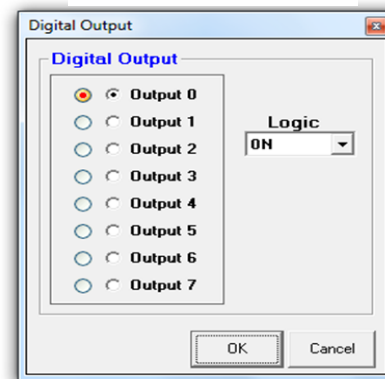
4. Editing Command Blocks

To delete Line and Blocks



1. To delete line "a", click on Block 1 and then Block 2, while mouse pointer on Block 2, right click and select "Delete Line" option from the pop-up menu.
2. To delete Blocks, delete all connecting line, right click on the block, and select "Delete block" option from the Pop-menu.

Property Window

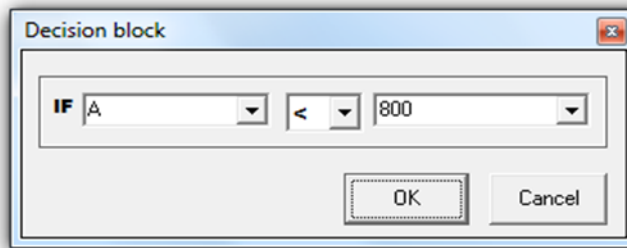


To edit blocks, double click on the block and make the necessary changes on the pop-up property Windows and click "Ok" when done.

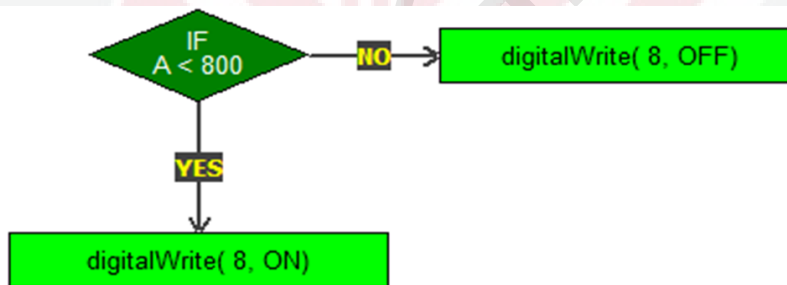
5. Decision Blocks

Select the blocks, define the property, connect line to try out

Decision block Property Window

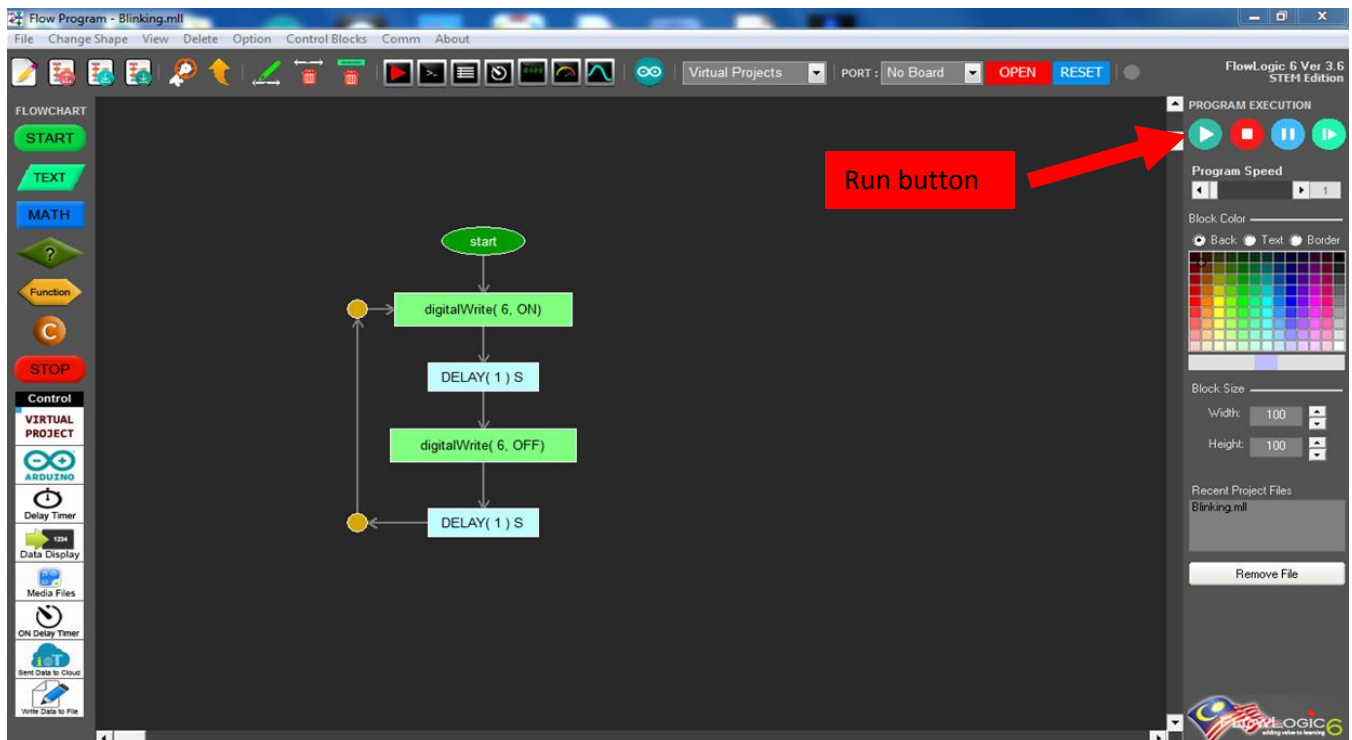


Condition statement as specified in the property window



Decision block requires two connecting point, the first connection to a block will be “YES” and the next connection will be “NO”. Connect the lines at your discretion based on the condition statement on the decision block.

6. Running the Flow program



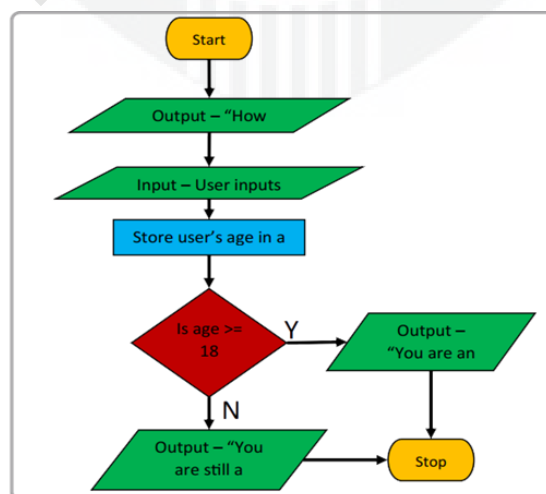
3.4 Algorithm

An algorithm is a step-by-step method of solving a problem or task.

3.4.1 Flowchart

A flowchart programming is an arrangement of a type of diagram that represents an algorithm, workflow or process using Flowchart blocks.

Flowcharts are used in analyzing, designing, documenting, or managing a process in various fields.

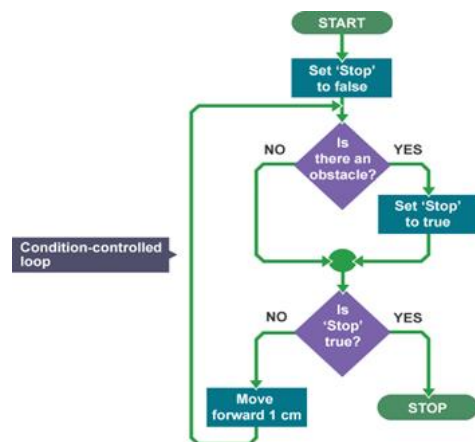


STEM Education uses Flowchart programming tool FlowLogic 6 to learn computational thinking by using Flowchart blocks to construct FlowProgram algorithm by:

1. Developing Console applications
2. Controlling and analyzing built-in on screen mimic model (virtual projects)
3. Controlling, Monitoring, analyzing real-world applications using Arduino UNO board

3.4.2 The Differences Between Algorithm and Computer Program

Algorithm



Computer Program

```

243 void ProgramManager::RecallProgram() {
244     string name;
245     bool searching = true;
246     while (searching) {
247         cout << "Enter name of program: ";
248         cin >> name;
249         if (ProgramNameIsValid(name)) {
250             if (ProgramFileExists(name)) {
251                 Program thisProgram;
252                 thisProgram.SetName(name);
253                 Read(thisProgram);
254                 WriteToScreen(thisProgram);
255                 searching = false;
256             }
257             else if (ProgramExists(name)) {
258                 WriteToScreen(programs[ProgramIndex(name)]);
259                 searching = false;
260             }
261             else if (EndingRecall(name)) {
262                 searching = false;
263             }
264         }
265     }
266 }
267
  
```

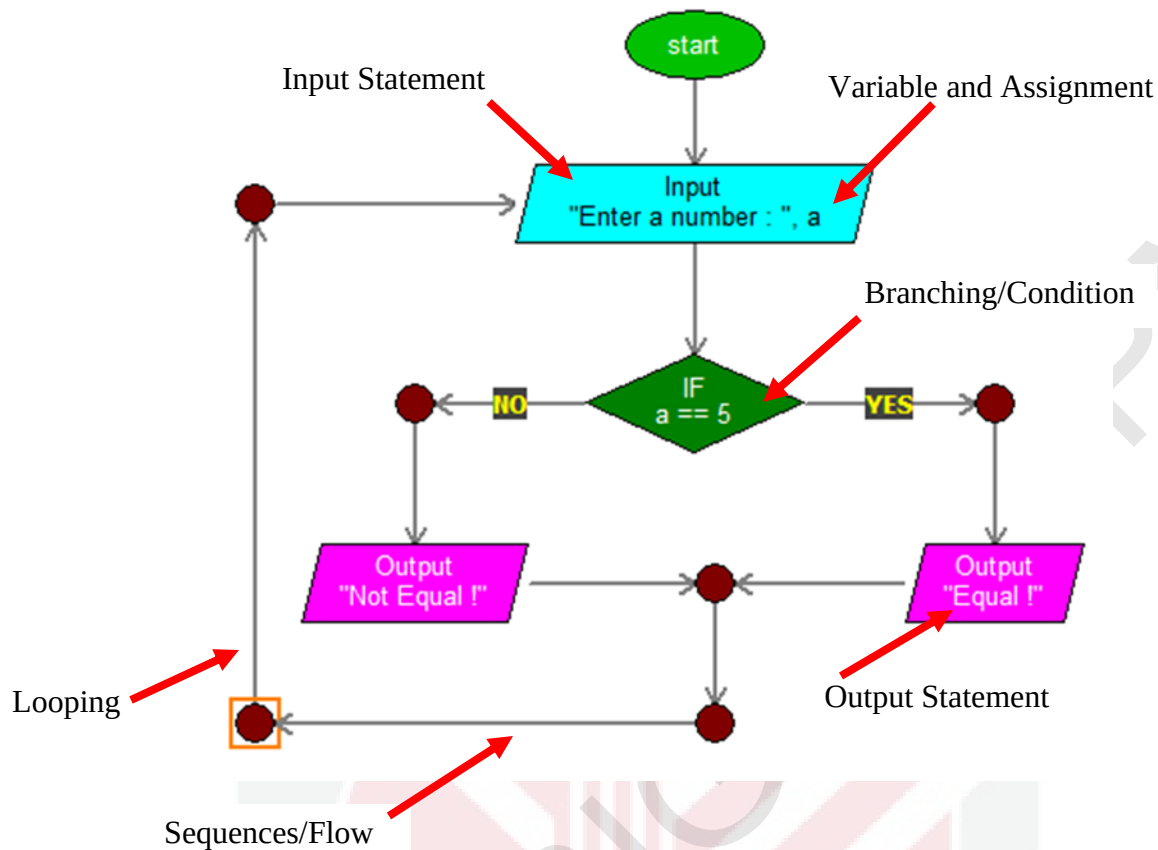
3.4.3 Algorithm Design

An algorithm design is logical flow or sequence of instructions that must accomplish a result.

1. Instructions must be well ordered
2. Instructions must not be the same
3. The process must eventually end or loop
4. The actions must be doable
5. The algorithm must produce the required result.

Algorithms have some subset of the following critical elements:

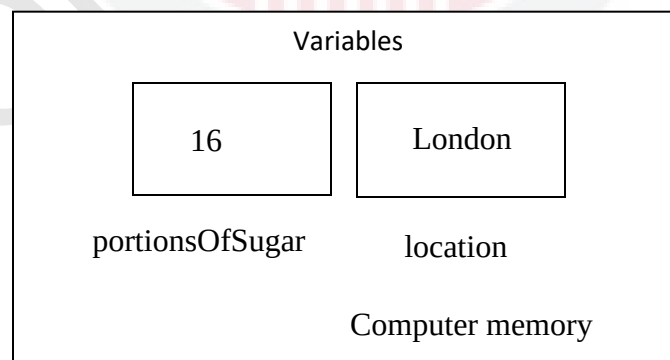
1. Input Statement
2. Output Statement
3. Variable and Assignment
4. Branching / Condition
5. Sequences / Flow
6. Looping



3.4.4 Variable

Variables are used to store information.

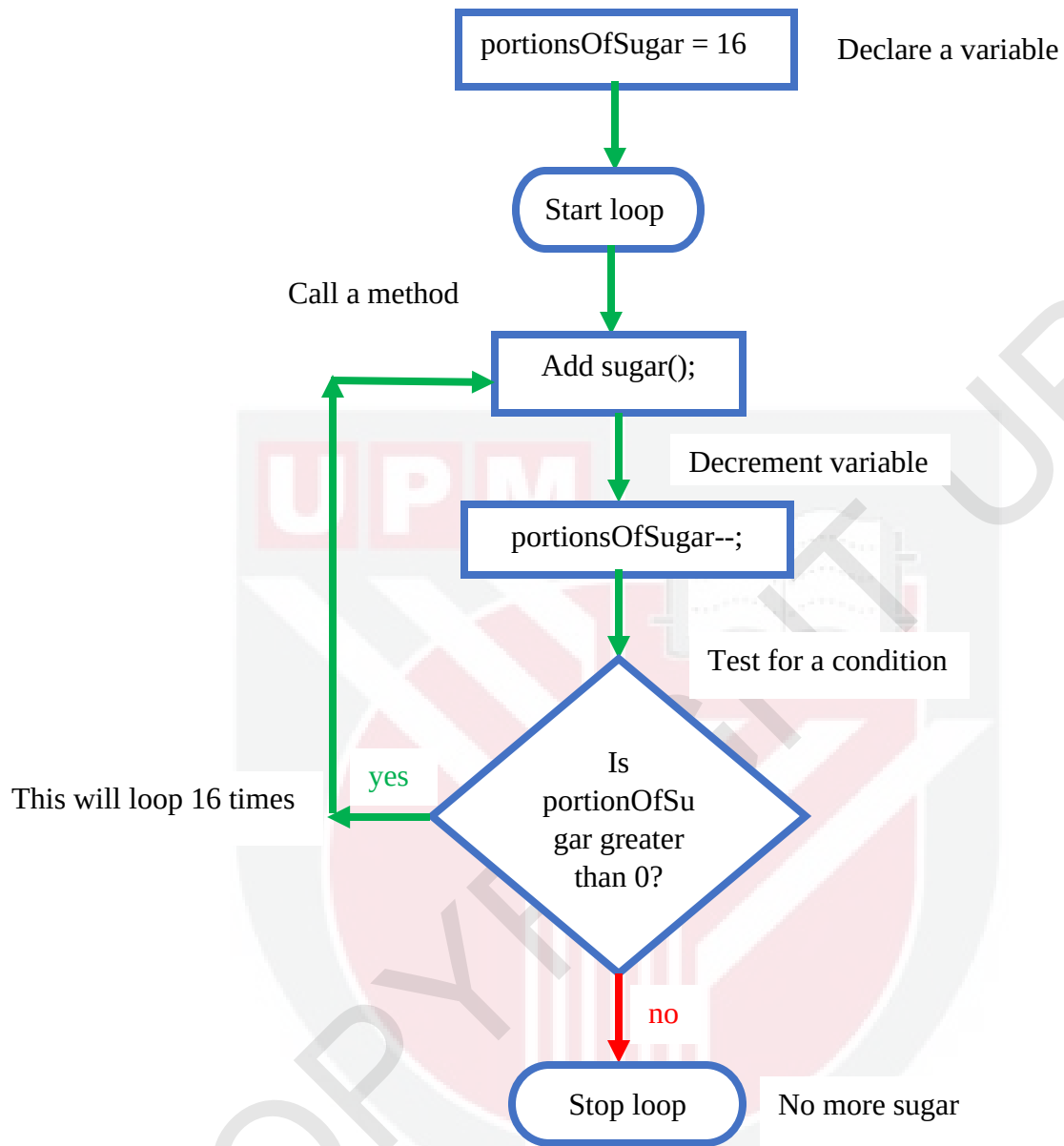
Variables are like containers that hold information. It must be given a unique name and assigned a data. This data can then be used throughout your program by referencing to variable name.



Assigning data to variable

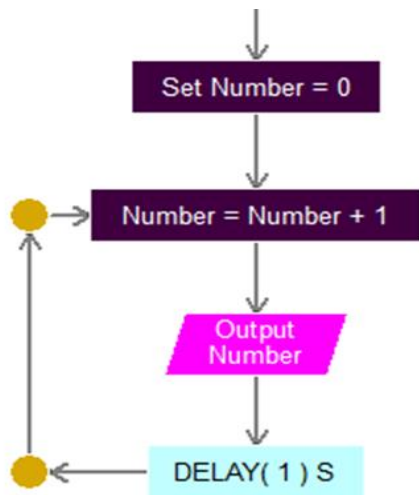
portionsOfSugar = 16

location = London

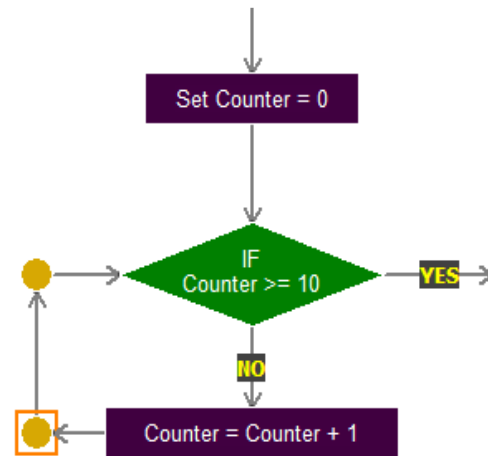


3.4.5 Loops and Conditional

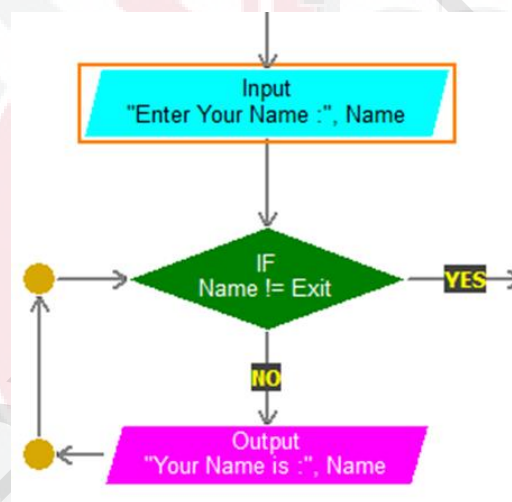
Repeat loop



For loop

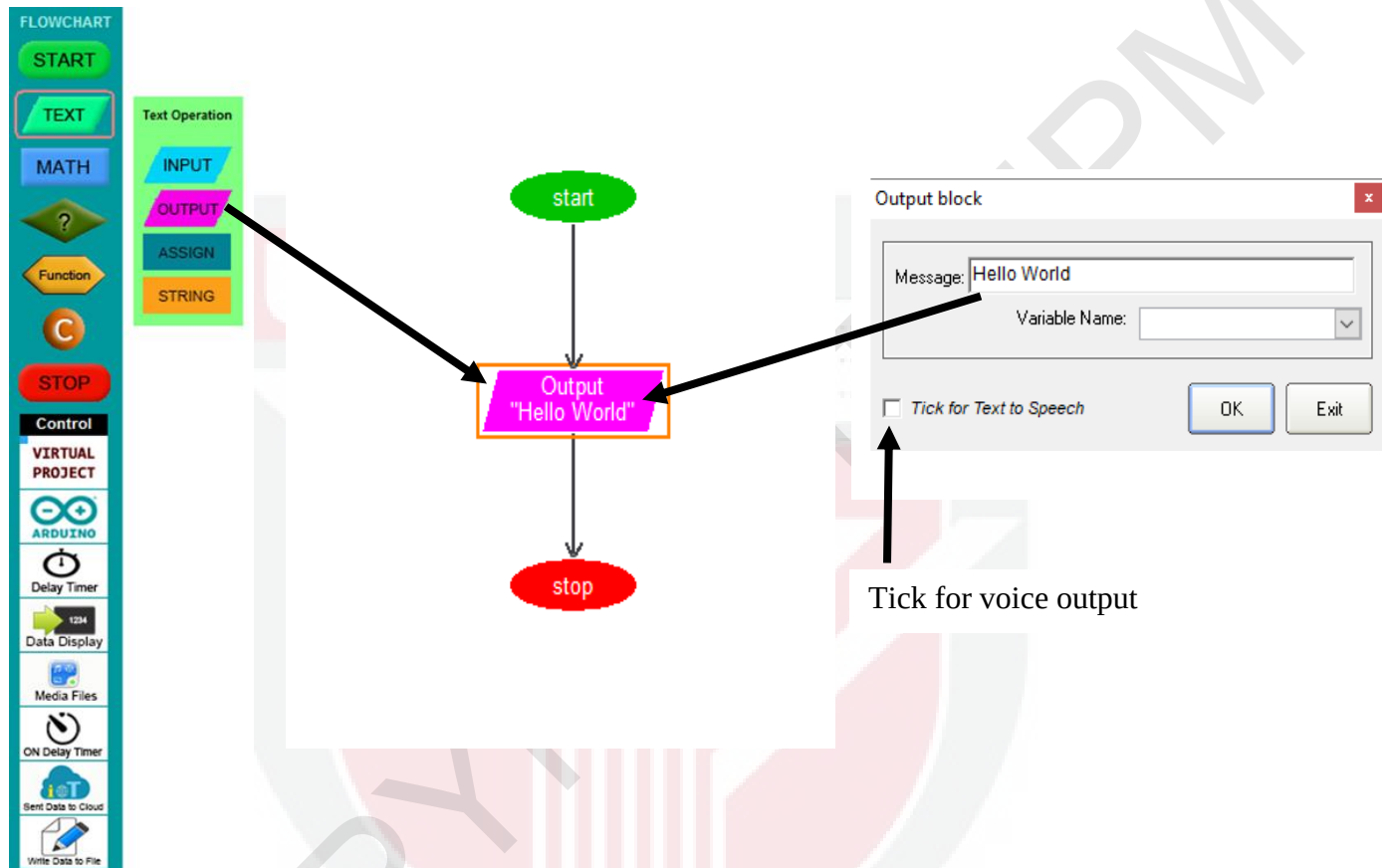


While loop

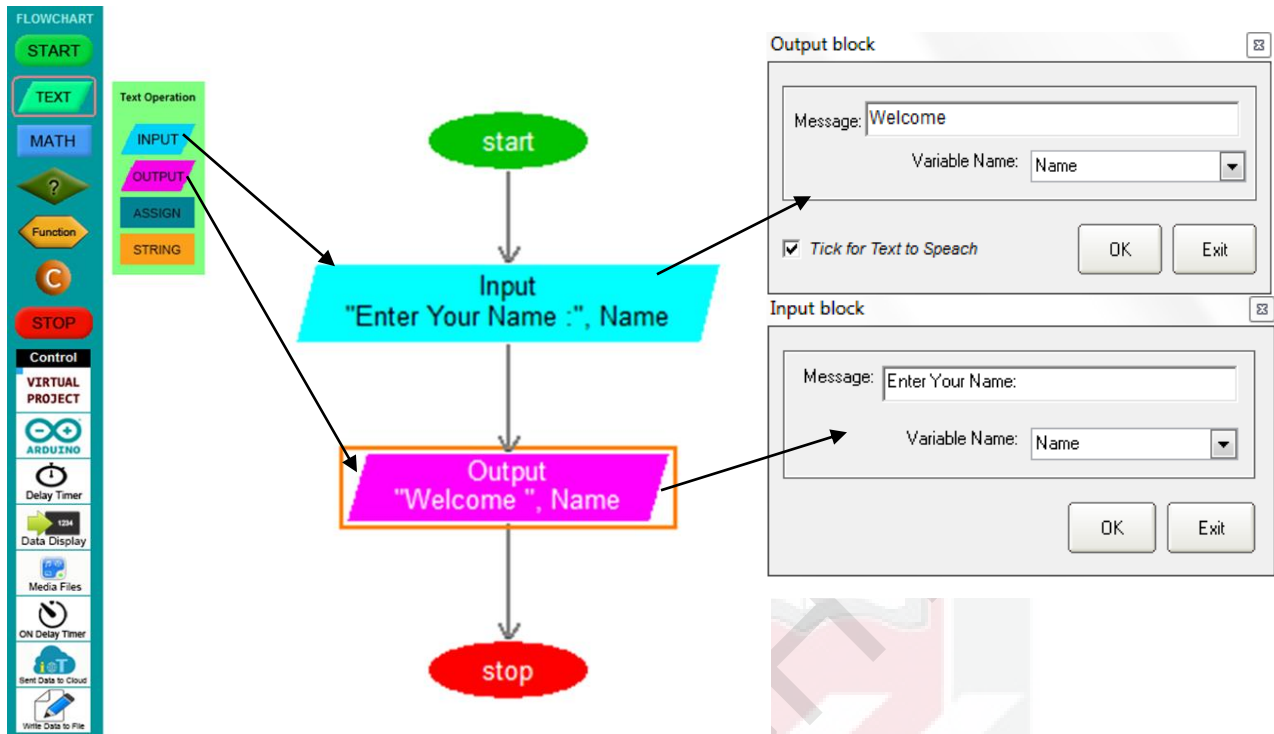


3.4.6 Console Applications

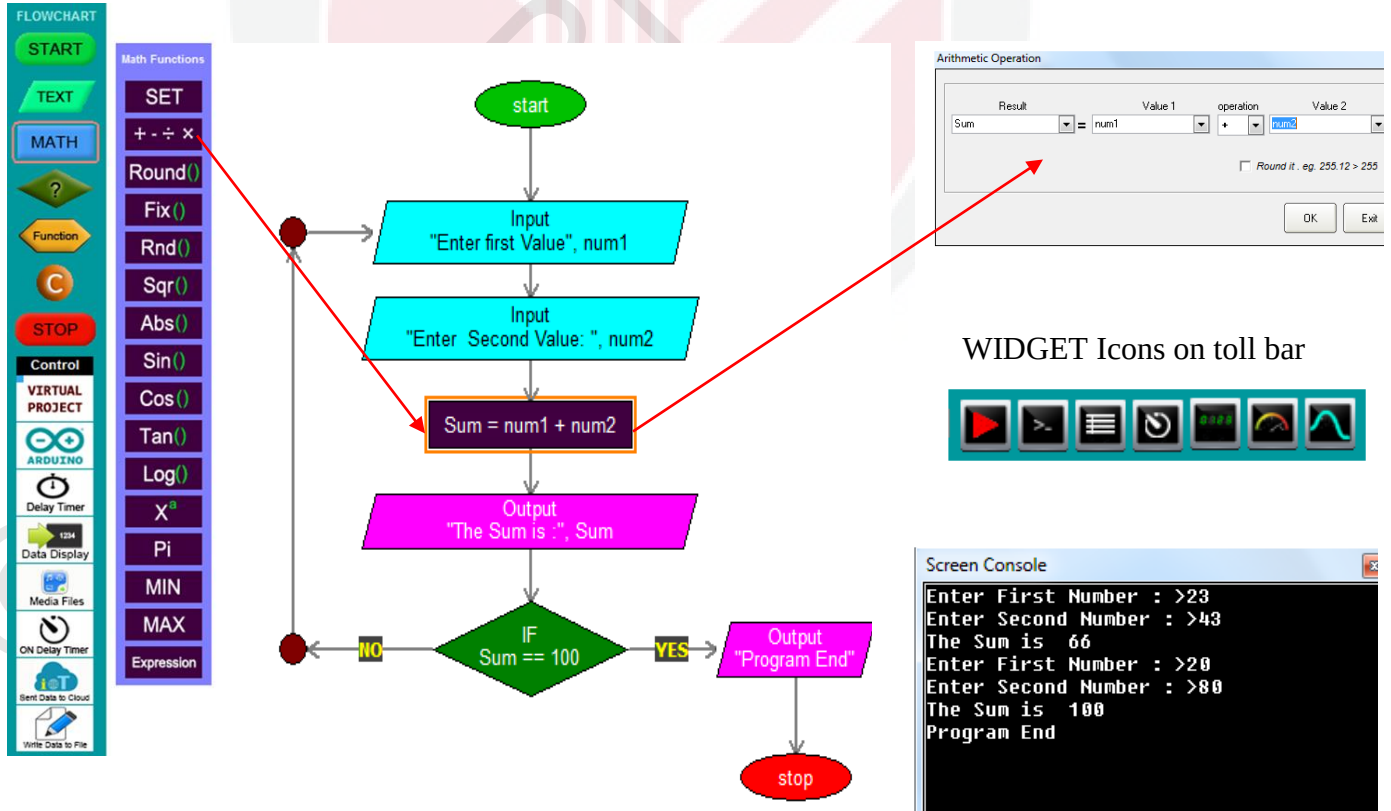
Example 1



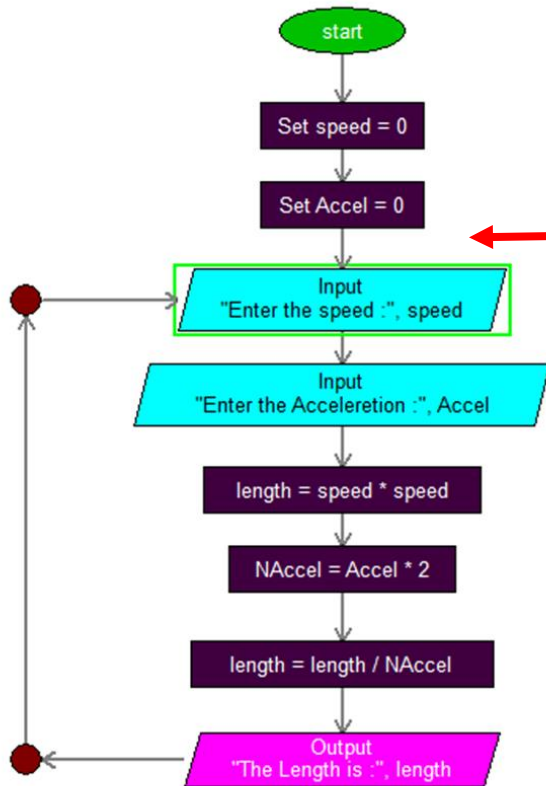
Example 2



Example 3



Example 4



Construct the flow program to produce the output shown below

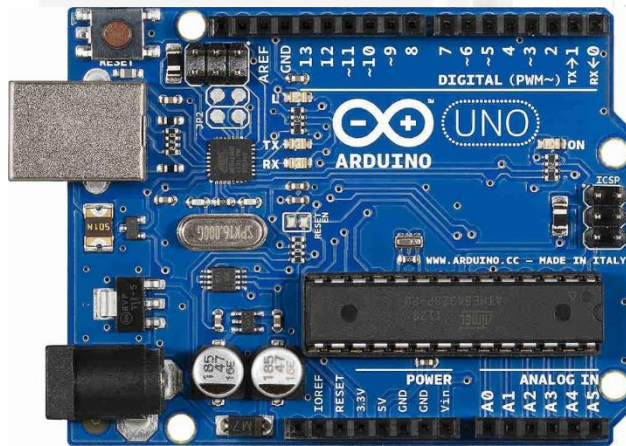
```
Screen Console
Enter the speed : >60
Enter the Acceleration : >20
The Length is : 90
Enter the speed : >
```

The screenshot shows a 'Screen Console' window with the following text: 'Enter the speed : >60', 'Enter the Acceleration : >20', 'The Length is : 90', and 'Enter the speed : >'. A red arrow points from the text 'the output shown below' to the console window.

3.5 Components

The research aims to prepare the fundamental approach to coding by using Arduino and Flow Logic 6 software, with the goal of aligning teaching learning with 21st century learning that unravels the use of various forms of technological knowledge that must be mastered by all societies, particularly students and educators in the field of science. The low-cost smart farming project will be designed using the following hardware components.

1. The Arduino UNO R3 ATMEGA328



2. Soldering solder iron 30W



3. Solder iron wire roll



4. DC 5V mini submersible water pump



5. Water pump pipe



6. 2 pcs 5MM 20mA LED (Red and Green color)



7. 2 pcs resistor 0.25W, 220 Ω



8. DHT 11



9. MQ8 Gas Sensor



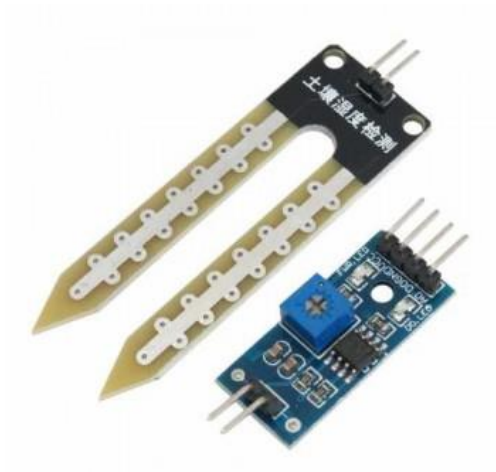
10. Transistor



11. Water level sensor



11. Soil moisture sensor



12. USB cable



13. LCD display



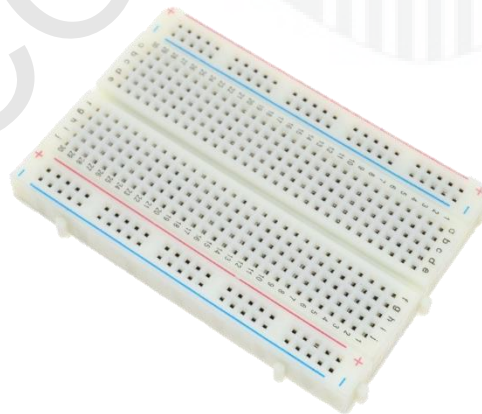
14. Male-to-male wire



15. Female-to-male wires



16. Breadboard



Source: Google Images

3.6 Arduino Uno

In terms of physical size, the Arduino Nano is the tiniest and most compact device, while the Arduino UNO is a medium-sized development board that can be used on a number of projects, including remote-controlled vehicles such as automobiles and boats. The Mega and Due are much larger boards, making them difficult to use in applications with restricted space.

The Due comes out on top for applications that require a lot of computing power thanks to its powerful processor and large RAM/ROM. While the Mega is a large Arduino with a lot of GPIO, its CPU speed is the same as the UNO and Nano (both Mega family members), hence there is no benefit in using it in terms of speed.

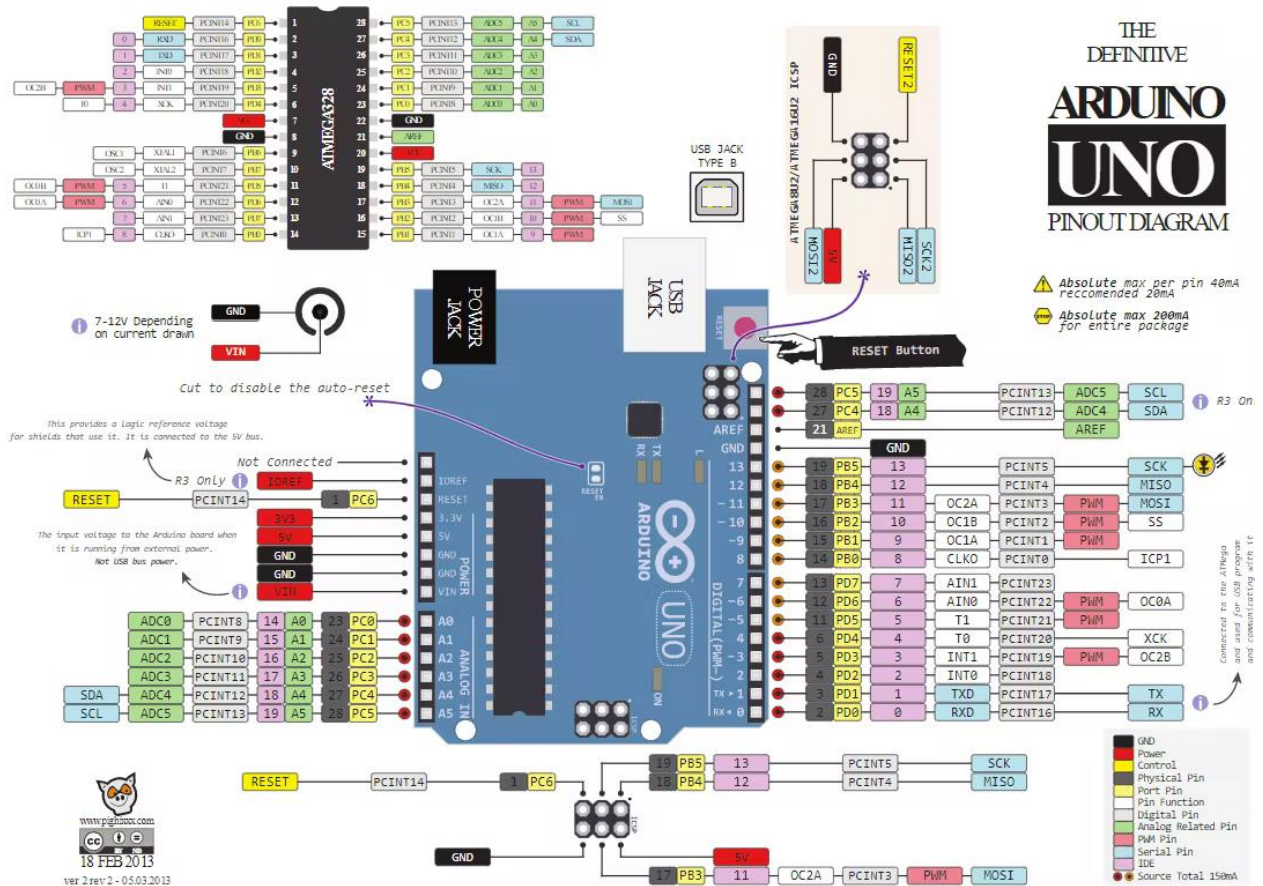
In terms of hardware and peripherals, the UNO and Nano are identical because they share the same CPU. If a project requires many GPIO, the Due and Mega are the obvious choices. The Mega is suited for applications that require a lot of GPIO but don't require a strong CPU.

Analogue projects may be made with any Arduino board, but the Due stands out since it features 12 analogue inputs and 2 analogue outputs. The Arduino UNO is the most common Arduino board. It is driven by a 16MHz Atmega328 CPU, contains 32KB of programme memory, 1KB of EEPROM, 2KB of RAM, 14 digital I/O, 6 analogue inputs, and 5V and 3.3V power rails.

The Arduino UNO features a pin header layout that is quickly becoming the industry standard for development boards, making it compatible with the majority of development board shields available.

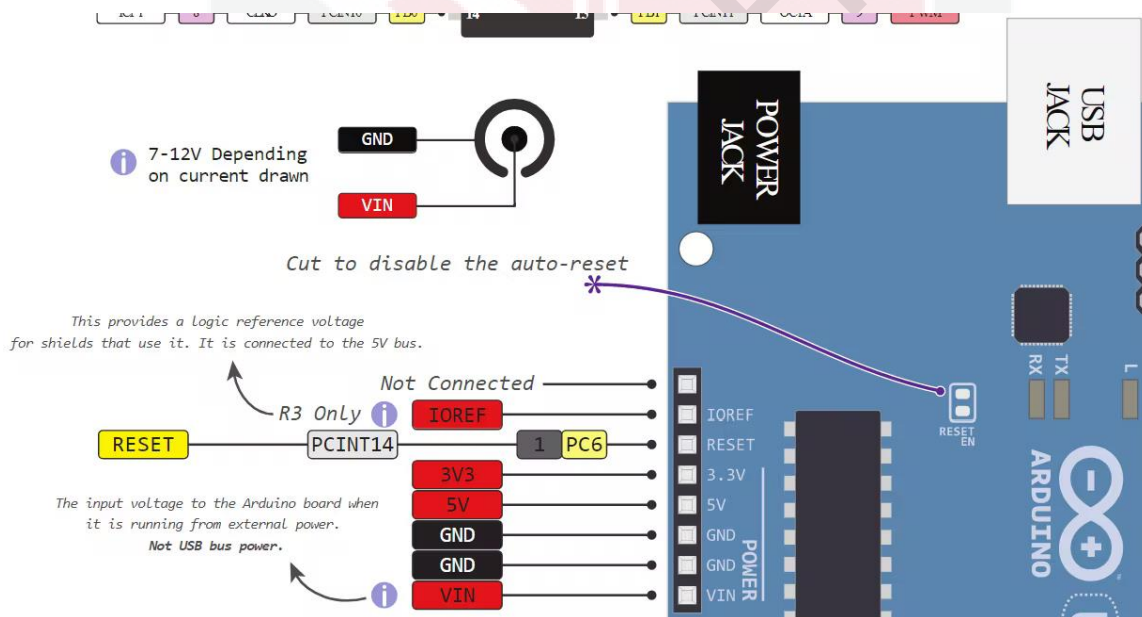
The UNO has a power connection that allows it to be powered by an external wall wart. For connecting the UNO to batteries, there is also a VIN alternative. The UNO's physical size (69mm x 54mm) make it a tiny development board that can be readily integrated into a variety of designs, and the four screw holes allow designers to lock it in place.

(Figure below is the Arduino Uno Pinout Diagram)



1. 1. Barrel Jack - The Arduino board can be powered using a barrel jack, also known as a DC Power Jack. A wall adapter is normally linked to the barrel jack. The board can be powered from 5 to 20 volts, but the manufacturer suggests 7 to 12 volts. The regulators may overheat and blow 7 volts above 12 volts, which may not be enough.
2. 2. VIN Pin – This pin is used to connect an external power source to the Arduino Uno board. The voltage should fall within the specified range.
3. USB cord — When linked to a computer, it delivers 5 volts and 500 milliamps.

(Figure below is the Arduino Uno Pinout for Power Supply Diagram)



Source image: www.circuito.io/blog/arduino-uno-pinout/

A 1 Ampere polarity protection diode is connected between the positive of the barrel jack and the VIN pin. The power available for the circuit is determined by the power source employed. For example, utilizing the USB to power the circuit is limited to 500mA. The MCU, its peripherals, the on-board regulators, and the components linked to it are all powered by this.

The 5V and 3.3V regulators on-board the Arduino define the maximum capacity available when powering the circuit through the barrel jack or VIN.



3.6.1 5V and 3.3V

They provide external components with regulated 5V and 3.3V power, as specified by the manufacturer.

3.6.2 GND

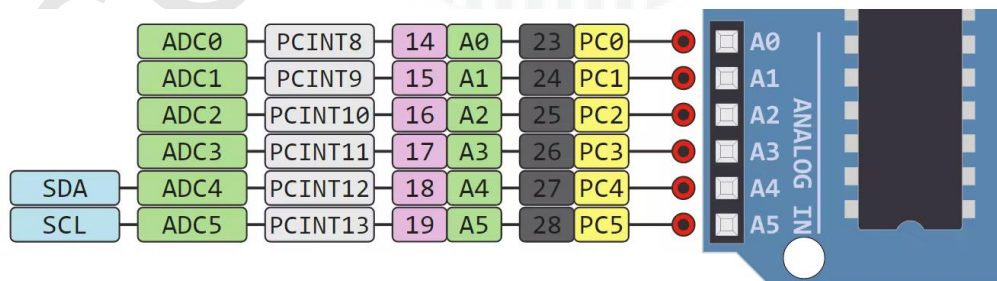
We can locate 5 GND pins in the Arduino Uno pinout, all of which are connected. The GND pins shut the electrical circuit and give a common logic reference level for the whole circuit. Always double-check that all GNDs (on the Arduino, peripherals, and components) are connected and share a common ground.

3.6.3 RESET - Resets the Arduino

3.6.4 IOREF-The input/output reference is connected to this pin. It gives the microcontroller with a voltage reference to work with.

The Arduino Uno has 6 analog pins, which utilize ADC (Analog to Digital converter). These pins serve as analog inputs but can also function as digital inputs or digital outputs.

(Figure below is the Arduino Uno Pinout for Analog IN Diagram)



Source image: www.circuito.io/blog/arduino-uno-pinout/

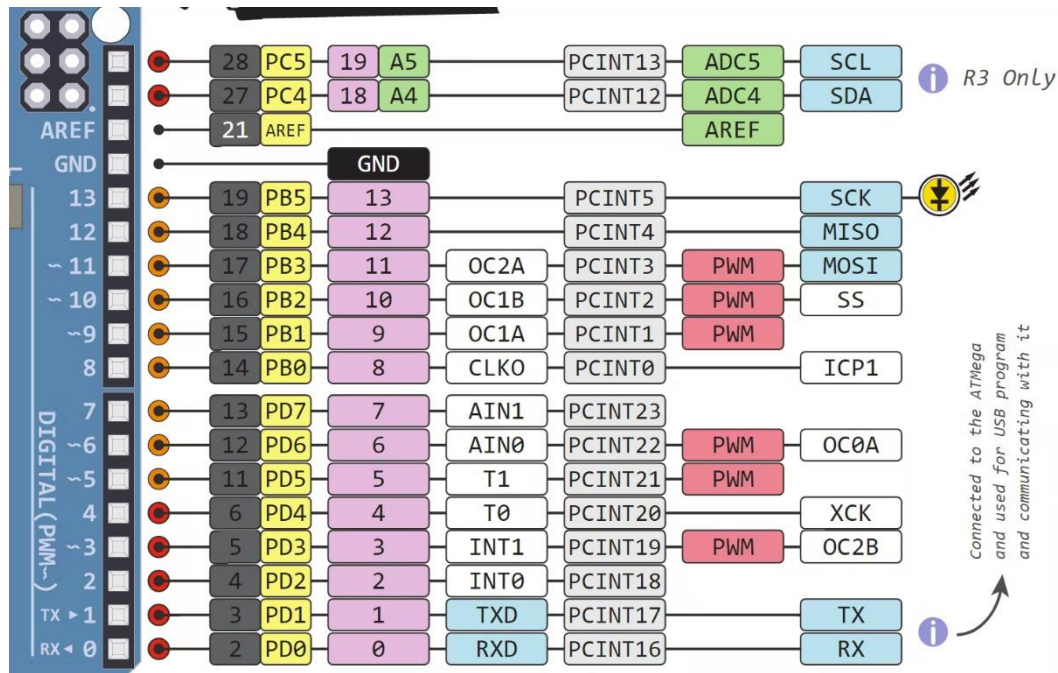
3.6.5 Analog to Digital Conversion

Analog to Digital Converter (ADC) is a term used to describe a device that converts analogue signals into digital signals. An electrical circuit that converts analogue signals to digital signals is known as an ADC. This digital representation of analogue signals enables the processor (a digital device) to measure and utilise the analogue signal during its operation.

Analog voltages can be accessed on Arduino pins A0-A5. The ADC on Arduino has a 10-bit resolution, which means it can represent analogue voltage using 1,024 digital levels. The ADC converts voltage into bits that can be understood by the computer.

Voice over IP is a common example of an ADC (VoIP). A microphone is built into every smartphone and converts sound waves (speech) into analogue electricity. This passes via the device's ADC, which converts it to digital data, which is then sent over the internet to the receiving side.

(Figure below is the Arduino Uno Pinout for Digital Pins Diagram)



Source image: www.circuito.io/blog/arduino-uno-pinout/

The Arduino Uno's digital input/output pins are numbered 0 through 13. The built-in LED is wired to pin 13 of the Arduino Uno. PWM functionality is available on pins 3,5,6,9,10,11 of the Arduino Uno.

It's crucial to keep in mind that:

1. Each pin can provide/sink a maximum of 40 mA. However, a current of 20 mA is advised.
2. The total current supplied (or sunk) by all pins is 200mA.

The term digital refers to a method of encoding voltage in one bit: either 0 or 1. Digital pins on the Arduino are pins that can be used as inputs or outputs depending on the user's needs. Digital pins are either active or inactive. They are in a HIGH voltage state of 5V when ON and a LOW voltage state of 0V when OFF.

When the digital pins on the Arduino are set as outputs, they are set to 0 or 5 volts. The voltage is supplied from an external device when the digital pins are designated as input. This value, which can range from 0 to 5 volts, is transformed into digital representation (0 or 1). There are two thresholds that can be used to determine this:

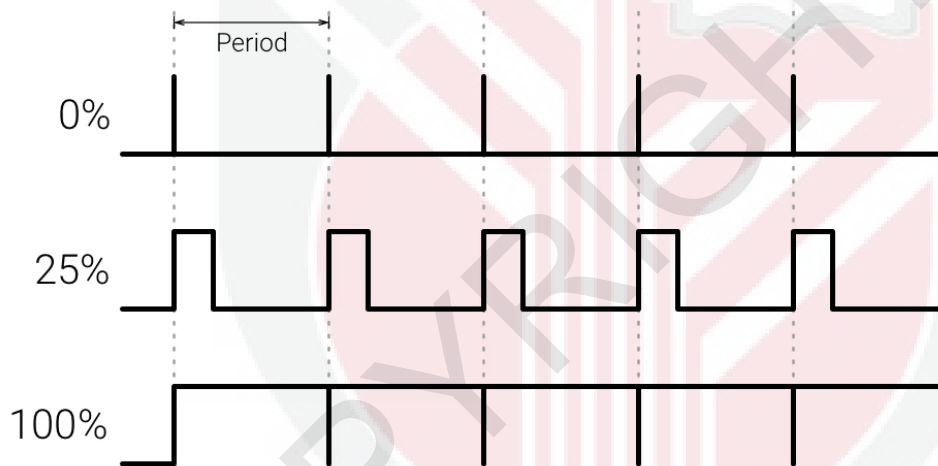
1. If the voltage is less than 0.8 volts, it is considered 0 volts.
2. When above 2 volts, the voltage is regarded as 1.

Make sure the logic levels match when connecting a component to a digital pin. The returning value will be undefined if the voltage is between the thresholds.

3.6.6 PWM (Pulse Width Modulation)

PWM is a modulation technique that converts a message into a pulsing signal in general. Frequency and duty cycle are the two main components of a PWM. The PWM frequency determines how long a single cycle (period) takes to complete and how quickly the signal changes from high to low. The duty cycle specifies how long a signal remains high during a period. The duty cycle is calculated as a percentage.

The PWM enabled pins in Arduino provide a constant frequency of 500Hz, while the duty cycle varies depending on the user-defined settings. Consider the illustration below:



Source image: www.circuito.io/blog/arduino-uno-pinout/

PWM signals are used to control the speed of DC motors, dim LEDs, and more.

3.6.7 Communication Protocols

Serial (TTL) - The Arduino Uno's serial pins are digital pins 0 and 1. The onboard USB module makes advantage of these.

3.6.8 Serial Communication

The Arduino board communicates with other serial devices like as computers, displays, sensors, and more using serial communication. At least one serial port is available on every Arduino board.

Serial communication takes place on digital pins 0 (RX) and 1 (TX) and via USB. The Software Serial Library for Arduino also allows serial communication via digital pins. This enables the user to connect numerous serial-enabled devices while keeping the primary serial port open for USB.

Hardware serial and software serial - Most microcontrollers contain hardware that allows them to communicate with other serial devices. To communicate, software serial ports use a pin-change interrupt scheme. Software Serial communication is supported by a built-in library. The processor simulates extra serial ports via software serial. Software serial's only disadvantage is that it takes more processing and cannot support the same high speeds as hardware serial.

3.6.9 Input Output (IO) Pin Assignment for Flow Logic 6

Digital Input – Pin 2,3,4,5

Digital Output – Pin 6,7,8,9,10

Analog Input – A0, A1, A2, A3

Analog Output – Pin 6,9,10

DHT11 Sensor – Pin 5

12C 16×2 LCD – Pin SDA, SDL – A4, A5

Table 2: Characteristics of Hardware Components

No	Hardware Components	Characteristics/Features
1	Arduino UNO board	• Has a pin header configuration • Has a power jack • Has a VIN option for connecting the battery • Adaptable to a variety of projects
2	Temperature Sensor	• Suitable for applications that need to be accessed from afar. • Operates between 4 and 30 volts • Low self-heating • Temperatures range between -55 and 150 degrees Celsius.
3	Soil Moisture Sensor	• Input voltage range: 3.3 V–5.0 V

		• Output voltage range: 0 V–4.2 V • Input current range: 35 mA • Signal and analogue output signals are the two types of output signals
4	Rainwater Sensor	• Working at 5 volts • Anti-conductivity • Long time use • Contains potentiometer that can be used to modify the sensitivity
5	Breadboard	• 200 tie-points, 2 Distribution Strips, • 1,000V AC / 1 minute Withstanding Voltage • A grid of holes in a rectangular piece of plastic • There are a variety of sizes to choose from, including larger and smaller versions. • It can be re-used • Single-core plastic-coated wire

		can be used to make wire links
6	Relay	• Suitable for the safe regulation of higher amperage a standard interface that may be operated directly by a microcontroller • Capable of controlling a large load current • A wide range of voltages that can be controlled
7	LCD Screen	• Typical brightness ratings range from 250 to 350 cd/m² • More adaptable
8	Gas Sensor	• 5V operating voltage • Load resistance: 20 KΩ • Heater resistance: 33.5 percent • Heating Consumption: <800MW • Sensing Resistance: 10 KΩ to 60 KΩ • Range of concentration: 200-10000PPM

		• Preheat Time: More than 24 hours
9	DHT11 (Temperature and humidity sensors)	• Can measure temperature from 0°C to 50°C with a 2.0°C accuracy • Humidity from 20 to 80 percent with a 5 percent precision
10	Water Sensor Level	There are three pins on the water level sensor: • Signal pin (S): This is an analogue output that will be connected to one of Arduino's analogue inputs. • VCC pin (+): Provides power to the sensor and it is advised that the sensor be powered with between 3.3V and 5V • The GND pin (-) is used to connect to the ground

3.7 Comparison of Arduino Boards

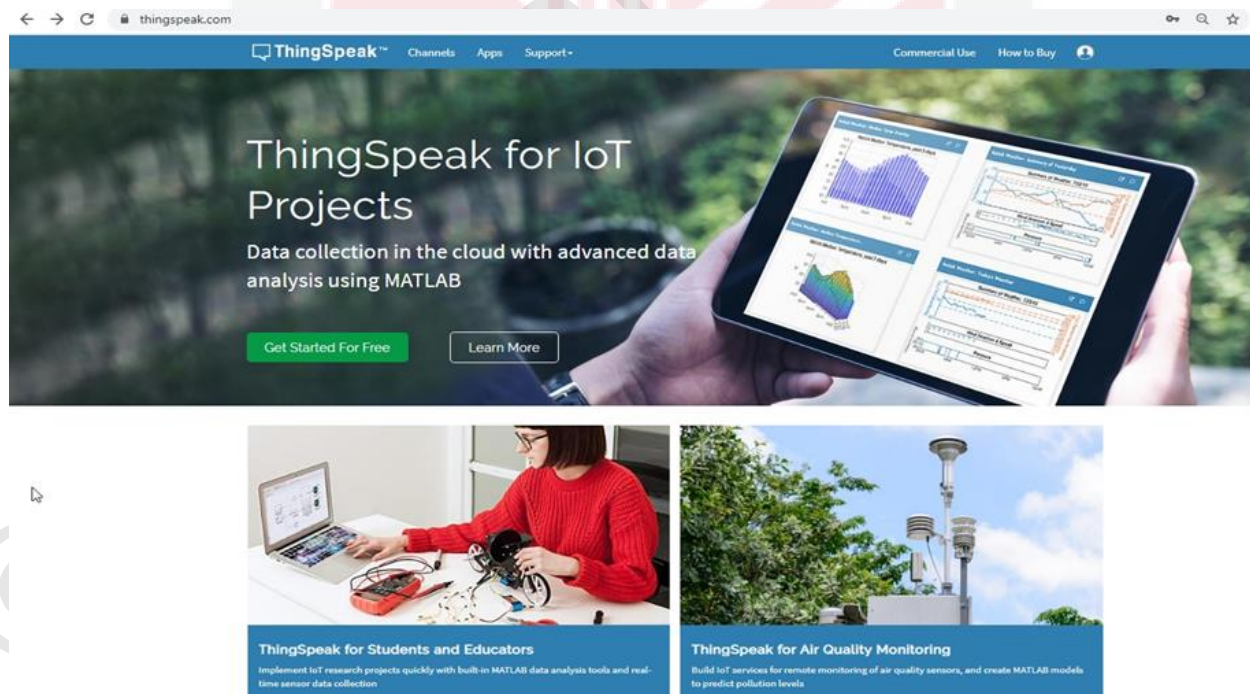
Table 3: Differences of Arduino Boards

Type of Arduino boards	Arduino UNO	Arduino Nano	Arduino Due	Arduino Mega 2560
Best Applications	Prototyping on the desktop and using Arduino shields	Simple projects with little costs and a low profile	Prototyping with high performance and better analogue I/O	More memory space and higher I/O requirements
Example Projects	IoT sensors, RC vehicles, a simple robot controller, a simple games console, and device testing	Sensor collection, RC planes, and portable electronics	Multiple-source data processor, home automation, and machine controller	Bench tools, multi-device control, machine controllers, and home automation are all examples of DIY projects.

3.8 ThingSpeak (IOT)

The Internet of Things (IoT) is a network of interconnected computing devices, mechanical and digital machinery, items, animals, and people with unique identifiers and the ability to transfer data without requiring human-to-human or human-to-computer interaction. When something is connected to the internet, it can send, receive, or both send and receive information. This ability to send and/or receive data makes things smart, which is a positive thing.

Data such as soil humidity and surrounding temperature, for example, should be retained as records that require periodic monitoring, because plants' photosynthesis rates vary based on external circumstances each day. The Internet of Things (IoT) plays a role in the collection of information, and the information may be quickly transferred and received by specified parties, allowing for a more efficient and systematic recording.



(Figure 3: Thing Speak free website)

Source: <https://thingspeak.com/>

CHAPTER 4

RESULTS AND DISCUSSION

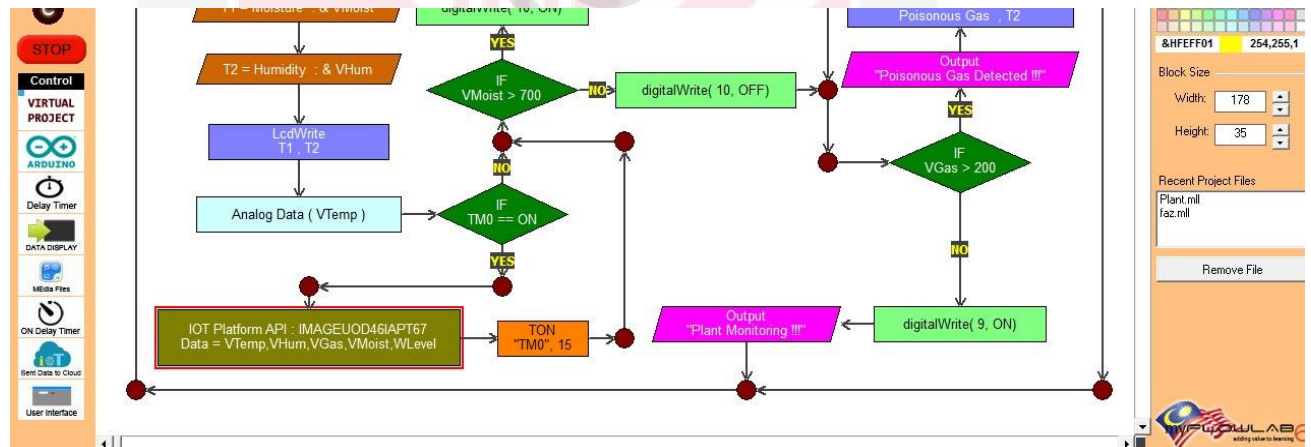
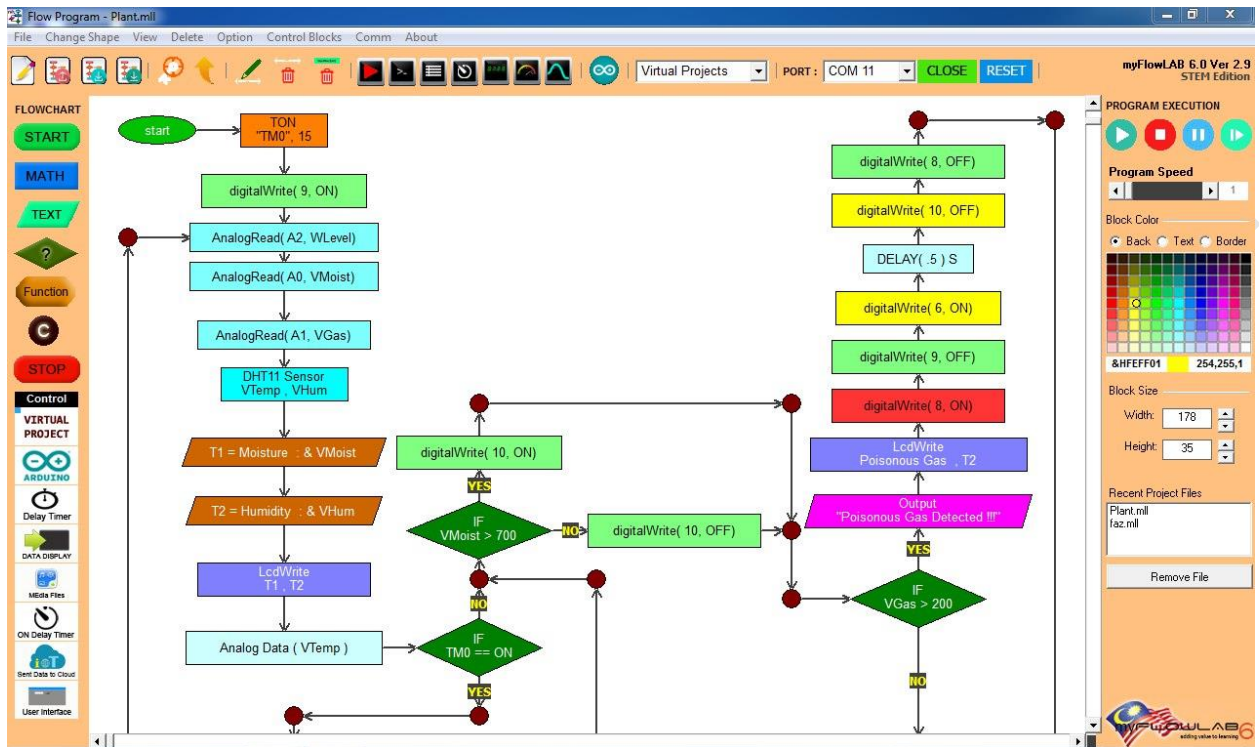
4.1 Introduction

Even though the Arduino UNO is the most popular board, other boards receive good support through online forums due to comparable architecture and the use of a common language and IDE. This implies it's less likely to fall into device-specific traps, such as those that prevent code from working owing to hardware configurations or flaws. Arduino code can be easily translated to numerous boards with nearly no changes, which is very valuable for designers who aren't sure which board to employ for a particular project.

Aside from that, hardware and money are the decisive variables in the implementation of each project. While the price of an Arduino is obvious (the cheapest option is usually picked), determining the hardware may be more challenging. When choosing hardware, keep the following aspects in mind:

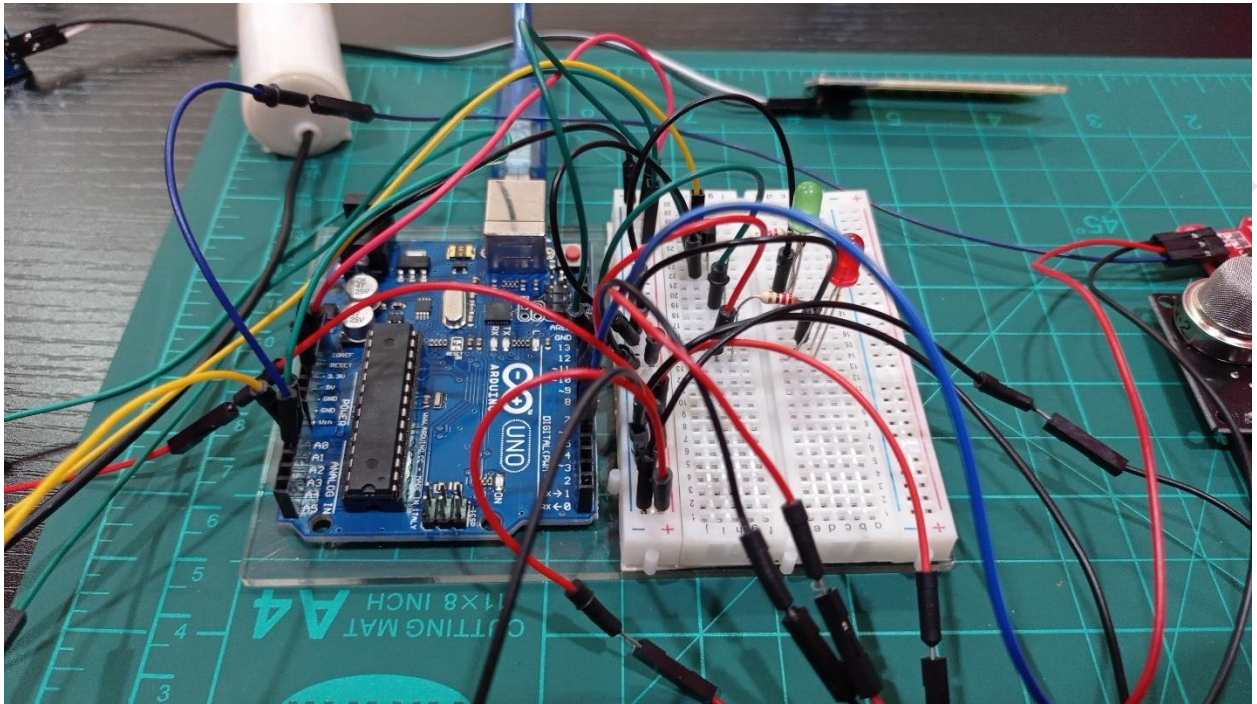
1. Physical measurements
2. Memory capacity
3. CPU Power
4. Capabilities of I/O
5. On-board peripherals
6. Weight
7. Connectivity

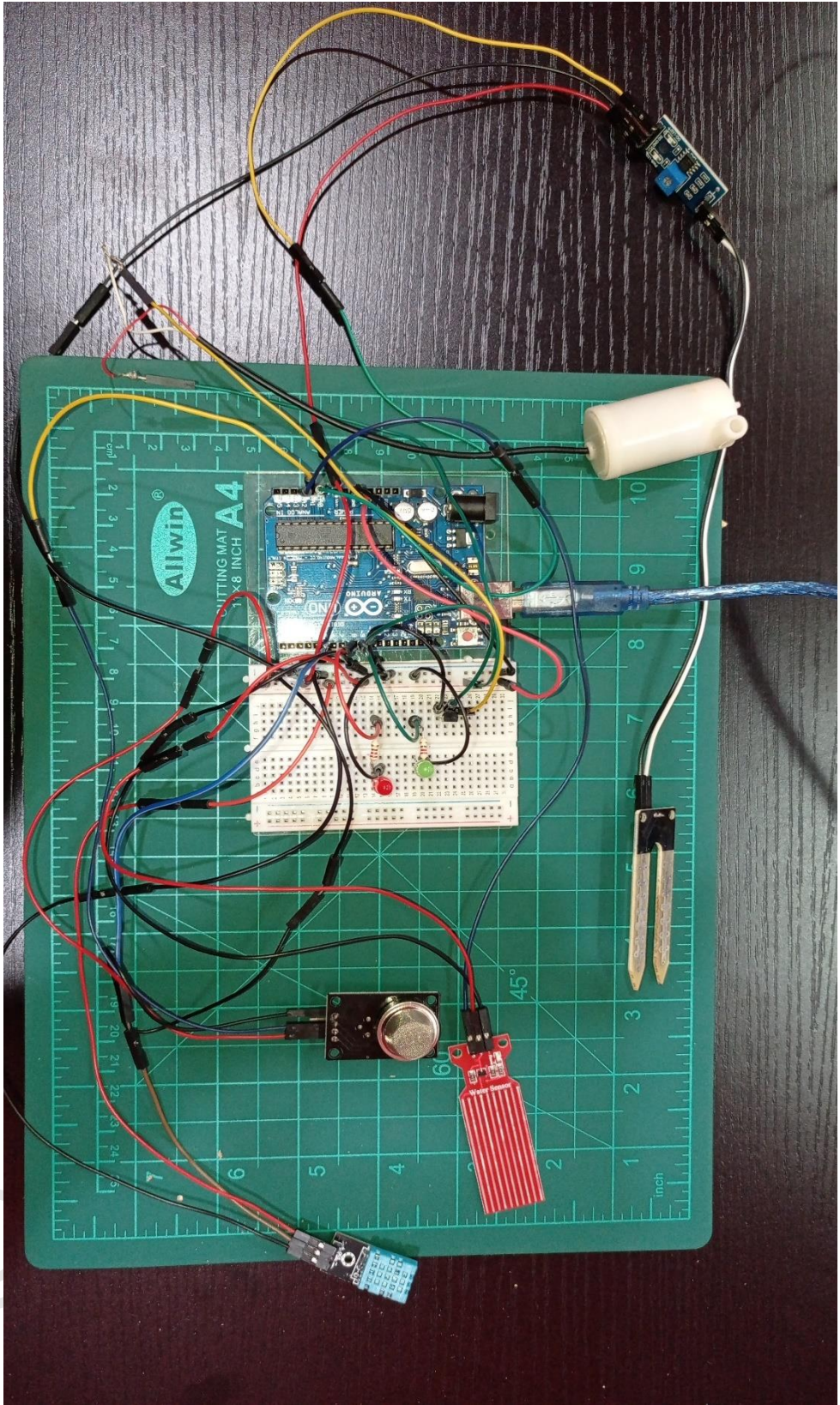
4.1.1 The Flow Program of Project

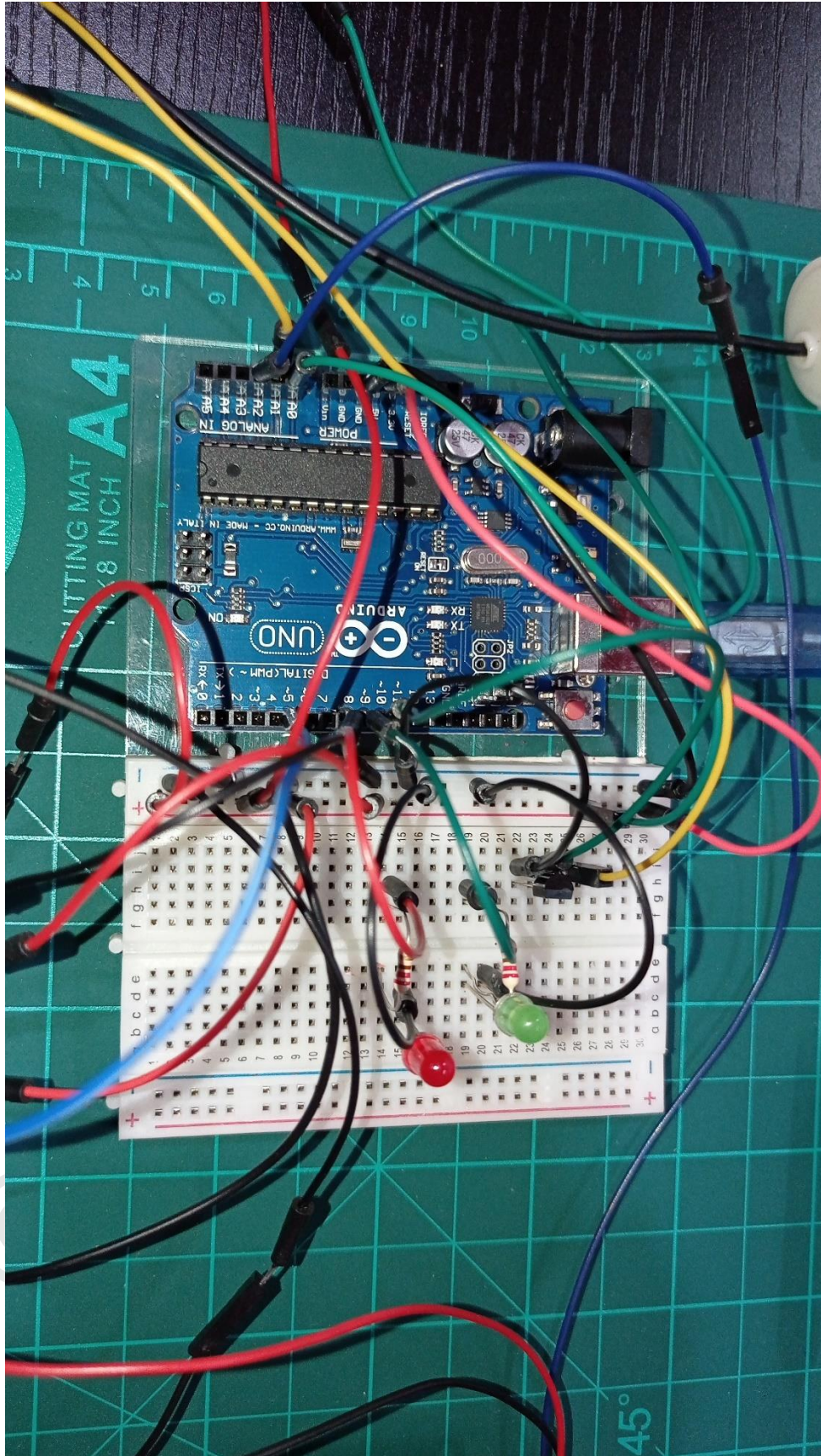


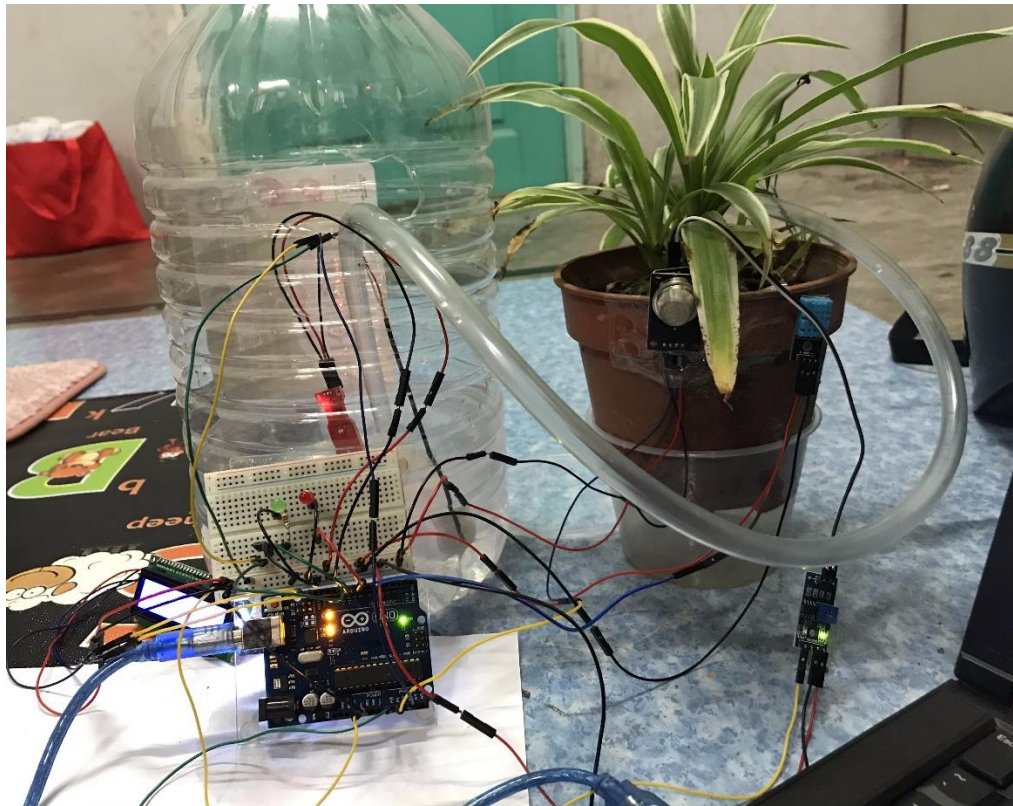
(Figure 2: Smart-farming Flow logic)

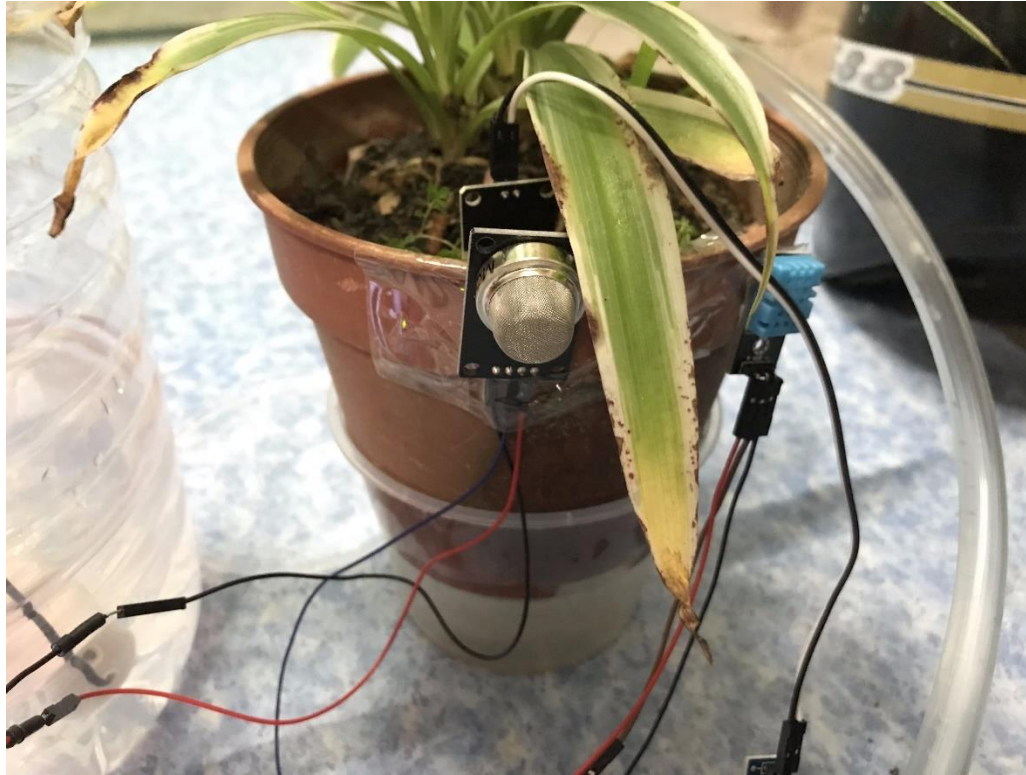
4.2.2 The Components











4.2.3 The ThingSpeak Record

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S
1	created_a	entry_id	field1	field2	field3	field4	field5	latitude	longitude	elevation	status								
2	2022-02-10	1	50	27	673	11	108												
3	2022-02-10	2	50	27	673	10	108												
4	2022-02-10	3	50	27	672	11	108												
5	2022-02-10	4	50	27	546	7	109												
6	2022-02-10	5	50	27	559	7	108												
7	2022-02-10	6	50	27	563	7	108												
8	2022-02-10	7	50	27	586	7	109												
9	2022-02-10	8	50	27	588	7	108												
10	2022-02-10	9	50	27	583	9	109												
11	2022-02-10	10	50	27	581	7	108												
12	2022-02-10	11	50	27	580	7	108												
13	2022-02-10	12	50	27	582	7	108												
14	2022-02-10	13	50	27	578	7	108												
15	2022-02-10	14	50	27	577	7	108												
16	2022-02-10	15	50	27	577	8	109												
17	2022-02-10	16	50	27	575	573	108												
18	2022-02-10	17	50	27	576	557	110												
19	2022-02-10	18	50	27	575	613	111												
20	2022-02-10	19	50	27	574	592	111												
21	2022-02-10	20	50	27	575	171	111												

SmartFazPlanting - ThingSpeak

thingspeak.com/channels/1657612/private_show

Incognito

ThingSpeak™

Channels Apps Devices Support

Commercial Use How to Buy SF

SmartFazPlanting

Channel ID: 1657612
 Author: mwa0000025623836
 Access: Private

Private View

Public View

Channel Settings

Sharing

API Keys

Data Import / Export

Add Visualizations

Add Widgets

Export recent data

MATLAB Analysis

MATLAB Visualization

Channel 2 of 2 < >

Channel Stats

Created: 3 days ago
 Last entry: 5 minutes ago
 Entries: 137

Field 1 Chart

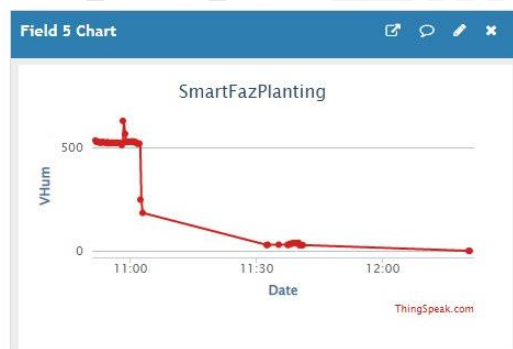
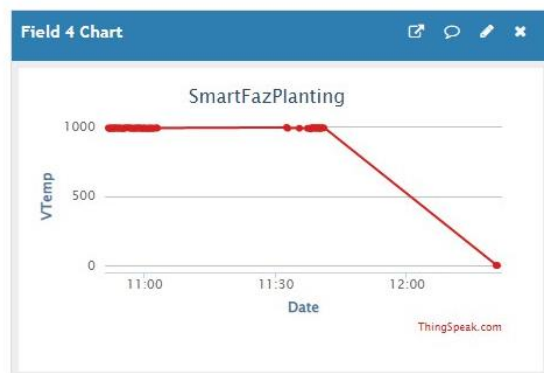
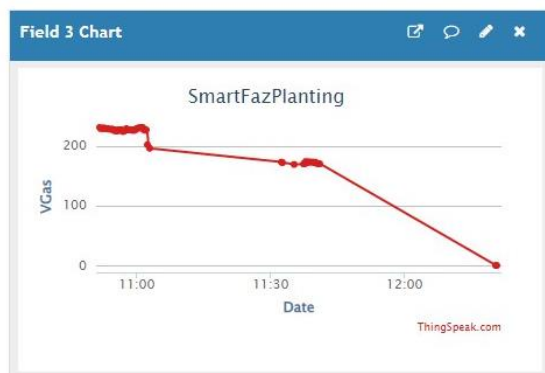
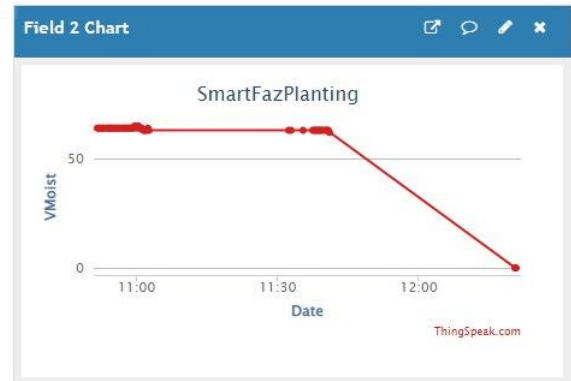
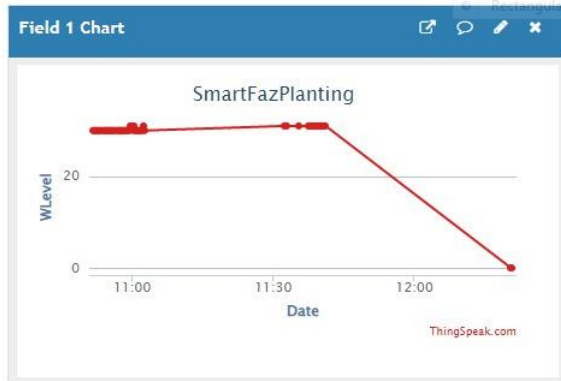
Field 2 Chart

annel Stats

ted: about 2 hours ago

entry: 25 minutes ago

ies: 99



4.3 General Result for Questionnaire

There are three components to the questionnaires used in this experiment in this section. In the first section, there are closed-ended questions that require responders to respond with a single word, such as "yes" or "no." The second half will be divided into two sections: section A and section B. The form of questionnaire used for section A is a multiple-choice question, which gives respondents various response alternatives. The goal of this section is to assess a prospective Science teacher's fundamental knowledge.

Section B, on the other hand, is built on the prospective Science teacher's preparation for the fourth global Industrial Revolution. In this section, two types of rating scale multiple choice questions were utilized to collect information from respondents using a linear scale. The scale can be vertical or horizontal, but only the horizontal scale is employed in this survey to assess the respondents' readiness for the industrial revolution, which has sparked a new wave of educational transformation.

Finally, the demographic question was created to gather information about the respondents' backgrounds. Respondents must select their gender, current year of study, courses, and several closed and open-ended questions that ask them to provide feedback or recommendations for the entire project implementation throughout this section.

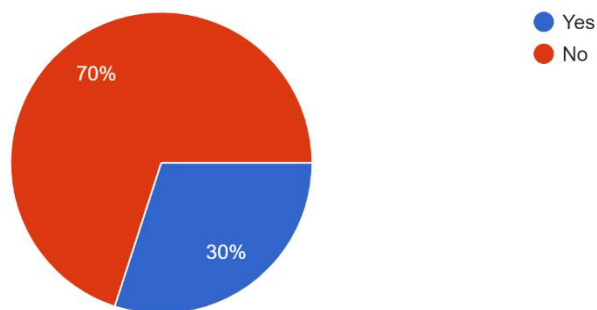
These questions were completed by University Putra Malaysia students pursuing a Bachelor of Science Education in Physics, Chemistry, and Biology. The prototype for this project was tested in the context of a STEM subject approach that deals with the perceptions of future science teachers at University Putra Malaysia. This project is designed to introduce prospective Science

teachers to Arduino technology to promote students' real-world learning and to assist prospective Science teachers in improving their teaching style.

4.3.1 Percentages and Analysis of Respondents on First Part of Questionnaire

Figure 4.1 (a) depicts the total number of people who completed the closed-ended survey. A closed-ended survey question only allows for a restricted number of responses. Respondents are unable to explain their answers and are limited to choose from a list of pre-determined possibilities. This question might be "yes" or "no," and there are five different types of questions for this section. A small percentage of respondents (30%) have heard of smart farming, whereas the majority (70%) have never heard of it. Figure 4.1 (b) depicts the total number of respondents (30%) who have heard of the Internet of Things (IoT), whereas many respondents (70%) claimed that they had never heard of IoT.

Have you heard about smart farming?
30 responses



Have you heard about (IoT) Internet of Things?

30 responses

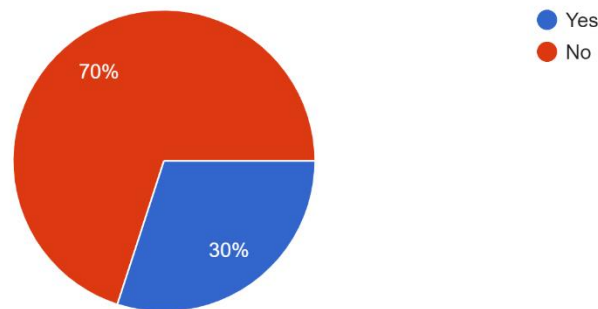
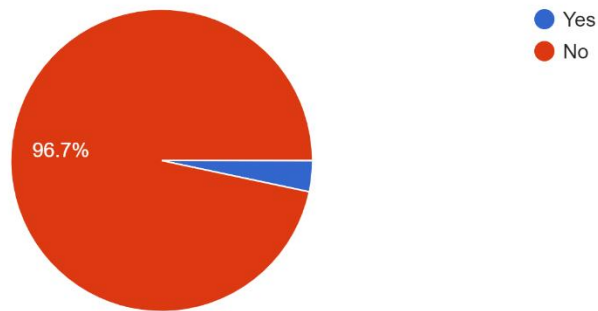


Figure 4.3 Pie chart for (a) Smart farming and (b) Internet of Things (IoT)

Figure 4.3 (c), on the other hand, demonstrates that 96.7 percent of respondents had never used an Arduino board during their studies, whereas just 3.3 percent have ever used the board. This means they have not yet had the opportunity to watch the growth of Arduino technology, which has already become a valuable teaching tool in education systems around the world, both formally and informally, and to which most children are now exposed as early as primary school age. Aside from that, figure 4.3 (d) reveals that the water sensor was used by the most people (3), while the humidity, temperature, and soil moisture sensors were used by the least people (1). Only one respondent out of a total of eight used all of the sensors listed in the option with photographs. Because the question is a checkbox type, the other (22) respondents leave the question blank (without ticking any alternatives), indicating that they have not used any of the sensors listed.

Have you used the Arduino board?

30 responses



Have you ever used these sensors?

8 responses

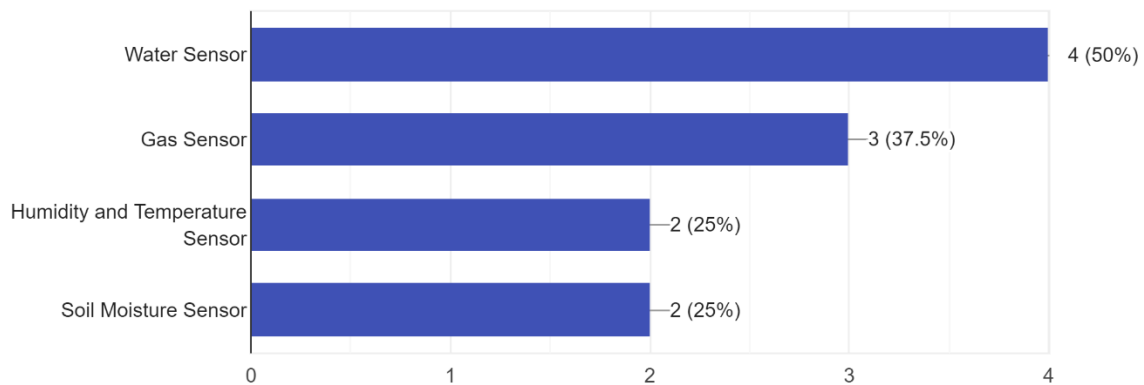


Figure 4.3 Pie chart for (c) Arduino board and Horizontal Bar Graph for (d) Type of sensors

Figure 4.3 (e) demonstrates that (100%) of the respondents, i.e., 30 people, all of whom are potential science instructors at the University Putra Malaysia, had never been exposed to the use of the Flow logic programme employed in this study. As a result, because it encompasses all

aspects of STEM education, this project has a reasonably high novelty value to be implemented and presented to potential science teachers.

Have you ever used Flow Logic 6 Software?
30 responses

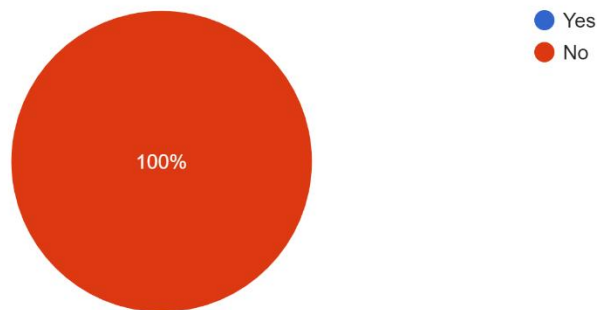


Figure 4.3 Pie chart for (e) Flow logic 6 Software

4.3.2 Percentages and Analysis of Respondents on Second Part of Questionnaire (Section A)

This section contains multiple-choice questions, some of which include image choices. It's great for inquiries that necessitate visual identification. It is employed in educational testing. Respondents are asked to identify the hardware component in the image multiple choice question below. The majority of the questions are multiple-choice, but the first is a single choice. This section is designed to assess prospective Science teachers' grasp of the smart farming model system.

Can you identify this component?



- ☐ Raspberry Pi
- ☐ Arduino Duo board
- ☒ Uno Cards
- ☐ Arduino Uno board

Figure 4.4 (a) Question review

The point totals for the 30 respondents who answered the multiple-choice questions are shown in the vertical bar graph. The average is 4 points out of 7, the median is 4 points out of 7, and the range is 1 to 6 points. There are two (2) respondents who received 1 and 2 points, respectively. There are (4) respondents who scored 3 points, and the same number of respondents (10) who scored 4 and 5 points, respectively. On the other hand, the number of responders who received a score of 6 points was also recorded. As a result, the MCQ question type offers a visually appealing interface that is extremely interactive when it enhances understanding and lowers survey abandonment rates.

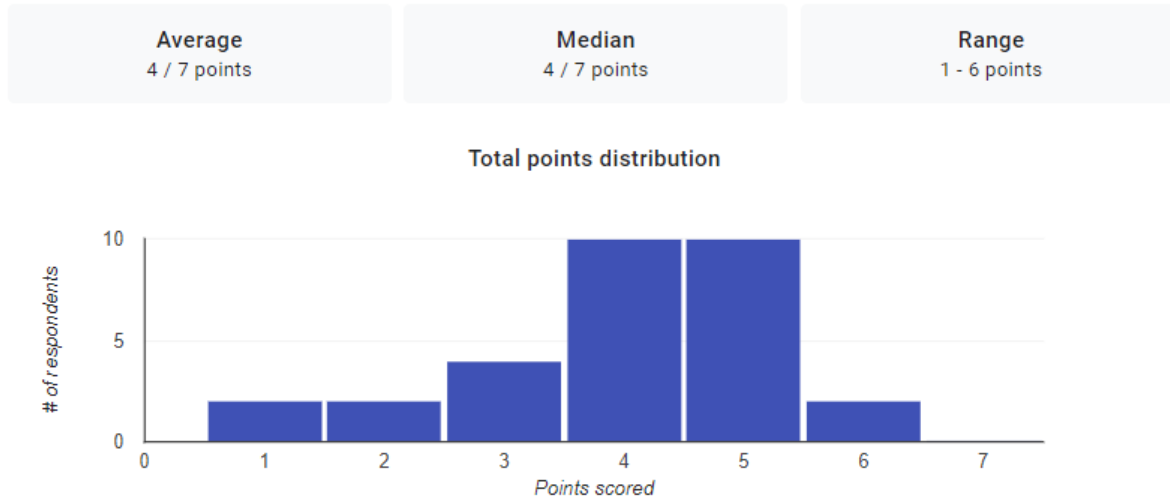


Figure 4.4 Vertical Bar Graph for (b) Points scored in multiple choice questions

4.3.3 Percentages and Analysis of Respondents on Second Part of Questionnaire (Section B)

Section B continues from the second portion of Section A, however the purpose is slightly different this time (Second part: Section A). The goal is to assess students with Bachelor of Science Education in Physics, Chemistry, and Biology at Universiti Putra Malaysia (UPM) for their readiness for the fourth global Industrial Revolution (IR4.0). Multiple choice questions with a rating scale are used to collect data from respondents on a linear scale. The horizontal example of a rating scale in Figure 4.5 (a) below asks respondents to score their cloud computing knowledge. A horizontal or inline example of a linear rating scale is shown below. A 5-point Likert scale is used. The 5-point Likert scale begins at 1. (1. Very Low, 2. Low, 3. Intermediate, 4. High and 5. Very High). Respondents are also asked to rate their expertise of big data and computer programming using the same question format. Respondents' ratings of their understanding of big data and cloud computing are both on the low end of the Likert scale, whereas respondents' ratings of computer programming are on the middle end of the range. As a

result, it has been shown that respondents should improve their technology skills in order to prepare for IR4.0.

Please rate your knowledge about Cloud Computing
30 responses

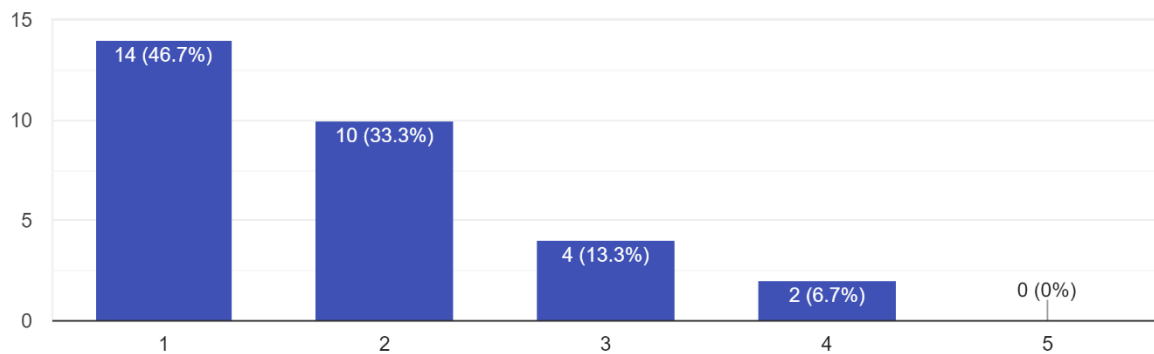
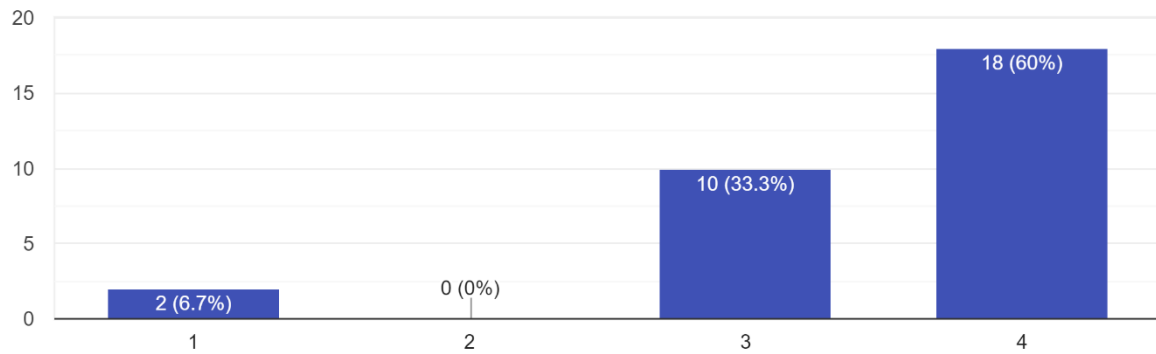


Figure 4.5 Vertical Bar Graph (a) Knowledge Ratings on Cloud Computing

The rating scale is a 4-point Likert scale with multiple choice questions. The Likert scale is a four-point scale that starts at one and goes up to four (1. Strongly Disagree, 2. Disagree, 3. Agree and 4. Strongly Agree). Respondents are asked to rate their perceptions of IR4.0 and STEM education in three different question forms. The scores for their impression of fundamental IT (Information Technology) are shown in Figure 4.5 (b), and it demonstrates that (60 percent) respondents strongly agree that they have the basic IT skills. Figure 4.5 (b) demonstrates that the majority of respondents (65.5 percent) strongly believe that the student's knowledge will be applied in a real-world setting. This is when the increased interest of pupils in STEM education becomes a factor in the instructional method.

Do you think the prospective Science teacher should have the basic IT skills?

30 responses



By applying IR 4.0 in education, does it extend the student's knowledge to the real-world situation instead of the typical school?

29 responses

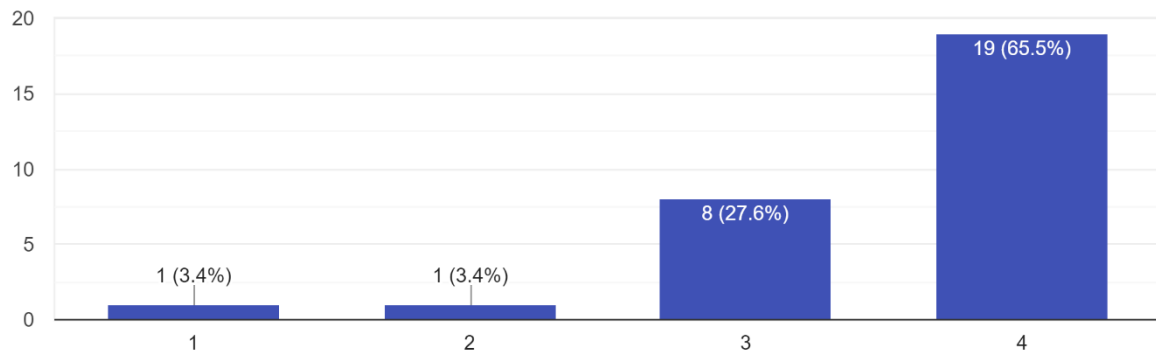


Figure 4.5 Vertical Bar Graph (b) Perceptions of the respondents on basic IT skills and (c) Perceptions of the respondents on student's knowledge of the real-world situation.

Figure 4.5 (c) demonstrates that most respondents (63.3 percent) want to learn more about STEM education. This means that graduates, particularly those pursuing a bachelor's degree in education, must develop self-learning skills in order to stay relevant in an era of rapid change.

In your opinion, does the IR4.0 makes you want to know more about STEM Education?
30 responses

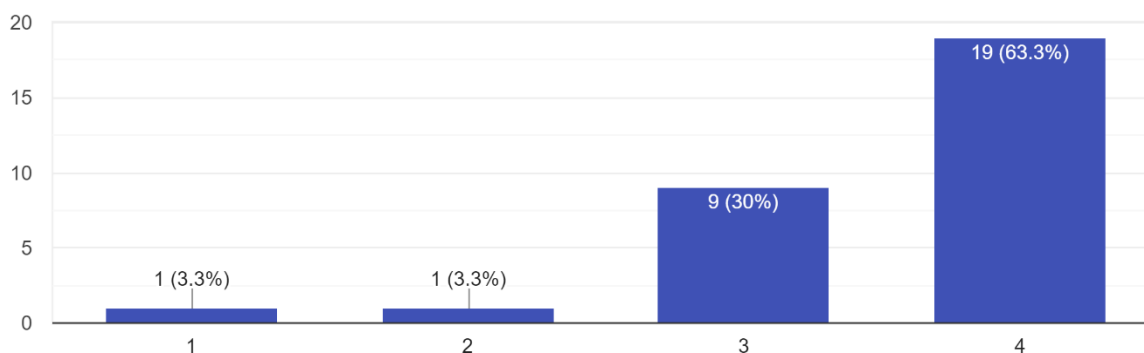


Figure 4.5 Vertical Bar Graph (c) Perceptions of the respondents on STEM education

4.3.4 Percentages and Analysis of Respondents on Third Part of Questionnaire (Demographic Questions)

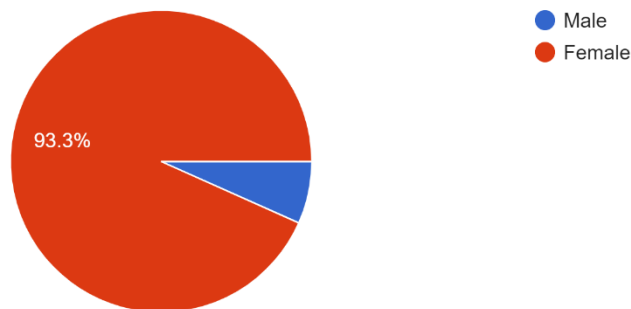
The types of questions in this section include closed-ended and open-ended questions. The questions are exemplified below.

1. Closed-ended questions

Figure 4.6 (a) depicts the total number of 30 respondents, with 93.3 percent belonging to the female gender and (6.7 percent) to the male gender. Figure 4.5 (b) shows the percentages of Bachelor of Science Education with Physics, Bachelor of Science Education with Chemistry, and Bachelor of Science Education with Biology courses. There are a total of 30 responders, with 60

percent coming from the Bachelor of Science Education with Physics degree and 26.7 percent from the Bachelor of Science Education with Chemistry programme. The Bachelor of Science Education with Biology programme had the lowest percentage of responders. The goal of the difference between courses is to assess future Science teachers' comprehension of the smart agricultural model system as a tool to aid in the 21st century learning process, as well as their readiness for the global IR4.0.

Gender
30 responses



Courses
30 responses

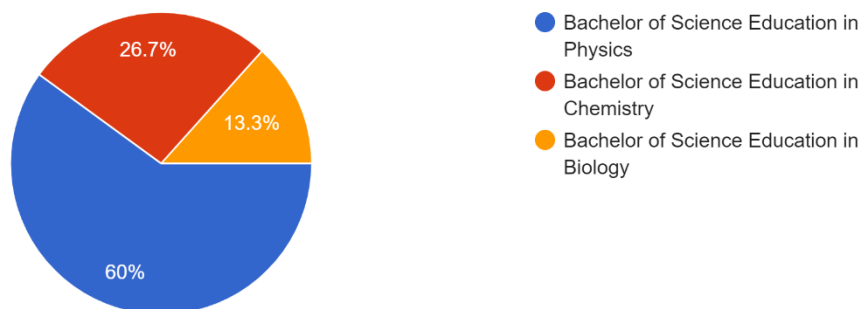
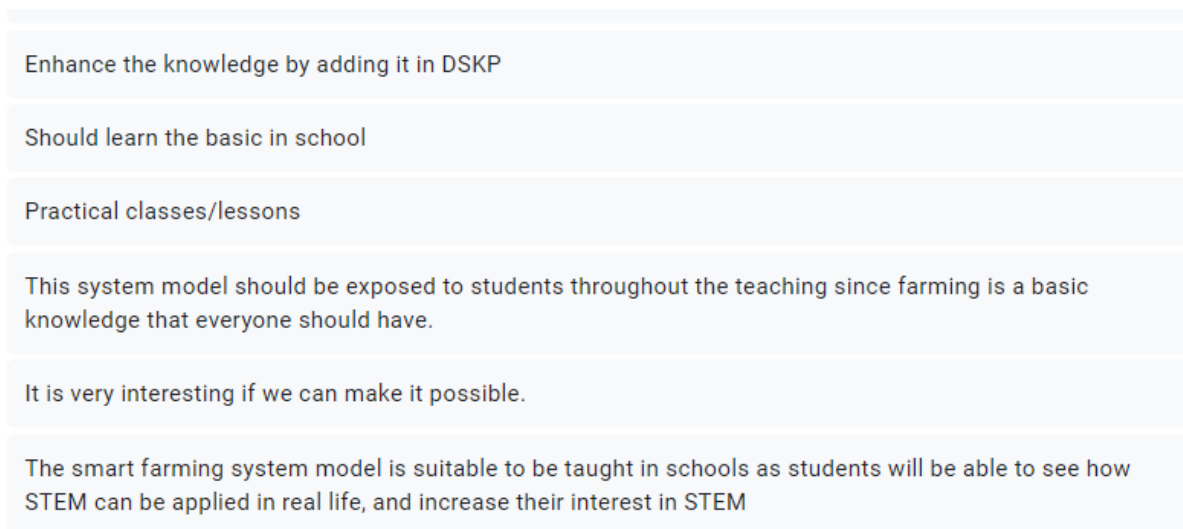


Figure 4.6 Pie chart for (a) Gender and (b) Courses

2. Open-ended questions

Respondents are asked to express their criticism or recommendation in an open-ended survey question. Figure 4.6 (c), for example, asks how likely a respondent is to propose the project's improvement and how they feel about using the smart farming system model as a teaching tool in Science, Technology, Engineering, and Mathematics (STEM) lectures in Malaysian schools. Some of them would like to be involved in the project's implementation, while others can connect the elements of STEM education to the usual school learning process. By definition, STEM education is more than just a curriculum; it is a way of thinking about learning. STEM education blends the four disciplines into a holistic learning paradigm focused on real-world applications, rather than teaching them as separate and isolated subjects.



- Enhance the knowledge by adding it in DSKP
- Should learn the basic in school
- Practical classes/lessons
- This system model should be exposed to students throughout the teaching since farming is a basic knowledge that everyone should have.
- It is very interesting if we can make it possible.
- The smart farming system model is suitable to be taught in schools as students will be able to see how STEM can be applied in real life, and increase their interest in STEM

Figure 4.6 Open-ended question (c) Views or feedback on project

CHAPTER 5

CONCLUSION

5.1 Conclusion

This study used a quantitative approach with a total of 30 participants. The goal of this study is to assess prospective Science teachers' understanding of the smart farming model system as a tool for implementing a 21st-century learning process and preparing for the fourth global industrial revolution (IR4.0) among Universiti Putra Malaysia (UPM) students majoring in Physics, Chemistry, and Biology. In general, aspiring science instructors should be able to demonstrate a fundamental mastery of the STEM area. They should be interested in learning more about STEM education in this setting. This is because teachers' teaching skills can increase pupils' fundamental knowledge. Other easy Arduino projects may be introduced to students at some time, either during the classroom teaching process or through co-curricular activities such as robotics or gardening. Basic computing abilities can also be provided to assist pupils unlock their creativity, improve their technical thinking, and pursue high-level education subjects all around the world.

This study was able to improve respondents' basic understanding skills for them to learn more about Arduino technology, the Internet of Things (IoT), electronics, and other STEM-related topics. As a result, the smart farming system assists teachers in connecting every STEM discipline into an integrated notion that blurs the lines between them. Students were motivated and engaged in meaningful instruction because of the activities detailed in this paper.

Meanwhile, to provide secondary school students with more opportunities to learn, there are many simple Arduino projects that could be created for prospective science teachers and their

students, which could be introduced in a short period of time and be simple to handle just to familiarize them with the fundamentals of Arduino knowledge, while other soft skills such as computing, electronics, and creative thinking would be developed indirectly. Furthermore, the project's planning is to create a teacher's handbook and a low-cost Arduino kit with basic components that secondary school instructors which they can use to expose their pupils towards related subjects to encourage technology and innovation learning.

This capstone project allowed me to gain experience with new technologies and tools. This was concrete evidence that Arduino technology has taught us how to be lifelong learners and master self-learning while teaching other class content. Of fact, this project is a culmination of everything I have studied in computer science classes, including programming languages, database systems, and electronic information, but it's only used to assess student cognitive abilities in educational settings. STEM education, on the other hand, is beneficial to all students especially who want to pursue STEM career in future. Also, students can establish mental habits that will help them succeed in any subject by focusing on logical thought processes and problem-solving.

Besides that, students will be introduced to physical learning, logic thinking, construction skills, and problem solving by introducing Arduino technology with the use of many types of advanced sensors at the elementary school level, either during in-class lessons or co-curricular sessions. As a result, many secondary schools employ it in cross-curriculum studies using creative ways. For example, in this study, temperature sensors are used to help students, particularly those in the scientific stream, engage more efficiently when learning about control. Apart from that, temperature measurement has a wide range of applications and innovations in our daily lives, from simple to complex projects, making it a useful tool for students to expand their knowledge and become more critical thinkers when they can relate the project to the real-world environment.

5.1.1 IR4.0's Educational Impact

In this context, IR 4.0 necessitates modifications in the content of not just technical but also general education. Across disciplines, new focus on skills will be required, as well as new content. As a result, new educational programmes will be required to satisfy changing expectations.

Moreover, jobs that demand creativity are likely to remain in the era of IR 4.0. Education, regardless of discipline, must be capable of producing highly creative graduates who can think critically. Graduates must be creative and entrepreneurial, as well as possess cognitive flexibility to deal with a variety of situations. Many of them will collaborate with both humans and robots. Meanwhile, a better communication and collaboration abilities will be required more than ever before. In Bloom's concept, education is said to affect all three domains (cognitive, affective, and

psychomotor) in this period. Thus, Application, Analysis, Evaluating, and Creating will become far more essential in the cognitive domain than lower-level cognitive talents.

5.1.2 Pedagogy

Mobile computing, cloud computing, social networking, and big data have presented an opportunity to establish a learning environment that enables for individualized learning that is time and location agnostic.

Learners will be able to create their own educational paths based on their individual objectives. It will become increasingly vital to convey deeper learning as the amount of complexity rises. Increased use of blended, project-based, scenario-based, and practice-oriented learning can help achieve this. Given the importance of innovation in STEM subjects, experts advise that maker spaces, which are distinguished by open-source innovation and learning-by-doing, be used to train graduates.

To put it another way, the Internet of Things may provide the foundation for the next era of smart agriculture (IoT). In recent years, the Internet of Things (IoT) has become increasingly important in the development of systems and applications to tackle real-world problems in all aspects of life. The smart farming system in this project is a combination of hardware and software expertise. Embedded systems and software programmes are included under the hardware section and Flow logic 6 was used to create this. Temperature and humidity sensor (DHT11), gas sensor, water level sensor, and soil moisture sensor are among the sensors employed. The Arduino UNO receives the data collected with the help of the sensors. The data gathered could be shown using Arduino software. Data ingestion and storage for the sensors mentioned earlier are likewise handled by Thing Speak. It is connected to an Arduino system to

make data storage easier and to keep the user up to date on the current climatic conditions of the subject.

The smart agricultural system is an IoT-based project that employs Thing Speak. To create this project, I used a variety of low-cost Arduino hardware components, including an Arduino UNO board that serves as the main grid or microcontroller and connects to USB. Other sensors for date and time include a temperature sensor (LM35), a soil moisture sensor, an LCD, and other Arduino hardware components. There are also some connectors and wires. A unique circuit will be used to connect all these components. I also utilized the Flow Logic 6 application for the software, which is a flowchart-based interactive programming integrated development environment (IDE).

5.2 Suggestions

This study can be utilized to inform future research at the university level. This research can also be used as a data guideline for teachers or Science students to evaluate students' grasp of Arduino technology in different ways. This research can be utilized in the future to compare a huge number of results in the field of STEM education. For example, it may undertake a poll among Malaysian universities on the same topic within the STEM aspects. In this method, we may examine the level of understanding and interest among scientific students at various colleges.

This experiment clearly indicates that non-science students can benefit from these low-cost platforms as well. The increased interest of students in technology is one of the most important conclusions to be derived from this teaching strategy. Furthermore, these abilities are

quite valuable, and some organizations predict that they will be in high demand in the labor market in the next years.

Throughout the survey, we encouraged prospective science teachers at UPM to learn Arduino technology and computer programming because it would result in a vast number of projects or innovations that could be shared with the next generation if they were able to apply their knowledge and skills in a real-world setting. Besides that, the respondents were asked to give their comments at the end of the questionnaire, and one of the results stated, "This system model should be introduced to students throughout the educational process because farming is a basic knowledge that everyone should understand."

Despite from that, programming in Flow logic was quite difficult, and it was a problem that I had to fix on my own because it does not highlight the faults that occur while using the "drag and drop" method of coding. It should be improved by detecting errors that may occur throughout the coding design phase. As a result, it encourages the user to inspect the error sections, where appropriate actions must be made based on the project's function. For instance, the gas sensor ranges for detecting a any leakage. Besides that, once this system is up and running, I did like to invite the students, particularly the respondents, to try it out and describe how it relates to the science, technology, engineering, and mathematics subject taught at the school and university.

This study also provided a quick overview of low-cost platforms that can be utilized in school settings to help students learn more effectively and constructively. Based on the Department of Physics of the University Putra Malaysia's experience, as a result, a large proportion of respondents chose these activities to reinforce engineering fundamentals, and

involvement has increased in recent years. One of the most important conclusions to be derived from this instructional technique is that students' output has grown significantly.

However, two sensors, the rainwater sensor, and the relay, are not used in the end of the project. This is because the project is hybrid, which means that in the early semester, there was a Covid 19 attack, which made it difficult to enter the laboratory completely. Because of the limited time available, this project will only use four sensors which are temperature and humidity sensor, a gas sensor, a water level sensor, and a soil humidity sensor.

In general, the project was successful and worked properly and succeeded in delivering the prototype on due time. I am proud and happy for this achievement especially that this is my first real big theoretical and practical project. It enabled me to get concrete results and to realize that I can indeed build products that would be beneficial in real life and that I can customized upon demand as future projects.

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