Development of computerized data acquisition system for science experiments

By

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14266

Interim submitted in partial fulfillment of

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Certification of Approval

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A project dissertation submitted to the

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Approved by,

,

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TRONOH, PERAK

MAY 2014

Certification of Originality

This is to certify that I am responsible for the work submitted in this project, that the original work is my own except as specified in the reference and acknowledgements, and that the original work contained herein have not been undertaken or done by unspecified sources or persons.

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(LIM ZI YI)

ABSTRACT

Nowadays, students are losing their interest in science subject. This is because they do not able to apply theory on the science experiment while they are still using old and conventional method to conduct a science experiment that might bring a lot of uncertainties in the actual word. The current available data acquisition systems in the market are costly installation fee and stiff learning curve that leads to the inconvenience to conduct an experiment or analyze the result would be unwanted by the students. The objective of this project here is to implement a data acquisition system, which is user-friendly and low cost. Through this project, a data acquisition system is designed. Waterproof temperature sensor, velocity detector, voltage/current detector are used to carry out certain science experiments. With the standalone monitoring system, users can view the result and analyze on the liquid crystal display. The users also can read the result on a give website address as long as the Arduino Mega is connected to a computer. The use of Arduino Mega with Ethernet shield coupled together will help in accomplished the web site for the database in this project. Here the user has to enter a password, which must register before, and this read from the system for clarification and verification purpose. By storing the database online, the user can read his result in a more efficient way. This project has been extensively tested in one of the science experiments. Experimental results have shown a result accuracy of 90% in this project by compared to conventional method. From this project, a better way to conduct science experiment is built and this work would illustrate the advantages of saving the time for better experiment results while doing the experiment.

Acknowledgement

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Chapter 1
Introduction

1.1 Project Background

Today's education system is too exam-oriented, which caused the students aim to pass the exam with flying color, but fails to apply the knowledge in real life. Hence, there is a need for paradigm shift of Malaysia Education System from using Rote Learning to Discovery Based Learning in schools. Discovery Based Learning is used to balance theoretical studies students learned in class and practical experiments in the lab. Besides, it is difficult to sustain the interest of students in some subjects, especially science subject through old and conventional method.

This project will be able to fit in current Malaysia Education system, especially the technological enhancement of the science environment. It uses the current technology to implement a data acquisition system, which is based on current Malaysia education scheme. In the Malaysia Education Blueprint 2013-2015, one of the eleven strategic thrusts is to enhance the science education. A survey carried out by the Ministry stated that although a big amount of money had been spend, there is only 80% of the teachers spend less than one hour a week using information, and communication technology (ICT), while one third of the students perceive to use ICT regularly. Hence, it is clearly to see that ICT usage is extremely low and cause the interest in science stream is on the downward trend. Apart from that, Malaysia was ranked in the bottom third for reading, Mathematics and Science in Programme for International Student Assessment (PISA 2012), conducted by Organisation for Economic Co-operation and Development. Thus, the need to increase the interest in science related subjects at the school level have become increasingly important.

One of the reasons why the science related subjects have become less popular is because it is rather difficult to sustain the interest of the students via theoretical approach. To keep students engaged, their interest in science must be enticed. Technology is a key element to promote students' interest learning. Technology based learning environment designed for problem based-learning, which make the learning process more interactive and students more effective and engaged. This kind of learning environment always involves collaborative learning among students where students can improve their soft skills, such as leadership, communication skills and others moral values.

Technology based learning helps to save time in order to get more accuracy result and analysis. Nowadays, the practical aspects are also important and the same old experiments are used with the conventional data capturing devices. Students usually waste so much time in just trying to capture the data and the need for analyzing the result becomes less important. Therefore, the used of technology based learning especially in science experiment will help to save time. Students can used the current sophisticated devices provided to complete the experiment in a shorter time. As the result, they can use the rest of time to investigate the data gained and furthermore to apply knowledge learned during the class for the experiment. Technology based learning has a wide range of advantages over the old traditional method. These devices are developed in a higher complexity and easy to access, measure and monitor some certain physical environment values such as, temperature and pressure. While using the devices, students' motivation to learn new technology and to gain knowledge is greatly increased. Hence, students' engagement in science will improve in a higher order when they are provided with new technology devices.

In this project, a battery operated data acquisition system will be designed, where the data will be transmitted to a computer for processing and can be analyzed easily. The real time data obtained from the experiments will also be displayed on a local LCD module on the standalone system. The challenge will be in making it universal data acquisition system that can be connected with few different sensors for data acquisition and log the data into webserver for analysis purpose.

1.2 Problem Statement

Based on Programme for International Student Assessment (PISA 2012) and Malaysia Education Blueprint 2013-2015, it is worth to investigate why the interest of science stream is on downward trend. The reason is because students do not able to apply theoretical studies on the experiment. Everyday while studying in classroom, what students have been taught is ideal concept from the textbook and all the disturbance values or the environment data are not in concern. However, there are so many uncertainties in the actual world, science experiments are not excluded. When students carry out the experiments, they will find out that they cannot get the ideal result as recorded in the textbook. Hence, a feeling of unattached will rise in their heart, which will lead to the loss of interest in science stream.

Nowadays in schools, throughout a science experiment, conventional measuring instruments, such as, voltmeters, ammeters and thermometers are utilized to gather data physically. A considerable amount of time is used on data gathering that might contain certain level of errors. However, these errors can only be detected once the analysis is carried out and charts are drawn. Usually, students can only do their analysis either they back in normal classroom or when they already home. There is no opportunity for the students to repeat their experiments in order to obtain new result. Hence, it is not easy for them to have a clear understanding about the objectives of the experiment and this may lead to the loss of interest in science too.

Taking all these constraints into consideration, it is timely that efforts are directed at designing low cost data acquisition system that can fit into our local education climate to assist in the innovation based learning approach.

1.3 Objectives and Scope of Study

1.3.1 Objectives

The objectives of this project are:

- To design a user-friendly computerized data acquisition system for conducting science experiments.
- To implement a low cost data acquisition system.
- To carry out the testing of the computerized data acquisition system designed in this project on few selected science.

1.3.2 Scope of Study

Based on the objectives, the scope of study of this project is as given below:

- Designing a Data acquisition system by using suitable microcontroller for science experiment
- Implementing Electrical and Electronic engineering in term of software and hardware knowledge into this project
- Data logging by using Arduino via Ethernet Shield to webserver.
- Carrying out research to design and calibrate the sensors for accurate data measurement.

Chapter 2
Literature Review

2.1 Education System in Malaysia

2.1.1 Current Education System

In Malaysia, The Ministry of Education (MOE) plays an important role to set a comprehensive schooling system from pre-school to secondary education. During the six years of primary school education, the syllabus is focuses on the development of moral values, reading skills, writing skills and arithmetic skills. The mastery of these skills is reinforced and emphasized to build a strong foundation for all subjects. Upon completion of primary stage of education, students will continue to secondary level of education [14]. Secondary education is divided into lower and upper secondary levels. Education at this level is general in nature and focuses on core subjects such as languages, Mathematics and Science. In order to cope with both practical and theoretical knowledge, science experiments are included in the syllabus. This teaching-learning environment aims to improve the quality of education in Malaysia.

2.1.2 Science Experiment in the Syllabus

Science is a core subject in the school curriculum and consists of science for primary, secondary, physics, biology, chemistry and additional science. At the primary and lower secondary level of education, students need to take science subject. While upper secondary level, they can choose to take either core science or science electives [17].

Science at primary level is aim to build a community that is culturally scientific and progressive through providing opportunities for students to acquire knowledge through experiential learning. Science continues to be offered at the lower secondary level and it is further develops and reinforces what has been learned at the primary level. According to the MOE, particular emphasis is given on scientific knowledge and thinking skill to make sure students can understand and appreciate the role of science and application of science for the development of the nation [16&17]. At the upper secondary, students are offered science electives for Science Stream or additional science for art stream students. In order to develop the interest of students in science, technical education is introduced and exam-oriented teaching is not encouraged. For examples, a Smart School concept is presented. Technology becomes an enabler to facilitate teaching, learning activities and experiments. A different approach, which reforms the current science curricular, emphasizes on discovery-based learning and several implementations are taking out to fit in this reform.

2.1.3 Problems faced in Schools

According to Oxford dictionary, education is defined as the process of receiving or giving systematic instruction. Based on the definition, education is the engagement by learning or teaching an instruction followed by the syllabus. However, this approach cannot assist students to really understand the theory they learned in class. The learning process in the classroom is never enough for them to survive in future. In Malaysia, the education system is facing difficulty in producing a competent student. Due to the societal pressure, the scoring of the test paper and A's in the exam indicates the performance of a student is school. When the education system in Malaysia emphasized on number of A's in exam slip instead of training other skills, students would not able to enjoy themselves in the schools and this lead to the losing of interests in study.

Besides, trends in International Mathematics and Science Study (TIMSS) 2011 and PISA 2012 saws Malaysia's ranking drop. According to TIMSS, Malaysia experienced the biggest drop in test scores among all countries for both Mathematics and Science [15]. However, in the local examination, the students are doing very well. It is showed that 92% of the students passed SPM Science exams, but only 67% of them know CO_2 stands for carbon dioxide. This situation of the declined ranking in TIMSS highlights a mismatch between Malaysia's current education system. Hence, MOE should promote discovery-based learning for science education. The schools should emphasize on lab experiments instead of merely learning from the textbooks.

2.2 Computerized Data Acquisition system (DAS)

Data acquisition is the process of measuring an electrical or physical phenomenon such as voltage, current, temperature, pressure, or sound with a computer. It is able to measure and to convert the resulting samples into digital numeric values that can be manipulated. In normal case, it converts analog waveforms into digital values for processing. Data acquisition system (DAS) is a basic network management that provides timeliness, reliable, fully formed network raw data for upper level of network management system [1]. Traditional DAS unable to adapt to the network change because of the rapid change of the data processing mode and it. Generally, the three common communication system used are Traditional RS332 Serial port, parallel port, and universal high-speed data acquisition system [2]. But they are not ideal in term of cost and transmission speed of data [2], [3].

A data acquisition system (DAS) consists of sensors, measurement hardware and a monitoring screen with programmable software. A sensor, which also called as transducer, is used as a measurement tool for physical phenomenon. It converts the data gained from the environment such as humidity and temperature into an electrical signal so that it can be read by DAS. The digital signal will then send to the DAS measurement hardware for further analysis. DAS measurement hardware is the interface between the signals and monitoring screen. The key components of the hardware are analog-to-digital converter (ADC), computer bus and signal conditioning circuitry. Last but not least, the DAS measurement hardware is connected to a monitoring screen with programmable software. The software will communicate between the software and the DAS measurement hardware to show the result on the monitoring screen.

2.2.1 Current Existing DAS in Market

Currently, there are many DAS in the market. Some of the examples are as shown in the table below.

No	DAS	Description
1	PASCO	• User-friendly. • Expensive.
2	LABVIEW	• Stiff learning curve. • Expensive.
3	PHYWE	• Design for science experiments. • Do not fit in current Malaysia Education System.
4	ENDEVO	• Filter signal and noise. • For industrial use only.

Table 1: DAS in the market

Through the years of DAS has been developed and used to obtain real time data. Various DAS applications with different specifications have been tried. The applications that are commonly used by public are LabView by National Instrument, PASCO and PHYWE. LabView is used to design program, which is easy to debug and maintain. It is highly flexible as it can communicate with external programming language such as DHL, C language, ActiveX, .NET, DDE and Matlab [3] while PASCO also a USB data acquisition system which works with any of PASCO’s ScienceWorkshop Sensors. PASCO is generally used to generate and view amplified signals, waveforms, and voltage or current value. By looking at the datasheet of both National Instrument (NI) and PASCO, it is stated that NI is faster in term of sampling time, which is 48kHz compare with PASCO, which is 10kHz. Although these applications have high-speed data transmission, but they are expensive and cost up to fifteen thousand ringgit Malaysia. Besides, learning curve for LabVIEW by NI is a stiff and confusing, students might need to a long time to learn how to use the program fluently. Meanwhile, ScienceWorkshop Sensors by PASCO is much more easier to access. However, both LabVIEW and PASCO are high-priced for installation and software. According to the official website by NI, the cheapest DAS they offered cost three thousand and eighty ringgit Malaysia excluding the experiment kits and software while PASCO costs for fifteen thousand ringgit Malaysia. LabVIEW and PASCO are expensive and they are big in size, which do not support standalone system.

PHYWE is another DAS that existing in the market. It is common used for teaching of science and technical training in schools to universities. It is specially implemented to meet international curricular standards in science education. However, the experimental courses covered by PHYWE experiments are not suitable for current education system [19]. Users need to buy all the products by PHYWE in order to experience the technology education in the school. Hence, it will cost a lot and not user friendly [18].

2.2.2 Researches about DAS

Recently, many researches on DAS are carried out to reduce the price and improve the performance of the system. Some universities designed USB DAS with acquisition, display and storage function by using LabView and Window platform [2], [3]. It is stated that USB DAS is easy to work stably and effectively. Besides, it is easy to operate and portable. Hence, it is suitable for acquisition and analysis.

Secondly, the open DAQ which features a mini-USB connector for power and communications presents a low cost DAQ that allows configuring and sampling the data in a short time. The DAQ is able to work with Python and LabVIEW to increase its scope [9]. However, the DAQ is specially designed for analog input and output, digital input and output, and counter circuitry, which is focus on instrumentation and measurement system.

Besides, PIC microcontroller with Bluetooth is used as the platform to store, display, monitoring and for acquisition in order to control Flexible Impeller Pump. Touchscreen HMI, non-volatile FLASH chip and external SRAM are attached externally and for easy data transfer to PC is equipped [5]. Fuzzy control is chosen because it is easier to get stable result and to reduce the chance to get robust. Apart from that, fuzzy control is simple for design and implementation, so the users can save time to design new DAS system. In short, USB DAS is easy to use and cheaper compare with existing DAS in the market. Nevertheless, none of the DAS designed can fulfill the need of current Malaysia education.

2.2.3 Microcontroller Used

The development in new sensors, modification in size and improvement in size and speed have all opened a new page for electronics devices [13]. Microcontroller is the key element to communicate with the chip to control the movement. There is a wide range of controllers, which take one or more inputs and adjust the outputs and performed feedback closed loop control. Different controllers required different control method to execute the outputs. Therefore, it is important to choose an appropriate controller of a project. There is an array of microcontrollers including the widely used Arduino and Basic range and the recently hugely popular Raspberry Pi [11].

There are some issues to take note while choosing the right microcontroller. Firstly, to consider about the operating frequency of the microcontroller to determine the chip operating speed. Then, users need to determine the size of the programming that can be store inside the microcontroller. Last but no least is to consider the energy consumptions of the microcontroller. Arduino is one of the user-friendliest microcontrollers in the market. There are different design and features of Arduino microcontrollers with different size and processing capabilities.

No	Features	Arduino Uno	Arduino Mega	Arduino Nano	PIC 16F
1	Microcontroller	Atmega 328	Atmega1280	Atmega328	microchip
2	Operating Voltage	5V	5V	5V	2-5.5V
3	Digital I/O Pins	14 (6 PWM output)	54 (15 PWM output)	14 (6 PWM output)	35
4	Analog I/O Pins	6	16	8	-
5	Flash Memory	32KB	128 KB	32KB	8KB
6	SRAM	2KB	8KB	2KB	368 bytes
7	EEPROM	1 KB	4KB	1 KB	256 bytes

Table 2: Features of some microcontrollers

Figure 1: Arduino Mega

Arduino Mega is chosen in this project as it is a user friendly USB programmable Arduino Microcontroller. It is open Source design based on the larger ATmega2560 It consists of 54 digital I/O Pins and 16 analog I/O Pins which is more than with Arduino Uno.

The 256 KB of Flash Memory, 8 KB of SRAM, and 4kB of EEPROM enable user to store more memory into the chip and has a better performance. Its clock speed is 16 MHz.

2.3 Critical Analysis

Technology of the future will be different than they are today, as they will include more and newer forms of technology. These technological advances will be readily available for use for students. A lot of present tasks of science experiment can be done with the data acquisition system. Already there is programmed software available for students of all ages. This data acquisition system might supersede the traditional way to do science experiments in terms of effectiveness and convenience. Besides, it is specially designed to fit in current Malaysia education system as it can be used to conduct all the science experiments in the school. Therefore, to fulfill the objective of improving the interesting among students for science subject by discovery based learning; an idea to develop a computerized data acquisition system for science experience using Arduino microcontroller board is generated.

The development of DAS using Arduino is divided into three subsystems, which are:

a. Sensors consisting of motion sensor, temperature sensor, voltage detector and current detector.

b. Data acquisition device to measure the physical value and interface with the monitoring system.

c. Monitoring system; can either be standalone or using computer to show the analyzed data and graphs.

Chapter 3
Methodology

This chapter explains how the SCIEDAS is conducted is applied to attain the goal of the project. There are two important parts to be taken into consideration, which are:

3.1 Hardware understanding and implementation.

For the hardware implementation, the most suitable hardware available in the market is surveyed. A research on what features us need and the price that is optimum to build this system is carried out.

The table below shows the hardware used in this project.

No	Hardware	Function
1	Arduino Mega	• Microcontroller of the project
2	Ethernet Shield	• To send the data to server
3	DS18B20 Temperature Sensor	• To detect temperature value
4	HC-SR04 Ultrasonic Sensor	• To detect velocity value
5	ACS712 Current Detector	• To detect current value • To detect voltage value
6	TFT LCD	• To display result

Table 3: Hardware used in SCIEDAS project

3.2 Software requirement and implementation.

Besides, the software implementation involves the process of assigning and designing software solution to guarantee that all the functions desired can be performed. This is the most complex part. Basic knowledge of C and Java language programming are necessary in order to complete the project.

The flowchart of the project is shown below. After researching and understanding the theory of the system, the first thing to do is to choose a suitable hardware. Whether making the hardware it using 8051, PIC or other microcontrollers or buying ready-made boards that is available in the market. Other components such as sensors are also identified.

SCIEDAS is using Arduino Mega is designed based on the methodology shown in the figure below to make sure that the system is reliable and function well.

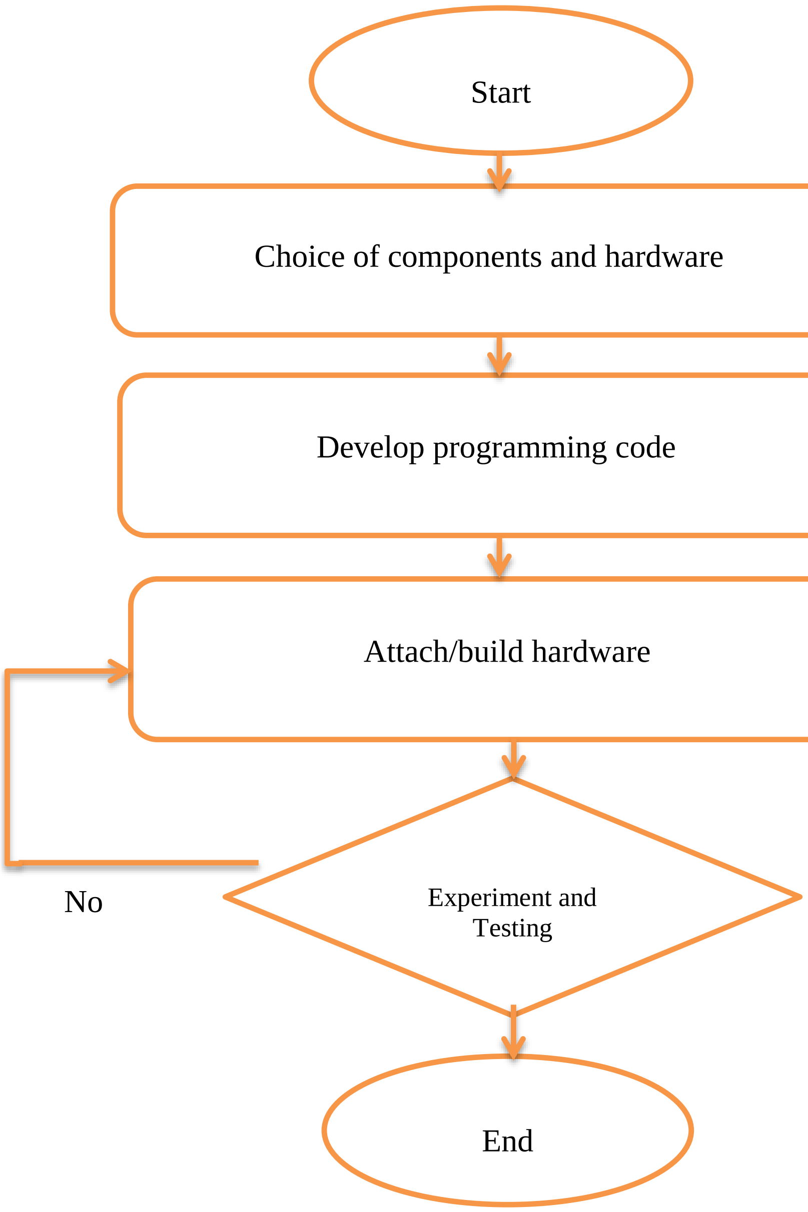


Figure 2: Workflow of the Project

3.3 Gantt Chart

No	Week / Activities	1	2	3	4	5	6	7		8	9	10	11	12	13	14
1	Literature Review															
2	Listing of Materials and Equipment															
3	Development of Concept															
4	Designing of Programming code															
5	Developing of online database															
6	Finalized Design Concept															

Initial concept of SCIEDAS is discussed.

Webserver of SCIEDAS is created

Hardware of the design is attached.

7	Experiment and Testing						**Experiment is carried out.**									

Table 4: Gantt Chart and Key mile stone of the project

Process

Suggested milestone

Chapter 4
Results and discussion

4.1 Development of hardware of SCIEDAS

In this project, SCIEDA, an idea to develop a computerized data acquisition system for science experiment using Arduino Mega microcontroller board is generated.

The figure below gives a big picture of a data acquisition system, which connected, to a computer (PC) and a LCD.

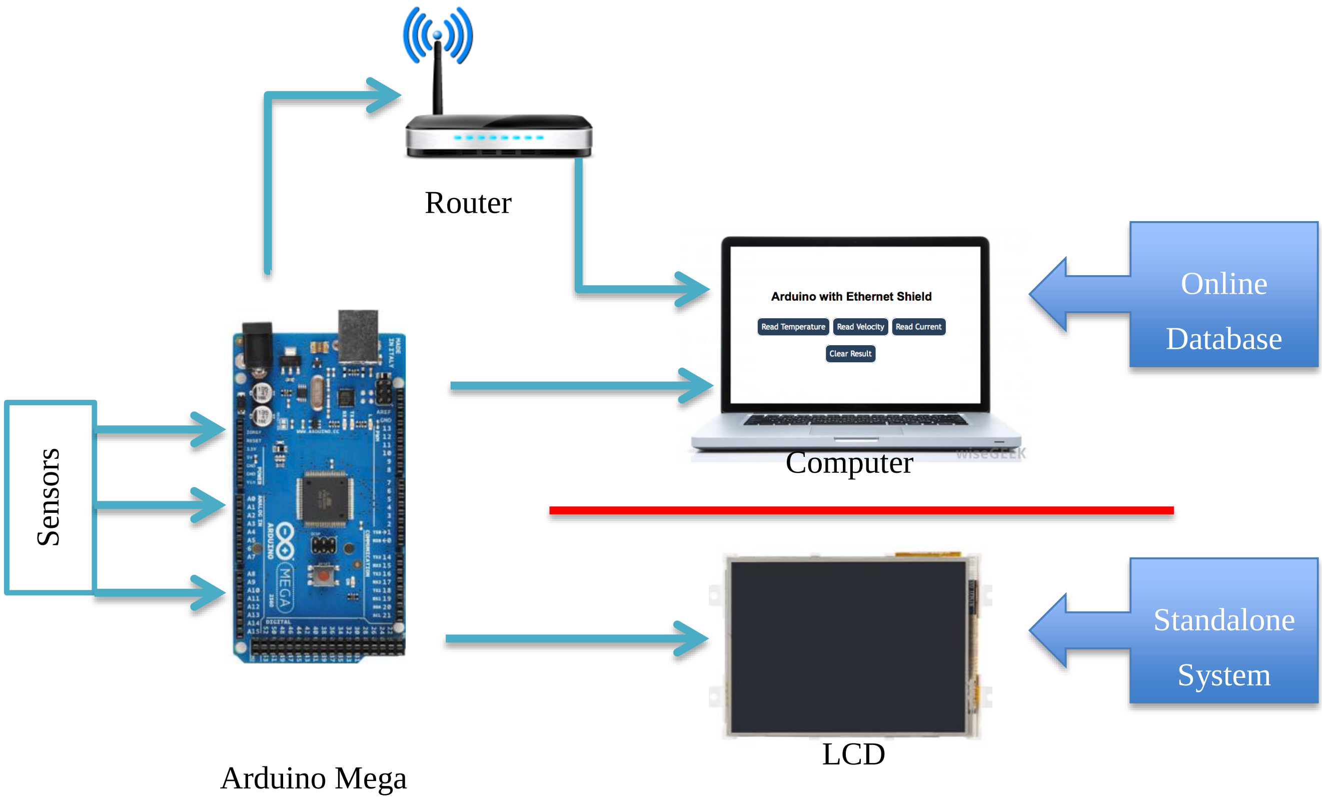


Figure 3: DAS framework for SCIEDAS

4.2 Selections of Specific Components for DAS

As mentioned in the earlier chapter, DAS consists of sensors, measurement hardware and a monitoring screen with programmable software. Hence, Different components were selected. The designing specifications of each system are determined and are shown below. The schematic drawing of DAQ system is designed by using Fritzing project software.

No	**System**	**Components**
1.	Sensors	• Temperature sensor • Ultrasonic sensor • Voltage detector/ Current detector
2.	DAQ	• Arduino Mega • Ethernet shield
3.	Monitoring system	• Standalone system • Computer

Table 5: Selection of components for SCIEDAS

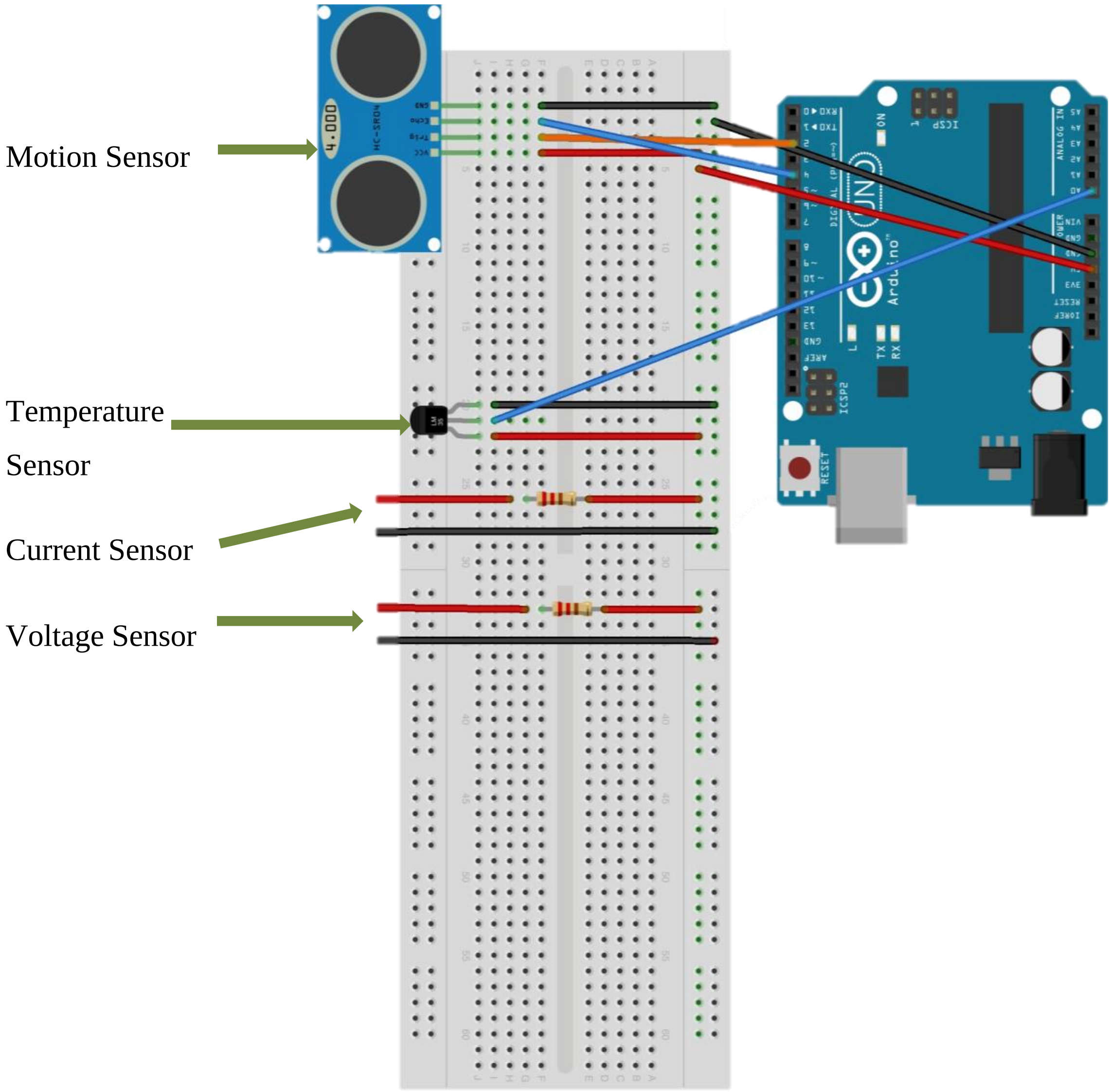


Figure 4: Schematic drawing for SCIEDAS

The figure above has clearly showed the schematic drawing for DAQ system. The hardware of the system is to be developed using an Arduino Mega microcontroller board based on Atmega256. There are four types of sensors being used in this project. Firstly, a waterproof temperature sensor, which is easy to connect, is used to ensure the temperature can be measured even in wet environment. Secondly, an ultrasonic sensor is used to identify the velocity of the moving object. Besides, a current sensor is used to sense the current flow of the electrical components. It is also used to measure the voltage value of a wire. Programming environment for Arduino is different with Python and LabView. The software used for development is Arduino IDE. Meanwhile, for easy access purpose, online database is implemented. Users can check the result online and analyze the graph easily.

4.2.1 Sensors

a. Temperature Sensor

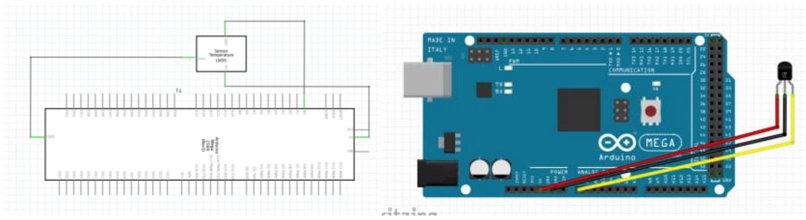


Figure 5: Circuit connection of Waterproof Temperature Sensor

DS18B20 is a digital measuring probe to allow user precisely measure temperatures in both dry and wet environment with a simple interface. The DS18B20 provides a configurable temperature reading over the interface, so the user can connect the wire and ground easily from the Arduino microcontroller board. This temperature sensor can measure the environment temperature from -35^{o}C up to 125^{o}C. It is chosen instead of using LM35 as students are need to measure the temperature of chemical substances in liquid form. Hence a waterproof temperature sensor, which can works perfectly in wet environment, is essential in this project.

b. Ultrasonic Sensor

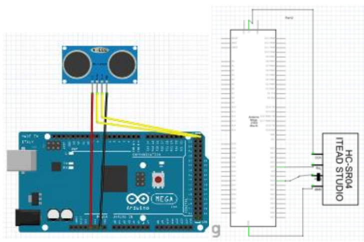


Figure 6: Circuit Connection of Ultrasonic Sensor

The motion sensor, HC SR-04 is used in this project. Ultrasonic transmitter emitted an ultrasonic wave in one direction. The timer is started to count when the wave is emitted and once it detects obstacles on the way, it will reflect the wave immediately to the receiver. Lastly, the timer will stop when it received the reflected wave.

The principle of ultrasonic distance measurement used the already-known air spreading velocity, measuring the time from launch to reflection when it encountered obstacle, and then calculate the distance between the transmitter and the obstacle according to the time and the velocity. Thus, the principle of ultrasonic distance measurement is the same with radar.

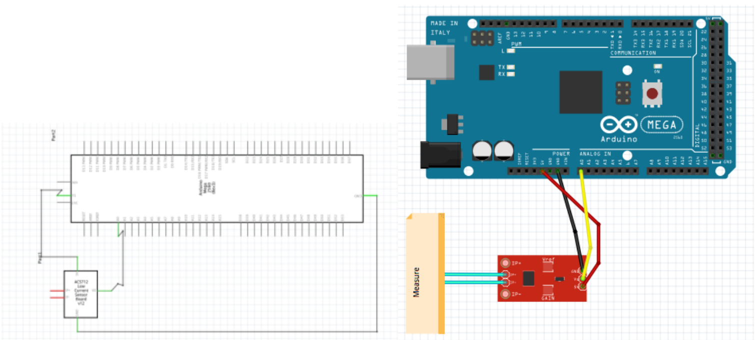
Distance Measurement formula is expressed as:

$$L_{Start} = C \times T_{Start}$$

$$L_{End} = C \times T_{End}$$

In the formula, L is the measured distance, and C is the ultrasonic spreading velocity in air, which is 340m/s, also, T represents time (T is half the time value from transmitting to receiving).

c. Voltage and current detector



In order to measure the value of voltage, the value is used as a voltage meter. The analog sensor on the microcontroller board senses the voltage on the analog pin and converts it into digital value so that it can be processes by the microcontroller. With this circuit, a voltage from 0V to 5V will flow into the board. The voltage and current will feed into the analog sensor can be calculated by: the equation as shown below.

$$V = IR$$

This current sensor gives accurate current measurement for both AC and DC signals. These are good sensors for metering and measuring overall power consumption of systems. The ACS712 current sensor measures up to 5A of DC or AC current. In this project, the current sensor is directly connected to the main controller board. It is useful for current measurement of electrical components such as resistors, conductors, diodes and so on.

4.2.2 Data Acquisition Device - Arduino Mega

Figure 7: Arduino Mega

Arduino Mega is chosen in this project as it is a user friendly USB programmable Microcontroller. It is open Source design based on the larger ATmega2560 It consists of 54 digital I/O Pins and 16 analog I/O Pins which is more than with Arduino Uno. The 256 KB of Flash Memory, 8 KB of SRAM, and 4kB of EEPROM enable user to store more memory into the chip and has a better performance. Its clock speed is 16 MHz.

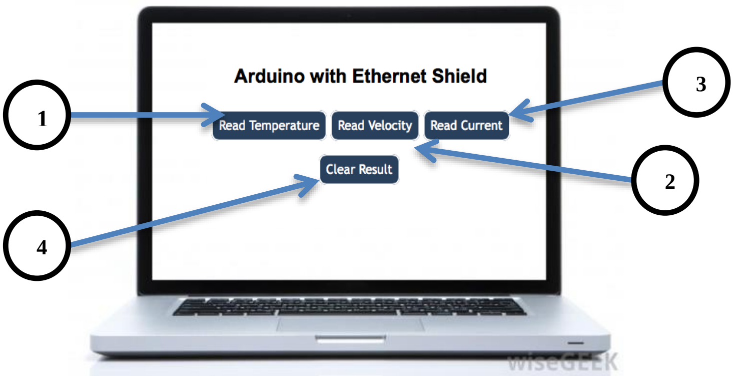
4.2.3 Monitoring System

i. TFT LCD with Touchscreen

Figure 8: TFT LCD with touchscreen

The standalone system of this project consists of a LCD. This display has a controller built into it with RAM buffering. The four wire resistive touchscreen display can be used in two modes: 8-bit and Serial Peripheral Interface (SPI). For 8-bit mode, 8 digital data lines is needed and 4 or 5 digital control lines to read and write to the display. SPI mode requires only 5 pins total, where SPI data in, data out, clock, select, and d/c) but is slower than 8-bit mode. In addition, 4 pins are required for the touch screen, which are 2 digital pins and 2 analog pins.

ii. Computer



No	Button
1	Read Temperature
2	Read Velocity
3	Read Current
4	Clear Result

Figure 9: Home screen of SCIEDAS software

4.3 Experiments and Testing

In order to test the accuracy of the project, experiment on measuring the temperature of Naphthalene is carried out.

4.3.1 Procedure

The experiment is conducted as structured below.

1) Apparatus is set up.

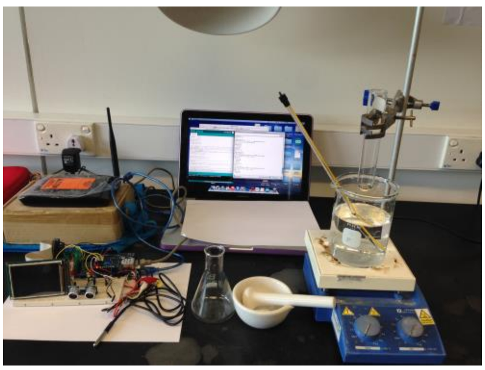


Figure 10: Apparatus set up

2) SCIEDAS and thermometer are placed inside the boiling tube.

Figure 11: A thermometer and Temperature sensor of SCIEDAS is put inside the boiling tube

3) A tablespoon of Napthlene is poured inside the boiling tube and heated until $60^{o}C$.
4) The value of thermometer is recorded and tabulated every 30 seconds.
5) Compare the results of the both instrument.

4.3.2 Results and Discussion

Thermometer

The table below shows the value gained in the experiment by using thermometer.

Time (second)	Temperature (oC)
0	60
30	63
60	63
90	65
120	68
150	70
180	72
210	75
240	76
270	77
300	78
330	78
360	78
390	80
420	84

Table 6: Tabulated Data of Thermometer

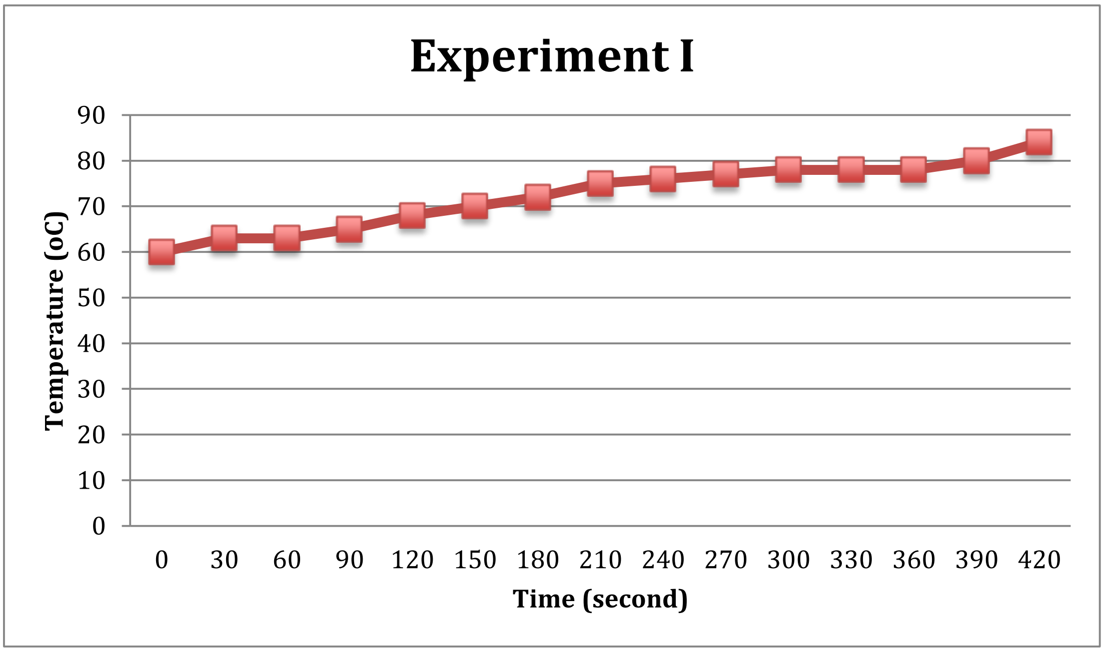


Figure 12: Graph analysis of thermometer

By using a thermometer, it is hard to observe the melting point of the napthelene. Besides, the graph plotted is not accurate, as the time value taken is 420 seconds only.

SCIEDAS

Users are allowed to gain their results from browser after they finished the lab. Figure 11 shows the home screen of the SCIEDAS. It is created to store database by using MySQL, which is the most popular database management system, XAMPP. Hence, it is very useful for this project.

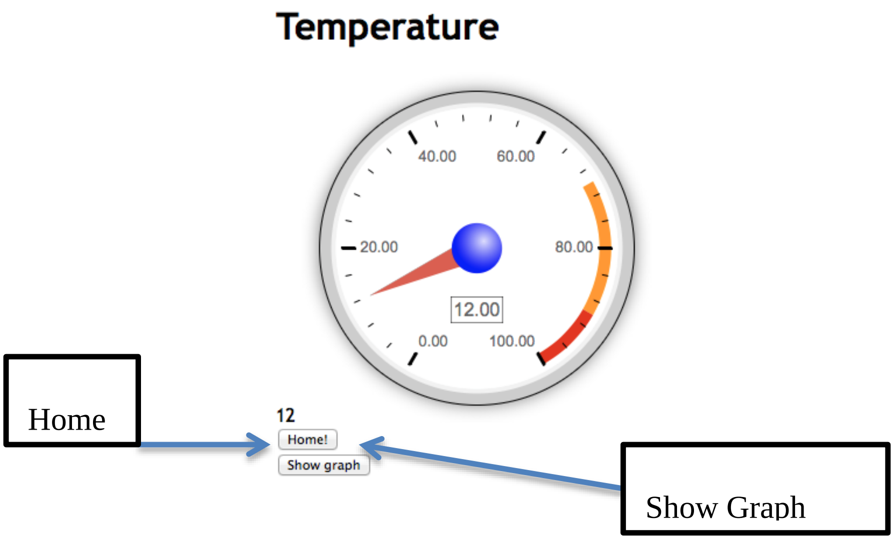
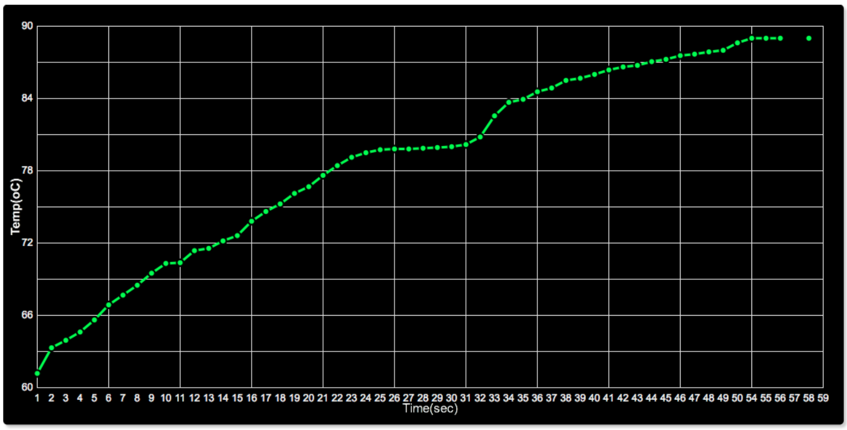


Figure 11: Temperature Gauge for Experiment I in SCIEDAS

By pressing the Read Temperature button at the home screen, users are direct to the next page which is Temperature Gauge to show the current value of the sensors. Users can go back to home screen by clicking Home button and get the graph by clicking the Graph button.

The figure below shows the graph and values obtained from the temperature sensor in table form.

Temperature



« Back

Figure 13: Graph Analysis of Experiment I in SCIEDAS

SCIEDAS Temperature Log

No	Time	Temperature in Celsius
1	0	61.18
2	30	63.31
3	60	63.93
4	90	64.62
5	120	65.62
6	150	66.87
7	180	67.68
8	210	68.50
9	240	69.50
10	270	70.31
11	300	70.37
12	330	71.37
13	360	71.56
14	390	72.18
15	420	72.62
16	450	73.81
17	480	74.62

Figure 14: Tabulated data for Experiment I in SCIEDAS

4.4 Conclusion

It is clearly showed that the result gained from SCIEDAS is more accurate than using a thermometer. The temperature maintained at 78^{o}C for SCIEDAS where the napthlene is at solid-liquid state. However, by using a thermometer, the temperature gained at that stage is unstable, which ranged from 75^{o}C to 77^{o}C. The value is not accurate as compared with SCIEDAS. Hence, user can gets the temperature values and graph in an easier way.

Chapter 5
Conclusion and Recommendation

5.1 Conclusion

The impactful effect of this project will obviously towards education. If this hardware can be fully develop into not just only measuring temperature but also monitoring the current value and voltage value, students, teachers as well as school will be beneficial from this project. Even though, there is certain cost needed to pay, it can be ensure that using hardware will less likely cost higher than developing software. Besides, this project helps teacher to let students feel engage to science subject. By using the current technology of DAS, students can conduct interactive science experiments and activities where they can simplify the science concepts and discover theory based on the experiment. As this project provides students tools to explore, it can ensure that they will not lose interest while doing the experiments.

From the course, this DAS project opened peoples' eyes to see any other aspect from other area or fields that engineering knowledge can be applied to reduce the burdens of that particular problem. Developing software or hardware both required engineering knowledge, as for example, to measuring server room temperature also require the knowledge about the components itself before any hardware prototype can be fully develop.

5.2 Recommendation

As a recommendation, while stopwatch is required for every science experiment; in future work expansion, it is suggested to enhance the DAS functionalities by implementing more features like a build in stopwatch. This is to monitoring the total time used during doing the experiment using the DAS. Besides, it is in the consideration that some targeted users might not be familiar with the DAS. In order to reach free and easy fulfillment for the users, it is recommended to write user manual to explain how to use the DAS hardware and software.

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Appendix

Student performance in creative problem-solving (2012)

	Mean score in PISA 2012	Share of low achievers (below Level 2)	Share of top performers (Level 5 or 6)	Gender difference (boys - girls)
OECD Average	Mean score	%	%	Score difference
	500	**21.4**	**11.4**	**7**
Singapore	562	8.0	29.3	9
Korea	561	6.9	27.6	13
Japan	552	7.1	22.3	19
Macao-China	540	7.5	16.6	10
Hong Kong-China	540	10.4	19.3	13
Shanghai-China	536	10.6	18.3	25
Chinese Taipei	534	11.6	18.3	12
Canada	526	14.7	17.5	5
Australia	523	15.5	16.7	2
Finland	523	14.3	15.0	-6
England (United Kingdom)	517	16.4	14.3	6
Estonia	515	15.1	11.8	5
France	511	16.5	12.0	5
Netherlands	511	18.5	13.6	5
Italy	510	16.4	10.8	18
Czech Republic	509	18.4	11.9	8
Germany	509	19.2	12.8	7
United States	508	18.2	11.6	3
Belgium	508	20.8	14.4	8
Austria	506	18.4	10.9	12
Norway	503	21.3	13.1	-3
Ireland	498	20.3	9.4	5
Denmark	497	20.4	8.7	10
Portugal	494	20.6	7.4	16
Sweden	491	23.5	8.8	-4
Russian Federation	489	22.1	7.3	8
Slovak Republic	483	26.1	7.8	22
Poland	481	25.7	6.9	0
Spain	477	28.5	7.8	2
Slovenia	476	28.5	6.6	-4
Serbia	473	28.5	4.7	15
Croatia	466	32.3	4.7	15
Hungary	459	35.0	5.6	3
Turkey	454	35.8	2.2	15
Israel	454	38.9	8.8	6
Chile	448	38.3	2.1	13
Cyprus*	445	40.4	3.6	-9
Brazil	428	47.3	1.8	22
Malaysia	**422**	**50.5**	**0.9**	**8**
United Arab Emirates	411	54.8	2.5	-26
Montenegro	407	56.8	0.8	-6
Uruguay	403	57.9	1.2	11
Bulgaria	402	56.7	1.6	-17
Colombia	399	61.5	1.2	31

Source: 12 OECD, PISA 2012 Database, Tables V.2.1, V.2.2, V.2.6, V.3.1, V.3.6 and V.4.7.

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Figure : Students' performance based on PISA research