Bringing IoT into Classroom

STEM X IoT

STEM:
- mainstream of science education
- unleashing student potential in innovation, design and application

IoT:
- rapidly emerging as the next generation communicating infrastructure
- a network of devices connecting to the internet
- allows physical entities and phenomenon to communicate with one another. Then, the collected data and information are connected to the Internet.

Project Introduction

Meeting the needs

Community partner: Sheng Kung Hui Lui Ming Choi Secondary School
Targeted group: Form 2 and 3 students
Needs: students could be exposed to STEM workshops that have more technology and engineering elements incorporated + have high relevance to students' daily life.

Our project

- Incorporate IoT-based learning framework into STEM education
- Present the problem: **how could students be counted automatically to reduce the workload of the teacher?** construct a device: "Electronic Prefect"
- Conducte a 2-stages STEM workshop, around 4 hrs each

Expected outcomes:
Science: circuit (voltage, ohm, current)
Techonology: Internet, programming, coding, database
Engineering: microcontroller, sensor
Mathematics: counting of student entry, optimal height for the placement of sensor in a door
Attitudes: curiosity + interest in science and the technological world.

Limitation and Difficulties

Environmental Limitations

(a) Resources management during IoT workshop

- **Inadequate supply** of materials (**cost estimation**)
our solution: **one set of materials** allocated to each group, while each student took turn to become the group leader and designed the steps to proceed only after constructive group discussion and consent

- **Inefficient technical support** from community partner (E.g. no wifi provided for IoT device and transmission of data after programming and coding)
our soluation: only introduced the theoretical concept and mechanism of IoT at the end of 1st workshop, but left the practical issue for students

(b) Time management during IoT workshop

- Students **consumed much time** than expected to master skills of writing sophisticated IoT programmes and long codes in the first workshop
our solution: multiple workshops (3 in total) with introductory / warm-up section (around 15 minutes) at the beginning of workshop with flexible progress (e.g. demonstration before hand-on practice)

- **Student's unfamiliarity** towards micro:bit and coding
our solutions: (1) provided **written instructions** (i.e. annotated cookbook) and oral guidance simultaneously; (2) divided students into **4 groups** (4-5 students per group) according to their technical abilities, and encouraged group discussion among high and low achievers; (3) **post-workshop evaluation** to assess whether learning diversity prevails and whether learning objectives (e.g. enhancing practical awareness of STEM) fulfilled

Project-specific Limitations

Accuracy of measurement

- **Unfamiliarity** towards the **effective sensing distance**
our solution: **determined the optimal point** to place the sensor apart (i.e. 20-25 cm maximum) by experimental trials for several times to draw a conclusion

- **Innate defect** of (a) counting underestimation for two students entering at the same time with same pace / (b) counting overestimation for students leaving and re-entering during the counting period **our solution:** students were advised to **fine-tuning the device** in addressing practical situation (e.g. two sensors and two infrared reference lines)

(b) Attributes of the target group (i.e. students to be counted)

- **Distinctive body shape** of students
our solution: **lengthened the effective sensing distance** (e.g. increase the wire length) to reach the minimum spacing required for a single student to enter the classroom

Design Rationale

Workshop design

Cooperative teaching

During the workshops, students divided into five groups. This way allows them to learn collaboratively. When they got problems or difficulties, they can try to find solutions within the group, learning from groupmates.

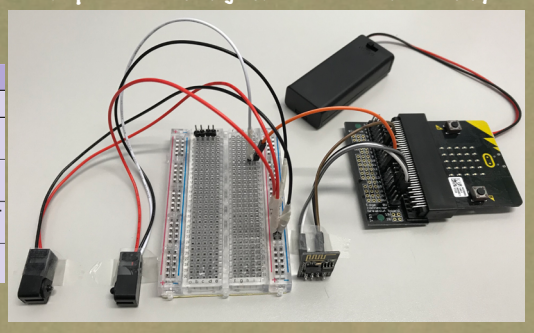
Scaffolding

When designing the content of the workshops, we will introduce the basic background, Micro:bit function, and simple programming activities. After students grasp the basic knowledge and concepts, they can use these concepts to develop more complex programmes and concepts. This approach allows students to learn effectively and systematically.

Generalisation and assimilation

In the 1st workshop, it is based on the introduction and explanation at the theoretical level. After that, we hope to let participants truly apply the concepts they learned in the 2nd workshop for building the device in reality.

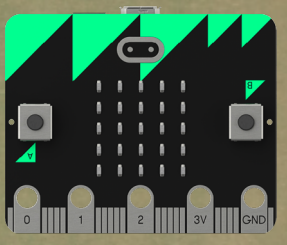
First workshop	Second workshop
Introduction of Micro:bit	Introduction of IoT
Basic of circuit and sensors	Basic of using WiFi module in Micro:bit
Writing the programme using Makecode Editor	Introduction of IFTTT
Using Micro:bit to control sensors through programming	Integrating Micro:bit and IFTTT through WiFi
	Testing of students' final products



Product design

"Electronic Prefect" as one of the use case of IoT in classroom:
- Automatically count the number of students inside the classroom
- Send the number to cloud services (e.g. Google Sheet, Telegram) for notifying the teachers (Teachers can acknowledge how many students inside the classroom without doing the roll call!)

Our design philosophy: Learning the CONCEPTS is more important than Learning a TOOL!



BBC Micro:bit as the core of the "Electronic Prefect"
- Simple but elegant microcontroller specialized for STEM education
- Built in LED display and several sensors to play with

Easy-to-build
- Only 3 electronic components with simple circuit are required
- Included Micro:bit for controlling, infrared sensor for detecting and WiFi module for sending

Easy-to-program
- Microsoft Makecode editor (Block-like editor) is used
- Drag and drop the blocks to write a program, NO coding is needed
- Our own PXT package for controlling the WiFi module

Wrap ALL codes needed to control the WiFi module for students keep using a block-like way to control it

IFTTT for connecting Micro:bit and Web services
- Famous free web-based service provides applets creating to carry IoT applications
- Signing up IFTTT service is much easier than setting up a server
- Linkage "Electronic Prefect" to Google Sheet for storing (as a database) and Telegram for sending messages to teachers

Group Reflection

This project is a real eye-opener for all of us, especially for those who are novices in IoT and Micro:bit. We all have broadened our horizon, both cognitively and pedagogically. Cognitively, we learnt how to operate the renowned coding system, Micro:bit and the term, IoT, which were unfamiliar to most of us. We attempted to integrate the people counting programme with the application of the principle of IoT for optimizing the efficiency of the attendance taking process. Pedagogically, we gained the first-hand teaching experience in a secondary school. It was quite challenging for those who are not studying the discipline of Education. With our ultimate teamwork and cooperation, the workshop turned out to be smoother and more effective than what we had expected as evidenced by the students' feedback. There is a saying, "Two heads are better than one". While we come from different university disciplines, with similar interests, the combination of our unique quality and competence does produce a wonderful synergy effect. As a group, all of us are indistinguishable crucial pillars. Upon completion of the U-STEMist Scheme, we wish to continue maintaining our friendship and contribute our effort to a more STEM-oriented learning environment and society.

Conclusion and Recommendation

This project proves that IoT could be integrated into classroom under this ever-changing technology-driven world. Our design of "Electronic Prefect" is indeed only one application in the prodigious pool of possibilities. More classroom investigations could be conducted by adopting the IoT principle in the foreseeable future. We have two recommendations: (1) conducting project-oriented teaching for students to allow them to think and create their own IoT device with teachers' aid in hardware and software suggestions; (2) encouraging students to think outside the classroom: how to make smart device that could facilitate daily life circumstrances?