Teaching with Hardware (MicroPython & BBC micro:bit)

Integration of hardware into primary and secondary education in order to motivate students

Mission

Introduce such activities into computing lessons at primary and secondary schools, which will familiarise students with interesting applications of programming and information technologies, thus motivating them in developing their digital literacy.

Goals

- Encourage all students in improving their computer skills, not only those, who plan a career in IT. The main purpose is not to increase numbers of people working in IT, but to improve digital literacy of kids which plan to study a field other than IT by learning them basic concepts of programming, hardware, protocols and their applications in different fields. This knowledge is useful for most professions, basic concepts of automation and programming are often used for example by accountants, architects, projectants, data analysts, scientists, and many others.
- Encourage students' algorithmic and logical thinking.
- Extend students' knowledge on information systems in context with how different subsystems work, in order to better understand concepts such as *Smart Cities* or *IoT* (Internet of Things).
- Activities with hardware are not supposed to replace currently taught topics, on the contrary, hardware is a tool which can be combined with currently taught topics and make them more enjoyable and captivating. Educational hardware can, for example, be combined also with computer graphics.
- Encourage experimenting with hardware and software in kids and lead them to better problem solving capabilities, including through inter-subject projects.

Why is it important to increase digital literacy

Currently, almost all professions rely of information technologies and electronic devices. In order to use them correctly, effectively and in a safe manner it is necessary to understand the basic principles behind them, which should be taught and computing lessons in schools. Thanks to knowledge of these principles, students will be able to store their private data more securely, deal with "the WiFi is not working" problems and last but not least use basic programming to automate repetitive computer work.

Despite the increasing usage of technologies in everyday life, the necessity to educate about them has not yet been reflected into computing lessons. According to *National report of PISA testing 2012* slovak students score significantly lower in digital literacy compared to the OECD average. Furthermore, the *PISA 2015* testing found that slovak students have worse results in team problem solving compared to the OECD average.

How we want to accomplish our goals

By combining both hardware and software we can create stimulating and interesting projects. Additionally, these projects often have a practical use in everyday life, such as creating creating an intelligent household, house alarm, automated garden irrigation system and many more. Students will gain new knowledge about technologies and simultaneously make use of it whilst developing their projects.

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What are Python and MicroPython? Why use them?

Python is a popular and comprehensive programming language which is also recommended for beginner programmers. This is why we can see an increase of it's usage at schools. Python is heavily used by companies such as Google, the European Organization for Nuclear Research CERN, social networks, including Facebook, Pinterest and Instagram, and also on programming lessons lessons at MIT.

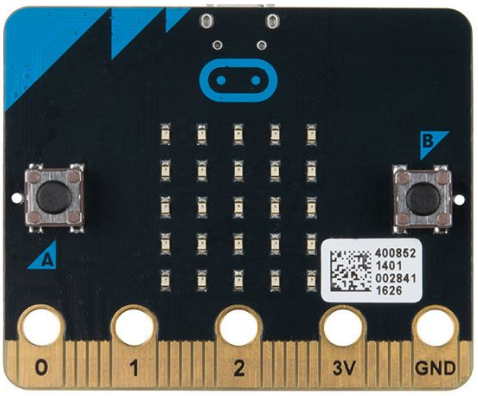
MicroPython is a modified version of Python capable of running on low power devices. Hence, we can use MicroPython to program electronics to interact with the surrounding environment thanks to additional components, such as LEDs, sensors, motors, buzzers, etc. These devices are significantly cheaper than computers for classic Python. The most important fact about MicroPython is that teachers and students can use the same language for both software programming and physical computing.

Where we gained our inspiration

In 2016, the BBC gave away almost 1 million educational boards called *micro:bit* to 11 year old students across the UK. During the first few months of the project 85% of asked teachers agree that it has made ICT/Computer Science more enjoyable for their students and 90% of asked students agree that BBC micro:bit helped to show them that anyone can code. A high increase in motivation to study ICT/Computer Science was found. This was even more accentuated for girls, increasing from 23% before they used BBC micro:bit to 39% afterwards, a 70% increase. Half of teachers who've used the BBC micro:bit say that they now feel more confident as a teacher, particularly those who say they're not very confident in teaching Computing.

What hardware will be used?

The pilot project plans to make use of the educational physical computing board called *BBC micro:bit*, mainly because of its specific design for education. The board can be programmed to interact with external devices, such as LED strips, buzzers, motion sensors, temperature sensors, and so on. Some students may be interested in programming robotics (line followers, robotic mechanic arm, etc.). During the second phase of the project, more advanced physical computing modules, such as the NodeMCU which contains an onboard WiFi interface, will be introduced to junior and senior students at high schools.



BBC micro:bit (Source: SparkFun)

1. Phase - Pilot Project

During the first phase of the project we will supply 5 schools with the needed hardware and educational materials in order to develop further materials and test the concept of teacher cooperation. All involved schools will access all of the activities and write detailed feedback. We hope to run the pilot project during the summer term of 2018. Afterwards, a detailed evaluation of the gained feedback will take place and new materials will be prepared for autumn 2018, when we expect more schools to join the program.

Further steps

After the pilot project we expect to create two sets of educational materials - one for the BBC micro:bit (airmed at primary schools) and one for the NodeMCU platform (aimed at high school students). Both will make use of the MicroPython language and both will be maintained in an online form, continually updated also by students and teachers using them.

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Educational materials and finances

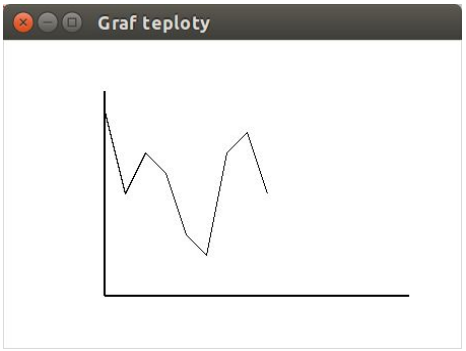
All created educational material will be published under an open licence on the project website www.microbit.sk free to use by anyone. The only necessary expense for schools is the cost of hardware components. Those are financed either from the schools budget, or by external school sponsors. The civic association SPy (Slovak Python User Group) gives advice in buying this hardware and how to implement it into computing lessons.

Time complexity for teachers

The projects strives to minimize the amount of time which the teacher has to spend preparing for the lessons and therefore we advise that most of the work should be done during the lessons together with the students. Teachers are expected to have at least a basic knowledge of Python, however, no hardware background is required and teachers are advised to learn together with their students. This way, the whole lesson will be more open to experimenting and learning by doing.

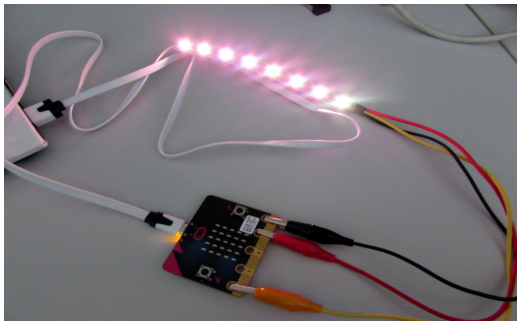
Examples of hardware projects which will be created by students

Computer Graphics - Drawing a Temperature Graph



This project uses a digital temperature sensor connected to the BBC micro:bit which will measure the air temperature. That will be sent via a USB cable to a computer, where a simple Python3 application will draw the temperature graph, using the standard graphical library `Tkinter`. The user interface and the hardware can be further developed to download weather forecast from the internet, add a humidity sensor, a light sensor, a rain sensor to create a home weather station.

Cycles on a LED strip



Neopixel LED strips are special types of LED strips, on which we are able to set individual light colour and intensity for each LED. Thanks to this, we can visualise `for` and `while` cycles and create light animations. Individually addressable LED strips can have multiple forms, from LED strips to matrixes and christmas chains.

Project coordinator

The project is coordinated by the civic association SPy, which is also the organizer of the annual international conference PyCon Slovakia and Python meetups in Bratislava. The conference includes a special track for teachers and educators - EduTrack - which tries to present teachers with the newest trends and possibilities in teaching programming. To support these activities the association organized oved 11 hardware workshops with MicroPython for teachers, students and general public during the year 2017.

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