

Use of educational hardware and software to encourage children to code

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Motivation

Primary and secondary computer education nowadays requires modern aids to be included throughout the educational process.

- The purpose of these aids is to encourage children to code, to be more interactive, and to express their creativity.

A new class of computing devices, called Single Board Computers (SBC) are tools that can help achieve the modern educational requirements as critical thinking, problem solving, creativity, interaction etc.

The main idea here is to present a short survey of educational programmable hardware systems.

- In our case study, we want to point out the benefits of SBC and their impact on the education process.

In order to evaluate the benefits of educational hardware will be carry out a questionnaire for the teaching staff in two primary schools.

Introduction

There are many initiatives, projects, communities, and foundations which are committed on design educational hardware and software.

- The idea is to encourage children to code with the use of robots and other programmable hardware platforms.
- The hardware board have a processor, sensors, USB connectivity and additional modules and accessories.

Educational software is customized for children of different ages with or without technical pre-knowledge to programming.

- The educational platform can be programmed on high level programming languages or by visual drag-and-drop block editors.

By using this educational aids children can work on many different and interesting problems and immediately to feel the benefits from their work.

- With this approach it will increase the interest, curiosity, concentration, creativity, and many other crucial personal development qualities.

Single Board Computers

As the name itself tells us, Single Board Computers (SBC) is a complete computer built on single circuit board, with:

- Microprocessor, memory, input/output (I/O) and other additional features required of a functional computer.

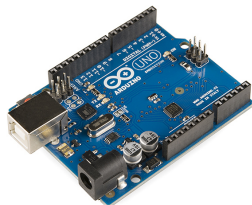
Microprocessors consist of only a CPU, and has surrounding chips that support various functions interaction with memory, interfaces, and I/O.

Will be briefly introduce the most popular and widespread educational hardware.

- Arduino, BBC Micro:bit, Calliope mini.
- Will be present their basic characteristics as well the most important features.

Arduino is an open-source, hardware and software company, develops and manufactures single-board microcontrollers and kits set

- The boards are Atmel 8-bit AVR, ARM Cortex-M or Intel Quark based with flash memory, pins, and features.
- They are equipped with sets of digital and analog I/O pins that can be connect to various expansion, modules, and etc.
- The boards contain serial communication interface among them USB which are used for loading programs.
- C/C++ programmed, using a standard API (Arduino language).
 - Arduino provides open-source IDE and web editor.



Micro:bit

The Micro:bit is open source educational hardware created by the BBC and the collaborators for computer education use in UK.

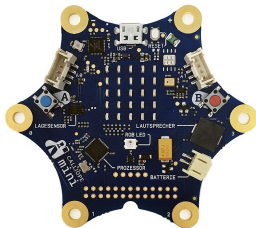
- The boards are based on ARM Cortex-M0, with flash memory, SRAM, 3V power supply, accelerometer and magnetometer sensors, connecting interfaces Bluetooth and USB, two programmable buttons, 25 LEDs display, and five ring I/O pins connectors.
- Can be programmed by Python, JavaScript, C++, Pascal and ect.
- There are two official code editors:
 - Microsoft MakeCode (visual block-based) and MicroPython they can run as a web application.



Calliope mini

Calliope mini is a tiny SBC developed for educational usage at German primary schools.

- The board are based on Micro:bit with ARM Cortex-M0, flash memory, RAM memory.
 - With additional components such as a loudspeaker, microphone and RGB light-emitting diode, two Grove connectors, extended I/O options.
- Can be programmed in C++, JavaScript, Python and etc.
- There are several editors that can run as web applications or as desktop editors.
 - The visual development software includes Scratch, Microsoft MakeCode and etc.



Analysis on Single Board Computers

The mentioned devices are chosen for analysis because of their predefined purpose.

- These devices are specially designed computing educational platforms which are intended for the youngest population.
- Each of the representatives have their strengths and specific characteristic.

For analysis purposes, will be consider different categories to evaluate and compare the chosen Single Board Computers.

- To have a more general and efficient analysis there will be considered several main categories as software, safety use, range of applications, development tool kit sets, study documentation as guides, books, tutorials, or videos.
- The comparation will be made upon the officially available hardware, software tools and documentation.

The intention here is not to make strict conclusion for the best educational SBC but rather to present general conclusions.

Tabular SBC analysis

SBC Categories	Arduino	Micro:bit	Calliope
Software	Intended for students (basic knowledge)	Intended for children (beginners)	Intended for children (beginners)
Compactness and safety use	Various board with different shape and sizes	Credit card size	Shape of a star for safer use
Tool kit sets	Wide range of different tool kit sets	Starter set with additional accessories	Starter set with additional accessories
Range of applications	Wide range of education, home and cheap industrial - scientific application	Wide range of educational application	Wide range of educational application
Study documents	Various study materials intended for students	Various study materials intended for children	Various study materials intended for children
Simplicity of use and understand	Requires certain knowledge	Easy to use and comprehend	Easy to use and comprehend

It is important to note that according to the analysis Arduino boards are for more advanced applications.

- These boards are intended for users with prior knowledge about programming languages and hardware.

The general conclusion about the other two SBCs is mostly the same.

- Both are designed and developed for use in computer education, and they are intended for primary school students.

Teaching staff questionnaire

With the support of British Council under the program “21st Century Schools” there was an online course, Micro:bit Basics for Teachers.

Apart of this, there was an internal training for the teaching staff in secondary schools OOU “Dedo Iljo Maleshevski” and OOU “Nikola Petrov Rusinski” in Berovo.

This was a good reason to carry out a questionnaire for the teaching staff that attended the training.

- The main aim of the results of this questionnaire is to obtain an assessment of the Micro:bit for their possible use in the educational process.

The questionnaire contained fifteen questions with multiple possible answers.

- The number of teachers that participate in this questionnaire are 24.

Micro:bit questionnaire for teachers, part I

1. Do you think that students are interested to embrace new innovative learning methods that include modern aids?					
Answers	Yes, the most of them		Yes, but only a few in a class		No, they are not interested
Results	11 (45.83%)		12 (50%)		1 (4.16%)
2. Do you think that the way in which you are teaching influences on students' motivation?					
Answers	Yes, it is crucial		Yes, but not always		No, the method is not important
Results	9 (37.5%)		14 (58.33%)		1 (4.16%)
3. How often do you use different teaching methods that include modern aids?					
Answers	Very often		Not very often		Never, I prefer traditional teaching
Results	5 (20.83%)		16 (66.66%)		3 (12.5%)
4. How often do you use a computer or other educational electronic device in a classroom when you are teaching a new unit?					
Answers	Always, when the unit allows	Not very often		Not very often, due to limited aids disposal	Never
Results	9 (37.5%)	8 (33.33%)		6 (25%)	1 (4.16%)
5. Are you willing to embrace the use of education aids such as Micro:bit in your classes?					
Answers	Yes, always when the aids are suitable		Yes, but rarely		No, there is no use of this types of aids
Results	14 (58.33%)		6 (25%)		4 (16.66%)
6. Do you think that use of Micro:bit will encourage/motivate students to code?					
Answers	Yes, all will be encourage/motivate		Yes, but only few of them		No, it will not make the difference
Results	9 (37.5%)		13 (54.16%)		2 (8.33%)

Micro:bit questionnaire for teachers, part II

7. Will you motivate students to use Micro:bit?			
Answers	Yes, very often	Yes, but rarely	No
Results	11 (45.83%)	11 (45.83%)	2 (8.33%)
8. Do you think that Micro:bit is simple for using and coding?			
Answers	Yes, it is simple	Yes, but for a certain group	No, it is complicated
Results	9 (37.5%)	13 (54.2%)	2 (8.3%)
9. Do you think that Micro:bit can helps you to improve and enrich the teaching plan?			
Answers	Yes, it will improve and enrich the teaching plan	Yes, but will takes me a long time than the usual planning	No, will not improve the process of planning
Results	5 (20.83%)	14 (58.33%)	5 (20.83%)
10. Do you think that with Micro:bit will be increase communication between students and increase your cooperation with students?			
Answers	Yes, will able to increase communication and cooperation	Yes, but will depends from the personal characteristic	No, doesn't increase communication
Results	8 (33.3%)	13 (54.2%)	3 (12.5%)
11. Do you think that use of this type of educational aids as Micro:bit can increase building and improve personal characteristics and skills as curiosity, concentration, creativity, communication, teamwork, etc.?			
Answers	Yes, I agree	Yes, partially agree	No. I disagree
Results	10 (41.66%)	13 (54.16%)	1 (4.16%)
12. Do you think that students who are usually passive on classes can be encouraged to be more active with additional aids as micro:bit?			
Answers	Yes, always	Yes, depends on the type of the unit, or the given task	No, the passive students are passive
Results	6 (25%)	15 (62.5%)	3 (12.5%)

Micro:bit questionnaire for teachers, part III

13. Do you think that you will need more time for preparation if you want to use the Micro:bit in your class?			
Answers	Yes, always independently of the lesson	Yes, but depends on the lesson	No
Results	10 (41.7%)	14 (58.3%)	/
14. Do you think that in general there will be benefits from using Micro:bit as additional aids in the educational process			
Answers	Yes	Yes, but not particularly	No
Results	10 (41.66%)	10 (41.66%)	4 (16.66%)
15. Would you like to recommend the Micro:bit to your colleagues?			
Answers	Yes, very often	Yes, sometime	No
Results	8 (33.33%)	15 (62.5%)	1 (4.16%)

According to the results, there is mostly a positive opinion for the need of innovative approach, but availability of educational hardware and aids leads to limitations.

The results lead to the general conclusion that use of such educational aids has a great potential to improve the educational process.

Conclusions

Here is presented general description of educational hardware aids as SBC.

An analysis has been made on the advantages and disadvantages of all presented educational SBCs.

We discussed the benefits from it and the improvements that it can apply on the educational process.

A questionnaire was carried out to assess teachers' opinion concerning the possible use of Micro:bit in the education process.

The questionnaire results give a general picture of the opinion of the teachers concerning the benefits and positive practices of the use of educational aids like Micro:bit.

