The BBC micro:bit in Slovakia

Nika Kvaššayová
Department of Informatics
Faculty of Natural Sciences
Constantine the Philosopher University in Nitra
Nitra, Slovakia
nika.kvassayova@ukf.sk

Marek Mansell
Faculty of Informatics and Information Technologies
Slovak University of Technology
Bratislava, Slovakia
marek.mansell@gmail.com

Martin Cápay
Department of Informatics
Faculty of Natural Sciences
Constantine the Philosopher University in Nitra
Nitra, Slovakia
mcapay@ukf.sk

Magdaléna Bellayová
eTeacher o.z.
Štefánikova 57
Nitra, Slovakia
magdalena.bellayova@pycon.sk

Abstract—**Physical computing allows students to develop concrete, tangible products of the real world. This can motivate them to fully open their imagination and provide them access to the different topic areas, not only computer science. The aim of this paper is to describe a project that spread the idea of physical computing among teachers and students in Slovakia. We think that the BBC micro:bit has a great potential to become a way to transform education, so our attention is devoted to this physical computing device. This paper also describes a grant for schools, the creation of supporting material for teachers, how webinars ran in a special virtual environment and analyzes the first contact questionnaire that gives us the basic information about the situation in primary and secondary schools.**

Keywords—microcontroller, microbit, programming, education

I. INTRODUCTION

The young generation likes things connected to the internet, like tracking and sharing their daily progress with the virtual community and they like the things that can adjust their parameters automatically according to their daily behavior. But how all these modern extensions really work is something unknown to them. We think that the one of the education goals should be to bring the teaching problems closer to their daily lives. The concept of things connected to the internet makes the learning process more interesting and interactive and with a greater impact on the cognitive process [1].

Many studies show the advantages of teaching programming with external devices instead of standard console-based applications. [2]. IoT-based projects have the potential to make a significant impact on the skill of engineering students as well as professionals working in hardware/software companies [3]. IoT projects consists of sensors (heat, pressure, light, accelerometer, gyroscope, motion etc.), wireless communication, LEDs and many more. Some of the sensor could be used for wearable technologies such as smartwatches, fitness trackers, VR. Students also enjoy projects with electrically conductive thread and needles [4].

But at the beginning a controller has to be chosen to manage processes, evaluate the sensors' data, and send the instructions to devices connected to it. Multiple controllers could be suitable, such the BBC micro:bit, Arduino boards, NODE MCU ESP32, ATtiny, Raspberry Pi, ARM STN, Adafruit Circuitmore. Each of them has preferred programming language, extensions, and sensors. All these boards are the ways to design real-world interconnection, the way how the hardware could interact with real people.

II. PHYSICAL COMPUTING

Physical computing consists of the inputs that represent the information from the environment, the outputs that represent the system's reaction and the processing that represent the system logic, the connection between the inputs and outputs. The last element of physical computing is the form that gives the meanings to all elements [5]. For example, a closed circuit as a complete path for current to flow could be implement as connecting a PIN with GND (ground). The project has the meaning if the close circuit concept is used as door alarm, reaction game, hot wire game or banana piano. There is another dimension of physical computing, the crafting and hands-on activities develop student's creativity. Using physical computing the problem solution become not only visible but also tangible, which makes the work meaningful [6]. The process of developing interactive projects bring us the presentation of several powerful ideas that can be used throughout the whole human life. On the other side we need to choose the correct projects, because many of them are fun and artistic, but may not be very helpful in demonstrating fundamental but non-obvious concepts such as variables, conditionals, or complex control flow [7]. Physical computing has impact on student's motivation, creativity, learning success, growth in competences and their understanding of computer science and computing systems [8]. The analysis results clearly show that physical computing has the potential to intrinsically motivate learners [9].

III. BBC MICRO:BIT

There is a growing interest in small programmable devices that can be used in schools and in extra-curricular contexts to teach computer science [10]. In 2013, the UK finalized a massive change in the ICT curriculum for primary and secondary schools, but as is often the case, the teachers were not properly prepared for it. That is why the BBC decided to aid the teachers by creating an easy to use yet powerful educational platform. In 2016, the BBC and a host of technical partners, including Microsoft, delivered such a physical computing device, the micro:bit, to every 5th grader in the UK [11]. In 2020 the second version was promoted. It contains a processor Nordic Semiconductor nRF52833 Nordic Semiconductor nRF52833 processor (512kB Flash, 128kB RAM), (512kB Flash, 128kB RAM), 25 GPIO Pins (4 dedicated), PWM, I2C, SPI, 10bit ADC, 2.4Ghz Micro:bit Radio / BLE Bluetooth 5.0, 200mA. We may program micro:bit temperature, sound, touch and magnetic fields (Fig. 1).

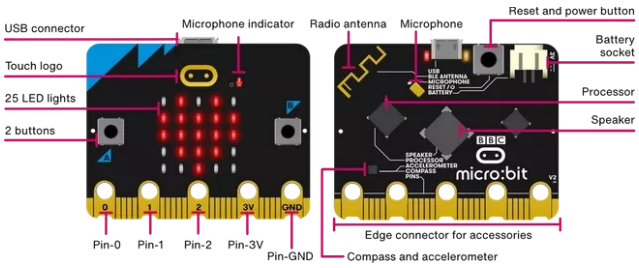

Figure 1. Educational starter kit [26]

The BBC micro:bit was developed directly for educational purposes and can be used at all levels of education. In primary school, we can carry out activities where we get pupils from a computer, where they program their own games [12]. They can even work together to create programs [13]. The block-based visual programming language Microsoft MakeCode is mostly used at primary schools and there is possibility to connect the micro:bit with Scratch. However, the advantage of the BBC micro:bit is that it can be programmed in the MicroPython language and C++ as well, which can also attract high school students [14][15]. By appropriate setting of projects, where students do not only program the project but also describe the progress, create video documentation, or present the project to the audience, we also develop the so-called soft skills [16]. The BBC micro:bit can be connected to expansion boards, which gives us the opportunity to add sensors to the motherboard [17], or even connect via WiFi to a cloud storage.

After the first year of use, teachers' and pupils' attitudes to programming have improved significantly [18]. The study in England proves that the motivation of the students was demonstrably higher, even for students who came from different backgrounds [19]. The positive attitude to BBC micro:bit was also among the students in Hungary [20]. After using the BBC micro:bit, the pupils from Nothern Ireland were able to link the issues that affect their own lives and how programming can potentially interact with their daily lives [21] and Danish teacher who do not have a technical education were self-confident using this small tiny device [22]. There are still more and more countries that try to find the correct way how to implement the BBC micro:bit in the educational process and Slovakia is one of them.

But when is the time to teach how to program the hardware project? We think that there is a huge gap among the young learners, so we need to demonstrate how the daily things works as soon as it is possible, the best way is to show it practically. The primary school is the place where we can start to motivate to think, to work, to teach programming more practically via the programmable hardware which is open for extensions. To fulfill our goals, we prepare a project directed to implementation of micro:bit to school education in Slovakia.

A. *Our „starter" kit*

Not all teachers are properly prepared to select suitable micro:bit components by their own. Therefore, the non-for-profit platform "Učíme s hardvérom" prepared own kit suitable for education supported by methodical material. This kit contains of (Fig. 2) 1x micro:bit V2, 1x USB cable, 1x battery holder, 2x AAA battery, 10x crocodile clips cable, 1x LED trip with 8 programmable RGB diodes and prepared crocodile clips cables, 1x speaker, 5x 5mm one color LED diodes, 5x resistors and conductive wire.

Figure 2. Educational starter kit [27]

This educational kit, as we will further explain in the following chapters, is used also during our webinars.

IV. ENTER PROJECT

The aim of the project is to develop and promote solutions that bring innovation in education and develop student's digital skills.

The ENTER project was officially launched in September 2020. The project is funded by the Slovak Telekom Endowment Fund. Multiple nonprofit organizations also participate in the project, mainly SPy (Slovak Python User Group), eTeacher, Aj Ty v IT and Pontis Foundation. [23]

B. *Activities of ENTER project*

To fulfill the project idea several activities directed at Slovak schools were prepared.

C. *Grant call*

In October 2020 teachers and schools could apply for up to 1000 €. The funds were earmarked exclusively for buying BBC micro:bits and micro:bit compatible extensions. 388 applications, which also included a detailed activity schedule, were submitted. The selection committee chose 243 projects that were supported and together 229 000 € was given to the schools.

D. *Digital library*

An important part of the ENTER project was to create open educational resources – written manuals as well as videos – so that both teachers and students can have access to step by step instructions for all kinds of micro:bit activities.

E. *Propagation*

The project's propagation can be divided in to two streams. The first stream was propagation among students, so that students would want to work with the BBC micro:bit. Multiple influencers and youtubers were involved, chiefly Slovakia's most popular youtuber GoGo alongside Patra Bene. They were showing how to use micro:bit in their videos. They had also other popular guests in their videos such as world cycling champion Peter Sagan. Other host were stand-up comedian, drum player, singer, or car racer. Each host has a small battle with a system controlled by micro:bit.

The second propagation stream targeted the general public and communicated micro:bit activities as well as the importance of digital skills. This was usually done by news coverage on television.

F. *Competition*

Several smaller micro:bit competitions were organized on the project's Facebook pages, however, the main ENTER Olympics competition was postponed to 2022 due to the COVID-19 pandemic.

G. *Consultants*

To provide teachers the best professional care, we established consultants for each project. Every teacher in the project had someone they could ask for help.

H. *Webinars*

We regularly organized free webinars for all teachers, o pen as well to teachers who did not participate in the ENTER grant call, which aimed to go through the work with micro:bit in detail and prepare them for teaching with micro:bit.

V. WEBINARS FOR TEACHERS

We planned on doing courses in person throughout Slovakia, where we would provide hardware, but due to COVID-19 we had to make them online. Even online courses - webinars could be helpful mainly if at a given time teachers had their own set of BBC micro:bit, so during the webinar they were able to do individual activities from home.

We made activities in the way that teachers or students would program something on the computer but then download program to micro:bit, stand up from the computer and examine how their program works on micro:bit. Big part of our courses in person was collaboration and it was something that we could not provide in webinars.

To replace courses in person with webinars, we had to find a good system. We shared our screen to show the programming part but also the hardware part (*Fig. 3*). We used software which showed image from camera set on micro:bit. So we could show program and micro:bit without participants switching between camera output and screen sharing.

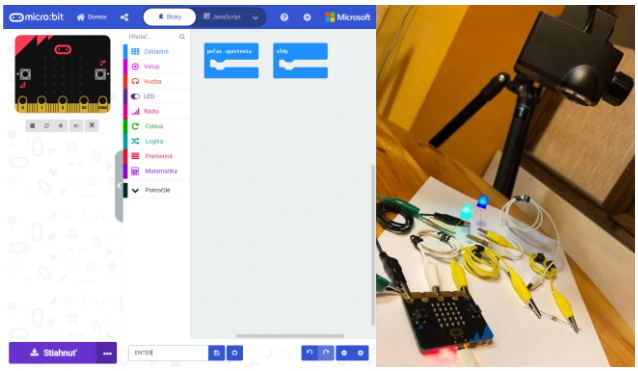

Figure 3. Set up of lector on webinars

We used two platforms on webinars – Microsoft Makecode and micro:bit classroom (in Makecode and Python mode). In Makecode we did simple codes, which could teachers do easily for themselves.

We used micro:bit classroom (Fig. 4) to show not only how they can teach with micro:bit online with their students but also to have them in our virtual class and be able to send them more complicated codes, so they could focus on the activity not only coding.

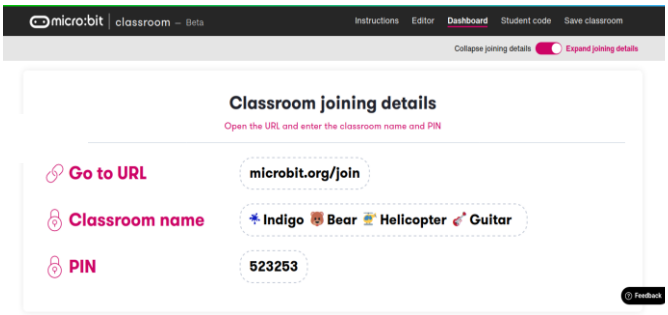

Figure 4. Teaching environment micro:bit classroom [26]

Webinars were organized in Blocks. We done 3 Blocks in Makecode and 1 Block in Python. Each Block consists of 2 or 3 webinars, which had each 2 hours. First parts of the webinars were more theoretical and second parts were more practical with specific activities. All in all, each teacher had the opportunity to attend 18 hours of online learning.

The first block consisted of two webinars, where we taught the basics, how to connect the BBC micro:bit to a computer, download Microsoft MakeCode programs, we showed programming environment, work with buttons, accelerometer and other build in sensors (magnetometer, light and temperature sensor).

The second block consisted of three webinars, where we taught radiocommunication in micro:bit, how micro:bit works with music and work with pins and circuits.

The third block consisted of two webinars, where we taught work with LEDs and neopixel LED strip.

Components for all three blocks are included in starter kit from "Učíme s Hardvérom".

Next school year we want to add follow-up Blocks (complex projects, additional sets) in Makecode and Python.

I. Mini Enter

To involve as many teachers as possible in the project a smaller grant call – "Mini ENTER" – was organized so that teachers could participate in courses and really try activities themselves and get excited for micro:bit. So thanks to mini ENTER over 50 teachers who were not successful in first round of grant program ENTER, from schools, which did not have a micro:bit, got one starter kit from "Učíme s Hardvérom". Conditions were, that teachers had to attend first and second Block of webinars and had to make some introduction of micro:bit in their class.

J. Streams

In addition to the previously mentioned online courses, several live webinars streamed on Facebook were organized about some additional platforms for micro:bit (Tinkercad) or how other teachers use micro:bit on their lessons (Ždaňa City). We also had a stream about the wearable technologies and the connecting micro:bit using an external board with cloud service ThingSpeak to create a IoT solutions. The next year we would like to do it regularly.

VI. METHODOLOGY

Our research was held in September 2020, at the beginning of the school year 2020/2021. It is divided into a pre-questionnaire and post-questionnaire. The post-questionnaire will be collected at the end of the school year in June/July 2021. We have decided to include primary schools and high schools or civic associations at schools. Private schools were not included. These mentioned institutions needed to fill out the pre-questionnaire when applying for an ENTER grant as its obligatory part.

When focusing on Slovak schools, there are 2431 state primary schools and 135 religious primary schools, together 2566 primary schools whocould have potentially applied for the ENTER grant [24]. Of these, 311 primary schools have actually applied. High schools are similar, there 524 state high schools and 72 religious high schools, together 596 high schools. From these high schools, there were 76 who applied for the ENTER grant. To conclude, 12,1 % of Slovak primary schools and 12,8 % of Slovak high schools applied for the ENTER grant (Fig. 5). The grant was publicized in television advertisements, on billboards, via e-mails addressed to schools, etc.

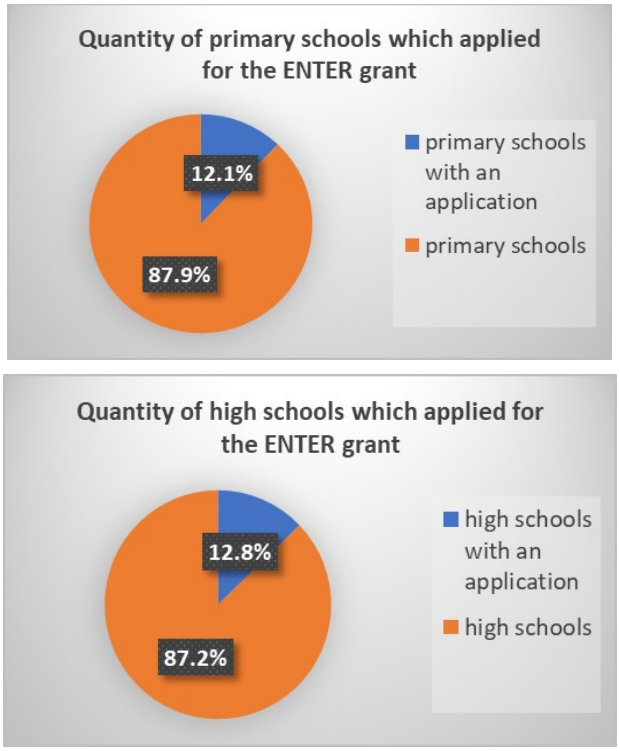

Figure 5. Schools wanted to joing the ENTER project

The pre-questionnaire was filled out by 387 teachers who teach Informatics. Of them, 63 % are females and 37 % are males (Fig. 6). From the research of women in education, OECD reported Slovakia has 46,2 % female teachers. In Informatics, a higher quantity of female teachers applied for the ENTER grant in comparison to teachers in Slovakia in general [25].

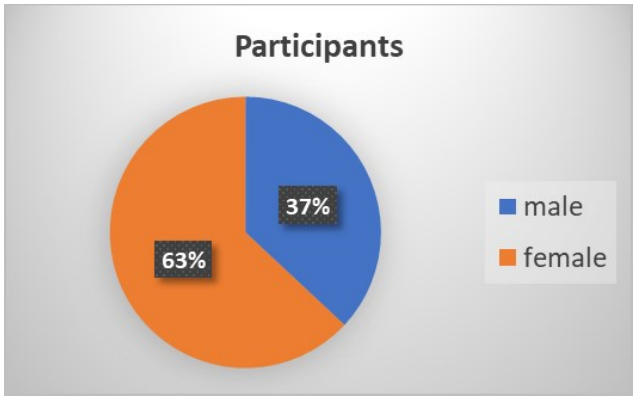

Figure 6. The participants of the project

The participants are divided based on types of school in which they teach. There are primary and lower-secondary schools (in Slovakia these are usually merged into one institution) and high schools are divided into grammar schools, high schools (business academies and secondary vocational schools) and other institutions (university or Association for

Youth, Science and Technology). Most of the teachers who applied for the ENTER grant were from primary and lower-secondary schools – 69 %. Grammar schools accounted for 13%, high schools (grammar schools excluded) for 17% and other institutions for 1% (Fig. 7).

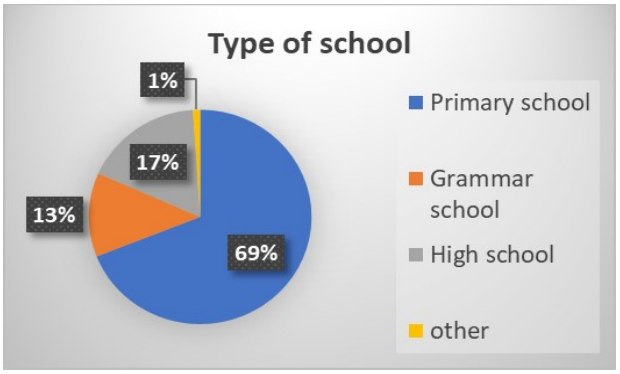

Figure 7. Type of school

We wanted to report teachers' education in teaching Informatics. Primarily, a qualified teacher of Informatics is the person who studied 5 years at the university study programme Teaching Informatics (a pre-service teacher training programe with the mandatory teaching practicum).

There is also another option when the person studies 5 years at the university study programme Teaching x, where x is not Informatics but other school subjects (e. g. History). If the person decided to have the qualification in Informatics, he or she needs to study Expanded education in Teaching Informatics. In this programme, he or she studies mostly Informatics because psychological or pedagogical basis he or she has already studied. On the other side, there are Informatics teachers in Slovakia who are not qualified. They are persons who are teachers with other school subjects, e.g. Biology teachers who teach Informatics or persons who studied non-teaching Informatics, e. g. Applied Informatics and they are not teachers but they teach Informatics. These situations happen because of low numbers of qualified teachers. It is caused by [25]:

- feeling valued in society (only 4 % teachers),
- salaries are low (under the average of university-educated people).

From the point of view of applications, there are 102 (26 %) fully qualified Informatics teachers, 123 (32 %) qualified Informatics teaches via expanded education, 100 (26 %) teachers with no qualification in Informatics, 26 (7 %) persons who studied Applied Informatics or similar programme and 36 (9 %) other people who teach Informatics and are neither teachers, nor Informaticians (Fig. 8).

We asked them if they have ever heard about the BBC micro:bit. 60 teachers (16 %) responded they already use micro:bits in their classes and another 80 teachers (21 %) responded they have attended a micro:bit course in the past. The majority of teachers, 205 (53 %), have only heard about the BBC micro:bit without any further experience with it. Only 42 teachers (11 %) who applied for the ENTER grant reported they have never heard about micro:bits (Fig. 9).

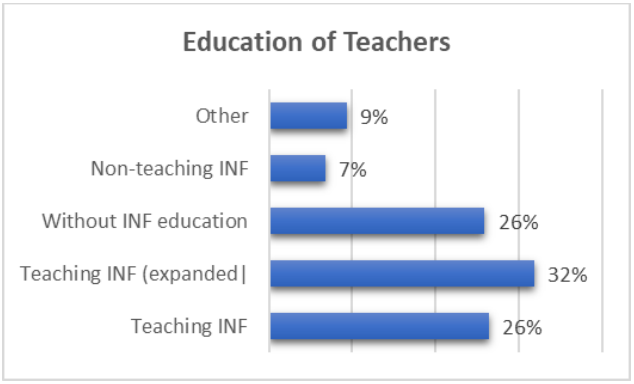

Figure 8. Education of teachers

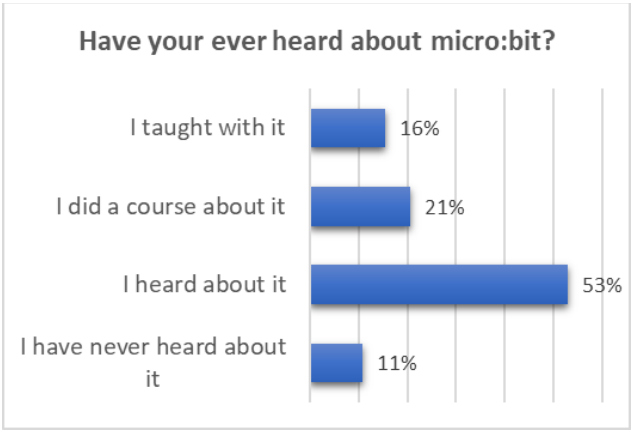

Figure 9. Task *Have you ever heard about micro:bit?*

Based on the data, we started to educate them how to use BBC micro:bit as it was mentioned in previous chapters. After each webinar, teachers had to fill out a feedback questionnaire to gain a certificate. The participants were mostly those who succeeded in the ENTER grant (243 of 387 = 63 %). Each participant could have attended any of the 4 webinars and they were asked to fill out the feedback form for each of the four blocks individually.

As of writing, the feedback form has been filled out 962 times. Firstly, we asked how much would teachers recommend the webinar to a colleague (Informatics teacher). The majority of responses were 10 of 10 with a strong agreement. The calculated Net Promoter Score (NPS) was 96%. (Fig. 10).

The second question was “Was the webinar format suitable for you? (number of meetings, time slots, number of participants, interactivity…)”. The participants were mostly satisfied, some responded they would prefer to have more meetings for the same amount of activities because they needed more time to practice the activities. The chosen time slot for the webinars (between 15.00 and 19.00) as well as the maximum participant capacity (30 people) were usually evaluated as suitable. They often wrote the online format was suitable because of the COVID-19 pandemic situation and many

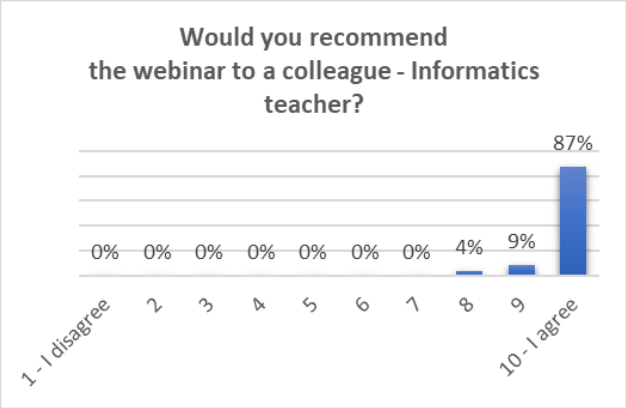

Figure 10. Task *Would you recommend the webinar to a colleague – Informatics teacher?*

institutions provided distance learning [28]. Many were also glad there was no need to travel but some teachers wrote they would like to meet personally.

The third question was "How to improve the webinar?". The most common answers included usage of Github, sending data via Bluetooth, having access to recordings of the webinars as well as having access to a larger number of alternate activities for certain topics which they could complete individually.

We also asked how the teachers evaluate our skills as lecturers. 82 % of respondents wrote 10 of 10 points, the rest answered 7 – 9 points.

When focusing on the difficulty of the webinar, 53 % agreed that it was rather easy, 29 % wrote rather difficult, 16 % wrote easy and for 2 % of respondents it was difficult (Fig. 11).

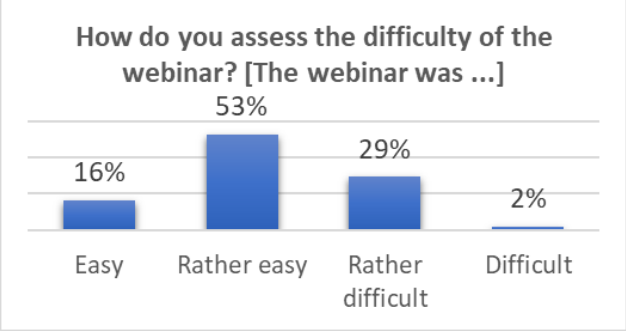

Figure 11. Task *How do you assess the difficulty of the webinar?*

VII. CONCLUSION

We focused on the BBC micro:bit and its education/learning in Slovak schools. We have realized the ENTER project which included activities such as a grant call, a digital library, BBC micro:bit propagation in mass media, multiple smaller competitions, consultants, webinars, mini ENTER call and online streams. In our research we focused on the general information of Informatics teachers in Slovakia and feedbacks from webinar participants. Our webinars were assessed at high rank, the participants would recommend our webinars to their colleagues and the difficulty was mostly "rather easy". The participants requested new topics such as sending data via Bluetooth, usage of Github and others. In the future, we would like to record our webinars and to continue with new topics.

ACKNOWLEDGMENT

The research for this paper was financially supported by granting Implementation of new trends in informatics into algorithmic teaching thinking and programming in the subject of informatics in secondary education (KEGA 018UMB-4/2020).

REFERENCES

[1] L. Huraj and M. Host'ovecký, "Internet of Things as tool for cognitive process in Computer Science study program," 2020 18th International Conference on Emerging eLearning Technologies and Applications (ICETA), 2020, pp. 200-204, doi: 10.1109/ICETA51985.2020.9379263.

[2] S. Korom and I. Zoltán, "System thinking competence and smart devices in programming education," 2020 18th International Conference on Emerging eLearning Technologies and Applications (ICETA), 2020, pp. 342-345, doi: 10.1109/ICETA51985.2020.9379183.

[3] D. Jarinová, A. Kanáliková and D. Tichá, "Project Oriented Teaching in Internet of Things Education," 2020 18th International Conference on Emerging eLearning Technologies and Applications (ICETA), 2020, pp. 248-253, doi: 10.1109/ICETA51985.2020.9379204.

[4] N. Klimová, "Wearables: Educational Projects Made with the BBC micro:bit," 2020 18th International Conference on Emerging eLearning Technologies and Applications (ICETA), 2020, pp. 323-329, doi: 10.1109/ICETA51985.2020.9379247.

[5] R. Krnáč, M. Cápay and Š. Koprda, "Education with physical device BBC micro:bit," 2020 18th International Conference on Emerging eLearning Technologies and Applications (ICETA), 2020, pp. 352-357, doi: 10.1109/ICETA51985.2020.9379166.

[6] M. Resnick. Showing th Seeds for More Creative Society. Learning & Leading with Technology, 18 – 22.

[7] K. H. Jin, H. Eglowstein, and M. Sabin. 2018. Using Physical Computing Projects, in Teaching Introductory Programming. In SIGITE '18: 19th Annual Conf. on Information Technology Education, Oct. 3–6, 2018, Ft. Lauderdale, USA. ACM, New York, NY, USA, 1 page. https://doi.org/10.1145/ 3241815.3241879

[8] M. Przybylla. Physical computing in computer science education. ICER '14: Proceedings of the tenth annual conference on International computing education researchJuly 2014 Pages 169–170https://doi.org/10.1145/2632320.2632336

[9] M. Przybylla and R. Romeike. Impact of Physical Computing on Learner Motivation. Koli Calling '18: Proceedings of the 18th Koli Calling International Conference on Computing Education ResearchNovember 2018 Article No.: 9Pages 1–10https://doi.org/10.1145/3279720.3279730

[10] S. Sentance, J. Waite, L. Yeomans, and . MacLeod. 2017. Teaching with physical computing devices: the BBC micro:bit initiative. In Proceedings of WiPSCE '17, Nijmegen, Netherlands, November 8–10, 2017, 10 pages. DOI: 10.1145/3137065.3137083

[11] T. Ball. Physical computing for everyone. ICSE-SEET '17: Proceedings of the 39th International Conference on Software Engineering: Software Engineering and Education TrackMay 2017 Pages 3. https://doi.org/10.1109/ICSE-SEET.2017.31

[12] M. Cápay, M. Bellayová. Vzbuďme v študentoch chuť programovať! Aktivity s BBC micro:bit 2019. In: DidInfo 2019 : medzinárodná konferencia o vyučovaní informatiky : 25. ročník konferencie, 03.04.2019-05.04.2019, Banská Bystrica. - Banská Bystrica : Univerzita Mateja Bela, 2019.

[13] M. Cápay, M. Bellayová. Aktivity s BBC micro:bit podporujúce kolaboratívnu prácu žiakov ZŠ. In: DidInfo 2019 : medzinárodná konferencia o vyučovaní. 2019, Banská Bystrica.

[14] M. Cápay, N. Klimova. Dokáže programovanie hardvéru zaujať študentov? In: DidInfo 2019 : medzinárodná konferencia o vyučovaní informatiky : 25. ročník konferencie. Banská Bystrica.

[15] M. Cápay, N. Klimova. Engage Your Students via Physical Computing! In: IEEE Global Engineering Education Conference, EDUCON2019 : The IEEE Global Engineering Education Conference, Dubai, April 9-11, 2019. P. 1216-1233.

[16] N. Klimová, M. Kvaššay, M. Cápay, M Bellayová. Development of hard skills and soft skills through competitive complex projects using BBC micro:bit. DIVAI 2020 : 13th International Scientific Conference on Distance Learning in Applied Informatics, Štúrovo, 2020. Praha : Wolters Kluwer, 2020.

[17] M. Cápay, M. Bellayová. The Simulation of Smart Home Processes with a Micro:bit. Didinfo 2020 : mezinárodní konference o vyučování informatiky. Liberec : Technická univerzita, 2020.

[18] BBC. 2017. BBC micro:bit celebrates huge impact in first year, with 90% of students saying it helped show that anyone can code. [online] Available at https://www.bbc.co.uk/mediacentre/latestnews/2017/microbit-first-year>

[19] S. Sentance, J. Waite, S. Hodges, E. MacLeod and L. E. Yeomans.,2017. "Creating Cool Stuff" - Pupils' experience of the BBC micro:bit. In Proceedings of the 48th ACM Technical Symposium on Computer Science Education: SIGCSE 2017. https://doi.org/10.1145/3017680.3017749.

[20] B. Czékmán, J. Kiss, 2018. HERJ Hungarian Educational Research Journal: Coding without (Age)Limits? Experiences with BBC Micro: Bit in Primary School. https://www.academia.edu/38055305/Coding_without_Age_Limits_Experiences_with_BBC_Micro_Bit_in_Primary_School

[21] S. Gibson, S., P. Bradley. A study of Northern Ireland key stage 2 pupils' perceptions of using the BBC micro:bit in STEM education. Published in: The STeP Journal Student Teacher Perspectives. University of Cumbria Vol 4 (1) pages 15-41.

[22] Denmark. DR ultra:bit: Cracking the climate code with the micro:bit. [online] Available at <https://microbit.org/impact/case-studies/dr-ultrabit/>

[23] M. Mansell, N. Klimová, M. Cápay, M. Bellayová. BBC micro:bit ako súčasť projektu ENTER, 2021. In. Didinfo 2021 : Banská Bystrica, 24.03.2021-25.03.2021. - Banská Bystrica : UMB, 2021. S. 184-185.

[24] *Zoznam škôl - najväčší databáza škôl*. [Online]. Available: http://www.zoznamskol.eu/. [Accessed: 02-Jul-2021].

[25] "OECD Data," *the OECD*. [Online]. Available: https://data.oecd.org/ [Accessed: 02-Jul-2021].

[26] "Micro:bit Educational Foundation," *Micro:bit*. [Online]. Available: https://microbit.org/. [Accessed: 03-Jul-2021].

[27] "EduTronik.sk," – *Keď programovanie bliká*. [Online]. Available: https://edutronik.sk/v2/. [Accessed: 03-Jul-2021].

[28] M. Varga, M. Kvassay, and M. Kvet, "Teaching Course on Algorithms and Data Structures during the Coronavirus Pandemic," in *18th International Conference on Emerging eLearning Technologies and Applications (ICETA)*, 2020.