

Article

Experience with Using BBC Micro:Bit and Perceived Professional Efficacy of Informatics Teachers

Nika Kvaššayová ^{1,*}, Martin Cápaj ^{2,*}, Štefan Petřík ³, Magdaléna Bellayová ⁴ and Eva Klimeková ⁵¹ Department of Informatics, University of Žilina, Univerzitná 8215, 010 26 Žilina, Slovakia² Department of Informatics, Constantine the Philosopher University, A. Hlinku 1, 949 01 Nitra, Slovakia³ National Institute of Education and Youth, Horná 97, 974 01 Banská Bystrica, Slovakia⁴ eTeacher o.z., Štefánikova 57, 949 01 Nitra, Slovakia⁵ Teaching with Hardware, Sibírska 21, 831 02 Bratislava, Slovakia

* Correspondence: nika.kvassayova@uniza.sk (N.K.); mcapaj@ukf.sk (M.C.)

Abstract: Our study is focused on the perceived professional efficacy of informatics in-service teachers with the experience of using micro-controller BBC micro:bit. In Slovakia, teaching using hardware is not typical. In addition, many teachers do not teach programming. BBC micro:bit is designed to be a tool for computer science (CS) teachers that should make a significant contribution to the innovation of CS teaching and enable CS teachers to implement CS lessons. The following research questions were asked. Q1: Is there a difference in the perceived efficacy to use teaching strategies based on experience with the micro:bit? Q2: Is there a relationship between the perceived efficacy of using teaching strategies and experience using the micro:bit? The research sample comprised N = 388 CS teachers employed in Slovak schools from the available selection. The research sample included CS teachers who participated in the project called ENTER. All participants have a grant, weekly online practices, supporting materials, and also consultant for implementation of a new teaching strategy. This study's findings indicate that the use of a microcontroller such as the micro:bit has a positive impact on self-efficacy for instructional strategies, but not for classroom management.

Keywords: BBC micro:bit; perceived professional competence; education

Citation: Kvaššayová, N.; Cápaj, M.; Petřík, Š.; Bellayová, M.; Klimeková, E. Experience with Using BBC Micro:Bit and Perceived Professional Efficacy of Informatics Teachers. *Electronics* **2022**, *11*, 3963. <https://doi.org/10.3390/electronics11233963>

Academic Editor: Luis Gomes

Received: 29 October 2022

Accepted: 25 November 2022

Published: 29 November 2022

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1. Introduction

The competency of a teacher is reflected in the quality of his or her instructional work. The present scenario necessitates ongoing development and adaptation of the teacher's competencies, particularly in the area defined as digital competences. Consequently, it is essential that the competence profile of each teacher aligns with the aims of raising and education in the school, while also taking into consideration the contemporary requirements of individuals and the job market and also teacher job satisfaction. Teachers who enjoy their occupation will invest greater effort in their work and achieve better results [1]. A teacher who is self-assured in his/her knowledge, abilities, and attitudes is beneficial to the school and, more importantly, the student. Several studies indicate that job satisfaction is one of the most important factors influencing teachers' relations to students, teachers' enthusiasm, and teacher retention [2]. Interest in the measuring of so-called self-efficacy, where people are self-organizing, proactive, self-regulating, and self-reflecting [3], has quite a long history, but the importance has increased in the last five decades [4]. The problem is that self-efficacy is hardly measured. It takes time for new technologies to reach society after their introduction. The teacher must be able to relate to technology and utilize it effectively in the classroom. Therefore, the introduction of new technology may not instantly result in a more effective teaching process. Efficacy beliefs affect the choice of activities, how much effort is expended on an activity, and how long

people will persevere when confronting obstacles [5]. Our contribution examines the influence of the introduction of new technologies in programming instruction on the perceived professional self-efficacy of teachers.

2. Related Works

Physical computing is currently a popular discipline that arose from the design of real-world interconnection. It is used to create interactive physical systems that sense and respond to the real world, objects that interact with people [6]. The resulting interactive objects are programmed and can be part of a network of installations [7]. Physical computing involves combining software and hardware and can be used to teach many aspects of computer science (CS) in a creative and motivating way [8]. From an educational perspective, this approach allows us to develop products that could be easily presented, evaluated, and discussed. It is close to Piaget's constructivist theory of learning in which the most effective thing is the way learners construct knowledge and develop competences from their own initiative, for a personally relevant purpose, when being engaged in creating visible artifacts [9]. People do not get ideas; they make them. What is important is that they are actively engaged in creating something that is meaningful to themselves or to the others around them [10]. A variety of tangible embedded "microcomputer" devices targeted at students and hobbyists are established in the market [6]. The studies showed that full-time access to physical "tangible" devices, such as programmable boards, lead to the improvement of the overall learning process [11–14]. When physical computing is adopted, approaches to develop computational thinking can be used, e.g., three-state progression of "use–modify–create (UMC)" [15]. In the use stage, students work with existing working programs (not-mine stage). In the modification stage, they start to change the model in a series of modifications with increasing level of sophistication and through these experiences they learn programming concepts in the process. Skills and confidence allow them to design their own computational projects in the final stage, wherein they create (mine stage). UMC sequencing is widely promoted to scaffold student engagement [16]. It provides students with a natural progression to learn computational thinking, while giving students more ownership over the artifacts they create [17]. UMS is based on elements from Experiential Learning Theory; knowledge is created through the transformation of experience [18]. The wide range of physical computing devices with different levels of technical capabilities can be categorized into five categories [6]: packaged no-programming electronics (Circuit Stickers); packed programmable products (Sphero, Ozobor, Beebot, Cubetto, Lego Mindstorms, and Vex Robotics); board-level peripheral devices (PicoBoard and Makey-makey; need to be plugged to computer during use); board-level embedded devices (microcontrollers, Arduino, micro:bit, Chibi Chip, need to be plugged to the computer only during programming, operate standalone using battery); and board-level general purpose (Raspberry Pi).

The interest in supporting learning through physical computing, which has been shown to be motivational, whilst also offering opportunities for collaboration and creativity, led to the development of a portable and low-cost pocket-sized codable physical computing device called BBC micro:bit [19]. A codable computer half the size of a credit card is inspiring students worldwide to develop core computing skills in fun and creative ways.

It consists of a LED matrix display, programmable buttons, I/O pins, buyer, sound sensor, accelerometer, compass, touch pin, and Bluetooth antenna. Through pins, it could be enhanced with different kinds of extension boards, sensors, and wires. Micro:bit-supported programs are coded in a no-installation, web-based programming environment and languages, such as MakeCode [20], Javascript [21] integrated into the MakceCode, Scratch [22], AppInventor [23], and Python editor using MicroPython [24]. There are several ways how to write the program: using the offline editor such as Mu or Thonny; official online environment; a novel tool that tries to attract the programmers, using the frame-based approach [25]; or using the online class system that helps the teacher manage the

students' code even during the distance-learning process. Due to a compactness and in-built sensors, which are a great advantage in comparison with other microcontrollers, we can simulate lots of technical processes directly during the class [26]. Usage of the extension board (IoT, Smart, and Drone); an external sensor; or wearable materials such as an electrically conductive thread, LED diodes, and power board, give us an opportunity to understand how things work in our everyday life [27] or develop experimental equipment and try to explain the underlying physics phenomena [28]. There is a wide range of STEAM (science, technology, engineering, art, and math) projects that could be realized through micro:bit: developing games [29]; the privacy, security, and safety [30]; solving real-world problems [31]; smart farming [32]; or even creating art, e.g., a paper-cutting lamp [33].

It was designed for educational purposes by the English BBC in 2016 and distributed free of charge to every pupil across the UK, i.e., about 1 million units to every 11- and 12-year-old child [34]. In 2018, micro:bit has gone global, with the device available in more than 50 countries [35]. The micro:bit became very popular as a tool to research computational thinking or designing programmed technological knowledge [36]. The research started in the United Kingdom [30,37] and Northern Ireland [38]. Other countries follow the research, most of them in primary school [39], focused on pupils' perception, motivation, and programming skills. In a pilot study in Finland [40], micro:bit was seen as easy to adopt and use, providing opportunities as a tool for creating new innovations and also as an object of learning. The initiative in Hungary [41] had a strong impact on the teachers and their plans to buy devices and on future educational activities at schools. Other research in Hungary found the micro:bit's positive correlation with the future profession [42]. An Serbian researcher had the same idea [43], and an Australian team consider the micro:bit as a tool to teach innovatively, develop STEM skills, and change negative attitudes toward computer science [44]. Other researchers from Australia empirically explored how secondary-school girls perceive computational thinking practices by conducting a mixed-methods approach, using the micro:bit [45]. In Denmark [46], young people are using the micro:bit to come up with amazing tech ideas to make their parents more climate-friendly. According to empirical research [47,48], the Swedish primary-school teachers are supported with teaching materials, based on the BBC micro:bit, and the Scope of Autonomy Model aimed to support teachers in developing and appropriating material for teaching programming and computational thinking with individual progression in accordance with the new curriculum [49]. The impact that a micro:bit had on education, involving almost all school institutions and spreading across libraries across the country, in Croatia is indisputable [50]. The impressions of students and teachers when they encountered it in the classroom for the first time was reported in Macedonia [51]. In Slovakia, there was a project spreading the idea of physical computing among teachers and students across the whole country, and micro:bit has become a way to transform education [52]. New educational curriculum for lower secondary schools in Austria (Basic Digital Education), use micro:bit sensor experiments and categorizes the tasks according to the quadrants of computational thinking (decomposition, patterns, abstraction and algorithmic thinking) [53]. The results of the research are that the BBC micro:bit has a great influence on motivation and attitude toward informatics; after a while, however, possibly due to the simplicity of the device, students reach the limits of the device, and here the competences of the teacher are needed. Without a teacher with self-confidence and high-quality competences, even the best tool in the hands of the students will, after time, become just boring hardware. Therefore, there is a need to direct the research not only to students' competencies [54] but also to the competencies of their teacher. The micro:bit study directed to teachers revealed that the most commonly used teaching methods with this physical computing device were live coding demonstrations, pair programming, discussion and collaborative work, and tinkering; used strategies did not always align with what they felt was effective [55]. Through the micro:bit programming lessons, teachers discovered the increasing pedagogical, as well as professional, competencies of teachers,

especially in regard to teaching methods such as pair programming, discussion of the problem solving, collaboration, cooperation, and use of debugging [52].

2.1. Computer Science Teacher Competencies

Professional competence is competence related to the ability to master specific knowledge. Teachers' pedagogical competence is the ability to manage learning, which includes the planning, implementation, and evaluation of learning outcomes of learners [56]. White perceived competence as an effective interaction between the individual and their environment [57]. Perceived professional competence is considered a quality that fundamentally affects the success of human activity, while acting as a mobilizer of human abilities, skills, and knowledge. The research-confirmed thesis is that a person's judgment of subjective, personally perceived professional competence in a specific activity is a good predictor of performance in that activity [58,59]. Teacher competence was conceptualized as a multidimensional construct underlying performance in the classroom that includes knowledge, skills, and affective motivational characteristics [60]. Professional teaching competencies are highly needed to produce enriched teachers for the society. The professional competencies may be classified under the three major competencies, namely instructional competences, organizational competences, and evaluative competences [61]. According to the European Parliament and the Council, digital competence involves the confident and critical use of Information Society Technology for work, leisure, and communication. It is underpinned by basic skills in ICT: the use of computers to retrieve, assess, store, produce, present, and exchange information, and the ability to communicate and participate in collaborative networks via the Internet [62].

The aims of education change very quickly depending on the demands of the era that directly affect the educational system. In the context of rapid curriculum change, teaching computer science in school requires new skills and knowledge that existing teachers may not have; adequate development of teachers' competencies during their education is extremely important [63]. Clearly a continuous learning process is required to become an excellent computer science teacher [64]. Digitally based learning concepts evolve quickly, and teachers are expected to be able to teach, not only to use, them. The constant change of the curriculum of computer science, which is becoming more oriented at STEM education, results in brand new competences [65]. Physical computing is a complex activity. With advancements in physical computing, both on the hardware and the software side, learners undergo learning processes that strengthen computational thinking and key competences, such as understanding computing systems, formulating problems, organizing and analyzing data, algorithmic thinking, effectiveness, and efficiency, that are necessary for all aspects of life [66].

When comparing several aspects [26], the BBC micro:bit platform seems to be the most reasonable choice as a physical computing platform for the beginners. Half of teachers who have used the BBC micro:bit say that they now feel more confident as a teacher, particularly those who said that they were not very confident in teaching computing [67]. We think that, due to micro:bit system errors, we can develop patience and resilience; even the teacher needs to learn from mistakes and practice the debugging and troubleshooting skills that are important to computer science [63].

2.2. Computer Science Teacher Efficacy

There is a conceptual distinction between perceived competence and self-efficacy. Perceived competence is in the framework of self-determination theory, and self-efficacy is in the framework of social-cognitive theory. Competence is more than merely some "ability" to perform a task and includes consideration of the personal importance of the task. Self-efficacy is defined as situation specific self-confidence [68].

Computer competence can be defined as individual knowledge and skills in applying computing technology to fulfill computer-related tasks successfully [69]. Computer self-efficacy as the perceived efficacy of individual ability to use computing technology to

perform specific computer-related tasks [70,70]. A study showed that participants who use micro:bit had a significant interest in learning about ICT, even though they perceived the area to be difficult; furthermore, the girls portrayed high levels of self-efficacy [71].

For White, the motivation to become competent is referred to as “effectance”, and the feeling of achievement is called “efficacy” [57]. A teacher self-efficacy is a measure of a person’s self-efficacy in the specific context of teaching [72]. Based on social cognitive theory, teacher self-efficacy may be conceptualized as individual teachers’ beliefs in their own ability to plan, organize, and carry out activities that are required to attain given educational goals [2]. Bandura [58] stated, “If there are no obstacles to surmount, the activity is easy to perform, and everyone has uniformly high perceived self-efficacy for it”. Teachers’ self-efficacy for teaching computer science varies with their academic background, but not with their amount of teaching experience or prior experience level [73]. Other research shows that teachers with more computer science teaching experience have higher levels of self-efficacy [74].

Self-efficacy has been shown to correlate with motivation and perseverance [75]; a significant correlation between teacher self-efficacy and increased student achievement by influencing teachers’ instructional practices, enthusiasm, commitment, and teaching behavior has been seen [76]. Teachers who have a strong sense of efficacy can motivate their students and improve their cognitive development. Teachers who instruct students at higher grade levels have higher levels of computer science teaching self-efficacy than do teachers who instruct lower grade [74].

Students’ achievement is influenced also by the collective teacher efficacy, defined by Hattie as the collective belief of teachers in their ability to positively affect students. It is a team of individuals sharing the belief that, through their unified efforts, they can overcome challenges and produce intended results [77]. To develop a collective teacher efficacy, a self-efficacy and leader’s ability to behave in ways that build relationships are needed.

Considering the abovementioned research, it was clear that micro:bit is the best choice for our project. Our decision was later proved by other research published during the realization of the project. Other researchers considered the micro:bit to not only be a tool to master programming, but also a device used for thinking about future professional development. The last research showed that the micro:bit is good at improving coding abilities and academic performance [78]. Furthermore, the micro:bit is now available in over 60 countries, and there are hundreds of registered hardware product accessories, a lot of content, and many partners [79].

Other researches investigate the micro:bit device as a tool focusing on fostering learners’ enthusiasm and interest in computing and programming [51,54,80,81] or how to develop computational thinking [22,39,45,45,47,48,53,82,83] or how to influence the competences [40,84]. Our study is uniquely focused on the perceived professional efficacy of informatics teachers.

3. Project ENTER

The year 2020 marked the beginning of the ENTER project. It was made possible thanks to the generosity of the Slovak Telekom Endowment Fund, which worked in conjunction with You Too in IT and Teaching with Hardware (which also collaborated with e-Teacher).

The purpose of this activity was to familiarize both the students and their teachers with various digital technologies. Digital Education was the name of the media campaign that was launched in September of 2020 in Aurelium. In order to facilitate the changes, grants to elementary and secondary schools were made available. The grant allowed teachers to spend up to EUR 1000 on new hardware for their classrooms.

3.1. Grant Call

During the year 2020/2021 of the project, there were 388 people who submitted a written application for the project. The selection committee narrowed the field down to 243 ideas, all of which were funded, and the schools received a total of 229,000 euros. Having said that, it was essential for educators to be aware of the hardware that met the requirements. According to this source (https://www.ssi.sk/wp-content/uploads/2020/12/121_KI_ZS_2018_19.pdf (accessed on 20 September 2022)), the qualification rate for the informatics subject in lower secondary education is only 45.4%. This is an extremely low figure. Because of this, we made an effort to bring awareness to the fact that there is hardware that is appropriate for elementary and secondary schools and that we can provide training for teachers on this hardware. We went with the BBC micro:bit and all of its associated peripherals. We were motivated to pursue this effort after reading about a project that took place in Great Britain and made successful use of the BBC micro:bit.

3.2. Hardware

Teachers mostly worked with BBC micro:bit version 2. As its primary CPU, the BBC micro:bit makes use of a System-on-Chip (SoC) manufactured by Nordic [85]. It is capable of supporting new types of complicated functionality, such as applications using AI and ML. When compared to the 16 MHz, 32-bit Arm Cortex M0 CPU that was utilized on the original micro:bit, the powerful 64 MHz, 32-bit Arm Cortex M4 processor with a floating-point unit (FPU) that is included into the SoC is a substantial advance. The original micro:bit only had 128 kilobytes of random access memory (RAM), while the nRF52833 contains a whopping 512 kilobytes of Flash memory (eight times that of the original device). Additionally, the nRF52833 is equipped with full-speed USB (12 Mbps) compatibility. The power consumption of the new micro:bit has been reduced to a minimum thanks to the nRF52833, which has also been designed to maximize battery life. It permits long-running data recording, for example, and it also has a power-off mode that helps preserve power when the device is powered by a battery or when it is not being used.

Bluetooth Low Energy (also known as Bluetooth 5.2) wireless connection is provided by the Nordic SoC. Because it is compatible with other micro:bits, smartphones, tablets, and any other device that uses Bluetooth LE, it paves the way for exciting new opportunities in the field of linked digital education. The micro:bit V2 has been updated to contain a built-in speaker, as well as a MEMS microphone, which enables the device to support teaching with sound right out of the box. The dedicated “microphone operational” LED makes it evident when the microphone is turned on and perceiving sound, thus enabling teachers to talk with students about concerns related to privacy and the effect of listening devices.

The Teaching with Hardware kits were the most common purchases made by educational institutions. These kits consist of a BBC micro:bit, a USB cable, a battery holder, alligator clips, speakers, LEDs, resistors, conductive wire, batteries, and a neopixel LED strip. In addition, courses were developed for this hardware, and initially, they were delivered synchronously over the Internet.

3.3. ENTER Conference

Additionally, in an effort to lend support to the educational system, the ENTER conference was held. At this event, educators and students learned in person or virtually about the following subjects:

- How to turn your interest into a profitable business;
- The process of developing content, as well as post-production techniques. How to make fashion accessories while also learning to program;
- The employment landscape of the future and the opportunities it presents for young people;

- Professionals in the business world regarding possibilities;
 - There Is No Future—a steam engine that transports you into virtual reality;
 - Education accessible through the Internet;
 - The psychology of children and the use of the Internet in education;
 - The future of education through the Internet, digital education, and hybrid schools;
 - In what directions can we take education in terms of technological advancement?
- There were more than 5125 people who attended the conference.

3.4. Mini ENTER Grant Call

After the grant call, it is possible to draw the conclusion that the level of financial assistance provided to schools across Slovakia was roughly equivalent from region to region. A total of EUR 2000 could be awarded to no more than one school. There was a total of 502 schools that applied for the grants, and EUR 390,000.00 was given out to them. The amount that was spent on each school, on average, was EUR 777.

In addition, we concentrated our efforts on schools that had been unsuccessful in the grant application process and had not been awarded any financial assistance. In this scenario, we attempted to motivate the teachers by means of the MINI ENTER challenge. The teachers were not required to develop a project; rather, they were only required to fill out an application. If the school did not have any micro:bits, the teacher was awarded a free basic Teaching with Hardware kit, along with micro:bit courses taught in Slovak. As a prerequisite, it was necessary for the instructor to finish the lesson and get at least some of the students acquainted with the micro:bit. This MINI ENTER challenge has already been completed by a total of 357 different participants over the course of its seven previous iterations.

3.5. Online Webinars

At first, all of the primary classes were offered live online to teachers who were equipped with the necessary technology. A total of 226 h was spent gaining knowledge on a variety of micro:bit-related subjects and challenges.

Because of COVID-19, we had no choice but to provide our lessons throughout Slovakia in an online format rather than in person. Even virtual classroom experiences such as webinars and online courses may be beneficial for teachers if, at the time of the webinar, educators had access to their own BBC micro:bit kits, which would enable them to do certain exercises in the comfort of their own homes.

We developed a set of activities in which a teacher or student would first create a project on a computer, then download the software to a micro:bit, and then walk away from the computer and examine how his/her program operates on the micro:bit. The ability to work together was an essential part of our in-person training, but unfortunately, this was not something that could be accomplished via our webinars.

We required a dependable infrastructure so that we could go from in-person courses to online webinars. We achieved this by sharing our screen in order to show both the code and the hardware components. The pictures that were taken with a micro:bit camera were shown through software that we used. In order for teachers to show the application and micro:bit without having people alternate between sharing their screens and using their cameras, we needed a solution.

During the webinars, we made use of both MakeCode and the micro:bit classroom (in MakeCode and Python mode). Using MakeCode, we developed fundamental scripts that individual teachers could easily put into practice on their own.

We used micro:bit classroom to not only show them how they can teach their students online, using micro:bit, but also to have them in our virtual class and be able to give them more complicated codes so that they could focus on the activity rather than just coding. This allowed them to learn more about the micro:bit platform.

Webinars were organized by using blocks in most cases. We finished one Python block and three MakeCode blocks. Each block consists of either two or three webinars that

are each two hours long. The first part of the webinar was more theoretical in nature, and the second part is more practical in nature and contains specific activities. The teacher had the opportunity to participate in webinars totaling 18 h.

- The first portion of the course consisted of two webinars in which we discussed the essentials, such as how to connect a micro:bit, download a program, and operate with buttons an accelerometer and other built-in sensors (magnetometer and light and temperature sensors).
- The second section consisted of three separate webinars, during which we discussed micro:bit radiocommunication, how micro:bit interacts with music, and how to work with circuits and pins.
- The work performed with LEDs and neopixel LED strip was shown in both of the webinars that were held during the third block of the event.
- The “Učíme s Hardvérom” starter kit provides you with the necessary components to construct all three blocks.

During the course of the next school year, we want to expand both MakeCode and Python by adding follow-up blocks, which will consist of more difficult projects and more sets.

3.6. Online Courses

After that, video courses that could be watched at the teacher’s own pace over the course of several weeks were developed. Each week, a new course has been made available to the teacher. Once the course begins, the teacher receives an assignment, which he/she will then be required to complete and turn in via the online portal. A certificate is made available to the instructor once all of the activities have been finished successfully. The following classes are currently available to teachers asynchronously:

Basic course:

- Familiarizing oneself with the BBC micro:bit, including its display and buttons,
- Including a button array and a motion sensor,
- Wireless communication,
- Music,
- Electrical circuits.

Course for the advanced:

- LEDs,
- Neopixel LED strips,
- Built-in sensors,
- Analog input,
- TinkerCad and input via digital devices.

3.7. Cooperation with Teachers and Organizations

In addition, written materials about things such as wearables, micro:bits programmed in Python, or a combination of micro:bit and Scratch were included. Block-based programming makes up the majority of the language, but Python, another programming language, is also utilized.

In addition, we implemented online webinars in cooperation with selected teachers, which were a shorter alternative to courses. The webinars usually lasted one hour and covered the following topics:

- Becoming inspired by the intelligent micro:bit town of Ždaňa,
- TinkerCad and BBC micro:bit environment for schools,
- Smart greenhouse with BBC micro:bit.

The organization known as Aj Ty v IT was also responsible for the arranging of workshops as a component of the ENTER project. She facilitated seminars at Slovakian schools, either in person or online. At the same time, they established the TechLib library, which

serves as a repository for programmable gear that can be checked out for a limited time. We also created consultants for each project so that we could provide educators with the highest possible level of professional attention. Every educator who participated in the study has someone to whom they can turn for assistance.

3.8. Enter.study Webpage

Additionally, information on the project may be found on a website that was developed just for it. There are instructions that discuss topics such as the MakeCode multi-editor or various educational strategies that were used during the COVID epidemic. Students and teachers alike have the chance to add their own creations to the micro:bit project database, which now has 60 different projects. Students and teachers in Slovakia are both given newfound motivation by these initiatives. Slovak YouTuber Gogo, who invited prominent persons and related subjects with micro:bits, made videos for the students, using micro:bits. Micro:bit acted as the referee for the various micro-battle competitions that took place between Gogo and his guest. These competitions included things such as seeing who could beat the drum the fastest, who could shout the loudest, who could cycle the fastest, and who could feel the most pressure from VR.

4. Methodology

The success of the implementation of the educational process is influenced by many determinants. In addition to the teacher's expertise, knowledge, efficacy, and motivation, an important factor, according to P. Gavor [86], is also the idea that the teacher has of him/herself, i.e., how he/she evaluates, perceives, and assesses him/herself as a teacher. The perception of one's professional competence can significantly contribute positively or negatively to the success of the implementation of the educational process. When teaching CS, the perceived efficacy to teach can be an important success factor. Micro:bit is intended to be a tool for CS teachers, which should significantly contribute to the innovation of CS lessons and should serve as a tool that will help CS teachers in the implementation of CS lessons. Based on the thesis of Nikodemová, Fenyvesiová, and Tirpáková [59], that a person's judgement of personally perceived competence (subjective) in a specific activity is a good predictor of performance in the given activity, our aim of the research was to find out the differences between the perceived professional competence of those CS teachers who have experience with the use of micro:bit in the educational process and among those who have no experience using micro:bit in the educational process. In addition, we focused our attention on finding out the relationship between experience with the micro:bit tool and perceived professional competence. Based on the stated objectives, we focused our attention on the following research questions:

- Q1: Is there a difference in the perceived efficacy of using teaching strategies based on experience with the micro:bit?
- Q2: Is there a relationship between the perceived efficacy of using teaching strategies and experience using the micro:bit?

4.1. Characteristics of the Research Set

The research set consisted of $N = 388$ teaching staff—CS teachers working in Slovak schools. When choosing the respondents, we used the available selection, and the questionnaire was filled out by CS teachers who were involved in the ENTER project.

It means the selection of respondents can be characterized as available. Then we distributed the questionnaire online.

4.2. Characteristics of the Research Methodology

The collection of empirical data among pedagogical staff—CS teachers—was carried out in the year of 2021 through a self-constructed questionnaire supplemented with items from The Ohio State Teacher Efficacy Scale (OSTES) questionnaire. P. Gavora [87] was responsible for adapting the aforementioned questionnaire to our conditions. The OSTES questionnaire is focused on the teacher’s perception of his own abilities for teaching. It is a tool for analyzing a teacher’s professional competence. In this context, we agree with P. Gavora’s statement [86,87] that “knowing the teacher’s perceived competence is revealing the teacher’s real usefulness”. The original OSTES questionnaire (also known as TSES: Teachers’ Sense of Efficacy Scale), which was developed by Tschannen-Moran and Hov, has 24 items to assess the full range of teaching tasks and capabilities [88] in 3 correlated factors: efficacy in student engagement, efficacy in instructional practices, and efficacy in classroom management [89]. The Slovak version of the OSTES questionnaire also contains 24 items, which are answered by teaching staff on an ordinal scale: 1—nothing at all; 2/3—a little; 4/5—a little; 6/7—a lot; and 8/9—a lot.

We used exploratory factor analysis with “varimax” rotation to verify the validity of the research instrument (Tables 1 and 2).

We verified the construct validity of the research instrument (scales and subscales of the questionnaire) by means of exploratory factor analysis with varimax rotation—see table items saturating individual factors after factor analysis. Based on the values listed in the Table 3, we conclude that the research tool was valid.

We verified the reliability of the research instrument using the value of Cronbach’s alpha coefficient. The value of Cronbach’s alpha coefficient for the subscale (dimension) efficacy for use instructional strategies was 0.871, and for the subscale (dimension) efficacy for classroom management, it was 0.877. The overall reliability of the research instrument is 0.875.

Based on the calculated values of Cronbach’s alpha coefficient for individual subscales (dimensions), we conclude that the research tool was reliable.

Table 1. KMO and Bartlett’s Test.

Kaiser–Meyer–Olkin Measure of Sampling Adequacy.		0.931
	Approx. Chi-Square	3082.924
Bartlett’s Test of Sphericity	Df	91
	Sig.	0.000

Table 2. T Items saturating individual factors after factor analysis.

Items Saturating Factors	Factors		
	α	I.	II.
Efficacy for instructional strategies	0.871		
How well can you implement alternative strategies in your classroom?	0.817	0.212	
How well can you provide appropriate challenges for very capable students?	0.811	0.176	
To what extent can you provide an alternative explanation or example when students are confused?	0.732	0.326	
How much can you gauge student comprehension of what you have taught?	0.724	0.374	
How much can you do to adjust your lessons to the proper level for individual students?	0.684	0.392	
How much can you do to motivate students who show low interest in schoolwork?	0.677	0.358	
How much can you do to help your students think critically?	0.618	0.276	
How much can you assist families in helping their children do well in school?	0.420	0.362	
Efficacy for classroom management	0.877		
How well can you respond to defiant students?	0.172	0.790	
How much can you do to calm a student who is disruptive or noisy?	0.366	0.785	
How well can you keep a few problem students from ruining an entire lesson?	0.287	0.770	
How much can you do to get children to follow classroom rules?	0.268	0.721	
How well can you establish routines to keep activities running smoothly?	0.362	0.676	

How much can you do to control disruptive behavior in the classroom?	0.340	0.623
Own number (eigenvalue)	7.183	1.262
% variance	51.309	9.011

To verify the factor structure of the scale questionnaire, we used exploratory factor analysis, based on its already existing and verified dimensional composition. As part of the exploratory factor analysis, we preferred the principal components method, using orthogonal varimax rotation. After the implementation of the factor analysis, 60.320% exhausted data variability was demonstrated. The KMO test of the adequacy of the selection (0.931) points to the excellent adequacy of the use of factor analysis for the obtained empirical data. Bartlett’s Test of Sphericity ($0.000 < 0.001$) rejects the hypothesis that the correlation matrix is a unit matrix.

Using factor exploratory analysis, we confirmed the existence of 2 dimensions: ability to use teaching strategies and efficacy in regard to managing the classroom (Table 3).

Table 3. T items saturating individual factors after factor analysis.

Efficacy for Instructional Strategies
How well can you implement alternative strategies in your classroom?
How well can you provide appropriate challenges for very capable students?
To what extent can you provide an alternative explanation or example when students are confused?
How much can you gauge student comprehension of what you have taught?
How much can you do to adjust your lessons to the proper level for individual students?
How much can you do to motivate students who show low interest in schoolwork?
How much can you do to help your students think critically?
How much can you assist families in helping their children do well in school?

Cronbach’s alpha showed a value of 0.871 for this dimension.

The items making up the classroom management ability factor were as follows (Table 4).

Table 4. T items saturating individual factors after factor analysis.

Efficacy for Classroom Management
How well can you respond to defiant students?
How much can you do to calm a student who is disruptive or noisy?
How well can you keep a few problem students from ruining an entire lesson?
How much can you do to get children to follow classroom rules?
How well can you establish routines to keep activities running smoothly?
How much can you do to control disruptive behavior in the classroom?

Cronbach’s alpha showed a value of 0.877 for this dimension.

The existence of the two factors identified by us, which characterize the didactic and managerial aspects of the teacher’s ability (self-efficacy), was also proven by the factor analysis of K. Kohútová [90]. Compared to the original factor structure of the questionnaire by the authors Tschannen-Moran and Woolfolk Ho [91], in the factor analysis carried out by us, similarly to K. Kohútová [90], the third factor—the ability to motivate the class—fell out. For this reason, we decided on a two-factor solution.

4.3. Interpretation

In the research, we focused on the difference and relationship between the perceived professional competence of CS teachers and the experience of using the micro:bit. We present the results of empirical findings in T1 and T2, where we used the inferential statistics method for data processing. Since the empirical data based on the Kolmogorov–Smirnov

test did not show normality of distribution, we used non-parametric significance tests such as the Spearman correlation coefficient and Kruskal–Wallis test (Table 5).

Table 5. T1 perceived efficacy of CS teachers based on experience with the BBC micro:bit.

Perceived Efficacy		Efficacy for Instructional Strategies	Efficacy for Classroom Management
Experience with the BBC Micro:Bit			
I have never heard of micro:bits	N	42	42
	AM	7.79	7.77
	Me	7.81	8.00
	SD	0.659	0.779
	Min	6	6
	Max	9	9
I have heard of micro:bits	N	205	205
	AM	7.92	7.75
	Me	8.00	7.83
	SD	0.811	0.920
	Min	4	4
	Max	9	9
I have completed micro:bit training	N	80	80
	AM	8.00	7.73
	Me	8.25	8.00
	SD	0.862	1.068
	Min	5	4
	Max	9	9
I have used micro:bits in my class	N	60	60
	AM	8.11	7.75
	Me	8.38	7.83
	SD	0.679	0.817
	Min	6	5
	Max	9	9
Kruskal–Wallis test		10.642	0.463
<i>p</i> -value		0.014 **	0.927

Legend: AM—arithmetic mean, Me—median, SD—standard deviation, Min—minimum value, Max—maximum value. **Scale used:** 1—nothing; 2/3—very little; 4/5—some influence; 6/7—quite a bit; 8/9—a great deal. **. Correlation is significant at the 0.01 level (2-tailed).

From the empirical data presented in T1, it is clear that there is a statistically significant difference in the perception of the professional ability to use teaching strategies ($p = 0.014$). CS teachers who have completed training on micro:bits and taught with micro:bits perceive their professional competence in the area of using teaching strategies to the greatest extent. This is also confirmed by the achieved arithmetic averages (AM = 8.00; 8.11) and medians (Me = 8.25; 8.38) of the respondents in the mentioned areas of perceived fitness. Conversely, the lowest level of ability to use teaching strategies is perceived by CS teachers who have never heard of micro:bits (AM = 7.79; Me = 7.81) and those teachers who have only heard about micro:bits (AM = 7.92; Me = 8.00). From the above findings, it can be concluded that the more experience CS teachers have with the use of micro:bit in the educational process, the higher their level of perception of professional competence in the use of teaching strategies. At the same time, the ability to use a teaching strategy can be perceived as an important factor in the success of the educational process (Table 6).

Table 6. T2 Relationship between the perceived efficacy of CS teachers and their experience with the BBC micro:bit.

Perceived Efficacy Experience with the BBC Micro:Bit		Efficacy for Instructional Strategies	Efficacy for Classroom Management
Experience with the BBC mi- cro:bit	Correlation Coef- ficient	0.125 *	0.008
	Sig. (2-tailed)	0.014	0.873
	N	387	387

*. Correlation is significant at the 0.05 level (2-tailed).

From the empirical data presented in T2, it follows that there is a statistically positive relationship ($p = 0.014$) between the perceived proficiency of CS teachers in the field of proficiency in using teaching strategies and experience with the BBC micro:bit. Based on this, we can conclude that the more experience CS teachers have with the use of micro:bits, the higher they perceive their proficiency in the area of using teaching strategies.

5. Discussion

First we must address the first research question: Is there a difference in the perceived capacity to use instructional tactics based on micro:bit usage experience? We found that there was a statistically significant difference in people's perceptions of a professional's competency to implement instructional strategies. Teachers of informatics who have successfully completed training on micro:bit and have taught using micro:bit have the highest impression of their professional abilities in the area of employing various teaching approaches. We can find more research to support our outputs; for example, Thorsen's results indicate that the training has improved in-service teachers' self-efficacy in teaching programming, creating a lasting impact [92], and also had a significant impact on the pre-service informatics teachers' self-efficacy perceptions toward programming [93]. The research in Norway shows that a new curriculum in continuing education programming can improve teachers' self-efficacy in teaching programming and also indicated that the teachers' self-efficacy has increased with experience over time, and that it does not significantly decrease without experience over time [94]. Other results indicated that the professional development format that supported mastery experiences had the strongest effect on self-efficacy beliefs and the implementation of a new teaching strategy [95]. The relationship between years of learning and instructional strategies is evident among language teachers, as well between the years of learning [96].

It is possible to find studies that prove that using microcontrollers emphasized a positive attitude to programming [97–102]. In contrast, Ntourou et al. do not prove that using a microcontroller has an effect on motivation, and self-efficacy was proved only partially [103].

In contrast, instructors who have never heard of micro:bit, as well as those who have just recently heard of micro:bit, see the lowest degree of capability to execute instructional strategies. Physical computing seemed to have a significant overall impact on computer science PSTs' self-efficacy [104].

Second, we must address research Q2: Is there a correlation between classroom management and the micro:bit experience? There is no proof of this correlation in our research. Thus [105], a teacher may feel efficacious regarding instructional strategies, in a general sense, but perhaps not particularly for those strategies involved in literacy instruction, or a teacher may feel efficacious for the teaching of reading strategies, but not necessarily for student engagement or classroom management. Suell [106] shows that the classroom-management dimension is affected among the alternative teacher instructional strategies.

We found that the perceived competency of informatics teachers to apply instructional approaches was significantly correlated with their level of knowledge of using the micro:bit. The perceived competence of teachers increases with the experience of the teacher [107]. This seems to indicate that the number of years of experience that

informatics teachers have working with the use of micro:bits correlates with the level to which they think they are skilled at using instructional strategies.

We think it would be interesting in future work to perform similar research on the same group but using a different technology than the BBC micro:bit. This is because we feel it would provide interesting results. Concurrently, we were able to see the variations that were the result of the time gap. Additionally, it is possible that we will monitor the development of new technologies and the BBC micro:bit in Slovakia.

In addition, it would be wise to investigate the backgrounds of the teachers who were included in the sample but were rated as having a lower level of perceived competence, as well as the factors that led to this result. They might also investigate whether or how the level of the teachers in this group has changed and then look for ways to aid those educators. The delivery of support may take the shape of applications for financial grants and the provision of physical hardware, educational programs, forums, conferences, consultations, and so on.

In actuality, we met these teachers and often heard about great experiences from them. The teachers most commonly discussed their fear of programming and micro:bit, as well as how the grant application motivated them to program alongside their own pupils. When a teacher decided to apply for a grant in order to buy micro:bits and utilize them in his classroom, an interesting situation occurred as a result. When the ENTER competition in programming was founded, he took his student team and submitted it into the competition. Despite the fact that they had never taken part in a competition before, they came in second place in Slovakia. The teachers also shared with us that the students have an interest in micro:bits, favor programming, and anticipate learning about informatics.

We would like our future work to enrich the mentioned investigations with an analysis of the teaching process through a modified method of observation, i.e., microteaching analysis. The data obtained in this way will provide information not only about the quality of the management of the teaching process but will also reveal the possibilities of its efficiency and improvement [59].

6. Conclusions

Physical computing, which arose from the process of constructing real-world connectivity, is now a very popular subject of study. The BBC micro:bit is a pocket-sized, low-cost, programmable physical computing device that was created out of a desire to promote learning via physical computing, which has been proved to be both motivating and offers chances for cooperation and creativity. This device is capable of many computational activities. In Slovakia, we were involved in the organization of the so-called ENTER project, which involved a funding application, the distribution of hardware to schools, an online webinar, and a number of online courses. They focused their major research efforts on two distinct research issues assessed by the inferential statistics method for data processing. Our study is uniquely focused on perceived professional efficacy of informatics in-service teachers with the experience of using micro-controller BBC micro:bit. In this sense, weekly online micro:bit practices and supported materials were prepared. The results obtained from this study demonstrate that use of a microcontroller such as micro:bit had a positive impact on the self-efficacy of instructional strategies but not for classroom management.

First we must address our first question: Is there a difference in the perceived capacity to use instructional tactics based on micro:bit usage experience? These differences had a statistically significant influence on our results. Teachers of informatics who have successfully completed training on micro:bit and who have taught using micro:bit have the highest view of their professional abilities in the use of a range of teaching approaches. This is due to their actual usage of these devices in the classroom. Teachers whose pupils have never heard of micro:bit and those whose students have just recently heard about micro:bit have the least ability to execute instructional strategies.

Second, we must address Q2: Is there a correlation between classroom management and micro:bit experience? Individuals' knowledge with the micro:bit was shown to have a significant association with their self-perceived skill as informatics teachers and their ability to apply instructional techniques. There seems to be a link between the number of years informatics teachers have worked with micro:bit and their confidence in their level to use instructional strategies. This leads us to the conclusion that CS teachers assess their self-efficacy and skill in the field of teaching strategies to be higher the more experience they have with the usage of micro:bit.

Author Contributions: Conceptualization, Š.P., N.K., M.B. and M.C.; methodology, Š.P., N.K., M.B. and M.C.; formal analysis, Š.P.; investigation, N.K., M.C. and M.B.; Resources, M.C., N.K., Š.P. and M.B.; data curation, N.K. and Š.P.; Writing, M.C., N.K., Š.P., M.B. and E.K.; original draft preparation, N.K., M.C., Š.P. and M.B.; writing—review and editing, M.C., N.K., Š.P. and M.B.; visualization, Š.P., M.C., N.K., and M.B.; acquisition, M.C. All authors have read and agreed to the published version of the manuscript.

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

Data Availability Statement: The data presented in this study are available on request from the corresponding author. The data are not publicly available due to privacy issues.

Acknowledgments: We would like to thank the Telekom company for their trust and support in solving the project, as well as all the hundreds of teachers who completed the micro:bitization process with us.

Conflicts of Interest: The authors declare no conflict of interest.

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