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A systematic review of the use of BBC micro: bit in primary school

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Abstract

This paper is a systematic review of the literature on the use of BBC Micro:bit in primary education, including twelve empirical studies published from 2016 – 2020. This literature review's goal was to investigate studies on the effects of using BBC micro:bit for learning. The Goal, Question, Metrics (GQM) approach was adopted as it represents a systematic approach for defining and evaluating a set of operational goals using measurement. Informed by the established systematic review method, the present study undertook the review in three main Phases: Planning, Conducting, Reporting. The relevant data are grouped into four categories. Students and teachers adopt a favorable attitude towards micro:bit, show enthusiasm, and find it interesting. Students consider that it encourages creativity and can help them understand conceptual and procedural knowledge related to computational thinking and problem-solving. The small number of the available literature, especially on the primary education level, demonstrates the need for more empirical research. The lack of any summarization of existing research makes the systematic synthesis of this data essential as it will contribute to more comprehensive knowledge. A meta-analysis was performed to ensure the validity and reliability of the results.

Keywords: BBC micro:bit, primary school/education

1. Introduction

Education is called to qualify students for the knowledge that will enable them to proceed from the simple consumption and use of technological products to their critical analysis, even giving their technological solutions [1-2]. In this context, there is a growing interest in small programmable devices that can be used to teach computational thinking and problem solving [3]. BBC micro:bit is a programmable device and was originally introduced for purely educational purposes. It is a portable, low-cost device and a new, innovative and promising tool.

2. Method

2.1 Goal – Research questions

The increasing use of this device reflects the importance of its creators' project and the importance of the further investigation. The systematic review is expected to present findings in both the teaching and learning process. The following research questions guided this review:

• What experiences have been recorded regarding the use of the micro: bit by primary school students?

• What experiences have been recorded regarding the use of micro: bit by primary school teachers?

• What capabilities of the micro:bit can be exploited in primary school and what obstacles have been observed during its implementation in practice?

Our systematic review includes three stages: planning, conducting, reporting [4]. The research field mapping began with searching for necessary information about the BBC micro: bit from the official website on its features, capabilities, and current data from its release and use. The research questions were then identified, and the following search string according to the Boolean system was derived: (micro: bit OR microbit) AND (learning OR teaching OR learn OR teach) AND (primary school OR education OR elementary school).

This string began to be used in December 2020 in international online databases (ACM, ASEE, ERIC, Google Scholar, IEEE XPLORE, ProQuest, SCOPUS, Springer Science, Taylor & Francis). The research concerns sources written in English that have been published since 2016 (when the release of the micro:bit board started) until 2020. Besides, the search concerns sources that have been published in reputable journals and have free access. The keywords could be included in the article title, summary, keywords, or even within the manuscript.

Specific inclusion and exclusion criteria were established, and the PRISMA Statement was applied to collect, identify and analyze source data [5]. The Goal, Question, Metrics (GQM) approach was

adopted to define and evaluate research objectives systematically and using measurement [6]. The relevant data are grouped into four categories. Firstly, studies that present both students' and teachers' experiences, secondly studies that describe the possibilities or any barriers that may result, thirdly studies related to the effects on skill development and its possible connection with increasing motivation for programming.

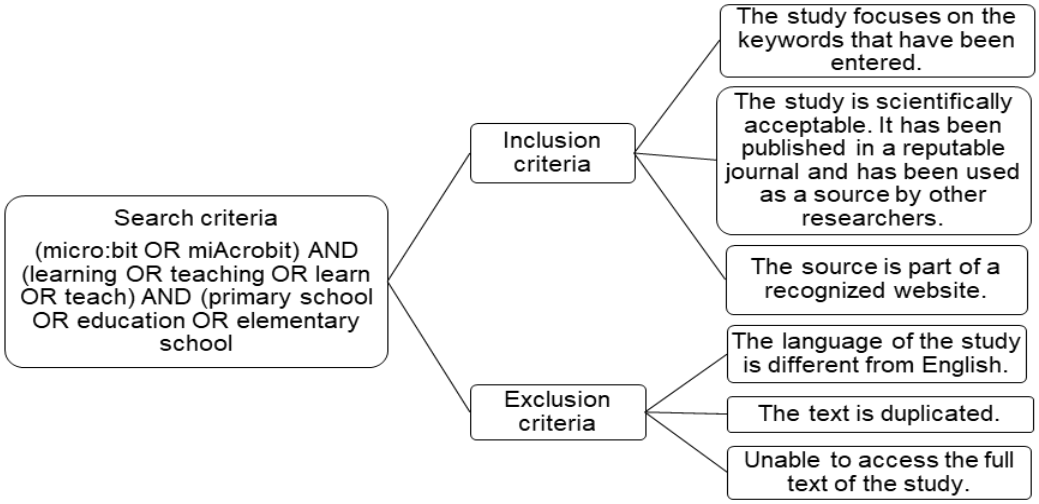

Fig. 1. Criteria for search, inclusion, and exclusion [4]

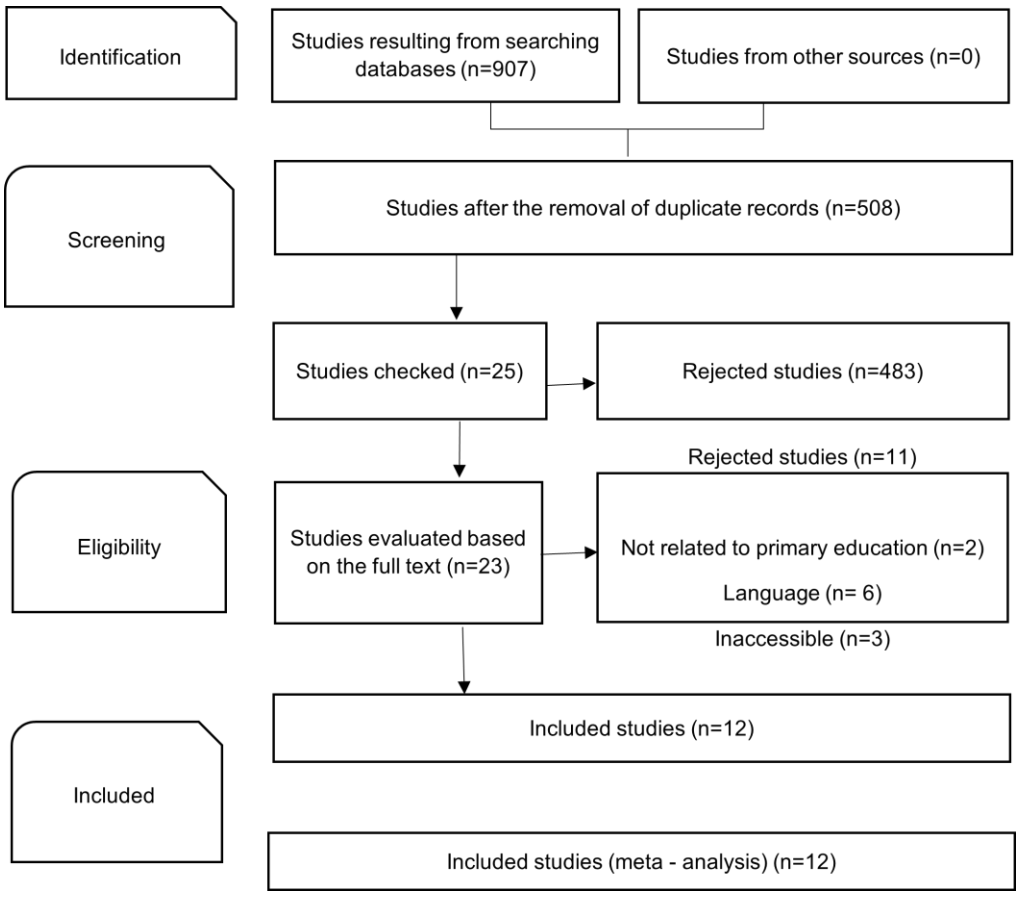

Fig. 2. Study selection phases [5]

3. Results

3.1 Student's experience

Particularly interesting and easy to use described the micro:bit by students, who view its integration positively into the learning context. They are actively involved in learning, have fun using such a tool, and feel satisfied during the learning coding [7]. Most students commented positively on the ease of use and usefulness of Micro:bit about understanding programming concepts and developing coding skills [3]. Starting with simple activities and gradually increasing the required level of knowledge, advanced concepts and skills can be taught [8].

It is also crucial for students to understand both the usage of building blocks in a technological solution, their role and understand the logic that governs the code, how to control the blocks and the flow of information that determines the solution's operation. Distinguishing all these parts will help to generalize this understanding in other cases as well [1].

Results show that students approach micro:bit in various ways [9] depending on their capabilities. Novice students approach coding through trial-and-error when more advanced students are aware of the coding process and can use the appropriate functions and blocks to get the desired result. [1-2]. Students also seem to associate the use of micro:bit with STEM lessons [10]. From their participation in activities with micro:bit, opposed views of students emerge. Some feel that the device has limited capabilities, and therefore, there is a limit to what they can learn from it [3].

3.2 Teacher's experience

Teachers seem to be experimenting with the implementation of various activities in which they utilize the capabilities of the micro:bit device. Most teachers' starting point was activities from the official website, while there are cases where teachers develop their original material or learning sequence [10]. This reflects the lack of confidence in teachers who prefer to start using a tried activity before developing their initiatives.

Teachers consider it essential to connect small programmable devices such as this one with everyday life to highlight their usefulness, contribution to learning and strengthen students' motivation [10]. Moreover, many teachers show great interest in further engaging with more advanced designs through micro:bit related to various topics and courses [11].

3.3 Possibilities – barriers

Various technical characteristics allow the teacher to differentiate the students' level of challenges concerning their needs and abilities [9]. Students often have problems with coding when using text-based programming languages. Block-based programming languages, as in micro:bit, alleviate writing problems and difficulties [12]. The teachers also mention practical difficulties [10]. The coding of micro:bit is usually done through online compilers (Microsoft MakeCode, python.microbit.org), so a reliable connection to the Internet is required [13]. Alternatively, some compilers do not require an internet connection but are not so easy to use. Besides, difficulties arise from teachers' lack of knowledge in computer science and programming languages [7].

Students report that by following activities offered by the website and step-by-step guidance, they do not understand the essence of what they are doing [10]. The shape of the blocks facilitates and guides students on how to combine them but is not enough to help students understand what blocks represent programming concepts, so generating code based on block shapes is challenging. Understanding and handling programming material includes procedural and conceptual knowledge that refers not only to the material itself but also to a general understanding of the concepts.

3.4 Impact on skills development and motivation in coding

Several students report that micro:bit allowed them to collaborate [10] with gamification elements [7] but also work individually [8]. micro:bit can be used as tool for developing problem-solving and programming skills and creativity and a pedagogical approach to STEM education. teachers [12,14].

Teachers describe the Micro: bit as an excellent motivation tool [12] but, there are cases of high-capable students that seem less enthusiastic due to the device's limited capabilities and not so advanced technology in their opinion. Moreover, some teachers noticed a decrease in the motivation of the students over time. micro:bit's integration in teaching seems to depend on the confidence and the level of knowledge of the teacher [8].

4. Conclusion

The use of micro:bit favors the positive attitude of students who find it fun and easy and are more likely to increase their involvement with it [9]. Despite the limited sample, the findings provide a clear picture of the experience in the use of BBC micro:bit [9]. It cannot be taken for granted that specific programming materials such as micro:bit automatically develop students' understanding of programmed technological solutions in everyday life [1,15,16].

The BBC micro:bit initiative is essential in encouraging physical computing in classrooms [11]. Pupils link the use of devices such as micro:bit with the interdisciplinary approach to STEM courses, language learning, art, demonstrating the potential impact of the device in the curriculum [8].

Students' contact with technology is essential to develop adequate skills to study and analyze existing programmable technological solutions (PTS) and design new ones (in our case with the micro:bit). As the use of micro:bit increases over time, there is room for more studies to better comprehend such devices in education [8]. Teachers facing this curriculum change need extra guidance on effectively teaching these new concepts to their students [2].

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