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Coding without (Age)Limits? Experiences with BBC Micro: Bit in Primary School

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Proposal information

STEM subjects (Science, Technology, Engineering, Mathematics) has an inevitable role in forming competency-based knowledge and developing of 21st century skills. The expected skills – algorithmic skills, problem-solving skills, self-directed learning skills – can also be fostered with teaching of the basics of coding. Therefore, integrating coding education and robotics into education at early ages all around the world is vital (Kanbul & Uzunboylu, 2017). As Kazakoff (2014) states, the permeation of the robotics can help the students' thinking turn from abstract to concrete. The advent of different entry-level programmable devices (e.g. Blue-bot, Bee-bot, different LEGO sets) and software (e.g. Scratch, ScratchJr, Lightbot, Kodu) can approve the development of the algorithmic skills beginning in the kindergarten instead of IT lessons in the primary school; after all using ICT devices (e.g. tablet) – even for assessment –can help to motivate children as well (Barrett, Jozsa & Morgan, 2017). One of the above mentioned physical computing devices is the BBC supported Micro:bit designed for educational purposes (Gibson es Bradley, 2017). This device was distributed almost worldwide, the Micro:bit consortium funded and produced over one million devices, enough for every 11-12 year-old in the UK (Sentence et al., 2017). The Micro:bit is a pocket-sized computer with a 5X5 matrix LED display, with sensors (e.g. accelerometer, compass, thermometer), with programmable buttons and with numerous forms of communication. It can be programmed with a computer or with different mobile devices. For programming the device several forms are available from entry-level block-based programming language (e.g. MakeCode, Scratch) to advanced-level (e.g. Python, JavaScript, C++) (BBC Micro:bit, 2015). With the wide range of programming environments the coding can be suitable for students with different abilities and ages, furthermore their problem-solving, self-

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directed learning and collaborative skills can be developed even in a multidisciplinary environment.

Micro:Bit was started to be used almost worldwide in the education amongst students with different ages. Large number of educators from different levels started to develop algorithmic skills and coding. From this perspective it can be generally vital to know whether there is any age limit for coding. Therefore, the aim of our research was to examine the applicability of the device and its software (MakeCode) and to have a picture about the student's attitude of programming and physical computing. We also put a stress on potential influential factors according to programming, therefore we examined the most related ones (gender, mathematical skills, frequency and insensitivity of computer usage). On the basis of our theoretical framework we hypothesized that (H1) The programming skills become better with age; (H2) The programming skills of the boys and the girls are different; (H3) The students' programming skills depends on their mathematic results; (H4) Those students who are active computer users are likely to achieve better results in programming and likely want to be a programmer. Our research questions were (Q1) What is the students opinion about the usage of Micro:bit and the different programming exercises? and (Q2) How the students conceive of the problem-solving tasks?

Methods

We made our research in a Hungarian primary school, where students learn information technology once a week from Grade1, but they had no previous experience with Micro:bit. The lower primary pupils (Grade 3-4) didn't learn anything about programming before, the upper primary students (Grade 5-8) learnt Imagine (former Comenius Logo) and block-based programming surfaces (e.g. Scratch and the different challenges of the "Hour of Code"). All students of the school were involved in the research, the only entrance condition was the confident mouse- and keyboard handling. Fitly to this condition 11 classes (Grade 3-8) took part in the examination (N=170); we had three classes from lower primary (n=43) and eleven classes (n=137) in our sample.

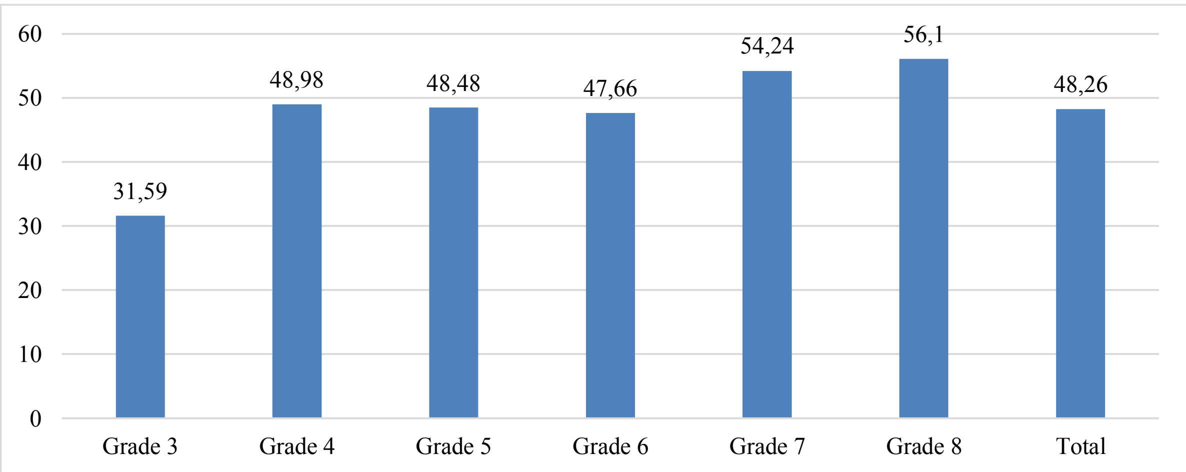
In our three-week-long examination the students worked with the Micro:bit and the MakeCode software for two lessons and at the third lesson they filled out the online questionnaire. The classes were divided into two groups so during the lessons the number of participants were between 8 and 16. In the first lesson the students could have a general perspective about the Micro:bit and they learnt the basics of the MakeCode surface. In the second lesson they revised the knowledge from the previous lesson in a modified format moreover they received new exercises based on the previous ones. Ten exercise which hierarchically built on one another were used to measure if students with various ages are able to comprehend and apply the necessary knowledge for the different levels of programming. The amount of exercises was built up such a way to surely fill in a whole lesson (45 minute).

During the data collection the results of the students were immediately recorded to an evaluation sheet after every single task. The performance of the students was evaluated on four different levels in a gamified way (with "little stars"). Zero star meant no solution, one star meant a partly good solution, two star meant a good solution with a little help and three star meant an excellent solution without any help. Because of the better comparability and easier interpretation, the "little stars" were converted into percentage points (*=33,33%; **=66,66%; ***=100%). During the third lesson the students filled out an online questionnaire which had eight items with a five level Likert scale, closed questions and the necessary background questions. We used SPSS 22.0 for data processing and we applied One-way ANOVA, correlation and frequency analyses.

Conclusion

In the second lesson of the examination the students received ten programming exercises with Micro:bit. As the exercises got harder the less pupils could solve; while the exercise1 were solved by 93,7% of the students, the exercise7 were finished less than 9% of the students. If we analyse the achieved percentage points by classes we can see that the score got slightly higher with the age, however the differences between the classes were minimal. Grade 3 achieved 31,59%, Grade 4, 5 and 6 achieved a mean percentage score of 48%, and Grade 7, 8 achieved 54,24% and 56,1% (ANOVA: $p<0,005$). These results show one major step in the percentage points, between Grade 3 and Grade 4 the difference is higher than 17%; this may mean that Grade 3 is that age when starting to code is the most optimal.

Figure 1: Achieved results (%) of the tudents, broken by classes (ANOVA: p<0,005)



We examined the students' results by gender if there is any statistical difference between the ability and skills according to programming. By the results of the eleven classes we can see that there is no significant difference between the genders (boys: 47,14%, girls: 49,79%). We also took a look at the students achieved results and their mathematic grade of the previous school year, but the statistical analysis doesn't show any major difference between them. The students' attitude towards the Micro:bit was

positive, over 90% "felt themselves" well during the programming, 57% of the students "found the programming easy", and in the case of problem-solving more than 80% found it useful. We also found that "computer usage activity" has a mild positive correlation with "I want to be a programmer later" (Spearman's correlation: 0,332; p<0,000) and a slight negative correlation with the achieved results (Spearman's correlation: -0,201; p<0,009).

Keywords: ICT, education, primary school, coding, programming

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