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Trends in Teaching Programming in Schools in Hungary

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Abstract. Programming education in Hungary has undergone significant changes with the new National Core Curriculum released in 2020. It introduced a new, revised Digital Culture curriculum in public schools as a successor to the earlier informatics subject. The new curriculum contains several new themes and topics, with a bigger emphasis on programming and algorithms. However, little is known about the effect of these changes on the teaching practices and tools used to teach programming. In this paper, we present the results of a survey conducted with schoolteachers, and data provided by the Educational Authority of Hungary. We identify the most common programming languages, environments and pedagogical methods used by teachers, to give a general overview of the trends in teaching programming in Hungarian public schools.

Keywords: programming, programming languages, teaching strategies, CS curriculum, Hungary.

1. Introduction

In Hungary the content of education in public schools is determined by the National Core Curriculum[1] (thereinafter NCC), a document issued by the government. The first NCC was issued in 1995, new versions were released in 2003, 2007, 2012, and most recently in the year 2020. While the NCC from 2012 is still in effect for students who started their current level of education before 2020, the latest 2020 NCC is already being implemented as well.

Informatics as a standalone subject was present in the NCC since its first 1995 edition. Even though the contents of the informatics subject went through a lot of changes through the years, the contents of the 2012 NCC was considered to be outdated soon after its release (Zsakó and Horváth, 2017). Textbooks designed for the 2012 NCC (Farkas, 2011; Rozgonyi-Borus and Kokas, 2018) had very little on algorithms and programming in general. In addition to some introductory programming with the Logo

[1] In Hungarian: Nemzeti Alaptantanterv, or NAT for short.

programming language, these textbooks only included code examples in the Basic and Pascal programming languages.

In 2020 the new NCC introduced a lot of changes to the informatics education landscape in Hungary. In addition to new themes, topics, and concepts, it contained changes to the high school final exam as well. The school subject itself has been renamed from informatics to digital culture. With the new NCC also came new textbooks for the digital culture subject. While in the past teachers were allowed to choose from several state-approved textbooks and exercise books, the new 2020 NCC has a single textbook for each subject for the given year and school type. With this change teachers no longer have the liberty to choose their preferred book for their classes. The new textbooks cover a more diverse set of programming topics than their predecessors. In addition to classic algorithmic programming, they showcase modern tools and environments like Scratch or Micro:bit boards. For advanced years the programming language of choice in these textbooks is Python.

In Hungary, the final exams (or graduation exams) are the final test for high school students before they go to university. Their score on these exams forms the basis of the score for applying to college. In addition to the contents of education, the NCC and related documents specify the contents of the final exams for each school subject. When it comes to the programming task of the final exam, both the current and the previous regulations allow the students to choose from several programming languages and environments. This provides a wide variety of options for teachers when it comes to choosing the programming language to use for teaching programming for their students.

Considering the changes in the National Core Curriculum and the overall changing landscape of programming education in Hungary, we decided to conduct research on the methods and tools that are being used in the country, as well as the changes and current trends in teaching programming.

2. Research Method

To create a map of teaching methods and technologies (i.e., programming languages, programming environments and other educational tools) that are currently being used in Hungary, a nationwide online survey was conducted with teachers who teach informatics, digital culture, or some other related subject in schools. Questions in the survey focused on the programming languages and environments the teacher uses, as well as the type of tasks they choose for their classes. We also asked what tools they used earlier but decided to abandon, to have a better understanding of the changes in the choice of tools.

We wanted to get differentiated information about the methods used for students of various age groups, thus our survey consisted of similar questions for years 1–4, years 5–6, years 7–8, years 9–10, and years 11–13. Hungarian school is twelve or thirteen years (some schools have an extra year for intensive language courses), usually divided into three stages. Years 1–4 is elementary school, years 5–8 is primary school, and years 9–12 is secondary school or high school.

To have a better understanding of the demographic distribution of the respondents, we also asked for anonymous data about the teachers themselves. These questions were about the type and location of the school where they teach, their level of education in teaching/pedagogy, and information about their years of experience teaching informatics-related subjects.

To complement the data collected with the survey, we also contacted the Educational Authority[2] of Hungary to request information on the programming languages and programming environments used by students on the final exams in informatics. The data we received about the final exams from 2013 to 2020 also provides some insight on the tools and methods that are being used to teach programming, even though we cannot observe the changes induced by the NCC of 2020 on this dataset.

3. Survey Results

The online survey was filled out by a total of 169 teachers. According to the Educational Authority and the National Institute of Vocational and Adult Education[3] at the time of the survey there were a total of 8038 teachers in Hungary who were teaching informatics or some other informatics-related subject. Of this total number, 4702 teachers work in general curriculum schools, and 3338 teachers work in vocational schools. Data from the survey responses was aggregated and analyzed. Where applicable, data entered in the freeform fields was merged with the responses for the predefined answers. Other information in freeform answers was processed manually to gain more insight on the trends and the reasoning for changes.

Demographic Data

As seen on Fig. 1a, respondents are evenly distributed between Budapest (capital of Hungary, 34%), county capitals (34%) and other cities (30%). With only four respondents, smaller towns and villages are not well represented (2%). As the 2012 NCC had no informatics subjects for the first four years of school, it is possible that many of the elementary schools in these smaller settlements don't employ informatics teachers at all.

Most teachers who filled out the survey (84%) have a university degree as opposed to those who posess a college degree (12.4%). While in the past teacher training was available on the college level, since 2006 all teacher training programs grant a university degree. This is well represented by that data about the respontents' academic training as seen in Fig. 1b.

[2] In Hungarian: Oktatási Hivatal.

[3] In Hungarian: Nemzeti Szakképzési és Felnőttképzési Hivatal.

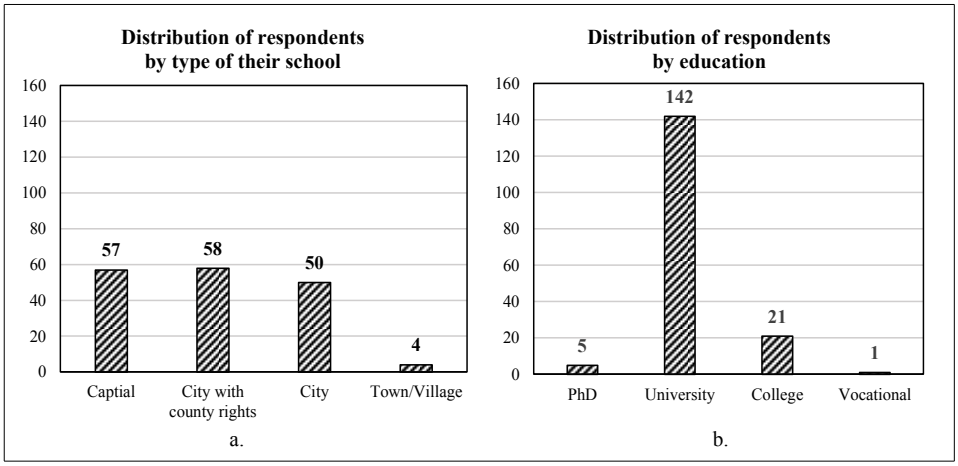

Fig. 1. Distribution of respondents based on their type of school (a) and their education (b).

Programming Languages and Environments

The biggest part of our online survey contained questions about programming languages and environments. We asked teachers to indicate what tools they use to teach programming to students of certain ages. As our default options we selected a mix of visual and code-based programming environments, but they also had the opportunity to add new options to the list.

As seen in Fig. 2 the most popular programming environment between years 1 through 8 is Scratch (with adoption rates of 62%, 81% and 49%), but it is still popular

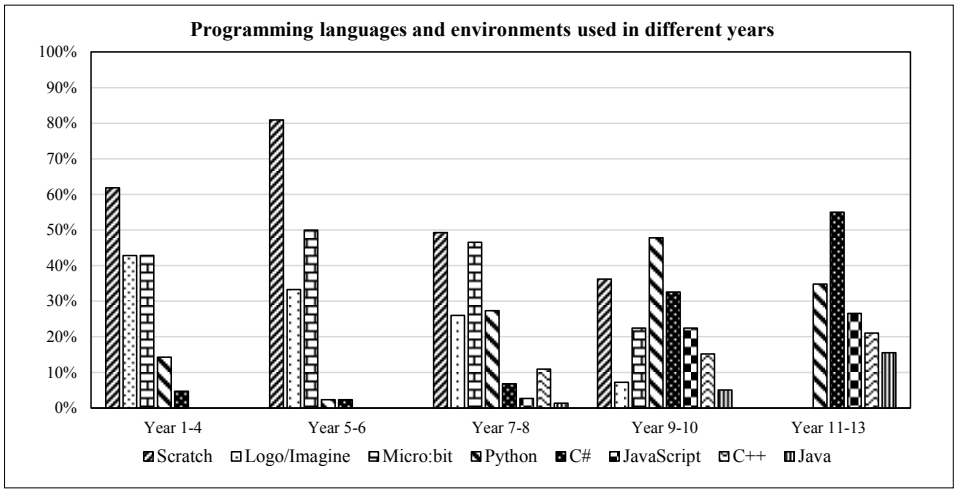

Fig. 2. Programming languages and envirommments used
for teaching programming for different age groups.

in years 9 and 10 (36%). Another popular choice throughout the years are Micro:bit boards. They are most popular also from years 1 to 8 (43%, 50%, 47%), but still used by some in years 9 and 10 (22%). This correlates with parts of the content of new textbooks for the NCC of 2020 (Abonyi-Tóth *et al.*, 2020; Abonyi-Tóth *et al.*, 2022, 2023; Lénárd *et al.*, 2020) that among others use these two environments for introductory programming for younger students. While Logo and turtle graphics is not present in the new elementary school textbooks (Lénárd *et al.*, 2021, 2022), it is still popular in the early years (43%, 33%, 26%), but it loses significance by the later years. Textbooks for these ages focus on teaching algorithmic thinking by the programming of virtual and physical robots.

As classical algorithmic programming goes, the new textbooks for years 9 to 11 (Abonyi-Tóth *et al.*, 2020; Abonyi-Tóth *et al.*, 2020; Varga *et al.*, 2020) use Python almost exclusively. Data from the responses show that Python is popular among teachers in these years (48% and 35%), but some teachers also use it earlier as well (27% in years 7–8). Other popular languages in the high school years are C# (33% and 55%), and C++ (15% and 21%). Java, a programming language that is also available for the final exams has lower numbers (5% and 16%). An interesting outlier in the later years is JavaScript, a language that cannot be used on the final exams, but it is still the 3rd most popular code-based language based on responses (22% and 27%). It is also worth noting, that Scratch is also used extensively in years 9 and 10 (36%), even though textbooks for these years already drop block programming in favor of code-based programming.

In our survey we also asked teachers about the programming languages and environments that they used in the past but have abandoned for some reason. We wanted to find out what are the tools and methods that teachers decided not to use anymore, and what was their reasoning to do so. Many respondents (roughly an average of 45% between years 7–13) said that they abandoned Pascal as they see it outdated compared to more modern options. Another language/environment that a lot of teachers mentioned in this category is Logo. Roughly 50% of teachers said that they used Logo in the past between years 1 and 8 but they decided to drop it. Many of these respondents said that they stopped using Logo in favour of Scratch.

Strategies for Teaching Programming

In addition to information about programming languages and environments, we also wanted to learn more about the types of tasks teachers use to teach programming to students of certain ages. We based our options on the strategies identified by Bernát and Zsakó (Bernát and Zsakó, 2017). These strategies include teaching programming and algorithmic thinking through turtle graphics, robotics, everyday algorithms, the creation of animations and graphical games, fundamental algorithms (mathematics-based) and application development (desktop or mobile).

As seen on Fig. 3, turtle graphics and robotics are popular methods in years 1 through 8. Even though Logo is no longer directly a part of the digital culture curriculum, it still

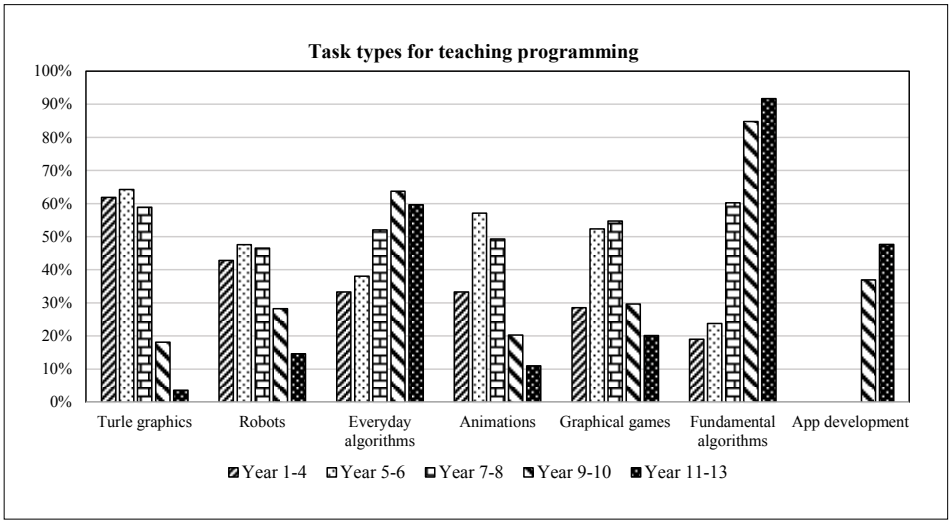

Fig. 3. Task types used for teaching programming in different years.

has around 60% adoption rate in these years (62%, 64%, and 59%). This could mean that teachers found new tools to teach using turtle graphics, as several respondents said that they abandoned Logo in favor of Scratch. The high numbers for the usage of robots (43%, 48%, and 47%) in these years aligns well with the new NCC of 2020 in which robotics gets a lot of focus in the early years.

The usage of everyday algorithms to teach programming is significant throughout all years. Interestingly it seems to be more popular in high school than in earlier years (64% and 60% in high schools compared to the 33%, 38% and 52% in elementary and primary school). The development of complex programs with graphical user interfaces is also used by a significant number of teachers in high school (37% and 48%[4]), but by far the most used method in this age group is the use of fundamental algorithms or programming theorems (Gregorics *et al.*, 2019; Szlávi *et al.*, 2019). Its use gets significant in years 7 and 8 (60%) and is used by almost all teachers in later years (85% and 92%). This is expected as the most popular programming competitions in Hungary as well as the programming tasks of the final exam focus almost exclusively on the usage of fundamental algorithms.

The creation of animations and graphical games teaching strategies for programming is most popular between years 5 and 8 with approximately half of respondents saying they use these approaches (57% and 49% for animation and 52% and 55% for games). Scratch, a popular tool for this age group can be used for both, so it can be a good choice for teachers who want to use these methods in their classrooms. The textbooks of the 2020 NCC also explore animations and games to a degree, but focus more on Micro:bit boards for this age group.

[4] Application development was not listed as an option for years 1–8.

4. Data on Final Exams

In Hungary final exams are organized biannually with one exam in the summer (May–June) and another in the autumn (October–November). As the normal time to take the final exams for students who finish high school is the summer, the number of students who participate in the exams of the summer period is significantly higher than those who take the autumn exams (ca. 11 times as much for years between 2013 and 2020).

Before the final exams in informatics, participating students must fill out a preliminary form to indicate the programming environment they want to use on the exam. The Educational Authority of Hungary has provided us with anonymous data about the responses from these forms for the exams between 2013 and 2020. The data we received contains information about both exam periods for each year, but as summer exams have a lot more participants, we opted to compare data for these exams to determine trends. Also, it is worth noting that the last year we have information about is 2020, so the changes triggered by the new 2020 NCC are not visible in the data.

On the form students only specify a programming environment, not the actual programming language. This means that we cannot get exact information about the programming languages used on the exam, but the environment is a good indicator of the language used. This means that for the analysis we grouped some programming languages together (e.g., C#, Visual Basic and Visual C++) as it is not possible to determine which one was used based on the data available. On the other hand, some environments in the list clearly indicate the programming language by listing the compilers available. We also have no data about the programming languages chosen by students who decided to take the exams on a Linux environment rather than Windows, as this is listed as a single environment on the form. The number of these students is very low (~0.6%) so omitting this data does not change the overall trends significantly.

As seen on Fig. 4, with consistently over 40% of students choosing it, the most popular programming languages on the final exams is the Visual Basic/C#/C++ group. While

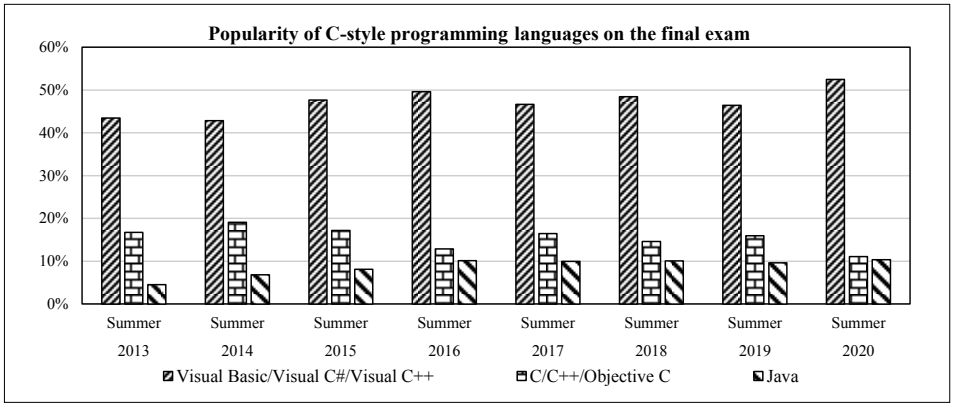

Fig. 4. Programming environments chosen by students on the summer final exams (2013–2020).

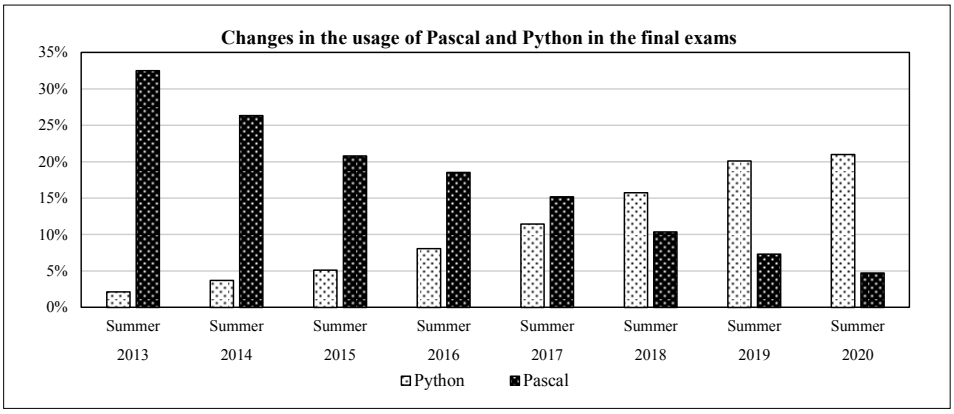

Fig. 5. The change in the popularity of Python and Pascal on the final exams (2013–2020).

based on the form responses we cannot tell which of the three indicated languages was used by the student, based on the results of the teacher survey it is logical to assume that most of the students in this category chose C# to solve the tasks of the final exam. This choice of environment shows a slight increasing trend in popularity with an average of about 1% per year increase in the investigated period.

C, C++, and Objective C are also in the same category based on the available options on the final exam form. These languages were selected by an average of 16% of the students with a very slight (~0.7%/year) decreasing trend between 2013 and 2020. With a similarly slight average change (~0.7% increase/year) Java is not particularly popular with an average of 9% of the students choosing it for the exams.

As seen on Fig. 5, the most significant changes in popularity can be seen in the usage of Pascal and Python in the given years. While popular in the past, the selection rate of Pascal dropped from 33% to only 5% in seven years. At the same time the number of students choosing Python has increased from 2% to 24% making it the second most popular choice. This trend is also indicated by the number of teachers who said in the survey that they use Python, and the high number of educators who said that they no longer use Pascal to teach programming.

5. Conclusions

With the release of the new National Core Curriculum in 2020 a lot of changes were introduced to the landscape of programming education of Hungary. With a bigger focus on algorithms and programming in the new curriculum we conducted an investigation on what programming languages, environments and task types are used by teachers in the country to teach programming, as well as the trends in the usage of programming languages in schools and the final exams.

Based on a nationwide survey conducted with teachers, we found that Scratch is a very popular tool in the country to teach programming, especially in elementary and pri-

mary schools. While Scratch is also used in high schools, the most popular languages for students of this age group are C# and Python. These languages are popular choices in the final exams as well. JavaScript is also popular in high schools, even though its use is not allowed on the final exams in informatics or digital culture. Other popular educational tools include Logo and Micro:bit boards. They are widely used to teach programming between years 1 and 8.

As for types of tasks, turtle graphics, robotics, and the creation of animations and visual games are the most popular methods to teach programming in the early years. In high schools tasks based on fundamental algorithms are dominant, with application development also being a relevant method. While used in every age group, the usage of everyday algorithms to deepen students' understanding of algorithms seems to be more popular in later years.

On the final exams between 2013 and 2020 the most popular programming environment of choice for students was Visual Studio. This indicates the popularity of C# for solving the programming tasks of the exam. The usage of Pascal is in a rapid decline in the final exam, while Python is becoming more and more popular.

While the data we collected through our survey and the data received from the authorities helped us to have a better understanding of how we teach programming in the schools of Hungary, due to the recent modifications in the framework of informatics education, it is important to repeat this research in the upcoming years to see what changes were caused in the trends in teaching programming.

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