Guess the Number! Implementation of the Game in Scratch: A Case Study for the Sixth Grade of Elementary Schools[*]

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Abstract: The teaching of Informatics in the 5th and 6th grades, in the section "Controlling and Programming" of the curriculum, usually includes the student's understanding "that the computer executes instructions received from man in a coded form" and the use of simple commands "to create shapes or the solution of simple problems." Scratch's easy-to-use and playful programming environment allows students to move from the world of educational games to Scratch programming through a fairly smooth process. Fundamental concepts such as variables and basic programming structures appear in the students' cognitive horizon and are acquired to a satisfactory degree in terms of their age and existing experiences, mainly through the desire for exploration. Thus, the Informatics course attracts students' interest in discovery and participation and makes the teaching of basic programming concepts easier and more friendly to them. The implementation of the game by 6th grade students had very satisfactory results.

Key words: scratch, programming, variables, structured programming

1. Introduction: Programming in the Educational Process

Computer programming is a very important skill. Research studies have shown that it contributes pedagogically, motivates the cultivation and development of high-level skills and higher forms of thinking, as well as the processes of transferring problem-solving skills to other areas of knowledge and objects (Κωστελίδου et al., 2015; Papert, 1998). Computer programming is a key component of digital literacy, which allows modern citizens to become active producers of interactive digital content on Web 2.0 (Peppler & Kafai, 2007). The cognitive value of teaching programming to secondary school students has been widely accepted since the early 1980s. However, its introduction into the upper classes of primary education has been gradual during the previous years (Δελτσίδης, 2012).

The traditional teaching of programming has resulted in being considered by the students as a difficult, tedious, boring, insignificant and antisocial task (Kay, 2011; Forte & Guzdial, 2004). It was observed that the lessons in programming were usually frustrating for both students and teachers because they often failed to arouse students' interest, while the teaching itself presented several difficulties and misunderstandings (Δαγδιλέλης,

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1996). The need to memorize a command repertoire and ultimately focus on the search for syntactic errors in the code has resulted in distracting the student from more fundamental teaching issues such as the concept of variables and programming structures. It is worth noting that the didactic usefulness of the algorithm of this game has already been applied and researched to high school students (Κυριακού, 2012; Κωστελίδου & Βασιλειάδης, 2015) and in the present case extends to students of upper grades of elementary schools. Finally, early childhood familiarity with ScratchJr to a small number of students confirmed the importance of utilizing this special edition of the environment (Παπαδάκης et al., 2015).

2. Description of Teaching Process and Implementation Methodology

The taught subject is usually part of the teaching curricula of the Informatics course of the 5th and 6th grades of elementary schools. It was actually implemented during 12 teaching hours according to the weekly course schedule. The students worked in groups of two or three as usual. The learning challenge was to identify whether the children could describe in steps the process of the game itself, understand the code given to them, explain it based on their own understanding, implement it in the specific programming environment and, consequently, to adapt it according to their imagination.

2.1 Required Equipment

The school's computer lab that was used for the particular implementation included 12 computers with sufficient capabilities in this case. The 44 (22 + 22) students of the two classes of 6th grade were divided into mixed groups regarding their sex and performance abilities of two or three people in 12 workstations, while the teacher played a supportive and encouraging role. The *Guess the Number!* game was implemented using the online version of the Scratch programming environment. The students were familiar with the online platform of Scratch and had active accounts on it since they were in the 5th grade. After a few repetitive lessons and the implementation of simpler exercises and games, the students were adequately equipped for the challenge posed by this task.

2.2 Students' Motivation

Being aware that students have only a basic knowledge of mathematics, the approach to exploring the code of the *Guess the Number!* game was made in order to familiarize themselves with the above concepts in a way that is as unnoticeable as possible. Through their desire to produce the final result, students sought to explore ways in which they could achieve it. Thus, various methods were used in practice. More specifically, in the beginning the IT teacher played the homonymous game with his students without the use of a computer. Then, this process was represented in the table. Emphasis was repeatedly placed on the "boxes" in which they should "store" the different "answers"-values during the game. The step-by-step process of the game was also emphasized and it was clarified that for each next step the collection of specific information had to precede. In addition, the concept of selection was gradually clarified as the course of the game depends directly on "whether" this or that applies.

2.3 Students' Prerequisites

During the implementation phase of the game, a prerequisite was the prior acquaintance and contact with the Scratch environment (Δελτσίδης, 2012). While the majority of students had a satisfactory and sufficient Scratch experience, a small group of students proved to be unaware of the "game-making" environment. Nevertheless, through collaborative teaching and due to the immediacy of the specific programming environment, these students

were also directly and with particular interest involved in the process. The "drag and drop" feature so that to construct a series of commands was quickly realized and immediately put into operation. Another thing that impressed the students was the ability to interact with the end user-player and to dynamically receive the necessary information each time the program was executed.

There were also some issues regarding the understanding of the logic for the implementation of the game as well as the ways of implementing the code in Scratch. For example, the notion of two protagonists (sprites) each having its own "space" where the commands are given to them regarding to what they are expected to execute was recorded as something that had to be explained in more detail to the students. Similarly, the introduction of variables and the clarification of the scope and role that each of them may have was an issue that needed further explanation in a way that is comprehensible and responsive to students' prior knowledge and experiences (Φεσάκης & Δημητρακοπούλου, 2005; Τζιμογιάννης & Κόμης).

Finally, the visual-artistic part fascinated the students. They had the opportunity to freely create the "space" — background of the game as well as to choose according to their preferences the two protagonists. Thus, some chose to talk between land or sea animals while others preferred human characters.

2.4 Further Exploration

The involvement of the students and the joy of the creation culminated with the participation of the children in the 8th Student Conference on Informatics, which took place on April 19–21, 2016 in Noesis Thessaloniki Science Center. A group of students representing both classes presented the game code to an audience of students from other schools using a video projector and then explained the function of the code and answered the questions of the listeners-students (see Βασιλειάδης, 2016, where the purpose and rules of the game itself and how they are implemented step by step in Scratch code are written down).

2.5 Overall Impression on the Implementation

Based on the overall experience of this particular project as observed in the cognitive changes of the students, it became clear that the students of the last grade of the elementary schools can with proper preparation conceive and process more advanced programming concepts in the Scratch environment. A necessary condition for the effectiveness of the activity proved to be the sufficient prior acquaintance of the students with the specific programming environment, either on-line or off-line. The educational use of ScratchJr in infancy can play a crucial role in the pace and degree of subsequent progress of students. Finally, the existence of one PC per two students at most also contributes greatly to the optimal response of students.

3. Conclusions

Overall, this attempt had unexpectedly positive results and it became clear that the Scratch environment can easily and playfully introduce and promote young students to the world of algorithmic and programming utilizing their logic and creativity. The experience of exploring and implementing the game was enjoyable and instructively effective. The students' interest was activated and the teaching of the programming concepts became in an easy and familiar way for the students, due to the graphical environment, but also to the rest of its inherent characteristics, encouraging the students to participate to such an extent as with video games or animated films (Dann et al., 2012).

It was also confirmed for the children of the upper classes of primary education, that through such a graphic environment, programming is taught more efficiently, attractively and in a funny manner, since technology-based learning can be indeed fun (Papert, 1998). As seen in practice, it evokes immediate student satisfaction which speeds up the learning cycle and helps him approach programming in a more imaginative way that encourages the development of skills.

4. Scratch Code

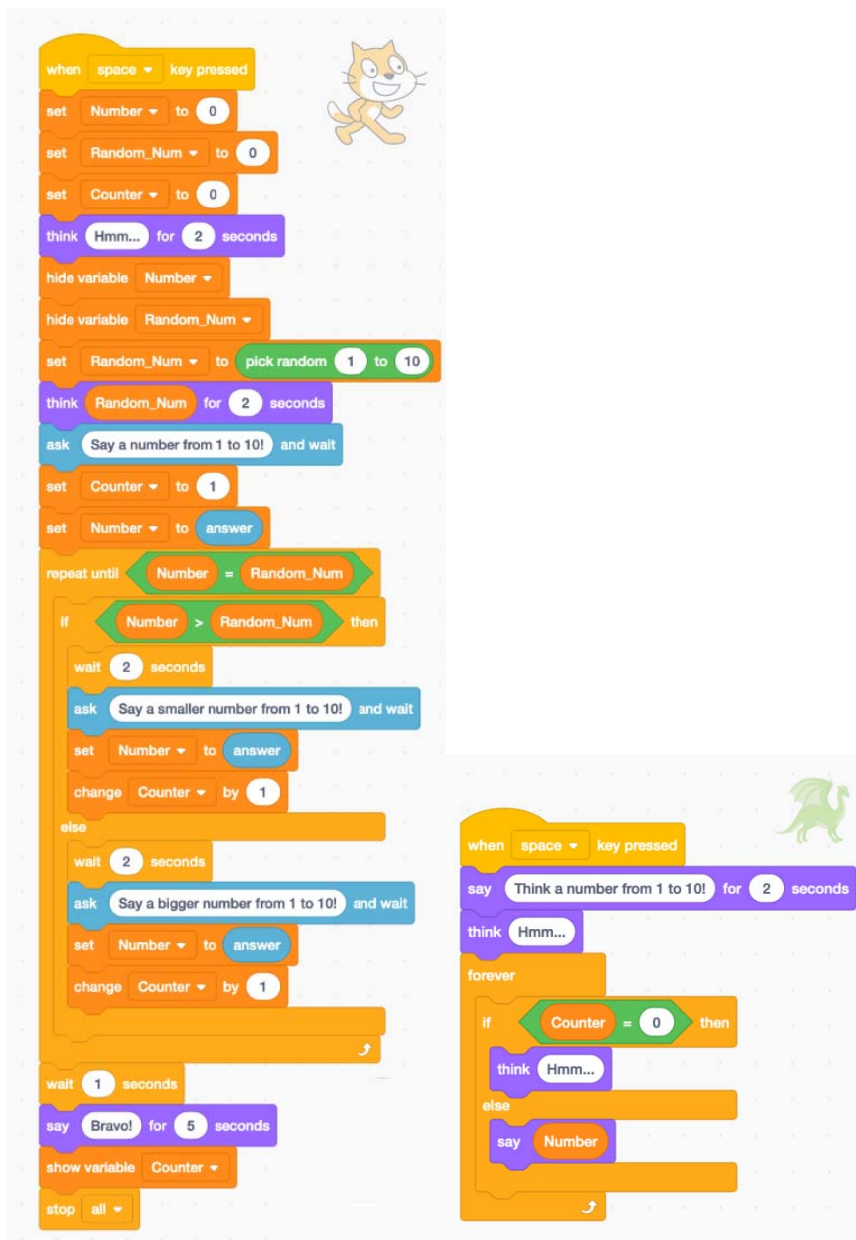The code used in this project is accessible in English in the following web site: https://scratch.mit.edu/projects/435261000/.

Figure 1   Character A (left) and B (right)

5. Samples of the Implementations by Greek students

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