

Researching on the Implementation of Graphic Programming

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Abstract. This paper expounds the role of graphic programming education for primary and middle school students and vocational students in the process of programming learning through examples. According to the characteristics of graphic programming, combined with the intelligence level and learning characteristics of them, a set of efficient education methods put forward. At the same time, the paper expounds the relationship between graphic programming and cross-subjects, as well as the reasons for strengthening and improving students' abilities, and comprehensively discusses the role of graphic programming in different stages, such as primary, secondary schools and higher vocational.

Keywords: graphic programming, programming level test, programming education, quality education.

1. Introduction

After years of development, Graphic programming (GP) [1][2] education has been quite popular in foreign primary, secondary and university education systems [3]. Our country emphasizes the necessity of programming education in the newly formulated primary and secondary education outline, and begins to make it more independent from information education, which is clearly indicating the importance of programming education in primary and secondary schools [4][5]. In July 2017, The State Council also issued a Notice on the "Development Plan of the New Generation of Artificial Intelligence", which clearly proposed that courses related to artificial intelligence should be set up in primary and secondary schools to gradually promote programming education [6].

Whereas, it is relatively popular in a few developed provinces of China, such as Shandong, Zhejiang and Jiangsu province. At present, most primary schools in our country do not set up regular programming courses, a few schools in the form of interest classes. There is no unified teaching material, outline and teaching program, and the corresponding hardware and software supporting facilities and teachers [3][8]. The same is true in the middle school, a few key schools will give priority to primary school graduates with strong programming skills, and form school teams to train them, hoping to win prizes in major competitions related to artificial intelligence and informatics. In the secondary, higher vocational and undergraduate education stage, there is no GP courses or related content teaching requirements.

2. Related works

Following the national policy of developing quality-oriented education and strengthening steam education, many researchers have invested in this field in recent years [7-17]. Zhao Yiyun, Liu Yue et al. proposed the implementation model of primary school programming curriculum based on steam education concept [7-8]. Hu Weiping et al. made an in-depth analysis of all aspects of steam education. They not only clearly proposed that teachers should strengthen situational interaction with students' psychology or behavior which are helpful to complete cognitive (thinking) interaction, emotional interaction and behavioral interaction based on projects, innovative design, task exploration and other processes, but also recognized the role of GP education in steam teaching [9]. Wang Xiaoxia and Hu Huiting actively explored the role and methods of GP in programming and physics teaching in middle school [10-12]. Wang Xihua and Jian Huilian have made meaningful attempts on the methods and strategies of GP education in primary schools [13-14]. Li Dongjun, Peng Zhijun, Ma Qiang et al

discussed the active auxiliary teaching role of GP in Python, C++, Flash and other courses in secondary and higher vocational education [15-17].

Although there have been more and more researches in this field, most of them only focused on the students of a certain age. Moreover, they did not rely on a quantifiable standard to deeply analyze the teaching effect and propose a strategy that could be implementing in practice.

This paper argues that the teaching of GP should have some relevance and continuity from primary school to university. At present, GP teaching is still necessary in secondary, higher vocational and undergraduate stages, because it has not been popularized in primary and secondary schools, and most students lack basic programming knowledge and skill.

3. Research works

This part first describes the knowledge and skills involved in the process of programming, and then take the grade requirements of "Youth Artificial Intelligence Programming Proficiency Test" sponsored by the Ministry of Industry and Information Technology & Audio-Visual Education Association as the standard to detail the specific content that students are required to master in each stage. In second and third part, it analyzes the levels that the students can reach in different periods. A teaching strategy is putting forward that should be useful in each grade of the middle and primary school as well as the middle, higher vocational and undergraduate stages. At last, it also briefly explains the reasons why GP can promote the improvement of Chinese class, mathematics and logical thinking ability in primary school.

3.1 Main content of GP and MIIT-GP test

GP tools use building blocks as statements. In addition, all of them divided into several categories with different colors and shapes, which is very convenient for students to remember and select. Although graphic based, it is also can be used to develop some sophisticated games, such as "Plants vs. Zombies", "Tetris", "Army Chess".

At present, there are many brands and companies related to GP in China. Some famous ones also provide relatively complete course videos that can support teaching plans. For the convenience of narration, this paper takes the grade requirements of "Youth Artificial Intelligence Programming Proficiency Test" as the standard [20], which is sponsored by the Ministry of Industry and Information Technology (MIIT) & the Society of Video Education. In addition, introduces in detail the skills and knowledge points should master in each stage of programming, as shown in Table 1. As can be seen from Table 1, from the primary to the senior level, the requirements for students in the application of program design and related modules are constantly improving. At the third level, it is very clear that the algorithm has specific requirements, which means the requirement of students' logical thinking ability.

Table 1. The requirements of Youth AI Programming level test

Test level	Syllabus requirements	Assessment point
First	Understand the basic definition and concept of the program, have the logical thinking of the program, can read simple programs; Have ability to write simple programs using common building blocks of graphical programming software (scratch or blockly).	Familiar with programming software, basic computer operations, common file management functions, role setting and attribute setting, input/output, mouse and keyboard event processing, use of detection modules, simple mathematical operations/logical operations, understanding and positioning of rectangular coordinate system, three basic program structures and repeat/wait.
	Understand the relationship between	

Second	artificial intelligence and programming, have a preliminary programming thinking; Able to understand and write more complex programs in graphic programming; With simple data calculation concept, can solve simple problems through graphical programming.	Complex relational expressions, nested use of multiple loops and conditional judgments, use of variables, drawing a variety of simple multilateral shapes, broadcast messages, simple flow charts, random numbers, etc.
Third	Have a preliminary understanding of the existence of algorithms in the program, have the abstract ability for simple problems; Ability to analyze tasks and propose different solutions; Can evaluate different methods of the same task, analyze and improve the program of graphic software.	Understand program operation process, binary/decimal conversion, understand function/write simple homemade building blocks, understand synchronous/asynchronous execution, timer, skilled in various arithmetic building blocks, string operation, list operation, understand and simple use of enumeration/recursion/sorting algorithm.

3.2 GP strategy in primary school and secondary school

In primary school, this paper mainly focus on the grade during 1-5 at aged 6-12. As we know, the age difference between students in the same grade is about six months. In addition, because of learning of programming is more age-related, so age is the parameter for the convenience of expression. Presently, programming education in primary school is mainly in two forms: after-school interest classes in schools and small-class classes in training institutions. In the experiment, two methods considered. At the end, an implementation plan and strategy put forward.

For interest class, teaching twice a week, one hour each way (holidays, summer and winter classes are not). Small-classes held once a week for an hour and a half.

As can be seen from the data in Table 2, most students with zero bases can pass the second Level test after 2-3 years of study, and a few can pass the third level test. After three to four years of study, nearly half of the students can pass the third level test.

There is a clear watershed in the pass rate of the second Level around age 8, mainly for the following two reasons: Students before the age of 8 still have some difficulty in understanding the subject; Logical thinking ability is still in the initial stage of enlightenment and development.

The pass rate of the third Level differs greatly from that of the first Level and the second Level, mainly for the following reasons: Students fail to meet the requirements of the third Level on algorithm and corresponding logical thinking ability; The questions of the third level programming pay more attention to the ability of logical thinking, which gradually loses the interest of GP; With the growth of age, some students' interests transferred.

Table 2. Annual pass rate of students during different age

Age	6--7	7--8	8--9	9--10	10--11
First level test(%)	81.1	92.3	99.1	100	100
Second level test(%)	0.5	26.3	93.4	100	100
Third level test(%)	0	0	7.2	23.1	54.4

Note: The annual pass rate for each level is cumulative with students who have previously passed.

In addition, the figures do not include the small number of students who

Therefore, this paper suggests that the teaching of interest classes should based on the first level in the first grade and grade two. In the third grade and fourth grade, teaching content related to the third Level should more suitable. In the fifth and sixth grade, we should strengthen the algorithm learning

and improve the program complexity, and organize students to participate in some high-quality competitions.

GP study in middle school is different from that in primary school. As middle school students have been out of the enlightenment stage of logical thinking, compared with primary school, they have a stronger mathematical foundation and understanding ability. Therefore, even for students with zero foundation, the understanding and mastery of graphical programming can achieve in a relatively short time, without more complex algorithms and data structures are involved. Therefore, GP is better to help students in mathematics, physics and other subjects [9-12], which requires the design of appropriate programming cases according to the content of the subjects.

Secondly, for students who choose science and engineering colleges and majors in the future, especially computer, automation, artificial intelligence and other related majors, courses of Python or C++ can offered, and GP can be integrated into the initial learning stage to assist in the transition from graphic to high-level language. GP is intuitive and interesting. It plays an irreplaceable role in the primary stage of cultivating students' programming skill and understanding algorithm implementation.

3.3 GP strategy in Secondary, higher vocational and undergraduate stage

At present, GP paid no much attention in middle and higher vocational schools, especially in undergraduate education. Only a few middle and higher vocational teachers try to combine it into the teaching of programming languages such as C++ or python. The graphical code is compared with the code of high-level language to help students had better understand [13-15], and good results have been achieved.

In fact, graphical programming can be treating as pseudocode that also can execute. Therefore, graphical programming languages and high-level language teaching does not conflict. At the same time, based on the experimental data in primary school, it also proves the effectiveness of GP for zero-basis students. Therefore, for a group of junior college students (72 students in total), the following teaching scheme is adopted in the experiments of C++ learning process: The total class time is 60 hours, 15 weeks in total. In the first 5 weeks, only study GP. 1-3 programs were required to complete during each class. The level of level 3 was finally reached. Including proficient in the use of three kinds of program structure, variables and lists, understand and complete the program using selection of sorting, bubble sorting, binary search, enumeration and function. From the 6th week, students gradually transfer to C++ content. Following the principle of "learning by doing and learning by doing" [18], about 25 minutes are spent in each class to introduce relevant knowledge points, and 1-2 programs are required completed, which are part of the textbook routines, part of rewrite previously done in the GP.

In the experiment, the students always maintained a strong interest in the learning process of GP, and more than 80% of the students completed all the sixteen programs. In the early stage of the transition to C++, due to the low overall quality of students, they lack the ability to master keywords, grammar, error correction and debugging. However, based on the preparation of the early GP studying, boredom and fear of high-level programming language learning eliminated well. Their interest in code programming did not significantly reduce. More than 30% of students have completed all the programming tasks. The effect is better than expected. In order to explain the experimental results better, the final statistical data only refer to the real test paper score. Table 3 is a comparison between the statistical results of the experimental class and those of previous students without using GP.

Table 3. Statistics and comparison on paper score

	Poor rate % (≤ 30 score)	Pass rate % (≥ 60 score)	Excellent rate % (≥ 85 score)
Previous students(without using GP)	7.3	63.1	2.1
Experimental class students	3.4	87.6	10.7

It can be seen from the experimental data that although the overall learning ability of the students are poor, the passing rate and excellent rate of the students' test scores have been greatly improved, and the proportion of low scores has also been significantly reduced. This shows that GP is also a very effective teaching method for college students. At the same time, using GP teaching to cultivate programming skill and algorithm foundation, and then gradually transfer to advanced language, which can be regarded as a more effective teaching strategy in the middle, higher vocational and undergraduate stage, worthy of more in-depth research.

3.4 Relationship between GP and other cross-subjects in primary school

Programming education focuses on cultivating students' ability to analyze and solve problems, and instructs students to complete program in accordance with the process of "analyzing problems--decomposing functions--composing by roles--testing". In this process, understanding ability improved at first; include understanding a large number of nouns and verbs as well as prepositions, adverbs and adjectives.

The second is presentation. They need to explain the problems encountered more clearly to the teacher, so that their expression ability can continuously improved in the process of communication.

The third point is the improvement of mathematical ability. Programming inevitably involves a lot of mathematical knowledge, such as variables, coordinate systems, positive and negative numbers, decimals, angles, polygons, random numbers, and so on. Most of this mathematical knowledge is not involved until the fifth grade of primary school [19]. However, through the learning of programming, students can easily master it in the process of "using before understanding". In addition, such as arithmetic/Fibonacci series, daffodil number and some other complex math problems, for the students who have pass or the second level test, it is not difficult to understand and finish program.

The fourth, and most important, is to improve the ability of logical thinking. Programming involves sequence/branch structure, conditional judgment, repeated execution, recursive call, function, serial/parallel concept, message passing and response between roles, decomposition problems and so on, all of which is good practice for thinking more logically.

Finally yet importantly, programming helps students develop their creativity, imagination, concentration, manipulative ability and many other aspects. It can say that programming is a high quality platform, which can apply multidisciplinary knowledge comprehensively and cultivate students' comprehensive quality.

4. Conclusion

This paper combines the author's own teaching experience and experimental data, summarizes the relevant experience and data of peers, and expounds the important role of graphic programming. Aiming at the teaching of GP in primary, middle and university stage, this paper puts forward the teaching strategies for different age groups, and analyzes the teaching contents and methods in each stage, which has certain practical guiding significance.

In primary and middle school, combined with the interdisciplinary knowledge involved in GP education, as well as the achievement and ability performance of experimental students, this paper lists the benefits of GP education in mathematics, geometry, understanding ability, expression ability, logical thinking ability and other aspects. It also explains the important role of GP education in culture of knowledge understanding, comprehensive ability and quality improvement.

In the middle and higher vocational stage, the special role of GP for advanced language learning explains through experiments, and the specific teaching methods have made a meaningful exploration.

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