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## ANALYSIS OF PROGRAMMING EDUCATION AT THE PRIMARY EDUCATION LEVEL

**Abstract.** Programming education has traditionally been provided at the undergraduate level worldwide. However, in recent years, there has been a growing trend in developed countries to introduce programming education at earlier ages with the aim of promoting software literacy, improving programming skills, and making programming education accessible to a wider audience. While some countries are updating their informatics lessons to include programming, others are incorporating programming lessons into their primary education curriculum for the first time. The level at which programming training is offered also differs between countries. The objective of this research is to explore how countries have integrated programming education into their curricula and to identify the differences between countries in terms of programming education. The study aims to answer the question of how programming education is provided at the primary education level both domestically and abroad. The research has found that programming education is increasingly recognized as important and many countries are now allowing programming lessons in their education curriculum, with some countries even introducing programming education in kindergarten. However, there are variations in the programming languages used and the skills taught to students across different countries.

**Keywords:** Computer Programming, Programming Education, Primary Education, ICT, children coding

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**Аңдатпа.** Программалау дүниежүзілік бакалавриат деңгейінде дамыған және білім жүйесіне енгізілген. Бірақ соңғы жылдарда дамыған мамандандырылған елдерде компьютерлік қабілеттерді дамыту, бағдарламалау қабілеттерін жақсарту және программа жетекшілігін әр түрлі аудиторияға тиімді етіп отыру мақсатында программалау білімін бірнеше жасқа кеңейту тенденциясы бар. Біраз елдер информатика пәніне

программалауды қосып, жаңадан жобалап курстарды жаңартуда, бәрі бірінші рет программа жағдайында оқу бағдарламасына программалау курстарын қосу үшін жұмыс жасайды. Программалау білімін беру курстарын саралау және елдер арасында программалаудың ерекшеліктері мен ұқсастықтарын анықтау мақсатында зерттеу жүргізілді. Зерттеу мақсаты программалаудың дербес оқуда және шетелде бастауыш сынып деңгейінде қалай қалыптасқанын анықтайды.

**Түйін сөздер**. Бағдарламалау, білім жүйесіндегі бағдарламалау, бастауыш білім беру, информатика, код жазатын балалар.

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**Абстракт.** Обучение программированию традиционно предоставляется на уровне бакалавриата во всем мире. Однако в последние годы в развитых странах наблюдается растущая тенденция вводить обучение программированию в более раннем возрасте с целью повышения грамотности в области программного обеспечения, улучшения навыков программирования и обеспечения доступности обучения программированию для более широкой аудитории. В то время как некоторые страны обновляют свои уроки информатики, чтобы включить в них программирование, другие впервые включают уроки программирования в свои учебные программы начального образования. Уровень, на котором предлагается обучение программированию, также различается в зависимости от страны. Целью данного исследования является изучение того, как страны интегрировали обучение программированию в свои учебные программы, и выявление различий между странами с точки зрения обучения программированию. Исследование направлено на то, чтобы ответить на вопрос о том, как обучение программированию предоставляется на уровне начального образования как внутри страны, так и за рубежом. Исследование показало, что обучение программированию все чаще признается важным, и многие страны теперь разрешают уроки программирования в своих учебных программах, а в некоторых странах даже вводят обучение программированию в детском саду. Однако существуют различия в используемых языках программирования и навыках, которым обучают студентов в разных странах.

**Ключевые слова:** компьютерное программирование, обучение программированию, начальное образование, ИКТ, кодирование детей.

*Introduction*

Currently, it is frequently emphasized that students all over the world should learn programming. It is argued that certain skills such as problem-solving, creativity, and higher-level thinking, which should be possessed by individuals in the 21st century, can be gained through the teaching of

programming and computer science [1, 2, 3]. In this context, the importance of programming education has been realized worldwide, and many countries have made arrangements in their curriculum programs. While some countries update the content of their informatics lessons in their primary education curriculums, others include programming lessons at various levels for the first time. Additionally, the level of classroom in which programming training is given and the skills that are intended to be developed through this education vary among countries.

According to a study conducted by the European School Network in 2015, it was stated that 18 European countries have included programming education in their primary education curriculum, and these countries have included programming education in their curriculum programs for various reasons. The countries and the reasons for including programming education in their curriculum are presented in Table 1.

Table 1. 18 European countries that include programming education in their curriculum and their reasons for including this education.

| | Supporting Logical Thinking Skills | Supporting Problem Solving | Engaging Students in IT | Supporting Coding Skills | Supporting IT Employment | Supporting Other Key Competencies |
|---|---|---|---|---|---|---|
| Austria | + | + | + | + | + | + |
| Belgium | | | + | | + | + |
| Bulgaria | + | + | + | + | | |
| Czech Republic | + | + | + | + | + | + |
| Denmark | + | + | | | | + |
| Estonia | + | + | + | | | + |
| Finland | + | + | | + | | |
| France | | | + | | + | + |
| Ireland | + | + | + | + | | + |
| Israel | + | + | + | + | + | + |
| Hungary | + | + | | | | |

| | | | | | | |
|---|---|---|---|---|---|---|
| Lithuania | + | | | + | | |
| Malta | | | + | + | | |
| Poland | + | + | + | + | + | + |
| Portugal | + | + | | | + | + |
| Spain | + | + | | + | | + |
| Slovakia | + | + | | | | |
| United Kingdom | + | + | + | + | + | |
| Total | 15 | 14 | 11 | 11 | 18 | 11 |

When examining the expectations of countries from programming education, it is mostly focused on "supporting students' logical thinking and problem-solving skills". Along with the 18 European countries given in Table 1, there are countries around the world that bring programming education to the primary education level. In this direction, the aim of the study is to reveal how programming education is included in the curricula of countries and to shed light on the differences in programming education among countries.

*Methods*
In this study, how countries include programming education in primary education level was examined through document analysis, which is one of the qualitative research methods. In this context, a literature review was conducted through digital databases, network logs, and press release sites. As a result of the searches, 10 countries that carried out projects on programming education at the primary education level were included in the study.

Programming education is mostly offered at the undergraduate level worldwide [2]. However, in recent times, especially in developed countries, some arrangements have been made to spread programming education to a wider audience by making students love coding and starting programming education at an earlier age. For example, in the UK, as of November 2013, computer programming education has been started in schools from primary school, and 2014 has been declared as the "Year of Code" throughout the country [4,5]. In addition, they have changed the content of the information and communication technologies course in schools by adding a compulsory and extensive programming section to the content of this course because it "could not keep up with the times." They have planned programming education specific to each level for 5-6, 7-11, and 11-14 age groups by dividing programming education in

schools into stages. In the first stage (5-6 age group), the aim is to teach what an algorithm is, in the second stage (7-11 age group), they aim to create more complex programs and be able to debug errors. In the third stage (11-14 age group), students are expected to be proficient in two or more programming languages [6].

The United States, with the support of the government, civil society organizations, technology and software companies such as Microsoft and Google, is making many efforts on coding education in schools. Among these efforts, the "code.org" platform, established in 2013, stands out. Thanks to this platform, which is used by approximately 6 million students in the USA, students can write their own programs using hundreds of coding concepts [6].

The Ministry of Science and Future Planning of South Korea announced that programming courses would be mandatory from primary school in order to provide an exceptionally skilled workforce. According to the announcement, primary schools will gradually start programming education in 2017, and high schools will start in 2018 [7]. With this implementation, it was emphasized that at the primary school level, the focus should be on understanding algorithms rather than computer operations [8].

When we look at the curriculum program of India, which has made significant progress in software, we see that computer education is included at almost every level.

A student in India is receiving education on the basics of algorithms in primary school (between 1st and 4th grades). In middle school, they transition to the BASIC programming language and take lessons on constants, variables, and loops. In high school, the courses are organized for writing more advanced programs [9].

In Estonia, a pilot program was implemented in 2012 and it was decided to provide coding education starting from the 1st grade of primary school [10]. As of 2015, the Australian Ministry of Education has planned to provide basic programming language and coding education for two years from the first grade (from the age of 5) in schools. The courses will later turn into advanced programming courses, and a system has been established so that an average student of 7 years old will have solved the basic programming logic [11,12].

In France, a study conducted in 2015 concluded that basic programming education could be provided from early childhood education. The aim of this education is to develop students' intuitive power and visual thinking. It also aims to help children understand that humans are the ones who program machines [13].

In Hungary, a project called "Programmer Girls" is being carried out to prove that "programming is not just a man's job". Within the scope of this project, middle school girls are being trained in the "Processing" programming language. This project, which is growing day by day, is supported by civil society organizations and different countries [14].

In China, it has been observed that basic coding education is provided at earlier ages. Basic coding education with card games is provided in early childhood education in China [21].

When the studies on programming abroad are examined, it is seen that the importance given to programming education by countries is increasing and there is a tendency in many countries to provide these education at early ages. In this regard, examining the current situation in our country will be beneficial for comparison with the studies conducted abroad.

As in other countries, the importance given to programming education is increasing day by day in Turkey. Within this scope, computer courses which were previously named "Computer Science" and "Information Technologies" in Turkey, were updated to "Information Technologies and Software" in 2012 through a decision [15]. For the first time, the term "software" was used in the name of the course and accordingly, topics related to algorithms and programming were included in the curriculum. Basic programming education started to be provided to students from the 5th grade onwards [16].

Various non-governmental organizations, the Ministry of National Education, universities, and companies carry out various projects to popularize programming education in Turkey. For example, through the EBA portal developed within the Ministry of National Education, students and teachers can write original programs or access the code lines of a program written by someone else to make improvements. In addition, in 2014, an event called "Computer Programming Children's Toy" was organized with the support of the Turkish Informatics Association and various universities. The aim of this event is to enable primary, middle, and high school students to realize that they can write their own programs with computer and internet technologies, and that this is a simple thing [17].

Kazakhstan is trying to keep up with the trend of popularity of programming. There are few projects that have been done in order to get people interested in programming by independent organizations and local primary schools. The most popular organization is Hour of Code which uses games like Minecraft to teach programming and to make programming lessons interesting and attention capturing [20]. Additionally, local schools are gradually adding some changes to ICT lessons in order to reach best results.

Also, there are some independent schools offering courses in order to get students to programming. One of them is Element school which carries out training in programming, web design, 3D design, and robot production aimed at the age groups of 7-8, 9-12, and 13-16. Thanks to these training sessions, students realize that programming is a problem-solving process. Looking at these studies, it is possible to say that programming education has also gained value in our country [21].

*Conclusion*

This study summarized how programming education is provided at primary school level in foreign countries and in our country. The information obtained as a result of the examinations is considered important in terms of guiding countries that have not yet included programming education in their curricula.

According to the results of the research, programming education is observed to be included in the education program under different titles. Computer programming, programming education, code education, coding, and algorithm are the most preferred course definitions. The difference between countries can be attributed to the level of education and the programming environment used. For example, China defines it as coding education and provides this education at the preschool level, while in Hungary, it is defined as programming and provided at the middle school level. America defines it as "coding" and provides block-based education to its students through the "code.org" platform, while India uses the concept of "programming education" at the middle school level and provides education in the "Basic" environment.

Another result obtained is that countries have shown an increase in their importance given to programming education after 2010, and there is a trend towards providing these education at an early age in many countries. This trend can be attributed to the groundwork laid by national or regional IT projects carried out in countries. For example, within the scope of the projects called "One Laptop per Student" and "Technology for Student Success" carried out in Maine and New Hampshire states of America after 2002, laptops were distributed to all seventh and eighth grade students [22].

As of 2015, it was planned to provide basic programming language and code education from first grade (5 years old) in schools in Australia for a period of 2 years. The main reason for the formation of this plan can be attributed to the nationwide computing project carried out in the country. As part of a project called the "digital education revolution" since 2007, every child at the primary school level in Australia was given a computer [23]. This project was completed in 2013, during which online resources were created and professional development training was provided to teachers.

Similar projects have been carried out in countries such as Portugal, Japan, Korea, Turkey, and Thailand, where there is a trend towards providing programming education at the primary education level [23].

When compared to the examined countries, it is seen that programming education is provided in later years in our country. Although our country has lagged behind in this regard, it is one of the two countries that has carried out special projects to eliminate gender differences in programming education. In this respect, it is possible to state that significant steps have been taken in programming education in our country.

In line with these results, various recommendations have been made for countries that have included programming education in their curricula and will do so for the first time:

● It has been observed that programming education is provided at the primary school level in many countries examined. In this regard, efforts should be made in our country to provide this education at an earlier age.

● Other countries have also made efforts to ensure active participation of female students in the programming education process, and projects targeting female students should be increased in all countries.

● Countries that have not yet included programming education in their curricula should first prepare the ground for students to access computers and the internet.

● The education ministries, non-governmental organizations, companies, universities, and other institutions should also be involved in the programming education process in countries.

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