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REPORTS

Informatics Curriculum and Programming Competitions: Azerbaijani Experience

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Abstract. To what extent does the content of the International Olympiad in Informatics (IOI), as well as other programming competitions in which students participate, correspond to the curriculum of secondary school informatics? In other words, can a student who fully mastered the curriculum of informatics taught in secondary school succeed in programming competitions? This article reviews the history of informatics and Informatics Olympiads in Azerbaijan, how the curriculum of the subject has changed from 1985 to the present, and in particular, whether the space allocated to programming in these updates is sufficient. How to eliminate the existing inconsistency in the new curriculum is explained using the example of specific standards.

Keywords: informatics curriculum, programming competitions, International Olympiads in Informatics, IOI.

1. Introduction

Probably, the team leaders at the International Olympiads in Informatics (IOI), as well as the organizers of such competitions in their countries, are often asked the following question: to what extent does the content of these olympiads correspond to the curriculum of secondary school informatics? In other words, can a student who fully mastered the curriculum of informatics taught in secondary school succeed in programming competitions?

Many teachers still believe that the content of the IOI is not related to the real school curriculum in informatics. In this regard, it is interesting to analyze the extent to which the content of the IOI is included in the curriculum of studying informatics at the profile level. It is important to determine whether there is a real opportunity for students to realize their interest in informatics, including preparation for the olympiad, directly within the framework of the education they receive at school. (Kiryukhin, 2008)

The article will look for answers to these questions, take a brief look at the history of school informatics and Informatics Olympiads in Azerbaijan, and touch on how the integration of these two contents is implemented in the new informatics curriculum.

First, let's turn to official documents. According to the relevant paragraphs of the "Rules for the Organization and Conducting of Schoolchildren's Subject Olympiads", approved by the Order No. 1256 of the Minister of Education of the Republic of Azerbaijan dated December 12, 2014:

3.0.2. Subject Olympiads consist of 2 (two) stages – district (city) and republican stages. The republican stage, in turn, consists of two rounds – semi-finals and finals.

3.1.2. At the district (city) stage, questions are prepared by the jury of the republican subject olympiads in a closed test format in *accordance with the school program*.

3.2.4. In the semi-final round of the republican stage, questions are prepared by the jury of the republican subject olympiads in a closed test format in *accordance with the school program* and in a relatively difficult format.

However, this document does not contain any information about whether the questions for the final round of the republican stage of the subject Olympiads correspond to the school curriculum. (Rules for organizing and holding school subject Olympiads, 2014) Let us note here that in general, it is normal for the questions to deviate from the school curriculum for the final round, because the winners of this round are candidates who will represent the country at the IOI. IOI has an approved syllabus, and this syllabus must be taken into account. However, despite the fact that the Republican Olympiad in Informatics has been held for more than 35 years, it is not normal for these Olympiads to have no approved syllabus to this day.

The Law of the Republic of Azerbaijan on Education, approved on June 19, 2009, included an article (Article 26.5) on the *non-competitive admission* of winners of world subject Olympiads, high-level international competitions and competitions to higher education institutions in relevant specialties. Although this change paved the way for stimulating schoolchildren to participate in Olympiads and developing the teaching of informatics, it naturally did not satisfy specialists, since it covered only international competitions and contests. Under the influence of discussions opened both at the official level and on social networks under the leadership of Ramin Mahmudzadeh, a prominent scientist and educator who led the Azerbaijani team at the IOI (1993–2019), on June 12, 2018, amendments were made to "the Law of the Republic of Azerbaijan on Education" and Article 26.5 was amended as follows: "26.5. *Winners of international subject Olympiads in any specialty, winners of republican subject Olympiads, high-level inter-*

national competitions and contests are admitted to higher education institutions in the relevant specialties without competition".

Prize-winners of the final round of the Republican subject Olympiads are granted the right to admission to relevant specialties in higher education institutions without exams. Therefore, it is important to ensure that not only students from specialized schools but all students have the opportunity to participate in subject Olympiads, including the IOI. In other words, the informatics subject curriculum should correspond to the program of the Republican Olympiad in Informatics to a certain extent. However, of course, the extent of this correspondence will be the subject of serious analysis and discussion from time to time.

2. A Brief Look at the History of School Informatics

Informatics as an independent science began to take shape in the middle of the 20th century, primarily after the invention of electronic computers. In the 1970s, with the invention of microprocessors and the creation of microcomputers and personal computers based on them, the process of informatization of many areas of human activity accelerated. Naturally, this process also had its impact on the education system. There was a mass demand for computer literacy and information literacy among the population. In such conditions, the issue of including the subject of informatics in the curriculum of general education schools became relevant.

Introduction of a new subject to schools did not happen suddenly, this innovation became possible after some preparatory work was carried out for a while. Thus, in the early 1960s, experiments were conducted to teach students the elements of cybernetics. As a result of these experiments, in 1970, the Fundamentals of Cybernetics course was officially included in the list of optional courses of secondary general education schools. This 140-hour course (70 hours in grade 9, 70 hours in grade 10) was taught mainly in physics-mathematics-oriented schools until 1985.

On April 12, 1984, at a joint meeting of the Central Committee of the CPSU (Central Committee of the Communist Party of the Soviet Union) and the USSR Council of Ministers, Resolution No. 313 was adopted. In that resolution, the USSR Ministry of Education, the Academy of Pedagogical Sciences, the State Committee for Technical Vocational Education, and the Ministry of Higher and Secondary Specialized Education were instructed to:

- To organize the study of the basics of computing and electronic technology in the upper grades of general education schools, technical vocational schools, and secondary specialized schools, so that to taught students the skills of using computers and are armed with knowledge of the wide application of this technology in the national economy. For this purpose, special courses should be prepared for students, necessary textbooks, teaching aids, school and inter-school cabinets should be created, and the use of computer technology in basic institutions and other departments should be envisaged for educational purposes.

- To inform the Central Committee of the CPSU and the USSR Council of Ministers in 1986 about the psychological and pedagogical problems associated with the use of computers in the teaching process of general education schools.
- To create cabinets of computing electronics and microprocessor technology in 1986–1990.

In the organizational and methodological document "Main directions of reform in general education and vocational schools", prepared in 1984, one of the main directions of school reform was declared to be the elimination of general computer illiteracy of young people and the inclusion of the basics of informatics and computing technology in the educational process.

At the end of 1984, under the leadership of A.P. Yershov and V.M. Monakhov, the program for the subject "Fundamentals of Informatics and Computing Technology" began to be developed, and in mid-1985, this program was approved by the USSR Ministry of Education. Fundamentals of Informatics and Computing Technology was included in the curriculum of general education schools as a subject from September 1, 1985.

In 1986, the "machine version" of the first program for the Fundamentals of Informatics and Computing Technology course was published. The course, which was intended to be taught in the two upper grades (grades 9 and 10), took 102 hours. Several teaching aids were prepared in accordance with the content provided in the machine version.

Textbooks and teacher's aids prepared under the leadership of A.P. Yershov and V.M. Monakhov were published in Azerbaijani in 1985–1987. This two-part textbook included the following sections:

Part 1

1. Algorithms. Algorithmic language
2. Building algorithms for solving problems

Part 2

1. Computer structure
2. Introduction to programming
   - 2.1. Algorithmic language
   - 2.2. Rapira programming language
   - 2.3. BASIC programming language
3. The role of electronic computing machines in modern society. Development prospects of computing technology

After our country gained independence in 1991, this textbook, like a number of textbooks on other subjects, was replaced by a national textbook (authors: R.A. Aliyev, T.M. Aliyev, M.A. Salahlı).

In 1997, a new program on informatics for general education schools was developed and approved by the Ministry of Education of the Republic of Azerbaijan. On June 15, 1999, the President of the Republic of Azerbaijan signed the Decree No. 168 "On Approval of the Program of Reform in the Field of Education of the Republic of Azerbaijan". By the Order No. 280 of the Ministry of Education of the Republic of Azerbaijan dated April 3, 2000, the new basic curricula for general education schools were approved and this curriculum began to be implemented from the 2000–2001 academic year. Infor-

matics programs (5–11 grades) that are appropriate for the new conditions were developed for general education schools. (Mahmudzadeh, 2015)

According to the Education Sector Development Project implemented under the auspices of the World Bank, in accordance with the implementation plan for the Curriculum Reform sub-component within the Quality of General Education and Compliance with Real Needs component, a working group was established by the order of the Ministry of Education No. 87 dated 08.02.2006 for the purpose of preparing the informatics curriculum and relevant assessment standards, and this group prepared the informatics curriculum. According to this curriculum, teaching of informatics in general education schools was envisaged in all grades of the general education level, that is, from grade 1 to grade 11. In 2007–2017, textbook sets for grades 1–11 were prepared and published in accordance with the new curriculum (Fig. 1). (These textbooks, as well as their Russian and Georgian versions, can be accessed at `https://trims.edu.az/site/search.php?category_id=c-1&courses_id%5B%5D=5&book_type_id=&lang_id=&grif_no=&grif_date=&search=ok`).

Fig. 1. Textbooks of informatics currently in use.

Here, it is necessary to mention two State Programs related to ICT (Information and Communication Technologies) that have had an indirect rather than direct impact on the teaching of computer science in the Azerbaijani education system: State program on the provision of secondary schools with the information and communications technologies in the Azerbaijan Republic (2005–2007) and State Program on Informatization of Education System in the Azerbaijan Republic for 2008–2012. Within the framework of these State Programs, certain works have been carried out in areas such as ICT literacy of teachers and equipping schools with equipment.

The theoretical and applied content of computer science is rapidly developing and updating. One of the reasons why this update is necessary in Azerbaijan is that since 2023, applicants wishing to participate in the competition for computer science-oriented specialties, in addition to mathematics and physics, take an exam *in informatics* at entrance exams to higher and secondary specialized educational institutions (but from 1992 to 2022 they took an exam *in chemistry*?!).

3. Teaching Programming in the Primary and Secondary Education System of Azerbaijan

In this article, since the content line of the computer science curriculum "Algorithms and Programming" is of interest to us, let's look at the changes that have occurred in this direction since 1985.

The initial version of the Fundamentals of Computer Science and Computing course, which was supposed to be introduced in 1985, was not related to any specific programming language. Instead, it was proposed to use the abstract Russian-language algorithmic language (RAYA). This was essentially a symbolic version of flowcharts.

However, A.P. Ershov used the algorithmic language, as well as its machine-implemented adaptation, Rapira, and BASIC in his textbook. Then BASIC became the only school programming language, and this situation continued in Azerbaijan for almost 20 years. Despite the fact that BASIC was removed from the list of programming languages allowed at the International Olympiads in Informatics in 1998, it was certainly not normal for this language to be the only programming language taught in the general education system of Azerbaijan for the next 10 years.

After the start of teaching informatics from the 5th grade in the 2005–2006 academic year, Pascal language was included in the 9th grade textbooks in 2008. However, the "life" of this language in the Azerbaijani general education system was not as long as BASIC. Thus, as already mentioned, according to the curriculum reform that was implemented in the Azerbaijani general education system in 2008, starting the teaching of informatics from the 1st grade also required a new approach to teaching programming. More precisely, it required that the programming language to be taught in the upper grades be one of the languages used in international programming competitions. In the new curriculum, programming was planned to be learned from the 5th grade.

Discussions were held with leading informatics teachers for several years about which programming language to choose. During the discussions, taking into account the age of the students and the level of preparation of the teachers, it was concluded that the most suitable language for grades 5–7 is the Logo language. However, how to solve the problem of the commands in the program code being in Azerbaijani? In 2012, a group consisting of the authors of the informatics textbooks for secondary schools (Ramin Mahmudzade, Ismayil Sadigov, Naida Isayeva) and programmer Jamshid Nakhchivanski developed a programming environment called *ALPLogo* at the Baku publishing house and it is still used with great success in schools of Azerbaijan (Fig. 2). The study of the programming environment was included in the informatics textbooks for grades 5th, 6th and 7th and was distributed to schools of the republic free of charge. The main feature of the program is that the commands can be written in Azerbaijani, English and Russian. Since 2013, republic-wide competitions have been held annually among students in grades 5–7. The ALPLogo program can be accessed and downloaded at `http://www.informatik.az/index/proqram_t_minati/0-13`.

When the question of which programming language to use to continue the programming line from the 8th grade was resolved, Python was given priority. Thus, in the 2015–2016 academic year, the Python programming language was switched from the 8th grade (Table 1).

From the 2018–2019 academic year, the Ministry of Education, with the support of BP-Azerbaijan company, began implementing the project "Organization of Informatics-oriented Classes in Grades 10–11". Within the framework of the project, 50 informatics-oriented classes were completed in selected schools in Baku, covering more than 1,000 students. Within the framework of the project, new content standards and a curriculum were written by experts for informatics-oriented classes. Based on these, 4 new materials for teaching is completed pilot classes – informat-

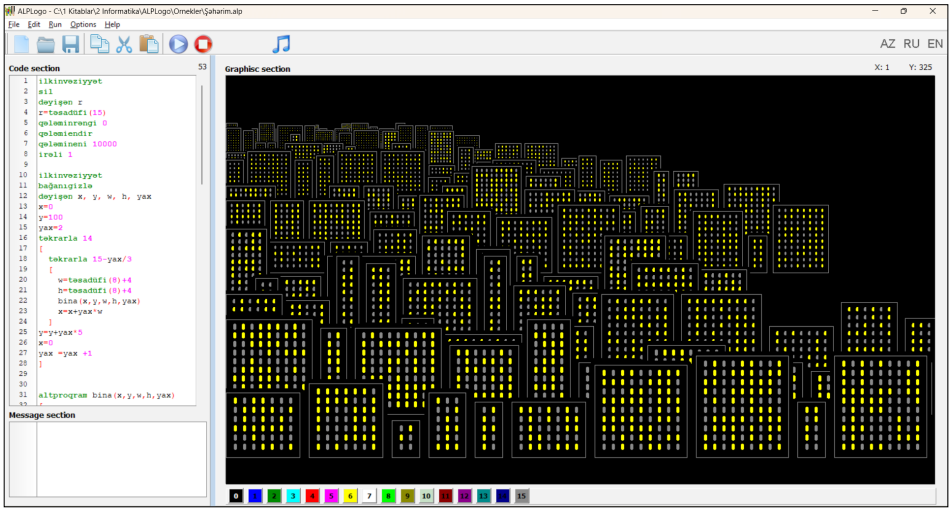

Fig. 2. Screenshot of the ALPLogo programming environment.

Table 1
Programming languages taught in Azerbaijani schools

Academic year	Programming language	Grades
1985/1986 – 1995/1996	BASIC	9-10
1996/1997 – 2008/2009	BASIC	10-11
2008/2009– 2014-2015	Pascal	9
2012-2013 until now	ALPLogo	5-7
2014-2015 untilnow	Python	8-11
Included in the new curriculum.	ALPLogo, Scratch	2-4
	Python	5-9
	C++	10-11

ics textbook and a methodological manual for teachers grades 10th and 11th – were prepared and made available to beneficiary schools. Unfortunately, this project did not produce the expected results. Thus, in 2020, only 30 percent of students graduating from informatics-oriented classes chose the ICT direction in higher education institutions – computer science or engineering, information technologies or security, robotics, aerospace engineering, informatics teaching or other relevant specialties. (`https://test.edugovaztest.cpanel.edu.az/az/news-and-updates/19555`)

The fact that the vast majority (70%) of graduates of informatics-oriented classes choose other specialties rather than ICT indicates either that the selection for those classes is not done correctly, or that the teaching is organized incorrectly (or at a low level).

Here, it is impossible not to mention the Digital Skills project, which has been implemented in the Azerbaijani education system since the 2017–2018 academic year and is gradually expanding its scope. According to the information provided on the official website of the Ministry of Science and Education (`https://edu.gov.az/az/programmes/reqemsal-bacariqlar_16387`), the main goal of this project is to ensure that students acquire in-depth ICT skills, achieve free and purposeful activity in the information space, and form themselves as competitive, logical and non-standard thinking individuals. The project is implemented by the Ministry of Science and Education and the international educational company “Algorithmica”. By improving the teaching of informatics, the project develops algorithmic thinking, logical thinking, project building skills in students, and teaches the basics of programming. The number of schools under the project has been increased to 762 in the 2024–2025 academic year, 230 of which were newly involved in the project. Currently, the project covers 6,000 teachers and 510,000 students in 57 cities and regions of the country. 1,370 students are studying in grades 10–11 with a focus on "Digital Skills".

The project teaches programming languages Scratch (grades 4–6) and Python (grades 7–11). Unfortunately, the project has not lived up to expectations. Although the number of teaching hours in the classes where it is taught is several times higher than the hours allocated to informatics, and sufficient funds have been spent, the project has not had any positive impact on the achievements of Azerbaijani students, neither

in international competitions nor in the latest international assessment (ICILS-2023). In our opinion, among the many reasons for the project's failure, despite the fact that a considerable amount of time has passed since its implementation, this subject, which is taught instead of informatics, still has neither a curriculum nor teaching materials.

4. Participation of Azerbaijani Students in Informatics Olympiads

The 1st All-Union Informatics Olympiad was held from April 13 to 20, 1988. Azerbaijani students did not participate in this competition, because at that time, informatics was not yet included in the list of subject Olympiads held in Azerbaijan among students. This event took place a little later.

In order to organize the Republican subject Olympiads of students in the 1988–1989 academic year, an order No. 329 was signed by the Ministry of Public Education of the Azerbaijan SSR on December 22, 1988. In accordance with the order, it was planned to hold the Olympiads in five subjects – Russian language, physics, chemistry, mathematics and *informatics* in the current academic year in three stages. The 1st Republican Informatics Olympiad was held on March 25–31, 1989. Shortly after this event, an Azerbaijani student also participated in the 2nd All-Union Informatics Olympiad held in Minsk, Belarus, from April 15 to 22 and was awarded 3rd place.

Another important event took place during this period. According to paragraph 2 of Section IV of the "Regulations on Subject Olympiads for Schoolchildren", approved by the order of the Ministry of Public Education of the Azerbaijan SSR dated October 10, 1989 No. 1100, starting from 1990, students who took 1st place in the school Olympiad are admitted to higher and secondary specialized educational institutions of the republic without exams in the established manner. In 1990, for the first time in Azerbaijan, six 10th-grade graduates who received a first-degree diploma in the final round of subject Olympiads were admitted to higher educational institutions in the relevant areas without exams, which had a positive effect on stimulating Olympiad winners in subsequent years. However, unfortunately, after the transition to a new system of admission to higher education institutions (centralized examinations by the State Customs Service), this rule (this concession) was abolished in 1993 (Decree of the President of the Republic of Azerbaijan No. 487). (dated July 27, 1993).

Over the past period, the scale of the Olympiads on informatics in Azerbaijan, although not at the desired level, has expanded from year to year. Now other competitions related to information and communication technologies are also held both among students and among teachers. However, the Republican Olympiad on Informatics for schoolchildren occupies a key place both in terms of importance and state support, because the winners of this Olympiad protect the honor of our republic at the International Olympiads on Informatics.

As for the participation of the Azerbaijani team in the IOI, Azerbaijan was invited to this Olympiad in 1993, but due to visa problems, it was unable to take part in the competitions held in Argentina that year. Our students first took part in the VI International Olympiad in Informatics, which was held in Sweden in 1994, and have since

been represented in all Olympiads held since that year. It should also be noted that the initiator of our country's participation in these Olympiads was Ramin Mahmudzadeh, who led the preparation of the Azerbaijani team for the competition until 2019. (However, during this period he was not listed as a team leader three times – at the 1994, 1995 and 1997 Olympiads.) Despite this, Ramin Mahmudzadeh was the leader of the Azerbaijani team at the International Olympiads in Informatics from 1994 to 2019. (Jalalli I., 2012)

Although about 10 years ago, the only international programming competition in which Azerbaijani schoolchildren participated was IOI, now they also participate in a number of other competitions throughout the year. Among these competitions, the following programming competitions are worth mentioning:

- International Zhautykov Olympiad, IzhO.
- European Junior Olympiad in Informatics, EJOI.
- European Girls' Olympiad in Informatics, EGOI.
- International School & Cup in Informatics "Junior", Cup ISIJ.
- InfO(1)Cup

The Bebras Computing Challenge (bebras.org) also plays a significant role in developing algorithmic thinking in schoolchildren and encouraging them to participate in informatics competitions.

It should be noted that the amendment made to the Law on Education on June 12, 2018 (*non-competitive admission of winners of republican subject Olympiads to higher education institutions in relevant specialties*) is already showing its positive effect. Thus, starting from 2020, Azerbaijani schoolchildren have won at least 1 bronze medal every year at the International Olympiad in Informatics. The results of our country's schoolchildren have also improved in other international programming competitions in informatics. We are confident that the positive effect of including informatics in entrance exams will also be evident in the near future.

At the end of this section, it is worth mentioning two recently published books that will have a great impact on the preparation of Azerbaijani-speaking schoolchildren for the Olympiads. Although the book Basics of Programming in C++ by Ramin Mahmudzadeh and Ismayil Jalali is intended primarily for students studying the basics of programming in higher and secondary specialized schools and who want to work in this field in the future, it can also be useful for teachers and students of computer science-oriented classes in general education schools, as well as anyone who wants to independently learn the basics of programming. The topics of computational geometry, combinatorics, long arithmetic given in a separate section of the book called Mathematics, as well as the Olympiad section, are intended for readers interested in programming competitions. (Mahmudzadeh, 2020).

In the second manual, Preparation for Programming Competitions, co-authored by Ismayil Jalalli (Sadigov) and Mikhail Medvedev, the book describes in detail the mechanism of holding programming olympiads and ways to prepare for them, analyzes the main topics and algorithms (Fig. 3). The manual is intended for students preparing for programming competitions, as well as their teachers. This book will also be useful for high schools with an emphasis on informatics. Students studying in information and

Fig. 3. Mahmudzadeh R., Jalalli I., Basics of Programming in C++. Baku, "Bakıneshr", 2020, 384 p.; Jalalli I., Medvedev M.. Preparation for Programming Competitions, Baku, "Bakıneshr", 2023, 512 p.

communication technologies at higher and secondary specialized educational institutions can also benefit from the textbook.

The materials of the book were selected based on the IOI syllabus. All examples in the book are written in C++. The program codes comply with the C++11 standard, which is allowed in most modern competitions. The Practice section at the end of each section of the book, which consists of 11 sections, provides problems related to the topic and their solution algorithms. In addition, to strengthen the mastery of the topic, additional problems from the Eolymp portal are recommended for independent work. This book, which is the third edition published in connection with the Azerbaijani programming olympiads, is dedicated to the dear memory of Ramin Mahmudzadeh, an outstanding scientist and educator who laid the foundation of competitive programming in Azerbaijan and led the Azerbaijani team in the international computer science olympiads. (Jalalli, 2023)

5. Features of the New Curriculum in informatics for General Education Institutions of the Republic of Azerbaijan

At a time when ICT are developing rapidly all over the world and the information society is being formed, there is a need to update the content of the subject of informatics, which is at the center of the theoretical and applied problems of these processes. This update is required by the recent work carried out in our country towards building an e-state, including the amendments made to the Resolution No. 103 of the Cabinet of Ministers of the Republic of Azerbaijan dated June 3, 2010, "On Approval of the State Standard and

Programs (Curriculums) of the General Education Level" on September 29, 2020. In this document, among the competencies formed in students at the general education level (the set of knowledge, skills, approaches and values that are acquired in the educational process and in life, necessary for any field of activity, as well as personal development, socialization and integration into society, employment, and lifelong education), two are directly related to the subject of informatics.

One of the main reasons for this update, as mentioned above, is the inclusion of informatics in the list of entrance exams to higher education institutions. Thus, according to the Resolution of the Cabinet of Ministers of the Republic of Azerbaijan dated March 12, 2022 "On Amendments to the Rules for Admission of Students to Higher Education Institutions of the Republic of Azerbaijan", approved by Resolution No. 39 of the Cabinet of Ministers of the Republic of Azerbaijan dated February 8, 2017, applicants who wish to participate in the competition for specialties included in the mathematics-informatics (MI) subgroup of the 1st specialty group from 2023 will take exams in physics, mathematics and informatics at the 2nd stage.

Unfortunately, the work on the preparation of the new curriculum for informatics began only in January 2024 and the process continued throughout the year. Currently, the document is awaiting approval. However, it should be noted that, considering that the current curriculum was developed in 2006–2007, textbooks based on the new curriculum will be put into use in the 2026/2027 academic year at best. This is, to put it mildly, not a good situation.

Based on the study and analysis of current world experience, the following content lines have been identified for the implementation of general learning outcomes of informatics:

- Data and information
- Hardware
- Software
- Algorithms and programming
- Information society

The content lines remain the same across all grades, but the content within each of these lines is intended to change from simple to complex, deepen, and expand. It should be noted that any concepts or skills included in the content of a subject may not be limited to the framework of just one content line.

During the preparation of this document, a number of related documents were analyzed, the experience gained during the implementation of the current curriculum (2013) and the Digital Skills project, as well as several international documents were taken as a basis. Among the international documents, the following should be specially noted:

- ICDL Workforce. Computer and Online Essentials; ICDL Workforce. Application Essentials.
- Computer Science Teachers Association (CSTA) K-12 Computer Science Standards.
- International Computer and Information Literacy Study (2023) Assessment Framework.

The **Data and Information** content line is divided into two main standards (content standards) and aims to ensure that students acquire the necessary knowledge and skills in *information processes and data sets*. The "International Computer and Information Literacy Study (2023) Assessment Framework" document was used in the development of the standards for this content line.
(`https://www.iea.nl/publications/icils-2023-assessment-framework`)

The **Hardware** content line is divided into two main standards (content standards) and requires students to acquire the necessary knowledge and skills in *information and communication technology* (computers, computer networks), including knowledge of *technical safety* rules when using these technologies. The "ICDL Workforce. Computer and Online Essentials" document was used in the development of standards for this content line. (`https://icdl.org/wp-content/uploads/2024/01/ICDL-Computer-Online-Essentials-Syllabus-1.0.pdf`)

The **Software** content line is also divided into two main standards (content standards), and it is intended that students acquire the necessary knowledge and skills in *system software* (operating system) and *application software* (text editors, spreadsheets, presentation programs, graphic editors and other programs). The "ICDL Workforce. Application Essentials" document was used in the development of the standards for this content line. (`https://icdl.org/wp-content/uploads/2024/01/ICDL-Application-Essentials-Syllabus-1.0.pdf`)

The **Algorithms and Programming** content line is divided into three main standards (content standards) and aims to provide students with the necessary knowledge and skills in *formalization and modeling*, *algorithmization*, and *programming*. The "Computer Science Teachers Association (CSTA) K-12 Computer Science Standards" document was used in the development of the standards for this content line. (`https://csteachers.org/k12standards/downloads/`)

The **Information Society** content line is divided into two main standards (content standards) and aims to provide students with the necessary knowledge and skills in the *informatization of society* and related *information security*. The "International Computer and Information Literacy Study (2023) Assessment Framework" document was used in the preparation of the standards for this content line. (`https://www.iea.nl/publications/icils-2023-assessment-framework`)

One of the features of the new computer science curriculum is the inclusion of a separate content standard in the form of "Demonstrates knowledge and skills in information security", in other words, information security issues are presented in the form of a separate content standard. This content standard covers all levels of education and is valid from 2nd to 11th grade. Since this content standard is new, let's dwell on it in more detail.

At the primary level, this content covers "the existence of threats to data in emergency situations such as fire, flood, war, earthquake and the importance of storing backup copies of important data elsewhere to prevent losses in such cases", "the existence

of attempts at unauthorized access to devices, programs and data, as well as methods to prevent them, the correct use of passwords and their protection", "potential threats to computers, computer networks and data – malware, cyber attacks, Internet fraud (spam)".

At the general secondary education level, the following issues are addressed: "biometric security techniques used to prevent unauthorized access to computers, computer networks, and data; malicious programs and the consequences they can cause on computers, ways to protect against those programs; the possibility of information posted on social networks being found and used by malicious individuals, not disclosing personal or sensitive information inappropriately when using communication tools; preventing the spread of inappropriate and false content; the purpose of encrypting information, the encryption process, various encryption methods, encrypting a given text with these methods, decrypting the encrypted text; criteria for evaluating the reliability of the website you visit."

At the upper secondary level, information is provided on the following topics: "intentional or unintentional attacks that may damage or otherwise endanger information and the systems that support it can be active or passive, intentional or unintentional, as well as direct or indirect; what tools are used to prevent hacker attacks; software copyright, software piracy and the damage it causes to the software industry".

Another feature of the new curriculum is the consideration of specialization at the secondary education level. Thus, it is envisaged that general issues of informatics will be taught at the primary and secondary education levels, and specific issues at the secondary education level.

As noted, since the winners of the final round of the Republican subject Olympiads gain the right to be admitted to the relevant specialties of higher education institutions without exams, not only students of specialized schools (classes), but all students should have the opportunity to participate in subject Olympiads, including the Informatics Olympiad. In other words, the informatics subject curriculum should correspond to the program of the Republican Olympiad in Informatics to a certain extent (both in terms of the chosen programming language and algorithms).

For the last two reasons, the importance of all content lines is taken into account in the curriculum, but taking into account the current and growing importance of algorithmization and programming, a larger space is allocated to substandards within this content line. Fig. 4 shows how the substandards are distributed across content lines. As can be seen from this table, approximately 44% of the total substandards belong to the algorithms and programming content line.

The Computer Science Teachers Association (CSTA) K-12 Computer Science Standards document was used to develop the standards for Content Line 4 (Algorithms and Programming), especially for the secondary level, and some of the standards were included in the new curriculum without any changes. Some of these standards are shown in Table 2. We believe that the implementation of these standards in the future will have a positive impact on both the teaching of programming in Azerbaijani schools and the achievements of students in programming olympiads.

Grade levels	Content lines					Total substandards
	1. Data, information	2. Hardware	3. Software	4. Algorithms and programming	5. Information society	
	Level 1 – primary education					
1	3	4	4	3	1	**15**
2	3	2	4	5	2	**16**
3	2	2	5	7	3	**19**
4	2	2	5	7	2	**18**
	Level 2 – lower secondary education					
5	3	2	6	7	3	**21**
6	2	2	6	9	3	**22**
7	3	2	5	9	2	**21**
8	3	3	3	10	2	**21**
9	2	2	2	9	3	**18**
	Level 3 – upper secondary education					
10	2	2	1	15	2	**22**
11	2	1	1	11	2	**17**
	27	**24**	**42**	**92**	**25**	**210**

Fig. 4. Distribution of substandards by content lines.

Finally, it should be noted that at a time when work on the curriculum was being finalized, the results of the 2023 international assessment on the International Computer and Information Literacy Study (ICILS) were announced. Since the results of Azerbaijani students were very poor, the standards of the aforementioned assessment were analyzed, and it was determined which standards were either absent from the current informatics curriculum at all or were present in higher grades. Based on this analysis, appropriate changes and additions were made to the new curriculum.

It is also necessary to note one important issue. The new curriculum in informatics requires updating the existing curricula of the specialties "Informatics Teacher" and "Mathematics and Informatics Teacher" of pedagogical universities. According to the information released by the Ministry of Science and Education, work has also begun in this direction (`https://edu.gov.az/az/news-and-updates/21899-1`). Thus, a Commission has been established in the Ministry of Science and Education to develop new educational programs for the bachelor's (basic (base higher) medical education) and master's levels of higher education. At the same time, 9 Working Groups, including the Educational Specialties Group, have begun their activities within the Commission. We hope that the new educational programs to be developed will meet the requirements of the modern era.

Table 2
CSTA Standards

CSTA K-12 Computer Science Standards	Informatics curriculum
3B-AP-10. Use and adapt classic algorithms to solve computational problems. (Examples could include sorting and searching.)	10-4.2.2. Explains sorting algorithms. (Sorting, selection sort algorithm, bubble sort algorithm)
3B-AP-11. Evaluate algorithms in terms of their efficiency, correctness, and clarity. (Examples could include sorting and searching.)	10-4.2.3. Evaluates algorithms. (Algorithm efficiency, algorithm correctness, algorithm clarity)
3B-AP-12. Compare and contrast fundamental data structures and their uses. (Examples could include strings, lists, arrays, stacks, and queues.)	10-4.3.3. Compares basic data structures and their uses. (Strings, lists, arrays, stacks, queues, dictionaries)
3B-AP-13. Illustrate the flow of execution of a recursive algorithm.	10-4.3.8. Uses recursion in the program.
3B-AP-19. Develop programs for multiple computing platforms. (Example platforms could include: computer desktop, web, or mobile.)	10-4.3.9. Develops programs for various computing platforms (desktop, web, mobile).
3B-AP-23 Evaluate key qualities of a program through a process such as a code review. (Examples of qualities could include correctness, usability, readability, efficiency, portability and scalability.)	11-4.3.7. Evaluate key qualities of a program through a process such as a code review. (Correctness, usability, readability, efficiency, portability and scalability)
3B-AP-24. Compare multiple programming languages and discuss how their features make them suitable for solving different types of problems. (Examples of features include blocks versus text, indentation versus curly braces, and high-level versus lowlevel.)	11-4.3.8. Compares several programming languages.

6. Conclusion

1. In an era when information and communication technologies are developing at a very fast pace and the information society is being formed, there is a need to frequently update the content of informatics, which is at the center of theoretical and applied problems of these processes.
2. The inclusion of informatics in the list of entrance exams for relevant specialties of higher education institutions from 2023 makes this update even more necessary.
3. Since the winners of the final round of the Republican Subject Olympiads currently have the right to be admitted to the relevant specialties of higher education institutions without exams, not only students of specialized schools (classes), but all students should have the opportunity to participate in subject Olympiads, including the Informatics Olympiad, and achieve success. For this, the informatics subject curriculum should meet the requirements of the Republican Olympiad in Informatics to a certain extent.
4. The types of questions, their topics and, most importantly, the training program (syllabus) for the final round of the Republican Olympiad in Informatics should be developed and approved soon.

5. Since we are talking about the curriculum for general education institutions, necessary changes should also be made in the direction of teacher training for the successful implementation of the new curriculum. That is, the curricula of the specialties "Informatics Teacher" and "Mathematics and Informatics Teacher" in higher education institutions should be revised.

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