Ministry of Education and Science of the Republic of Kazakhstan
Suleyman Demirel University

Maksat Galiyev

Programming Olympiad as a Subject in Schools for Sustaining IT Education

THESIS

Presented in Partial Fulfillment for the
Degree of Master of Science in Computer Science
(degree code: 7M06102)
Department of Computer Science
Faculty of Engineering and Natural Sciences

Supervisor: **Assistant professor, PhD, Zhaparov M.K.**

Kaskelen, 2022

Suleyman Demirel University

Faculty of Engineering and Natural Sciences

Department of Computer Science

Dean of Faculty

Dean of the faculty Assoc. prof. Ph.D. Azamat Zhamanov.

Maksat Galiyev

«30» May 2022

Topic of the thesis:

Programming Olympiad as a subject in schools for sustaining IT Education

Thesis submitted as part of the requirements for the award of the MSc in "7M06102 - Computer Science", SDU, 2020-2022

Head of Department Assoc. Prof. Cemil Turan

Academic Supervisor Assistant Prof., PhD, Meirambek Zhaparov

Master's student Maksat Galiyev

Kaskelen, 2022

Abstract

The qualification of teachers and coaches involved in the search for and preparation of students for informatics olympiads has a significant impact on the motivation of students to study informatics and participate in informatics olympiads. The analysis of development trends, international informatics competition, and school informatization programs has enabled the definition of three levels of informatics and information and communication technologies (ICT) for teacher preparation. These levels of ICT preparation of school teachers and their relationship to one another are described in the given thesis. In addition, not only is the curriculum for teachers described, but also the methods of teaching in various platforms such as learning management systems. Organization of the preparation of teachers, taking into account the distinctive features of each level, will permit the essential number of participants in the informatics olympiads to increase and will improve the outcomes of their participation and the international informatics olympiads.

Аңдатпа

Оқушыларды информатика бойынша олимпиадаларға іздеуге және дайындауға қатысатын оқытушылар мен жаттықтырушылардың біліктілігі оқушылардың информатиканы оқуға және информатика бойынша олимпиадаларға қатысуға уәждемесіне айтарлықтай әсер етеді. Даму тенденцияларын, информатика және мектептерді ақпараттандыру бағдарламалары бойынша халықаралық жарыстарды талдау мұғалімдерді даярлау үшін информатика және ақпараттық-коммуникациялық технологиялардың (акт) үш деңгейін анықтауға мүмкіндік берді. Мектеп мұғалімдерін АКТ-ға даярлаудың бұл деңгейлері және олардың бір-бірімен байланысы осы диссертацияда сипатталған Сонымен қатар, мұғалімдердің оқу бағдарламасы ғана емес, сонымен қатар оқытуды басқару жүйелері сияқты әртүрлі платформаларда оқыту әдістері де сипатталған. Әр деңгейдің ерекшеліктерін ескере отырып, мұғалімдерді даярлауды ұйымдастыру информатика бойынша олимпиадаларға қатысушылардың едәуір санын көбейтуге және олардың информатика бойынша халықаралық олимпиадаларға қатысу нәтижелерін жақсартуға мүмкіндік береді.

Аннотация

Квалификация преподавателей и тренеров, участвующих в поиске и подготовке учащихся к олимпиадам по информатике, оказывает значительное влияние на мотивацию учащихся к изучению информатики и участию в олимпиадах по информатике. Анализ тенденций развития, международных соревнований по информатике и программ информатизации школ позволил определить три уровня информатики и информационно-коммуникационных технологий (ИКТ) для подготовки учителей. Эти уровни подготовки школьных учителей к ИКТ и их взаимосвязь друг с другом описаны в данной диссертации. Кроме того, описана не только учебная программа для учителей, но и методы преподавания на различных платформах, таких как системы управления обучением. Организация подготовки учителей с учетом отличительных особенностей каждого уровня позволит увеличить существенное количество участников олимпиад по информатике и улучшит результаты их участия и международных олимпиад по информатике.

Contents

1. Introduction

1.1 Aims and Objectives

Programming Olympiads aid students in mastering all of the aforementioned skills and cultivating the necessary professional characteristics. The application of Olympiad techniques in the educational process reduces the aforementioned negative effects on students while simultaneously enhancing their level of readiness for professional endeavors after graduation. Olympiads represent a shift from teaching according to standard curricula to expanding the educational component, increasing the quantity and improving the quality of understanding the fundamentals and fundamental skills of the profession. This is related to the following characteristics of the Olympiad movement.

1. Olympiads encourage the development of a distinct programming style and the capacity to test programs for potential flaws. According to statistics, champions pass the tasks on their first attempt.

2. Teamwork in training and competitions leads to the development of techniques and competencies for collective job performance.

3. A severe lack of project management graduates is one of the most pressing problems in the education of Russian programmers. The emphasis on success is one of the Olympiads' undeniable qualities. It is identical for those who did not win as well as those who did. Students acquire the cooperation skills necessary to form and lead their own teams in the future.

4. Olympiads foster scientific and technological creativity, independence, and the ability to navigate quickly through a variety of situations.

It should be noted that many Olympiad teaching strategies are appropriate for all students, not just the best-prepared ones. Obviously, it is not necessary to require extensive daily training and the ability to develop complex algorithms without the aid of books from the majority of students, but the following activities are valuable and essential for all programmers:

- A requirement for stringent compliance with I/O standards
- Compliance with stringent memory usage and execution time constraints
- Performing simple tasks in a brief amount of time
- Automatic testing of programs using tests for which no material is available, as well as subsequent debugging
- Group-based problem-solving and code development

The competitive programming study group aims to strengthen its members' understanding of the typical topics of a programming marathon, including graph algorithms, Backtracking, Strings processing, computational geometry, dynamic programming, and fundamental number theory concepts, among others. It is necessary to construct a framework for the study group in order to formalize the training process through the application of techniques and methodologies that are adapted to the current level of the students[18]. It also aims to create a website where the framework's information can be shared, as well as a document and material repository that will serve as the basis for the work of the various programming marathon teams.

Numerous universities across the globe have developed their own methodologies, programs, strategies, and techniques to prepare their programming marathon teams. Some of the most infamous examples are at Stanford University with its SLPC study group ("Stanford Local Program Contest"), where regular preparation marathons are held for their students and can be accessed by any external agent, and at the National University of Singapore, where, led by Steven Halim, they have developed a methodology that revolves around the book Competitive Programming 3 and the Uva Hunting tool to adequately prepare their teams, placing the primaries on the book and the tool. Similar to there methodologies, there should be build and implemented a Olympiad teaching method for schools children. For better improvement in IT in the future.

1.2 Thesis Outline

The skill of high-quality coding, which is the foundation of a programmer's profession, can only be acquired through practice. You can only learn from your own mistakes. The primary objective of the teacher's Olympiad approach to task development is to provide students with the opportunity to learn from their own mistakes. Using Olympiad techniques to teach programming must begin in the first year, as this is when students gain an understanding of the process of creating, debugging, and testing programs. In this thesis, we will examine the significance of Olympiad programming, its impact on the future of the IT industry, and how to promote its growth in our country.

2. Literature Review

2.1 Importance of Olympiad

Subject Olympiads for students are one of the most effective forms of identifying abilities and levels of giftedness in the subject area, they contribute to the development of mental and creative abilities, and stimulate self-control of learning outcomes. In addition, they are a means of career guidance, helping with the choice of a specialty when entering universities and subsequent specialization. On the other hand, for the teachers of the Olympiad it is one of the means of controlling the quality of education and confirming one's own qualifications, Olympiads often become a competition not only for students themselves, but also for their teachers.

In our opinion, subject Olympiads allow gifted students to demonstrate a high level of subject training, development of intellectual skills, personal and moral-volitional qualities. The main goals and objectives of the Olympiad are:

- Identification and development in students creative abilities and interest in research activities;
- Creating the necessary conditions for support for talented youth;
- Popularization and propaganda of science and scientific knowledge;
- Involvement of scientists and practitioners in the relevant fields to work with gifted children.

The Olympiads for schoolchildren have become the means that ensures the effective formation of knowledge, skills and abilities of students necessary for their personal and professional self-determination. The Olympiad stimulates and motivates personal and intellectual development of students, supports gifted children,

promotes their self-determination and continuing education, reveals the connection between the areas of knowledge that make up the content of the Olympic disciplines, with other areas of knowledge, develops and maintains the interest of students to educational and scientific activities.

The rapid development of informatics and information technologies at the end of the twentieth century laid the foundation for the creation and development of the Olympiad in informatics. Already in the 1987-1988 academic year in the USSR the first All-Union Olympiad was held in computer science, and in 1988-1989 academic year - the first Olympiad[10]. Continuous improvement of the system for identifying, supporting and developing gifted schoolchildren and students creates conditions for the development of the competitiveness of our participants at the Olympiads in informatics at the international level.

Analyzing the level of development of modern technical means, it should be noted that in order to successfully perform at Olympiads of various levels, a student must have certain skills in working with personal computers, know their main characteristics, take into account how they affect the with their help, tasks and how to get around the existing limitations, for example, memory and speed. Device Understanding and computer organization also allows writing more efficient programs.

Equally important for participation in Olympiads in Informatics is the skill of working in computer networks that provide the necessary conditions for the competition. And subsequent automated verification of participants' decisions. Proficiency in network technologies should include both theoretical knowledge and practical skills[7]. Despite the fact that the main rounds at the Olympiads in informatics usually precedes a trial round, which allows you to get acquainted with the software used at the Olympiad and gain the necessary practical skills in an olympiad environment, better get these skills in advance to feel more confident during tours.

Having received a sufficiently rigorous statement of the problem, the participant must be able to build its mathematical model, taking into account technical and substantive restrictions. Proficiency in mathematics and the basics of informatics is especially important, since it is difficult for schoolchildren to achieve success at olympiads without good preparation in the field of set theory, logic, theory graphs and combinatorics, without knowing the theory of information cod-

ing. Moreover, as computer science develops, the ever-increasing complexity of analysis methods has an impact on the solution of practical professional tasks and problems.

When solving problems, the participant of the Olympiad must demonstrate knowledge and ability to use the main types of algorithms (algorithms for working with various data structures, graph algorithms, brute force and dynamic programming algorithms, integer arithmetic algorithms, theory algorithms games, computer geometry algorithms and others), controlling that their complexity was in perfect alignment with the constraints specified in the condition of the problem. It is in the field of algorithm development Olympiad participants have the opportunity to demonstrate their best creative qualities when solving Olympiad assignments. The participant must understand that developing a good algorithm is critical to the performance of any software system[13]. In addition, this allows you to delve deeper into the problem and can suggest solutions that do not depend on programming language, hardware provision and other aspects of implementation. The study of the theory of algorithms at the stage of preparation for the Olympiad develops in schoolchildren the ability to choose the algorithm most suitable for solving a specific problem, or prove that it does not exist. This ability should be based on knowledge of the class of algorithms that are designed to solve a certain set of known problems, understanding their strengths and weaknesses, and evaluating the effectiveness of various algorithms in a given context.

It is necessary to highlight such a skill of the participant of the Olympiad in Informatics as knowledge of modern operating systems and the ability to work with them, which is the basis of his further successful career in the field of programming. Knowledge of operating systems contributes to the formation of mature thinking of the student and good knowledge of network technologies and protocols, virtual machines, methods of modern programming.

The participant of the Olympiad must also be able to work with one or more integrated software development environments (composition of languages programming is determined by the organizers of the Olympiads), and be able to use modern technologies of programming, debugging and testing programs. Students should not only be able to write a program in any one language, but also understand the different programming styles that are specific to different languages. Understanding the variety of programming languages and different paradigms makes

it much easier to quickly master new languages. Therefore, we conclude that in order to successfully perform at the Olympiad in Informatics, students must know the basic programming constructs, basic data types and structures, the basics of input / output, operators, functions, methods of passing parameters, as well as strategies that are useful when debugging programs.

A student's abilities for programming are manifested in the process of preparation and participation in the Olympiad, they are expressed by a combination of algorithmic and programming abilities that ensure the successful solution of non-standard problems, the speed of thought processes, the systematic mind, the stable manifestation of intellectual curiosity and the desire to acquire new knowledge in the field of programming. Possessing such qualities as the ability to abstract and understand the relationships between elements, a student capable of programming at the Olympiads demonstrates the flexibility of thinking, criticality, a tendency to plan, analyze and systematic work.

The interest of participants in the Olympiads in achieving the highest results (including as a condition for entering a higher educational institution) translates into a willingness to replenish knowledge and retrain, improve their skills and abilities. A special role is played by self-training, the ability to obtain knowledge from various sources and to activate the system of accumulated knowledge in a timely manner. Thus, students are directly involved in the development of their own giftedness. It can be said that the Olympiad is an incentive to achieve better results in the future, promotes the development of stress tolerance, and gives experience in teamwork.

In the case of Suleyman Demirel University students who have prepared and knew about olympiad programming before applying to university, we can see that they have very good results on programming and algorithms. Was collected a dataset of grades in the "CSS 220 - Advanced Algorithms" course within the last 5 years, which has 2160 rows of different students. So, it was totally anonymous and had no identification number on it. This dataset was analyzed by using library pandas in jupyter notebook. There was a classification of olympiad students as ACM and non-ACM students. In total, we had about 30 students, which is 6 students per year from both Computer Science and Information Systems departments.

In the graphic below grades of all students who have registered and studied

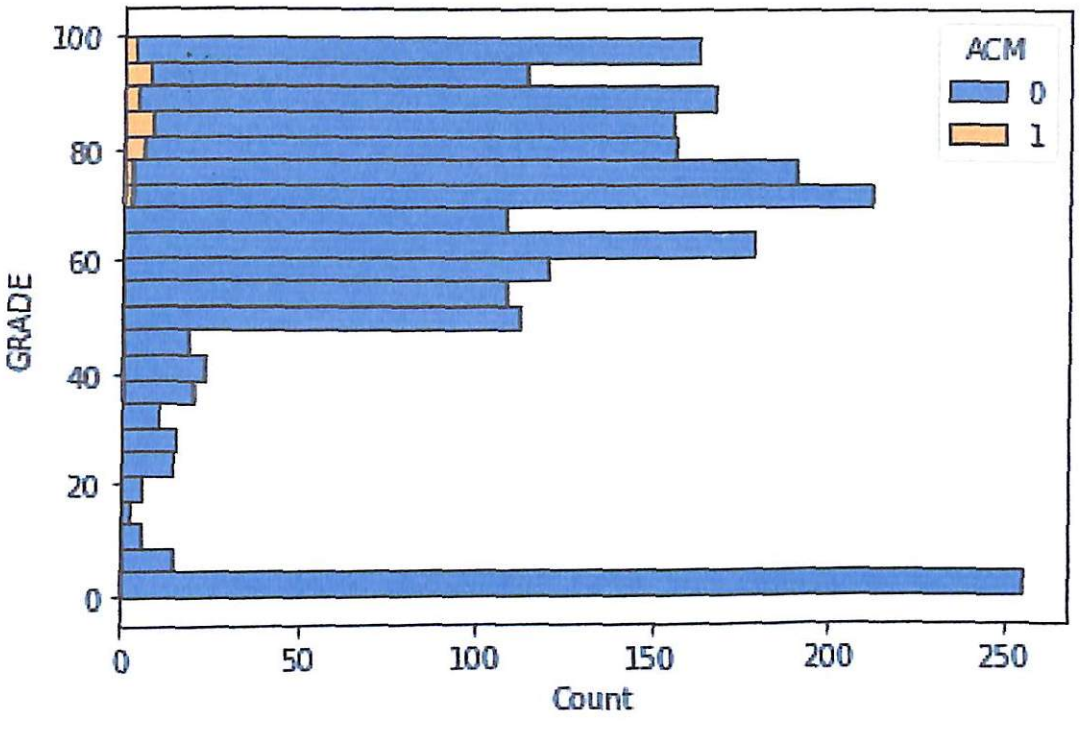

Figure 2.1: ACM Students Grades

course "CSS 220 - Advanced Algorithms" are represented. And ACM and non-ACM students are classified differently. So, it is obvious that ACM students have great results on this course, none of them has below 70 points.

For the teacher, the development of the giftedness of schoolchildren and students in the field of programming in the process of their preparation for participation in Olympiads in Informatics is provided due to the choice of forms of individual work with students and depends on the level of development of their giftedness. The content of the curriculum should focus on a carefully crafted, comprehensive and in-depth study of the main ideas, problems and themes. It should implement the application of productive thinking skills to enable students to rethink existing knowledge and generate new ones, enable them to explore the ever-changing flow of information, promote their self-development, and should take into account a higher level of thinking, creativity and significant excellence in execution[15]. Assignments and results should be under control of teacher. Training under the relevant program can be carried out both in traditional and remote form, using all modern information technologies in the educational field.

For the purposeful preparation of students for Olympiads in Informatics, schools and other educational institutions form groups of students to conduct extracurricular work with them in the form of electives, circles, special courses,

electives, etc. Prepared, talented and interested schoolchildren and students are selected into groups. Groups can be formed by the availability of basic training or by the level development of thinking, creative potential[4]. The most effective work in small groups. The purpose of the small group is to maximize the involvement of students in the educational process, in the process of preparing for the Olympiads. Applying their own experience to the proposed tasks, they decide what information they need, as well as how and where to get it.

The main role in the preparation of gifted students for Olympiads in Informatics is occupied by tasks, and the success of the competition as a whole depends on how well they are developed. Moreover, successful problems after the Olympiad quickly spread among future participants, they begin to be actively used in preparation for competitions, and new Olympiad problems are created on the basis of them. As a rule, these tasks sorting and data retrieval, dynamic programming, modeling, optimization, long arithmetic, linear and binary search, greedy algorithms, recursion, graph theory, combinatorics, and working with string and file type data.

In general, the process of creating an Olympiad task in informatics should include the following main steps:

- Preparation of the text of the problem statement;
- Development of requirements for the software used in the process of solving problems;
- Development of a methodology for checking solutions to problems;
- Preparation of a system for evaluating solutions to each problem, including partial and complete solutions;
- Development of checking programs (with automatic verification of participants' decisions).

For the Olympiad in Informatics, both revised and supplemented tasks previously used at other Olympiads in Informatics, as well as original ones, can be used. The main criteria for the selection of Olympiad tasks should be the following indicators:

- Original problem statement or original idea;

- In the text of the task conditions, terms and concepts that do not go beyond the studied subjects should be used;
- There should be no ambiguities in the wording of the task, the text should be written in an accessible language;
- The task should not require special knowledge for its solution;
- The formulation of the problem should presuppose the presence of a formalization stage in its solution;
- The task should be optimal in terms of complexity;

Each task should allow participants to fully reveal their creative potential, demonstrate the level of development of algorithmic thinking, logic and intuition.

When forming sets of tasks, one should take into account the age characteristics of the participants, the relationship of the proposed tasks with the programs for studying computer science and mathematics in educational organizations. Considering that the purpose of the Olympiad in Informatics is to identify the most talented students who are passionate about programming, they must be given the opportunity to fully demonstrate their creative abilities, so that the results of their performances can reveal the best of them. At the same time, it is important not to scare away only beginners in the Olympiad movement with the complexity of tasks, to involve them in this process and increase their motivation to further improve their knowledge and skills.

2.2 Motivation for Participation in Olympiad

University students' most popular and well-known programming competition is the International Student Programming Olympiad (ICPC). It was first held in conjunction with the ACM Conference on Informatics in 1977. Since then, the Olympiad has been organized annually by the Association for Computing Machinery (ACM).

ACM ICPC is a group undergraduate competition that imposes certain restrictions on the composition of participants: university understudies or graduate understudies of their first year of study are not older than 24 years old, and each

team consists of three individuals. Undergraduates cannot participate more than twice in the previous schedule and five times in the regional determination. The group is tasked with completing as many of the proposed tasks as possible within the allotted time. Prior to the final, there are a few territorial selection stages (quarterfinals and semifinals) for which any number of teams may be designated by the colleges of the competing region. However, only one team from each school may qualify for the annual final, which is held in a different country each year[1].

Young coders can apply their knowledge in a fun context and improve their analytical and problem-solving skills through coding competitions. By participating in coding competitions, children can gain real-world problem-solving experience and hone their coding abilities. Furthermore, it is an effective method for applying to high-tech companies such as Amazon, Google, and Facebook. Survey was done for Olympiad participants of Kazakhstan, as where they want to build their career in the future. As it is shown in the chart 2.2, most of the ACM Programmers wants to be in high tech companies. And this shows their ability to become a part of big infrastructure in IT world.

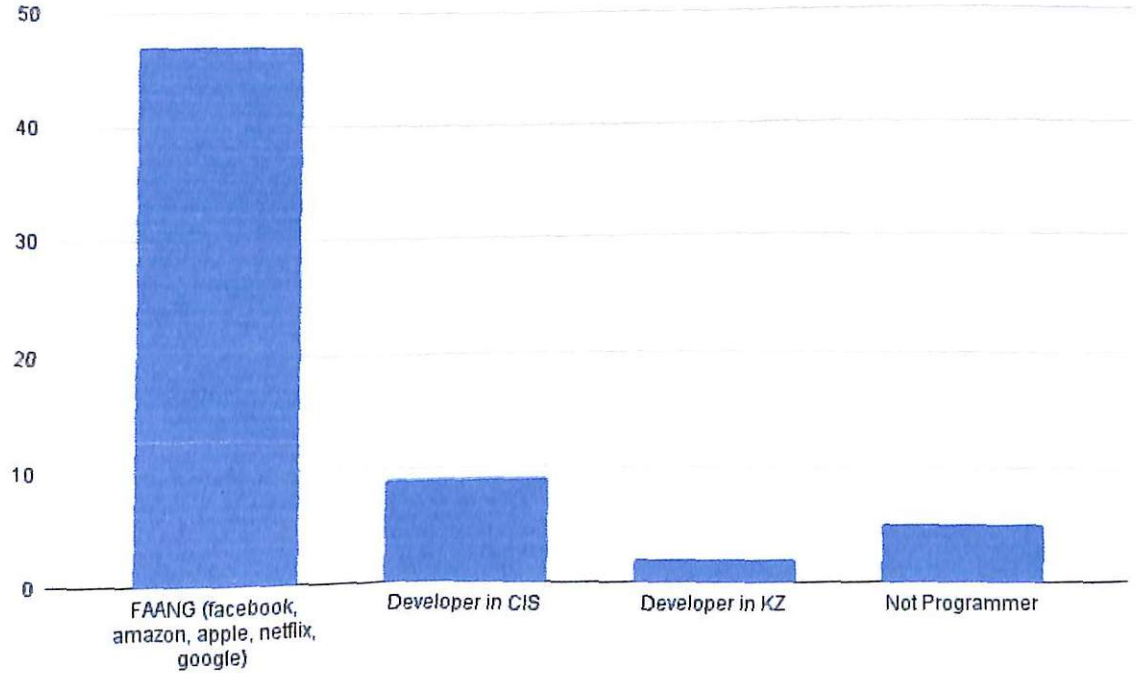

Figure 2.2: Future career places of ACM participants

Typically, higher education institutions, state educational authorities, and corporate structures are the ICPC's organizers (in the latter two cases, with the

participation of higher education institutions). On a competitive basis, the ICPC is attended by: schoolchildren (primarily seniors); university and technical school students (primarily in specialized fields); and graduate students in their first year of study. On a non-competitive basis, postgraduate students in their final years of study, teachers, and others can participate in the ICPC. Motives for schoolchildren's participation in the ICPC typically include: confirmation of their own skills and abilities in conditions of direct competition with other participants; bolstering the reputation of schools (colleges); receiving awards granting admission to universities without competition, etc[5]. Motivation for participation is different for students of schools and universities.

Olympiad for Schoolchild The objectives of internal Olympiads and participation in ICPC at higher levels for schools are: the organization of extracurricular activities that stimulate programming; the selection of students to prepare for competitions at higher levels; and the concealment of the reputation of schools at district, city, and regional ICPC, etc.

The objectives of school education authorities in the regions' participation in the ICPC are: evaluating the levels of schoolchildren's training in various educational institutions; and admission to universities. Universities can justify the costs of hosting "school" Olympiads by their increased regional competitiveness, career guidance, and selection opportunities.

Olympiad for University Students People who become champions and receive medals at the finals of a competition typically begin to study in school, and the majority of them achieve some level of success in school olympiads. Why must students have it? Even putting aside the opportunity to travel to cities and countries where tournaments are held and make new friends with like-minded individuals, as well as an interest in programming and a passion for competition, there are a number of significant benefits to be gained from such an experience.

Initially, the Olympiad engages and motivates a person to write a great deal of code, and as a result, he writes it rapidly and error-free. This is extremely useful for future professional endeavors. This individual will be asked to solve the same Olympiad problems during a job interview for a developer position, for example. If he has the necessary experience, he will

easily obtain the position he desires[17].

In general, success in these competitions is indicative of a student's superior intellectual abilities. During their participation in ACM competitions, students acquire the skills necessary to find optimal solutions to fairly complex problems, which aids them in processing large amounts of data when working on actual projects.

Lastly, there is prestige. Olympiad participants invest a tremendous amount of time and effort, but the medal of international competitions is an outstanding accomplishment that increases a university graduate's appeal in the eyes of potential employers. The ACM/ICPC finals, for instance, are regularly sponsored by IBM, which awards cash prizes to tournament champions and internships or jobs to members of gold-winning teams.

Benefits for Universities The participation of university teams (and individual participants) in the International Collegiate Programming Contest (ICPC) enables universities to compare the quality of their students' training in the field of programming and enhances their reputation at the regional level and within Kazakhstan's higher education system. There is no increase in their competitiveness on the market for postgraduate education services, which could facilitate the acquisition of grants, etc.

Within the framework of the ICPC, universities are able to conduct an internal selection of students in order to engage them in research and contractual activities, work on grants, admission to postgraduate and master's programs, etc. - both during the course of their studies and after they have graduated.

The level of corporate interest in such contacts is reflective of the fact that the preparation and conduct of the majority of ICPC interregional and international level contacts are sponsored by large commercial firms active in the field of information technologies.

Government agencies and research organizations utilize ICPC to a lesser extent as a platform for the selection of prospective employees. From the perspective of the Ministry of Education and Science of the Kazakhstan, the implementation of the ICPC helps to improve the training of students in areas related to information technology: it allows you to compare (with

a number of caveats) the quality of such training in different universities; contributes to increasing the authority of Kazakhstan universities at the international level, since, unlike a number of Olympiads in other areas, domestic ICPC accredits universities on a global scale.

During the preparation for the olympiads, pupils and students can participate in remote Internet programming olympiads for intermediate knowledge assessment. The experience of participating in such competitions increases the level of subject preparation of the participant, as he becomes familiar with the technologies of holding Olympiads; receives sets of tasks and their evaluation criteria, the ability to solve problems in conditions similar to those of real Olympiads in virtual competition with other participants, as well as self-development and self-awareness.

It should not be forgotten that successful participation in programming tournaments provides young programmers with the opportunity to obtain a prestigious and well-compensated job in the computer industry, and for schoolchildren - the opportunity to enter and continue their education at the nation's most prestigious universities. Thus, systematic work on the preparation for Olympiads in Informatics fosters the effective development of student talent.

2.3 Methodology Of Preparation

In the era of advancing information technology, there is a need for skilled programmers. This is due to the fact that the modern path of human development is the path of informatization. Our world's information technologies are developing and advancing, allowing us to enhance quality, facilitate work, and reduce time. The use of computers is expanding in a variety of fields. Professionals in information technology are progressively more in demand each day. Programming contests are one method for locating and identifying talented programmers.

Programming Olympiads are contests in which participants solve a variety of problems in any programming language. The Olympiad demonstrates the creative potential of schoolchildren and students, and provides them with practice in resolving complex and engaging problems. The primary purpose of any Olympiad is to assist schoolchildren in selecting their future profession and students in their future careers, as well as to identify talented students with an exceptional approach

to programming and information technology. Programming tasks in the Olympiad improve reasoning and intelligence. Programmers can continuously develop and improve their programming skills due to their interest. The Olympiads' competitive aspect is also of interest. To be successful at the Olympiads, one must train and solve problems. It encourages students and schoolchildren to learn. Many schoolchildren are not exposed to Olympiad programming during their education and, as a result, struggle to choose a specialty in the future. Everyone should have the opportunity to attempt sports programming.

Programming Olympiads are currently prevalent. Consequently, the number of programmers competing in Olympiads increases daily. In order to hold programming olympiads, however, a significant amount of work is required; thus, the idea arose to develop a software environment that would make it easier to create and conduct programming olympiads. In addition to identifying talented programmers, the Olympiads aim to foster the socialization of participants. At the Olympiads, participants make new friends and gain valuable experience. Organizers of programming competitions frequently provide participants with information technology-related lectures. Universities are interested in the fact that Olympiad participants among schoolchildren attend their institutions. In turn, companies associated with information technology, such as Google Inc. and Yandex, frequently sponsor and organize such competitions in an effort to find prospective employees. Popular programming competitions include TopCoder Open, Google Code Jam, Facebook Hacker Cup, Yandex.Algorithm, and Russian Code Cup.

Education primarily develops students in terms of content. Depending on the teaching method, however, the content of education is assimilated differently by students and influences their development. Teaching methods should allow for the construction of a system of increasingly complex learning tasks at each stage of study and for each subject, the formation of the actions required to solve these tasks (mental, linguistic, perceptual, etc.), the transformation of these actions into more complex operations, the formation of generalizations and their application to new concrete situations[6].

The objectives of studying computer science fundamentals in school are as follows:

- The formation of initial concepts regarding the characteristics of information and how to manipulate it (in particular, using a computer);

- Development of problem-solving skills using the most prevalent computer science techniques (using formal logic, algorithmic, system and object-oriented approaches);
- Broadening perspectives in closely related areas of knowledge to informatics;
- Enhance students' ability to solve logical problems;

Identification, support, development, and socialization of gifted children are gaining importance in contemporary education.

For instance, the Basic Informatics Olympiad for elementary school students. This Olympiad should be based on examinations. The examination questions should be selected so as to assess the general level of preparation and provide an opportunity to solve the most important problems that arise during the Olympiad in Informatics.

- Different levels of instruction in informatics ;
- Differences between school-learned algorithmic languages;
- Various software studied in computer science classes;

2.3.1 Initial Stage of Preparation

The first stage of the development of forms and methods for preparing schoolchildren for the Olympiad in Informatics was largely determined by the development of school informatics and the formation of the Olympic movement in the country on this issue.

Preparation for the Olympiad in Informatics was conducted either in school by the most qualified informatics teachers or in additional training centers by specialists whose professions were closely related to informatics and computer technology. Frequently, these individuals lacked a specialized education, but they were experts in their field and found their calling working with school-aged children. These specialists determined the high starting point for the preparation of gifted students for the Olympiad in Informatics, since computer science classes at school could not compensate for the lack of depth and subject matter training for children[19].

The interest of schoolchildren in the Olympiad in Informatics led to its appearance in school classes, group classes in special summer and winter children's camps, and academic circles. The partnership between general and additional education for children, as well as the technical resources provided to the school by the country's top universities, which allowed the school to utilize the capabilities of their computer centers to work with gifted children, played a significant role at this stage.

Collective methods of educating children involving more than one teacher or mentor have played a significant role. The general approaches that emerged in the process of preparing schoolchildren for various levels of Olympiads enabled them to quickly adapt to learning with different mentors regardless of the location of their studies. This was aided by the fact that students, former laureates and prizewinners of international Olympiads, who became an integral part of this work, actively participated in preparing schoolchildren for the Olympiad. With the assistance of Olympiad-participating youth, a pool of potential coaches-educators was developed in the country. After graduating from high school, the former "Olympian student" mentors university students in preparation for the student Olympiad and teaches students from his home school.

2.3.2 Second Stage

The second stage, which replaced the first stage in the development of forms of work with talented youth and the preparation of the best of them for international Olympiads, can be referred to as the stage of the formation of corporate training models that expand traditional individual education. These models involve the formation of different age groups of students, which will serve as the foundation for future olympiad communities. In these communities, Olympiad winners and prizewinners, groups of scientific mentors comprised of teachers of computer science, teachers of higher education, professional parents, and scientists become united students of higher education.

The second stage is distinguished by the emergence of specialized educational institutions in the field of information technology. These are information and technological lyceums - the first schools specializing in ICT-specific training for children. In addition, many physics and mathematics lyceums began to offer specialized training in the field of informatics. All of this had a positive effect on

the evolution of collective forms and methods for preparing schoolchildren for the Olympiad and, eventually, on the academic achievements of our students.

2.3.3 Third Stage

The third phase involves the development of communicative or network models of work with gifted students and their preparation for the Olympiad. At this time, the Internet is the most important technical resource, as it has already been implemented in every school in the country. All of this cannot affect the emergence of new forms of work with talented youth based on the integration of information and educational technologies, given the Internet's active penetration into the home[16]. Initially, a network Olympic community has been established, uniting diverse groups of Olympiad schoolchildren from across the nation. The Internet Olympiad in Informatics is a third new form that began to develop actively in the third stage. Now, Internet Olympiads in Informatics are frequently held in the country. Since 2006, the Internet rounds of the final stage of the Olympiad in Informatics for schoolchildren have been held at the federal level as an example of such an Olympiad. Students who did not qualify for the final round have the opportunity to assess their abilities and solve the same problems and in the same manner as those who are competing in the full-time competition. Regional Internet Olympiads in Informatics have been held for a number of years. Moreover, in certain regions of the country, these Olympiads also have a qualifying nature, allowing them to identify as many talented schoolchildren as possible in order for them to prepare for and compete in subsequent stages of the Olympiad. This is crucial because not all schools host an Informatics Olympiad. Participating in an online Olympiad is therefore the only means of self-expression available to students attending such academic institutions.

In the chart 2.3 represented the most useful and helpful platform for Kazakhstan Olympiad participants. As it is shown there, the most used one is Codeforces.com. The goal of Codeforces is to offer a convenient platform for creating, conducting and discussing programming competitions. Completely independent of the admin, you will be able to prepare and conduct the competition yourself. You decide for yourself whether it will be open to the whole world or will be a local competition of your university.

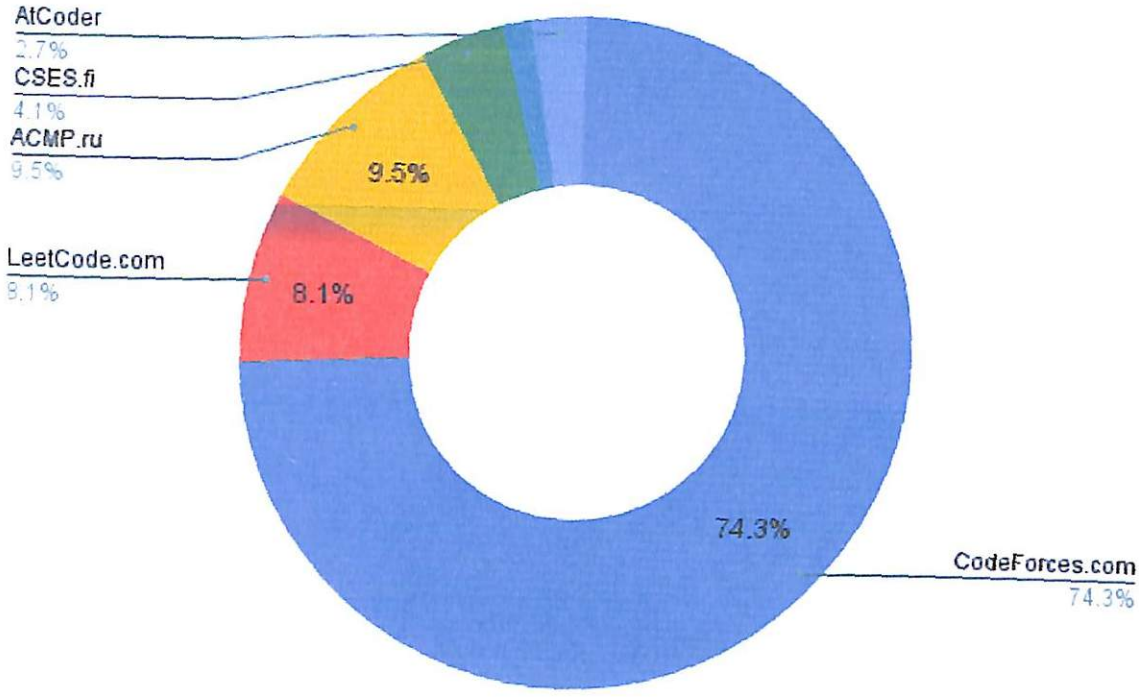

Figure 2.3: The most useful platforms for coding

The formation of a distributed portfolio of schoolchildren on the Internet is a significant consequence of the growth of Internet Olympiads. This enables us to develop novel approaches to the mechanisms for selecting gifted children, exposing them to the community of mentors regardless of the child's location. Due to a lack of familiarity with the communicative form of training Olympiads, regional mentors' interest in this fact remains relatively low. However, with the development of network technologies and the expansion of this form's coverage of children, new and useful additions to the system of teaching gifted children are possible, as evidenced by the experience of developed nations, particularly the United States, in this regard. There, leading universities control the communicative forms of work with gifted children in computer science, which are essential.

2.4 SDU Open

Programming Olympiads at the university are held annually as part of career guidance. Their goal is to improve the training of students in the field of programming and familiarize schoolchildren with the university, learning opportunities in modern specialties. In addition, it is a way to prepare a team of students to participate

in national and international programming competitions. The Olympiad is held in team mode in the form of competitions according to the rules of international Olympiads, mainly in computer classes of the Department of Information Technology. When there are many applications for participation, it is necessary to attract computer classes from other departments.

The term university name plus "Open" represents programming Olympiad that holds there. One of the examples can be SDU Open. SDU Open, The International Collegiate Programming Contest hosted by Transtelecom and the Faculty of Engineering and Natural Sciences at Suleyman Demirel University, invites university students with exceptional programming skills to compete in an epic battle. Teams of students compete to demonstrate their programming and problem-solving skills by attempting to solve 10 programming problems in five hours.

Preparation for this event was in a high level. Long before the start of the Olympiad, an organizing committee is created whose tasks are: developing the rules and program for the Olympiad, preparing and sending out invitations to educational institutions Suleyman Demirel University in the city of Kaskelen and the Almaty region, preparing an audience fund and coordinating with the educational department of the university, rescheduling classes, registering teams assignments, their testing, creation of a course of tasks in the automated program testing system, preparation of rules for registering teams in the university computer network, instructions for developing and testing programs in the automated program testing system and catering for participants during the Olympiad, and attributes of summing up the Olympiad and awarding the winners . On the eve of the Olympiad, when the acceptance of applications for participation is terminated, work is underway to distribute teams of students and schoolchildren into computer classes. Each team consists of three people. One team is allocated one computer. This is also a task, since it is required to distribute teams in accordance with the capabilities of the classes, and so that teams from the same school, lyceum, college, student group and faculty of the university do not end up in the same class. This is done to prevent participants from exchanging ready-made solutions to problems and to reduce the burden of the organizing committee in identifying plagiarism and disqualifying teams. It is known that this forced disqualification of teams has a negative impact on the atmosphere of the Olympiad.

To automate the process of registration of teams of students and schoolchildren who arrived at the Olympiad, lists of teams are preliminarily created and badges in the form of pyramids with the names of teams, educational institutions, and audience numbers are made from sheets of writing paper. Pyramids are installed on the system blocks of computers and the information placed on them makes it possible for the organizers of the Olympiad to quickly respond to the teams' comments about network problems and questions about software testing.

The Department of Information Technologies has developed a database for registration of participants in the Olympiad. Within the framework of the course design in the discipline "Program Design and Programming Languages", students developed a software system that allows you to create lists of teams, distribute them among audiences, create a scan of the pyramid-badges with text, sum up the results of the Olympiad and generate a report on its holding.

Great assistance in the preparation of the Olympiad is provided by the dean's office of the Faculty of Automated and Information Systems and the department for working with external companies. The organizers and the career department attract sponsors (IT companies interested in training specialists at the university), which allocate valuable gifts to reward the winners. Gifts to the participants of the Olympiad is one of the pleasant moments of participation in the Olympiad, and as a result participation becomes motivated in raising the level in programming. In 2021, Transtelecom became the main sponsor and co-organizer of SDU Open.

Transeelecom is one of the leading Russian telecom operators. The company is a provider of backbone communication services for operators and the largest corporations in Russia, and is also one of the leaders among providers of broadband Internet access, television and telephony services for end users in the regions.

Sponsors of SDU Open 2021 allocated 10 million tenge for prizes for students from various universities in Kazakhstan. After the end of the Olympiad, SDU together with Transtelecom held a closing ceremony and awarded the winners. The company selected some participants for further employment.

The peculiarity of the Olympiad is the participation of schoolchildren, i.e. children. Schoolchildren arrive at the Olympiad accompanied by teachers, who must be accepted and accommodated for the duration of the Olympiad. In an auditorium equipped multimedia technical means, the tournament table of the competition progress is displayed on the screen of a large TV. The table shows

all the participants and the information related to them: the number of solved problems, the number of attempts to submit problems for testing by the testing system, the penalty time accrued for solving problems, and the place occupied in the standings. Programming Olympiad requires a lot of concentration, mental and physical stress from the participants. The program of the Olympiad provides for a "coffee break", during which participants are offered harmless drinks and foods.

The Olympiad ends with summing up, considering appeals, awarding the winners and analyzing the problems proposed at the Olympiad. Of course, special attention is paid to preparing students for participation in the Olympiad.

3. Research question

3.1 Problems of Preparation for Olympiad

In connection with the actualization of the Olympiad movement in our time, the problem of organizing the process of preparing school students for participation in Olympiads is becoming increasingly important. Olympiads in academic subjects act as one of the types of intellectual competitions for schoolchildren in a specific scientific field, which make it possible to determine the degree of educational achievements of students, as well as to test the ability of students to apply the acquired knowledge in the process of solving tasks that have a high level of complexity. Olympiads of this kind are held in order to identify and develop schoolchildren's creative abilities, interest in scientific activities in order to promote scientific knowledge.

For schoolchildren, subject Olympiads are one of the most effective tools for revealing the possibility and degree of assimilation of theoretical material. Also, such activities help school students to develop mental and creative abilities. Participation in subject Olympiads contributes to the development of abilities in school students according to the areas of training at a higher level. Further, using the example of Olympiads in Informatics, we will consider the key requirements for the knowledge and skills of participants, as well as a number of characteristic problems that teachers often face in the process of preparing school students for such events.

Nowadays in our country we have only a few schools where programming olympiad is provided. These schools are: Bilim Inovation Schools, Nazarbayev Intellectual schools, Physics-Mathematics State Schools. 3.1 It is not because of financial or time problems, it is more because of not having an experience. According to survey 3.2 taken from active Olympiad participants from all over

the Kazakhstan, we can see that most of them started to learn sports programming from schools.

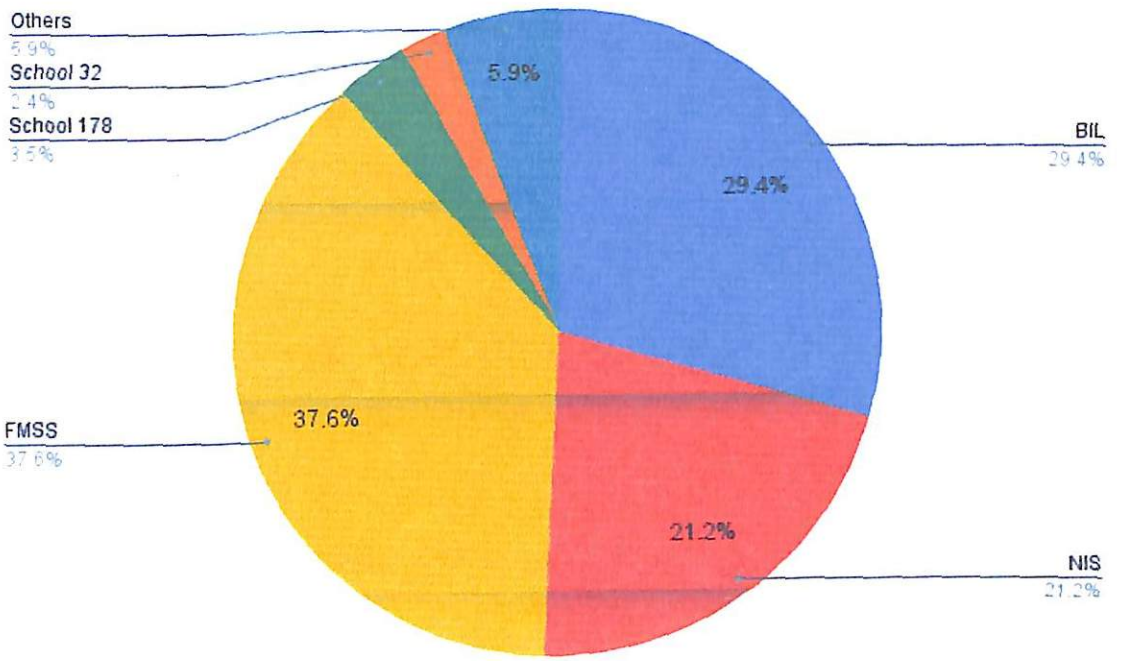

Figure 3.1: Schools that prepares to programming Olympiad

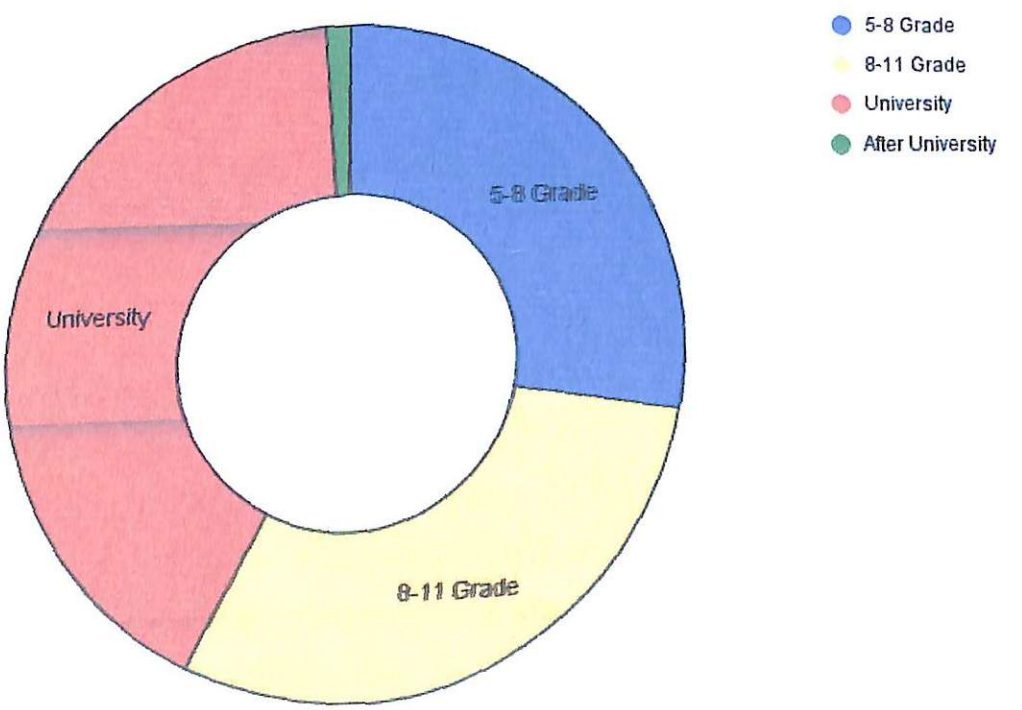

Figure 3.2: When Olympiad participants are started to learn programming?

The state school educational standard includes complex curricula for all school educational fields (math, natural sciences and informatics, philology and humanities sciences, technology, and art), mandatory requirements for teaching pupils and conditions of the teaching process (list of school equipment), school supplies, and school materials (Federal book list for school subject).

Now, the state school educational standard has introduced a number of new issues to schools:

1. To cultivate students' interest in emerging information technologies.
2. On the basis of an informatics course, guarantee the development of ICT competence among students.
3. On the basis of an open school stage of the Russian Olympiad in Informatics, identify informatics-talented students.
4. To provide gifted students with the opportunity to prepare for the final stages of the Informatics Olympiad.
5. Actively collaborate between schools and make available to students via the Internet professional-oriented elective courses taught by coaches from different schools.
6. Utilize the school's informational space effectively.
7. Utilize students' ICT skills actively in a variety of school subjects.

For these issues to be resolved, it is necessary to equip teachers with ICT. Clearly, the informatics instructor at the school solves problems 1–3. Their professional competencies are entirely outlined by the state standard in the school's informatics class. A description of the curriculums for introductory and advanced informatics courses in schools. Through an open school stage of the Olympiad in Informatics, it is precisely these informatics teachers who help to identify talented students in the field. Every five years, the competencies of informatics teachers in comprehensive schools are developed alongside the standard state update in informatics[11].

For resolving problems 4–5, it is crucial to choose coaches from among informatics instructors. These educators prepare students for participation in the

final stages of the Olympiad in Informatics. Task 4 requires the development of curricula for the special ICT preparations of informatics teachers-instructors by schools. This article describes for the first time, based on the authors' analysis of the competition task content of the Russian and International Olympiads in Informatics over the past decade, the curriculum for preparing such teachers-coaches. This curriculum includes mathematics, logic, and programming in addition to the standard topics on informatics for schools. On the basis of additional preparation topics, the teacher can design elective courses for students in ninth through eleventh grade as part of their high school career-oriented education. Above all, these curriculum topics are automatically incorporated into specialized courses for students - future Olympiad in Informatics competitors.

When discussing the informatization of education, it is impossible to overlook the teachers who do not teach computer science in the classroom. This is the majority of teachers at comprehensive schools, and they must be ICT-savvy in order to utilize the school's informational environment in collaboration with students. Such a partnership with ICT-competent teachers in a variety of school subjects will allow ICT-active students to advance in other school subjects with advanced ICT usage and help define the profession of the future. Lastly, problems 6–7 require the unification of ICT competencies for school teachers in order to be resolved.

It follows from what has been stated above that the level of ICT preparation for school teachers in different subjects should vary. It creates difficulties for ICT, teaching them, and the organization of pedagogical partnerships between students and teachers in the use of ICT, particularly for students who have abandoned informatics. The school should not only identify ICT-talented students, but also integrate ICT into other subjects and provide students with opportunities to use advanced information technologies in their future careers. The school's mission is to prepare gifted students for innovative endeavors, including those with intensive ICT use.

3.2 Levels of ICT Teachers

Let's start, first of all, with the fact that the organization of the process of preparing students for participation in the Olympiad begins with the preparation of the

teacher himself.

The analysis of the state school educational standard and the content of the competition tasks of the Russian and International Olympiads in Informatics over the past decade has enabled the classification of three ICT preparation levels for school teachers:

1. Each teacher's level of ICT preparation in comprehensive schools.
2. The level of ICT training that informatics teachers have in order to enhance their professional skills.
3. The level of preparation of informatics instructors and coaches who will prepare students for the final stages of the Informatics Olympiad.

The initial level of ICT preparation is the responsibility of all general education teachers. This standard is shared by all teachers. This level establishes standard ICT competencies for teachers of various school subjects. In a school's informational environment, the common ICT competence of teachers demonstrates a level of collaboration with teachers and students. This level can be considered the teachers' informational culture. This level of teacher preparation is crucial so that students can apply ICT skills to a variety of school subjects. Informatics teachers in schools cultivate the ICT skills of students.

The second level of ICT preparation involves informatics teachers with professional expertise. The informatics education standard for public schools specifies this level of preparation for informatics teachers. It should be noted that in Kazakhstan, the reliability of the goals and objectives of teaching the subject "Computer Science" in the state standards of secondary education in 1998 and 2002. more or less corresponded to the state of the educational process of those times and some of its main provisions were borrowed from existing standards.

At the present stage of development of the methodological system of teaching informatics in the Republic of Kazakhstan, the understanding has come that, along with strengthening the general educational significance, it should also be characterized by the fundamental knowledge of school informatics. In this regard, in the future it is necessary to carry out search work to identify the fundamental foundations of school informatics, adapt the content of educational material to the

age of students and the standards of study time, determine the cores of building a course, and implement inner subject communications.

The third level is the most advanced level of preparation for teachers of informatics. It is the preparation of informatics teachers who will prepare students to compete in the final stages of the Olympiad in Informatics or IOI. The content of modern competition tasks and international informatics olympiads define this level of preparation. The curriculum developed by the authors of this paper is based on an analysis of the Olympiads in Informatics and IOI competition task content over the past ten years, as well as school informatization programs.

It is important to note that the three levels of ICT preparation for informatics teachers in comprehensive schools are interrelated. As a result, it is reflected in the success of students in the informational world; this is particularly true for talented students in the field of informatics and their state-sponsored education. It also influences the use of ICT in the classroom, creative development, and career development.

As stated previously, the second level of preparation for informatics teachers is defined by state school educational standards of informatics and ICT or by comparable documents that serve as the basis for the study of informatics or computer science in comprehensive schools. It is abundantly clear that the preparation of informatics teachers varies from country to country, so it is unnecessary to speak generally in this instance. Therefore, we will only consider the preparation of elementary and secondary school teachers.

3.3 Common ICT Skills of School Teachers

Experience has shown that it is possible to consider the modern common ICT competence of comprehensive school teachers to be the development area most closely aligned with professional teacher skills. This closest development area mandates the following equipment: a teacher workstation with a computer and such ICT resources (including new digital equipment and specialized software) as to form the tool making computer system (TCS) of professional teacher activity, which is part of the education's informational space. Internet educational resources that are already widely utilized by comprehensive school teachers play a crucial role in TCS. In the following list, some examples of such Internet-based

educational resources are provided.

1. I.G. Semakin, L.A. Zalogova, S.V.Rusakov, L.V. Shestakova. Informastics: Textbook on the basic course. - M.: Laboratory of Basic Knowledge, 1998. A science that studies all aspects of receiving, storing, converting, transmitting and using information. Familiarity with information as the main subject of the discipline information of one cycle and with a computer as a tool for working with information, an object of study and improvement

2. E. Y. Bidaibekov, M. P. Lapchik, Zh. K. Nurbekova, A. E. Sagymbaeva, G. S. Zharasova, N. N. Ospanova, D. N. Isabayeva, Methods of teaching computer science, Almaty 2014. The study of the structure and general properties of information, as well as patterns and methods of its creation, storage, search, transformation, transmission, and application in various spheres of human endeavor. The textbook is intended for students of pedagogical universities to systematically study the course "methods of teaching Computer Science".

3. Yu.A. Shafrin. Information technologies: Textbook. M.: Binom, 1996. A set of disciplines that study the properties of information, as well as ways of presenting, accumulating, processing and transmitting information using technical means. Mastering modern software tools.

4. A.P. Ershov, V.M. Monakhov, etc. Fundamentals of Computer Science and Computer Engineering: Grade 10-11: Part 2 Enlightenment, 1985. Science that studies the methods of accumulation, processing and transmission of information. Formation of algorithmic culture and computer literacy.

5. A.G. Kushnirenko, G.V. Lebedev, R.A. Svoren, etc. Fundamentals of computer science and computer technology. - M.: Enlightenment, 1991. A discipline that studies methods of presentation, accumulation, transmission and processing of information using a computer.

6. Computer Science: Textbook for economic special universities/ Edited by N.V. Makarova. - M.: Finance and Statistics, 1997. The field of human

activity related to the processes of transformation and use of information using a computer. Formation of information culture.

3.4 The Common Curriculum of Improvement School Teachers

The common curriculum for the improvement of comprehensive school teachers was developed based on the analysis of various variants of similar programs in the following projects: "Teacher to the future" (Intel, 2003), "Academy of teachers" of the international initiative Microsoft "Partners in learning", "Informatization of education system," and the programs of numerous ICT training centers in regional areas. There are variations in the content of each of these programs, each of which takes into account unique aspects of training.

The experience of all programs over the past five years must be summarized in the developed curriculum. Some parts are invariant for all teachers in comprehensive schools; they facilitate the development of a shared information culture among teachers, conditioned on their level of computer literacy.

The common curriculum of improvement for comprehensive school teachers is comprised of six modules for preparing teachers with the aforementioned ICT competencies. No training module exceeds 18 hours. There is a component of the training program corresponding to each type of competence. Notably, each module focuses on ICT competence in educational activity. This aspect of the curriculum enables a teacher to achieve competence in the field of ICT, not on a user level, but on a professionally oriented level in terms of integrating ICT into pedagogical practice.

The following is a summary of the common improvement curriculum for teachers in comprehensive schools. It is geared toward 72 hours of study. 26 hours are devoted to theory, while 48 hours are devoted to practice. Modules 1, 2, and 3 comprise a 36-hour course in computer literacy. Modules 4, 5, and 6 comprise a 36-hour-long course on the teacher's common information culture. For groups of computer-literate teachers, the curriculum can be implemented on the basis of 36 hours of a common information culture course and 36 hours of the additional module 7 (updated modules 1–3). The topics that can be substituted with the additional module 7 are determined based on a primary examination of teachers.

With the use of the additional module, it is provided on those topics for which a teacher has demonstrated competency, in order to advance his trajectory of development in the ICT school environment.

Typical modules of the standard curriculum for the preparation of elementary school teachers are presented here in the list below:

1. Introduction to Information Technology
    1.1. ICT-preparation within the framework of instructional activity
    1.2. Workshop for teachers on the "Concept of Uniform Information Space of Educational Establishment, Model of Its Construction, and Personal Information Space of the Teacher"
2. The computerized organization of a teacher's workplace
    2.1. The arrangement of the instructor's personal information space and computer workstation
    2.2. Overview of Microsoft Windows/Linux
    2.3. General questions regarding the technique for introducing digital equipment into the teaching and learning process (interactive board, digital laboratory, computer models)
    2.4. Work of a practical nature. TCS is a part of the school's informational space and supports professional teacher activity (the school schedule, the electronic journal of lessons)
3. ICT is the methodological basis for preparing evidence-based and instructional materials
    3.1. Methods of preparing instructional materials (such as Microsoft Word or Open Office)
    3.2. Preparation of materials for distribution containing graphic elements
    3.3. Methods for preparing evidentiary and educational-methodological materials (such as Microsoft PowerPoint or Open Office)
    3.4. Practical Work: "Creation of Evident and Educational-Methodological Materials Utilizing Microsoft Office/Open Office"

4. Internet use for educational purposes

   4.1. The building blocks of the Internet network. Internet-channels, principal operating principles of satellite segment, and the uniform Space for Educational Information Internet-based services provide educational opportunities

   4.2. Information search systems in the Internet network for use by the instructor and students

   4.3. Internet-based educational resources (review and thematic search)

   4.4. Informational security measures

5. Utilizing digital educational resources in teaching

   5.1. Realization of Federal target programs included a review of digital educational resources

   5.2. Teachers' workshop on "Designing a Lesson Utilizing Digital Educational Resources"

   5.3. Activity of teacher groups in the school's distance-learning area, where students are studying at home

   5.4. Additional practical work on the use of digital educational resources (DER) in training curriculum subjects (in groups) using the DER of the school media library as an example

In General:

6. *Supplementary modules*

   6.1. Particularities of education cooperation within the context of teachers' work with students. Teams for school projects. Understanding ICT-project (in school subject)

   6.2. As the school's ICT-team, a computer help service is provided by a technology organization

   6.3. Technology organization student publication team

   6.4. Computer club of the school's technology club with digital laboratory

The content of each training segment is conveyed through both lectures and practical training, in the form of computer lab work and workshops. Workshops are discussion-based practical lessons that do not require the use of computers. These lessons are recorded on video, and participants can watch them multiple times to improve their comprehension. The purpose of workshops is to identify the most effective methods for delivering lessons to various groups of teachers using ICT resources. These workshops are important for the development of socially beneficial school projects and the search for new methods for the preparation of each comprehensive school teacher based on remote technologies.

The further development of the described curriculum can be accomplished by adding 18 hours of new modules that incorporate new ICT application areas in the classroom. If teachers become proficient in computer literacy, modules 1–2 and 3 of the computer literacy course will soon be relegated to an area of independent study.

The following decade will be dedicated to the growth of teachers' information culture. Distance education technologies based on the Internet, TV-technologies, and interactive media resources will play a significant role during this time period. The most significant changes will occur in the teacher's computer workstation and digital lab equipment. Common to the ICT culture of teachers will be the mastery of instructional design tools and a management system for educational processes. Interschool information system will replace the school's information space[8].

All of this will necessitate teachers' comprehensive mastery of the common ICT competencies and system development of their information culture in the uniform education information space. In this case, new training modules should be incorporated flexibly, for each teacher, into the development trajectory of information culture.

3.5 Curriculum for Informatics Teachers and Coaches in Programming Olympiad

The preparation of informatics teachers and coaches for national and international informatics olympiads should, on the one hand, be based on the state school educational standard for informatics and, on the other hand, take into account the contemporary competition task contents of national and international informatics

olympiads. The analysis of the currently enforced state school educational standard for informatics suggests a curriculum of preparation for informatics teachers based on their professional ICT competence.

Taking into consideration the methodology outlined in the work of Kiryukhin, V.M. [20] defining the contents of the Olympiad on Informatics, we will select the following key components of the complex curriculum for preparing informatics teachers and coaches for informatics olympiads. The complex curriculum presented below for the preparation of informatics teachers and coaches for informatics olympiads is comprised of seven sections, each of which reveals subtopics. Each topic, in turn, contains in greater depth the didactic units revealing key knowledge and skills that enable each student to develop an individualized preparation trajectory for the Informatics Olympiad.

1. Mathematical Foundations of Information Technology
    - 1.1. Functions, relations and sets
    - 1.2. Basic geometry
    - 1.3. Basic logical operations
    - 1.4. Techniques of proving
    - 1.5. Basics of Algebra
    - 1.6. Basics of combinatorial calculus
    - 1.7. Graph theory
    - 1.8. Basics of probability theory
    - 1.9. Linear programming
2. Creating and Evaluating Algorithms
    - 2.1. Algorithms and their properties
    - 2.2. Data structures
    - 2.3. Basic algorithmic analysis
    - 2.4. Algorithmic strategies
    - 2.5. Recursion
    - 2.6. Basic computational algorithms

2.7. Numeric algorithms

2.8. Graph algorithms

2.9. Dynamic programming

2.10. Geometrical algorithms

3. Programming Fundamentals

3.1. Programming languages

3.2. Programming constructions

3.3. Variables and data types

3.4. Data structure types

3.5. Fundamental programming species

4. IT facilities

4.1. Digital logic

4.2. Data representation

4.3. Computer engineering principles

4.4. Memory

5. Operating systems

5.1. Operating systems basics

5.2. Basic functions of operating systems

5.3. Memory control

6. Basics of programming technologies

6.1. Programming facilities and space

6.1.1. *Programming space*

6.1.2. *Testing facilities*

6.2. Software quality assurance

7. Calculation methods and modeling

7.1. Basics of computational mathematics

7.2. Modeling basics

For the preparation of informatics teachers and coaches for informatics olympiads using the outlined curriculum, it is important to keep in mind that topics and didactic units should be presented in a progressive order from easy to difficult. Particularly, it is necessary to master the initial level of complexity before proceeding. Moreover, if teachers or coaches do not prioritize preparing students for a successful performance at the final stage of the Olympiad in Informatics or the IOI, it is sufficient for them to master only the first level of complexity. It is crucial that these informatics instructors or coaches have more knowledge, even if they only teach to the introductory level; however, not all of them will be able to master a higher level of complexity.

Only the most qualified instructors and trainers can be promoted to the third level of difficulty. It is important to remember that the performance of their students at informatics olympiads can be used to evaluate the level of preparation of any informatics teacher-coaches. If students win medals at the IOI, their informatics teacher-coaches will create a gold fund of coaches who are able to prepare students for national and international informatics olympiad victories.

4. Teaching Methods

4.1 Role of Coach and Duties

As a result of the actualization of the Olympiad movement in our time, the issue of organizing the process of preparing school students for participation in Olympiads is growing in significance. Olympiads in academic subjects serve as one of the types of intellectual competitions for schoolchildren in a particular scientific field, allowing for the assessment of their educational achievements and the evaluation of their ability to apply acquired knowledge to the solution of tasks with a high degree of difficulty. Olympiads of this type are held to identify and cultivate the creative abilities and interest in scientific activities of schoolchildren in order to advance scientific knowledge.

Subject Olympiads are one of the most effective methods for determining the potential and degree of theoretical material assimilation among students. In addition, such activities help students develop their cognitive and creative abilities. Participation in subject Olympiads contributes to the development of higher-level training skills in school students. In addition, using Olympiads in Informatics as an example, we will examine the key requirements for the knowledge and skills of participants, as well as a number of common challenges that teachers face when preparing students for such competitions.

Let's begin with the fact that the process of organizing students' preparation for the Olympiad begins with the teacher's own preparation. In the chart 4.1, Olympiad participants gave a feedback on question: "Do we really need a coach?". So, the answer was "Yes" and especially for beginners.

Considered to be the primary challenges a teacher faces in preparing a student for the Olympiad are:

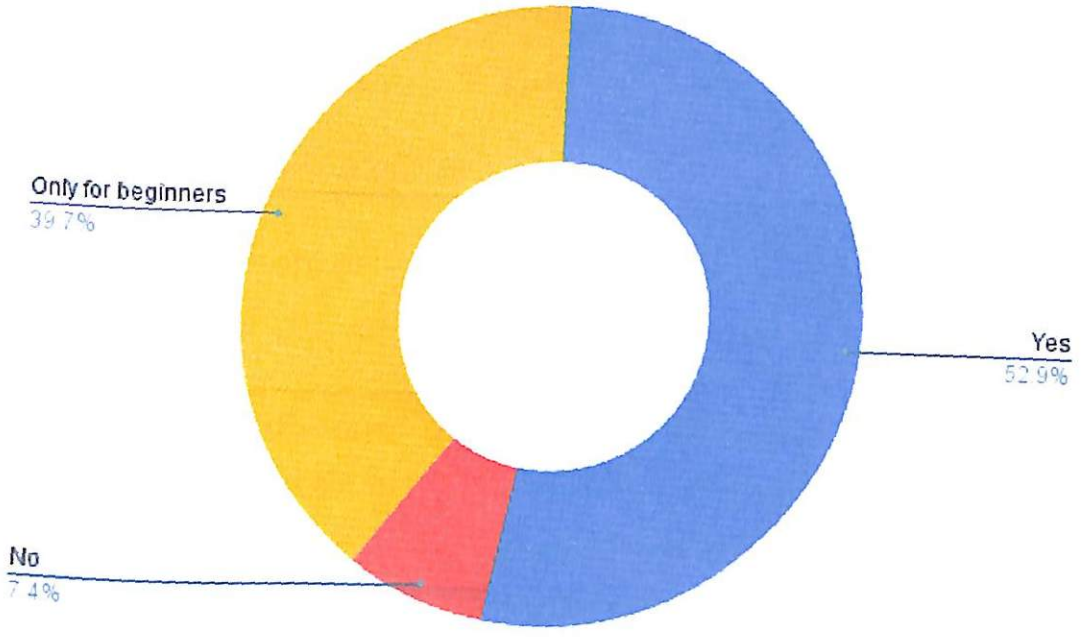

Figure 4.1: Do we really need a coach?

- Instructing the student on how to organize their own activities in order to participate in the Olympiad;
- Mastering the structures of these occurrences;
- The study of algorithms for solving problems presented to Olympiad competitors;
- Proficiency with programming languages;
- Time to master and test the Olympiad tasks that students must solve.

It should be noted that the range of problems solved at the Olympiads quite limited. Despite this, the solution of Olympiad problems in most cases is caused by the occurrence of certain difficulties for both the student and the teacher. This is primarily due to the fact that some tasks require the student and the teacher to have certain knowledge in the field of higher mathematics and dynamic programming. In addition, verification of solutions and development of tests takes a lot of time.

Successful participation in computer science Olympiads guarantees the student the availability of knowledge:

1. Technical characteristics of computer equipment;

2. Key features of popular operating systems;

3. Ways to formalize the tasks set;

4. Key types of algorithms;

5. One or more programming languages, the list of which is approved directly by the organizers of the Olympiads.

The results obtained during the analysis of computer science Olympiads [12] indicate that such events include many different tasks, in particular, problems in arithmetic, combinatorics, dynamic programming, etc.

As an example, we will present a list of Olympiad tasks that were proposed to be solved by students at the regional stage of the Olympiad in computer science in the 2017/2018 academic year.

Table 4.1: List of topics of Olympiad tasks

Tasks	Complete solution of problems	Partial solution of problems
"Campus"	Modular arithmetic, application of the formula	Linear search
"Calculator"	Dynamic programming, greedy algorithms	Linear search of options
"Data placement"	Algorithms on graphs	Brute force, linear search
"Minerals"	Binary search, combinatorics, algorithms on graphs	Iteration of options, algorithms for finding the maximum match, algorithms for finding the maximum flow
"Automated delivery management"	Linear search of options, formula output	Full search of options, dynamic programming
"Large linear Collider"	Linear passage, data structures, combinatorics	A complete search of options, modeling
"Force fields"	Data structures, scanning line	Brute force, sorting
"Professional development"	Working with trees, algorithms on graphs	Linear search of options

At the moment, the key documentation in determining the content of tasks for conducting subject Olympiads in schools, in particular Olympiads on such a subject as computer science, applies state educational standards of secondary general education in computer science and ICT at the primary and profile levels.

The analysis of many years of practice allows us to conclude that the key problem in the process of preparing school students to participate in Olympiads is that the section "Algorithmization and programming" of the initial or profile course "Computer Science and ICT" allows students to learn only a small amount of material on these topics. This, in turn, leads to insufficient preparation of school students for computer science Olympiads.

Solving the problems of computer science Olympiads is a separate educational section. This section goes far beyond the educational process in its theoretical and

practical content. To solve such a task plan, a student must have a certain level of training and a knowledge base in this subject area. In this regard, many teachers who are interested in high-quality training of participants of subject Olympiads and their victory began to conduct additional classes in their free time. As a rule, such classes are conducted in the form of elective courses or subject circles.

The general preparation of students for participation in subject Olympiads involves a number of the following actions:

1. Selection of gifted students;
2. Testing of students to determine their level of training in computer science;
3. Development of skills to work with advanced computer technology;
4. Mastering one of the key programming languages;
5. Mastering algorithms that are necessary to solve Olympiad problems;
6. Study of various methods of solving known algorithms;
7. Analysis of the effectiveness of programs;
8. Mastering the ways of testing software products;
9. Development of ways to write and configure software products on a computer[3].

4.2 Proposed Method of Training

In order to solve the problems of high-quality training of school students who take part in computer science Olympiads, a special methodology was created and introduced into the practice of teaching Imantau secondary school in Republic of Kazakhstan.

The subject part of this teaching methodology was developed in two forms: full-time and distance. Conducting classes with school students can be carried out in small groups, which include from 3 to 5 people. In the process of conducting classes, the degree of preparedness of students should be taken into account[9].

In addition, lectures and practical classes can serve as forms of organizing the learning process.

Training on each individual topic may include several stages.

The first stage is a lecture lesson, which is carried out within the didactic unit. As a rule, this stage begins with the development of the theoretical bases of the subject area. To do this, the analysis of the main algorithms for solving problems of this type is carried out.

With full-time training, the development of an algorithm for solving such problems is mastered under the direct supervision of a teacher. With another form of education – distance learning, the study of materials is carried out by schoolchildren independently.

The second stage is practical. In order to check the level of mastering of the studied material, a number of additional typical tasks are introduced into the task systems. They are sorted out by students depending on their level of preparedness with the participation of a teacher in the framework of interaction with a small group. In the process of considering such tasks, the teacher and the students consider the conditions of the tasks, establishing their sufficiency or redundancy.

The third stage is laboratory practice. In the process of conducting laboratory classes, students are invited to independently solve a certain number of non-standard tasks.

To solve problems by students at the maximum level of complexity for them, the teacher selects tasks of 3 categories for laboratory classes.

1. Tasks with a level of complexity that allows students to solve them independently;
2. Tasks with a level of complexity that only students with an average degree of training are able to solve;
3. Tasks with a level of complexity that can be solved only by a certain circle of students with a high level of preparedness.

This kind of methodology allows solving problems that arise when preparing students for computer science Olympiads, relying on compliance with the following set of didactic conditions:

- The presence of formed task systems that cover key sections of computer science and are created on the basis of Olympiad tasks in computer science.
- The use of task systems that make it possible to make adjustments to the learning process in accordance with the achieved degree of readiness of students;
- Continuous monitoring of the level of students' knowledge in the field of programming.
- The opportunity for students to demonstrate their abilities at the highest possible level for them through working in dynamic small groups.
- The teacher has experience in preparing school students for computer science Olympiads.
- Availability of software and material and technical base for full-time and distance learning of schoolchildren.

In the process of preparing secondary school students to participate in subject Olympiads, many different teaching methods can be used. All these techniques can be used by the teacher during additional classes. This allows students to master the studied material in a shorter time with greater efficiency.

For faster mastering of new educational material by students, the teacher conducts lectures. As a rule, their duration does not exceed 20 minutes.

Practical classes in preparing school students to participate in computer science Olympiads are held in small training groups. Often the number of these groups does not exceed 5-6 people. Their creation can be carried out both according to the level of development of the participants' thinking, and according to their basic training. The purpose of small groups is, first of all, to maximize the involvement of students in the learning process and to provide conditions for the effective use of the accumulated experience of students and available funds in the process of solving Olympiad tasks. In the process of finding a solution, students

independently decide what data they need, as well as how and where they can get it.

Most students take part in classes in groups of different ages. In such groups, older and more experienced participants act as mentors: they introduce newcomers to programming features, some ways of writing and configuring software products, and give answers to questions that newcomers have. Individual tasks are used in groups of different ages. Their issuance is carried out by the teacher, taking into account the degree of training and interests of students.

In the course of group problem solving, active learning methods are often used, in particular, brainstorming. In this case, the group members express their own ideas and thoughts on solving the tasks assigned to them. As a rule, brainstorming is limited in time and does not exceed 3-5 minutes. The teacher records each thought on the blackboard as it arrives. In the process of brainstorming, students cannot speak out about the proposed ways of solving the tasks assigned to them. At the next stage, the teacher forms a list of these ideas, on the basis of which, together with the group, evaluates each idea and prioritizes them.

Independent work of students is intended to deepen the acquired knowledge. Independent or homework on practical tasks helps students develop learning and research skills. For independent work, individual tasks are compiled, which vary in volume, complexity, creative orientation, and deadlines.

Consultations (group, individual) are intended to receive assistance in the form of an oral explanation of the material by the teacher, receiving instructions or jointly compiling an algorithm or solving a problem.

Consequently, such a method of preparing school students for computer science Olympiads makes it possible to activate their creative potential. In addition, it allows you to effectively solve the problems of high-quality training of Olympiad participants and develop the giftedness of students in the system of developmental training.

The present methodology of preparation for the Olympiads can be used to solve the problems facing computer science teachers preparing participants of the Olympiads and students participating in the Olympiads. The proposed methodology is not full-fledged, but it will help not only in preparing for the district Olympiad, but also for higher-level Olympiads.

4.3 Learning Management System

In the community of higher education institutions, the Learning Management System, or LMS, is an online portal that connects instructors and students. It facilitates the easy sharing of classroom materials and activities. It is also a portal that enables lecturers and students to interact outside of the classroom, engaging in forum discussions that would otherwise consume too much time meant for learning in class.

In this era of information technology, the internet is widely accessible and readily available in urban areas, where the majority of universities are located[2]. Internet is defined as a vast computer network that connects smaller computer networks around the world, and it includes commercial, educational, governmental, and other networks that all use the same set of communications protocols.

The majority of students have access to the internet as their schools or universities provides internet access and there are typically libraries with internet within walking distance that cater to students. Those who subscribe to an internet service provider also have internet access within their own residences.

In order to develop and educate Olympiad programmers, it is important to choose the right LMS. As we know, these people will need math and informatics content[14]. And also the most valuable thing is that LMS should be able to run and test in programming languages. Nowadays we have very different options to choose from. However, the top chosen and best rated platforms that fit our criterias are CodeHS and CodingRooms.

4.3.1 CodeHS

CodeHS is an interactive online learning platform that teaches computer science and programming to schools and individuals. By providing online instructional materials supported by remote tutors, CodeHS aims to increase access to and knowledge of computer science. Students practice computer science concepts and programming skills in the site's introductory learning module by giving commands to a dog named Karel. Similar to the original Karel programming language created by Richard E. Pattis, Karel the dog must complete various tasks by navigating a grid-based environment and placing and retrieving tennis balls using only simple commands[21]. Languages such as JavaScript, Java, and HTML are utilized in

later learning modules to teach more complex ideas.

The mission of CodeHS is to provide exceptional computer science teaching and learning opportunities to students around the world. CodeHS is committed to providing teachers, students, and team members with enjoyable, accessible, and inventive learning opportunities. They believe that education, specifically coding in formal K-12, higher education, and beyond, has the ability to unlock the full potential of every individual.

Advantages of CodeHS:

- **Easily Manage Student Rosters and Attendance.** Invite students to your CodeHS section or automatically import your roster from an external platform, such as Google Classroom, regardless of whether your class is virtual or in-person.
- **Collaborate and Share Student Feedback.** CodeHS enables the sharing of student programs, announcements to students and teachers, and personalized feedback.
- **Review and Grade Student Code Automatically.** Utilize a suite of grading tools and customizable settings to save time grading and managing hundreds of student submissions.
- **Track and Analyze Student Data Instantaneously.** You have access to all the data reports and dashboards required to assess student comprehension and track their progress throughout the year.

4.3.2 Coding Rooms

The Coding Rooms IDE is a highly effective, user-friendly, browser-based development environment. Code operates on a robust Linux instance where you can serve your project as a web application, view it as a desktop graphical user interface, or even create desktop applications with sound. Visual Studio Code can even be used in Coding Rooms[22].

Assess learner knowledge with multiple-choice questions, Parsons problems, drag-and-drop, code select, and more; embed interactive content, videos, and images with ease; and format text using HTML/CSS. Similar to a Google document, multiple collaborators can edit a learning page in real time.

Advantages of Coding Rooms:

- **Real-time instruction.** Lightning Grader enables you to track a student's real-time progress for each interactive block with a single click. And Presentation Mode enables students to view their work alongside an instructor's page in real time.
- **Built-in video conferencing.** By the help of video conferencing, integrated into Coding Rooms, no additional software is required for live, remote instruction. Using our presentation mode, a comprehensive set of options, including audio, video, screen sharing, and meeting recording, is permitted.
- **Automated grading.** The Coding Rooms IDE supports input/output comparisons, unit testing with a variety of popular frameworks, and custom bash script testing to automate grading and provide immediate feedback in a straightforward manner.
- **All levels of learners.** Whether for corporate training or K-12 education, live classroom or asynchronous learning, Coding Rooms provides the adaptability and customizability required to create a compelling learning experience.

4.3.3 Comparison of LMSs

Overall, CodeHS is a well-thought-out product that offers simple curricula for K-12 computer science teachers who may need a foundational curriculum to shape their classes. On the other hand, Coding Rooms is primarily a tool for teachers to effectively teach programming. Based on its platform features, Coding Rooms may fit more use cases for a broad spectrum of computer science teaching requirements, depending on the needs of the teacher and the degree to which they wish to customize their own curriculum.

In the table 4.2 shown a main differences of CodeHS and Coding Rooms.

Table 4.2: Comparison of LMSs

Features	CodeHS	Coding Rooms
Programming Languages	✓	✓
Unit Tests and Input/Outputs	✓	✓
Theoretical Content	✓	✓
View All Students Code in Real-time	✗	✓
Comments on Code	✗	✓
Private Projects	✗	✓
Group Projects	✗	✓
Video Conference	✗	✓

For the future coaches and instructors of ICT, Coding Rooms will be a great option not only to deliver content, but also to monitor and navigate students.

5. Conclusion

Historically, the concept of an algorithm has been the most fundamental in computer science and information and communication technologies. As a result, the fundamental component of a computer science course in school is instruction in algorithmization, programming, and computer implementation techniques. Numerous methodologists note, however, that the practice of teaching algorithmization and programming presents numerous unresolved problems. Historically, there has been a decline in fundamental instruction in this area due to the course's increased emphasis on technology. In regulatory documents, the decrease is also accounted for, but in practice, algorithmization and programming are frequently eliminated from the foundational curriculum of computer science and Information and Communication Technologies.

The thesis work proposes techniques for teaching algorithmization and programming in schools, emphasizing that the greatest emphasis should be placed on both the academic study of algorithms and their implementation in a programming language. Usage of "Coding Rooms" Learning Management System(LMS) will rapidly increase preparation in online format. The abilities of "Coding Rooms" opens a new opportunities for learners from different places.

Preparing teachers according to their assigned levels of information technology competence plays a crucial role in the development of each nation's informatization. The teacher preparation curricula presented in this work are applicable in other nations where informatics and computer science are included in the national education program on informatics and where national informatics olympiads are held. Experience in this area can also be useful for the systematization of informatics and ICT teacher preparation programs in any nation. The problem of enhancing the information technology skills of teachers should be resolved in a manner that ensures not only a high level of informatics education in comprehen-

sive schools, but also student success at the IOI.

References

[1] *ACM International Collegiate Programming Contest website.* 2006. URL: `http://acm.baylor.edu/acmicpc/`.

[2] Michael Dolinsky. "A New Generation Distance Learning System for Programming and Olympiads in Informatics". In: *Olympiads in Informatics* 11 (2017), pp. 29–39.

[3] Pavlova E.S. *Methods of using task systems as a means of developing giftedness in preparing schoolchildren for computer science Olympiads.* Volgograd, 2014, p. 219.

[4] G. Futschek and V. Dagiene. *Education and Technology for a Better World.* Proceedings 9th WCCE 2009, 2009.

[5] Maksat Galiyev and Gulnara Saimassay. "Goals Of Conducting And Motivation For Participation In Programming Competitions". In: *IYSC Conference (not published)* (2022).

[6] Maksat Galiyev and Gulnara Saimassay. "Methodology Of Preparing Schoolchildren For The Olympiad In Informatics". In: *SDU Journal* (2022).

[7] Lasse Hakulinen. "Survey on Informatics Competitions: Developing Tasks". In: *Olympiads in Informatics,* 5 (2011), pp. 12–25.

[8] G. Horváth and K. Diks. "A proposal for an IOI syllabus". In: *Teaching Mathematics and Computer Science* 4 (2015), pp. 193–216.

[9] Metodija Jancheski. "Improving Teaching and Learning Computer Programming in Schools through Educational Software". In: *Olympiads in Informatics* 11 (2017), pp. 55–75.

[10] Vladimir M. Kiryukhin and Marina S. Tsvetkova. "Preparing for the IOI through Developmental Teaching". In: *Olympiads in Informatics* 5 (2011), pp. 44–57.

[11] Vladimir M. Kiryukhin and Marina S. Tsvetkova. "Strategy for ICT Skills Teachers and Informatics Olympiad Coaches Development". In: *Olympiads in Informatics* 4 (2010), pp. 30–51.

[12] *Methodological materials for checking and evaluating the performance of Olympiad tasks by participants of the regional stage of the All-Russian Olympiad of Schoolchildren in Computer Science in the 2017/2018 academic year.* 2019. URL: `https://olimpiada.ru/activity/73/tasks/2017?class=11&year=2017`.

[13] Avdeyuk O.A. and Lemeshkina I.G. "Using Of It-competition For Talent Students Determination And Skill Evolution In Programming". In: *Modern High Technologies* 5 (2016), pp. 306–310.

[14] E.S. Pavlova and O.A. Avdeyuk. "The Use Of Distance Learning In Preparing Schoolchildren For Computer Science Olympiads". In: *Pedagogical sciences* 3 (2011), pp. 28–30.

[15] Giovanni Serafini. "Teaching Programming at Primary Schools: Visions, Experiences, and Long-Term Research Prospects". In: *Informatics in Schools. Contributing to 21st Century Education* 4 (2011), pp. 143–154.

[16] Alexander A. Sergeevich. "Student Programming Olympiads: the coach's view". In: *Our Authors* (2001), pp. 19–21.

[17] Verhoeff T. *Future World: Educating for the 21st Century.* Conference and Exhibition at IOI, 2007.

[18] Verhoeff T. "The role of competitions in education". In: *A New Learning Paradigm* (2010), pp. 207–214.

[19] I.A. Tarasova and E.G. Shvedov. "General Approaches To The Development Of Methods Of Preparing University Students For Subject Olympiads". In: *Collections of conferences of SIC Sociosphere* 9 (2013), pp. 117–118.

[20] Kiryukhin V.M. "The modern contents of the Russian national olympiads in informatics". In: *Olympiads in Informatics* 1 (2007), pp. 90–104.

[21] *What is CodeHS?* 2022. URL: https://codehs.com/info/what_is_codehs.

[22] *Why Coding Rooms?* 2022. URL: https://www.codingrooms.com/#:~:text=%E2%80%9CWith%20Coding%20Rooms%2C%20learners%20can,party%20applications%20on%20their%20computer.%E2%80%9D.