The Approach of Early Olympiad Preparation "Olympic Lift"

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Abstract. An approach of involvement of 10–14 years old children in early education in informatics and their training for participation in informatics olympiads is presented in this paper.

Keywords: informatics, computer science, olympiads in informatics, IOI, preparation for informatics olympiads, methods of work with talented children, developmental teaching.

1. Introduction

The observations from the last years have shown that to win gold medal at the International Olympiad in Informatics (IOI) becomes harder and harder.

There are many reasons for this:

- **First**, the number of the countries that participates in the IOI is increasing. The number of competitive teams and students that are able to win medals is increasing too. It means that these countries adopt the world experience for training the talented in the domain of informatics children. And this process is supported by organized the IOI community conference, by placement on the Internet of a huge amount of didactic and methodical materials on training for programming contests in the different countries, and by the increasing the opportunities for school students of the world to participate in the various open programming contests on the Internet.
- **Second**, the development of information technologies increases the complexity of the IOI. Olympiad tasks become considerably complicated. There was a necessity to use automatic evaluation systems for testing the solutions of the tasks from previous IOI. Such evaluation systems (including a large archive of competitive tasks) are already available on the Internet and students actively use them in preparation for IOI. In Russia, such a service also already exists.
- **Third**, the complexity of the problems of an IOI and the technology of the contests narrowed very much the range of teachers that are ready to be coaches of

young students. This creates serious problems for school students. All teachers understand that children need to start preparing for programming contests as early as possible in order to have sufficient time to achieve high results at the IOI. But many teachers consider themselves not ready to work with the top level students or that it is very difficult for them.

Organizers of the Olympiad in Informatics in Russia have already created methods of work with talented students aged 15–17 years (Kiryukhin and Tsvetkova, 2010). These methods brought good results. But the start in 15–17 years is rather late. The school teacher could reveal the talented child and start process of her/his preparation to participate in contests earlier – at the age from 8 to 12 years. This paper describes the experience of Russia to establish in each school an environment – a so called "Olympic lift", for training of very young students to participate in programming contests.

2. A School Training Environment for Programming Contest

There are about 45000 secondary schools in Russia. We will describe the system of training talented schoolchildren starting in 5th grade (when students are 10 years old). The goal is, when these students are in the 9th grade (15 years old), to be able to compete on equal terms with the best IOI participants. This system could be applied at schools in Russia where children voluntarily participate in the National (Russian) Olympiad in Informatics since 5th grade (Kiryukhin, 2008, 2009, 2011, 2013).

Important methodical approach in development of school children talent is the choice of a syllabus for teaching informatics. But this isn't enough. To provide a successful start of the talent in any subject, it is necessary to have a teaching syllabus in the primary school, aimed at the development of the child. A number of schools in our country teach students according to programs of "early development". The main feature of these programs is including in them (for all subjects that could be chosen by school children) additional tasks, including specially selected creative tasks. This specificity of the talented children teaching is important for two reasons: first, early development of children in primary school helps schools reveal talents, and, second, it helps the children to receive a motive for development in the chosen area of teaching.

For school informatics it was required to combine different curricula into one comprehensive curriculum from the second to the eleventh grades.

This curriculum includes:

- Curriculum of a regular school course in informatics for all grades of the secondary school from 2nd to 11th.
- Curricula of additional teaching of informatics: additional courses in mathematics and informatics for 5th–7th grades (zone of nearest development).
- Individual curricula for olympiad training (horizon of talent development).

Curriculum of regular school course in informatics is created in such way that the pupil could follow the course according to an individual plan. That is why the programs and textbooks are developed for the different profiling directions: humanitarian, social

and economic, scientific, and technological. Each child has her/his "route" for studying informatics at school. For participants in the Olympiad in Informatics both the scientific profile and the technological profile are dedicated. The general course of informatics for 5th–6th grades is provided as a preparation to enter into a profile. The schools, which are actively working with pupils and are training them to participate in the Olympiad in Informatics, certainly include the general course in the current curriculum of the school. Further they can choose curricula and textbooks of different level of complexity. At primary school different possibilities of studying informatics are provided for children too: beginning from the 2nd or 3rd grade at the choice of school.

Curricula of additional teaching on informatics are curriculums for studying the basics of informatics: algorithms, programming languages, elements of mathematical logic, sets theory, introduction to counting, probability theory, graph theory, number theory, geometry. Schoolchildren can study such topics not only after lessons at school, but also in programming clubs at school or near the home, as well as at schools for distant education attached to the best universities in the country. For such schoolchildren in different regions of the country, winter and summer schools of informatics are organized where teaching is combined with the rest.

Individual curricula for olympiad training are purposeful curricula for self-study work of schoolchildren preparing for the different stages of National Olympiad in Informatics. It defines the horizon of her/his talent development. For the studying of such curriculum the children are suggested to participate in remote training contests and in the open internet contests in informatics in the country and in the international internet contests in informatics. And more, school children studying such curriculum receive a plan of work for every half-year, set of tasks to solve during the year and a consultant – an experienced coach to help (through the internet) the olympiad winners in the region.

The usage of three different curricula for students helps the talented children to reach increasingly higher levels of personal achievements annually. We will call such growth of achievements "Olympic lift". As a result, this method of talented children development forms super intellectuals who successfully implement the social lift in professional activity, becoming IT professionals in their country and in the world.

The analysis of the results of Russian students from the Olympiad in Informatics over the last 7 years showed that the most successful are those students who began their olympic lift at the age of 8-10 years. These children were revealed at early age and had the possibility for equitable and sustainable development in the school, in partnership with their coaches and the academic community.

The three curricula are included into the methodical system of the National Olympiad in Informatics which includes:

- Methods of teaching school courses in informatics.
- Methods of development of the talent (formation of a zone of the nearest development of the talent, choosing the content of an advanced course in informatics and mathematics, studying of additional topics on informatics in advance).
- Methods of individual teaching (development the content of Olympiad in Informatics, achievement of the development horizons of the talent at the different stages of the National Olympiad in Informatics).

It is important to note that formation of the nearest development zone and development of school students' motivation in the field of informatics just begins at the primary school. The school teachers of informatics together with the primary school teachers involve the students in the subject and reveal the children interested in informatics. It is very important to give the chance to kids to participate in competitions on development of algorithms. An example of such a competition for students of primary schools is offered with free access on the website with virtual labs in informatics (System of Virtual Labs in Informatics "Book of Problems 2–6", 2008).

For pupils of 5th–6th grades the curriculum of school course of informatics and the curriculum of additional classes in informatics and mathematics (as a zone of the nearest development of the talent) are dominating, and the horizon of development is an additional group training (according to an individual plan) for school or the municipal stage of the National Olympiad in Informatics, requested by students. It is very important that this training doesn't demand involvement of the special coach and is carried out by the school teachers of informatics with the tasks of school and municipal stages of the National Olympiad in Informatics. Achievement of the child (the development horizon) in this case is the diploma of winner of a school stage of the National Olympiad in Informatics. The school stage of the olympiad in Russia is organized at each school that has children intending to participate, starting from 5th grade (10 years old). At a school stage of the National Olympiad in Informatics it is very important for the teachers of informatics to reveal the talented students interested in informatics and to involve them as soon as possible in groups for profound studying of informatics (following an additional curriculum) at their schools or in programming club at schools where such classes are given. Such careful on time attention to the talented children from the 5th grade increase the opportunities to fully develop their talents in the future.

Russia's experience has shown that every school teacher of informatics should know about the whole curricula in informatics in order to be able to choose the appropriate road for school students with different motivation, to motivate talented children to work on an individual plan and understand their capabilities and the capabilities of the potential pedagogical partners, who work in the system of additional education or universities.

Teachers and coaches are often surprised that their efforts in advanced classes do not bring good results at the Olympiad in Informatics to their students. The reason is that the olympiad is a competition and has its specificity. It only fixes the level of growth of the talent. For increasing the achieved level additional training for the olympiad is also required within an individual curriculum. Moreover, it should be decided – by the teacher, the coach and the pupil – to what kind of competition the student is preparing. This will determine what kind of competition tasks (or which tasks book) has to be used in the training process.

The individual curriculum of olympiad training can't be accomplished without regular (daily!) work of the student. Since 10–12 years old children do not have the experience to plan their work yet and have not yet formed strong-willed qualities, they certainly need an adult helper – a mentor or tutor. Any talented child studies at school. He is there almost every day, so his school teacher can act as her/his mentor. This is the most important mission of the school teachers in informatics which could: monitor individual

self-preparation of the students (especially of these aged from 10 to 14 years); contact the coach of the child in case of need; help the child to enrol in a district programmers club or distant school at an university; trace participation of the child in the selected for her/him competitions; help the child to co-ordinate his absence from school during the olympiad; explain to parents the child's problems; and others. This particular cooperation of child and mentor forms a real willingness of a schoolchild to manifest her/his talent and sustained successful results in all stages of the National Olympiad in Informatics – from school stage to the final stage (the "Olympic lift").

The basis of self preparation for different stages of the Olympiad in Informatics and constructing an individual trajectory of such preparation (individual schoolchild plan) consists of the following methodological and didactic materials on the Olympiad in Informatics:

- The sample curriculum of the Olympiad in Informatics (offered to schools by the Central Methodical Commission of the Russian Olympiad in Informatics – ROI) which is used by the teachers in training for school and municipal stages of ROI, by coaches of the student for the regional and the final stage of the ROI and the coaches that train the national team for the IOI.
- Materials for theoretical preparation – printed and published in electronic form on sites, including video lectures.
- Collections of olympiad tasks of all levels of complexity and all topics of olympiad preparation with brief methodical guidelines for their solution.
- Websites with collections of olympiad tasks and possibility of automated testing of tasks solutions.
- Websites providing regular online competitions in Informatics and programming.
- The sample curriculum of the ROI has three levels of complexity: "initial" – for 5th–6th grades (10–12 years), "basic" – for 7th–8th grades (12–15 years) and "advanced" – for 9th–11th grades (15–17 years). The third level provides a special part dedicated to training the national team for the IOI. This curriculum is a basis for development of programs of individual olympic preparation of the students for the stages of the ROI.

The curriculum for olympiad preparation in informatics for student aged between 10 and 12 years is fixed in the individual plan of each student. It is created on the basis of her/his achievement of studying both the basic curriculum of a school course in informatics and the curriculum of additional profound preparation. I.e. the individual curriculum for olympiad preparation has to be formed from both the school informatics teacher and the coach of the student. It is clear that if the student studies in 5th grade and her/his horizon of development is participation in the IOI in the 8th grade then her/his individual curriculum of olympiad preparation has to be mastered for and completed during the corresponding period (3 years in our example).

An important component in self-preparation for the Olympiad in Informatics is participation of the students in the internet programming contests which are organized regularly in many countries. It is important to choose for each student a subset of such contests, without overloading her/him, and then to ask her/him to participate in the chosen contests. It will allow the student to gain solid experience in participating in program-

ming contests. And moreover, in such a way school students learn to self-assess because they periodically compare results of their performance with the results of coevals from other schools, regions and even from other countries. It gives the chance to the teacher-mentor to trace constantly deficiencies in teaching of the student, to correct the individual plan of her/his self-preparation curriculum, and also to make recommendations to his coach in the programming club or university.

Besides, the teacher can recommend to the student to complete the school course of informatics in advance, according to her/his individual plan. For example, in 5th grade the student could study the course for 7th grade, in 6th–for 8th, and during the 7th–9th grades to study the course for 9th, 10th and 11th grades. Then during the training at 10th–11th grades she/he will be able to choose an advanced course in informatics at the most difficult level. The coach, in turn, could introduce amendments in the additional curriculum of profound teaching of this student.

The possibility to participate in online programming contest for each student, irrespectively of in what school she/he is enrolled in and where they live, helps her/him for self-preparation, but most importantly is that it helps the best regional teachers, mentors and coaches from the programming clubs and universities to pay attention to this student and to include her/him in the activities of additional profound teaching of informatics and to create for her/him an individual curriculum of olympiad preparation.

The helpful international websites for individual training of Russian students for programming contests were identified as:

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http://www.topcoder.com/tc
http://www.hsin.hr/coci/
http://acm.uva.es, http://train.usaco.org/usacogate
http://www.acsl.org, http://www.inf.bme.hu/contests/tasks
http://www.mii.lt/olympiads_in_informatics
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3. The Teacher's Role in Olympic Preparation of School Students

Many teachers ask us how they can prepare the pupils from the 5th grade for successful participation in all stages of the ROI. The fact is that the olympiad preparation of such students must be situated after the lessons and on specific curricula (Kiryukhin and Tsvetkova, 2011). In different years children from 3rd, 4th, 5th, and 6th grades participated even in the final stages of the ROI. For example, 245 school students participated in the final stage of the ROI in 2014 and among them were one 9 years old student, one 11 years old and five students of 12–13 years old.

Taking into account the above mentioned, the work of the teacher with gifted children in domain of informatics, in the contemporary world, has to be organized as follows:

- **First**, the search of talented children has to be done in the primary school. All necessary conditions for this are available and the school students after the 4th grade are already ready to study in 5th–6th grades more difficult algorithms and the basic capabilities of programming environments. And here we are discussing about cooperation of teachers in primary and secondary school that will permit the smooth passing of students who have demonstrated outstanding ability in primary school

under the concerns of the secondary school teachers. The role of the primary school teachers is just this – to reveal kids that are enthusiastic for studying informatics.

● **Second**, the informatics teacher has to organize additional classes with children for olympiad preparation at school. The role of the teacher of the secondary school is to attract children from the 5th–6th grades to the school stage of the Olympiad in Informatics, to inform them about programming clubs in the area or at the school, to provide information on Internet resources and textbooks, to invite them to visit additional classes of group for initial olympiad preparation. It is desirable that this group includes school students of different age, for example, 10–12 years old. It would be very useful if some classes dedicated to analysis of olympiad tasks for these children was carried out by older pupils, aged 12–14. Children perfectly understand each other.

It is important that winners of the regional or final stages of the ROI, as well as other awarded students, were involved in training of group of children from the basic levels of olympiad preparation, and winners and awardees of the municipal stage participated in preparation and holding of school stages of the ROI for children of 5th–6th grades. Teachers have to keep contact with olympiad winners that graduate of school, becoming university students. They could be further coaches of groups for profiled olympiad preparation and on-line consultants for children of groups for basic olympiad preparation.

● **Third**, it is not possible to demand all informatics teachers work with talented children, to ask from them strong management of all necessary theory and practice for solving of difficult olympiad tasks. In this situation a task of the teacher is to contact with those who can help him, and the student, to gain necessary knowledge and skills. Such persons could be professors of the closest universities, the former olympiad winners who are university students and even high school students who already achieved certain success in the Olympiad in Informatics. That is, the role of the teacher is to know the olympiad community of the region or municipality, to be in contact with this community and to include the gifted school student in it in time.

● **Fourth**, the work with each talented student has to be based on an individual trajectory of teaching according to the individual plan (Individual preparation plan to the IOI, 2010). The plan shall be for a fixed period and includes a list of planned to explore topics theoretical preparation, a list of related training tasks that are settled, the list of necessary resources to implement the plan and the results of the plan and periodic self-test.

In this plan the self-training of the student plays an important role. To help students make such a plan and to control its fulfilling is also an important task of the teachers who work with talented school students. With this plan the teachers can monitor the dynamics of student achievements, completeness of olympiad tasks solutions, speed and quality of the student etc.

● **Fifth**, the work with gifted students should be done with the use of modern information technologies (e-mail, chat, distance learning systems, internet systems of remote video presence) and on a regular basis. It is important that during the inde-

pendent work the student has the opportunity to quickly ask for help, not only from the teacher, but also from the coach and the members of the olympiad community. Besides, it is necessary to provide the students with access to automatic evaluation system in order to receive complete and accurate information about the results of checking the correctness of task solutions, to identify its deficits and to adjust in time his plan for the future work on the solution. At the same time, planning the work of teacher on olympiad preparation should be based on well-known collections of tasks from past Olympiads in Informatics, including IOI tasks. These tasks are a methodical collection of the teacher.

4. Schoolchildren Olympic Lift

When the teacher trains talented schoolchildren they should not approach the stages of their olympiad preparation the same way as it is done in a school. Stages of training of a talented child should be defined in accordance with his high development potential and taking into account the natural stages of his growing up. This means that the teacher cannot overload the children physically, but cannot also stay away from their high demanding, intellectual capacity and motivation for learning and development. This is similar to the movement of the lift which moves steadily upwards from floor to floor (horizons of development) without shocking jumps and overloads, but with a guaranteed result of the upward movement, not from school year to school year, but from one development floor to another such floor, that could be ahead of traditional school grades.

These olympiad lift floors are: elementary school (talent identification), 5th–6th grade (10–12 years old), 7th–8th grade (12–14 years old) and 9th–11th grade (15–17 years old). Correspondence with various forms of work with talented schoolchildren for each olympic lift floor is shown in Table 1. Olympic lift floors reflect also the stages of growing of children, taking into account changes in the nature of their behaviour (changing of priorities in behaviour, as psychologists say) and physical capabilities. Thus, a sample of teaching route of talented child (lift movement) must fit into his school life and to be correlated with his physical and psychological changes of growing up.

In the movement of the olympic lift it is possible to identify three thresholds of growth:

- **The first threshold** is the child's transition from primary school to basic school. If teachers were engaged in the identifying of the talent, this transition will be smooth for the child, and she/he will be included in a natural way in the olympiad. This threshold is also the *entrance in the olympic lift*.
- **The second threshold** of growth is between 6th and 7th grade at school. This is the stage of the threshold of the determination of the talented student – in what area he will develop. This is his *individual profiling choice*. After it a planned and very hard work comes, following an individual program of olympiad preparation.
- **The third threshold** comes between 9 and 10 grades (when the student is 15-16 years old). Talented children in this moment of development (in the case of regular work with them) have already made the choice for themselves and determined their

future specialty. And this choice helps them to make next move of the olympic lift. This allows talented students to develop steadily in Olympiad in Informatics and to organize their profiled preparation very intelligently and independently.

For every talented schoolchildren it can be shown the sample route of movement on the olympic lift which is presented in Table 1. It is necessary that teachers understand well what the olympic lift is for pupils. Only then they will be able to help talented pupils throughout their preparation as mentors.

Table 1
Forms of work with talented schoolchildren for each olympic lift floor

Stages of schooling	Olympiad lift floors in promoting schoolchild in the Olympiad in Informatics
Primary school, 1st–4th grades.	Informatics club in primary school with informatics teacher.
Basic school, 5th–6th grades.	• Additional teaching and informatics club at school. • School stage of the Olympiad in Informatics. Goal – to become the winner. • Municipal stage of the Olympiad in Informatics. Goal – to become a winner or a medallist.
Basic school, 7th–8th grades (an individual teaching plan for the 7th grade, an individual teaching plan for the 8th grade).	• Lyceum program on informatics and mathematics. • Participation in on-line programming school at the university. • Programming club, network community of the olympiad participants, summer and winter schools in the region. • Participation in the regional stage of the Olympiad in Informatics. Goal – to become the winner. • Participation in the final stage of the National Olympiad in Informatics. Goal – to become a winner or a medallist. • Participation in a training camp of candidates for the National team.
Going to high school, 9th grade. High School, 10th–11th grades (individual plan of pro-filing tea-ching for 9th–11th grades).	• Individual programs of profiled teaching. • Participation in the final stage of the Olympiad in Informatics. Goal – to become the winner. • Regular training camps, including using distance environment of olympic preparation. • Participation in the International Olympiad in Informatics.

5. School Resources for Advancing of Schoolchildren with Olympic Lift

Every school in cooperation with the organizations for additional education, the associations "school-university" and the system for distant education in the region creates the conditions of ensuring the advancement of gifted pupils with the olympic lift. Among these resources are the following:

- Full-time training camps with the program of the Olympiad in Informatics for up to 30 days per year.
- Open internet collection of tasks from school, municipal, regional and final stages of the Olympiad in Informatics from the last 5–7 years.
- An environment for on-line communication with regional coaches working with gifted children and receiving consultation from them.
- On-line training contests, carried out on a regular basis according to the level of olympiad preparation.
- Open collection of video lectures on the basic topics of olympiad preparation.
- Internet environment for self-training and open olympiad e-library.
- Computing equipment for organizing of all kinds of activities with gifted students, satisfying the requirements of the Olympiad in Informatics.
- Team of coaches (on-line moderators of training sessions).
- Medallists of regional and final stages of the ROI and university students, participants of the world collegiate olympiad (ICPC).
- Website for training sessions, with forum for leaders and training teachers.
- Regular on-line training contests for students included in the long list of the National team for participation in the IOI (at least once every two weeks) using tasks of past years with appropriate level of difficulty.
- Statistics of results and coaches analysis of the individual deficits in preparation of the gifted students.
- Individual plan for independent work of each student, based on the analysis of her/his common failures in solving the olympiad tasks and the task from on-line contests.

6. Conclusion

In conclusion, it should be noted that in modern conditions the work on development of gifted students should take place in close cooperation of primary school teachers (revealing young talents), basic school teachers (involving children in the olympiad community and developing their talent), high school teachers together with universities teachers and top students (achieving success in national and international competitions). The coordinating role in this interaction must belong to informatics teachers who are directly involved in the education of gifted children in school and a very important educational role – the role of mentors.

It is possible to formulate an important conclusion: programming contests allow every talented child, who decides to participate, a guaranteed formation of creative personality, exhibiting high availability of creative evolution in the future professional activities. It is very humane and highly significant quality of the creative personality, which could be formed in any country where their Olympiad in Informatics is organized, on the basis of systematic teaching of schoolchildren in accordance with the programs for development potential of the child at different age levels. And the technique of working with talented children called the "olympiad lift" is quite effective for the purpose.

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