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ORGANIZATION OF TEACHING SCHOOLCHILDREN PROGRAMMING IN THE CONTEX OF INTERNATIONAL EDUCATIONAL CLUSTER

Akkassynova Zhamilya[*], Pak Nikolay[**], Ivkina Liubov[***], Romanov Dmitry[****] and Khegay Liudmila[*****]

Abstract: The analysis of scientific and pedagogical literature and relevant studies of recent years, the study of the real state of integration of education, science and production, allows us to state that the problem of the development of scientific and educational clusters has not been sufficiently developed. In the conditions of the region, the general basis - goals, tasks, principles, functions, mechanisms, values, resources for the development of scientific and educational clusters is not sufficiently represented. Conceptual bases for the development of regional scientific and educational clusters that reflect the interaction of education, science and production have not been developed.

The study of psychological, pedagogical and methodological literature on the research problem and the state of practice made it possible to identify the contradiction between the need for the development of educational clusters in the region and the insufficiently developed scientific and pedagogical foundations of this process in the context of integrating education, science and production.

The paper highlights the reasons causing the greatest difficulties for pupils when learning programming. It is shown that the existing class system cannot address a problem of pupils' low motivation to learn computer science.

The purpose of the research is to present and justify a model of megalessons on programming, conducted in international educational cluster to provide better quality of the learning of computer science.

The essence of the model is an organization and execution of "megalesson" simultaneously for several schools of the cluster. Megalesson is driven by joint participation of teachers, students of pedagogical higher education institutions, and IT-business professional(s), with shared context created using videoconferencing tools and cloud services.

Results of the pedagogical experiment are presented to prove the efficiency of the suggested model. Also, unsuccessful cases of performing megalessons are analyzed to draw conclusions and to suggest possible improvement of the technology.

Keywords: Continuous learning, integration of education institutions, international educational cluster, cluster approach, "megaclass" educational platform, megalesson.

INTRODUCTION

Computer science, both as a science and as a branch of technology, has been developing quite rapidly, which poses demands to both the future specialists'

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computer literacy and to a level of general information culture of a human. Foundation of the computer training is laid in the school, and pupil's satisfaction in life, and, in particular, his/her willingness to be trained successfully in higher education institution (HEI) depends on the quality of the learning process of computer science too. Nevertheless, traditional methodical system of teaching of pupils of computer science, unfortunately, does not meet modern requirements posed by the society and acceleration of scientific and technological progress in computer systems, and information and communication technologies (Záhorec *et. al.,* 2012). Despite the fact that the school course of computer science takes an important place in forming pupils' scientific intuition, their socialization, in gaining modern professional knowledge, it is disconnected from the real practice. According to Bosova (2014), nowadays pupils are much less interested in learning computer science compared to 20-25 years ago. Special attention should be paid to studying of "algorithmization and programming" chapter which causes the greatest difficulties in its learning.

Key reasons such situation arise are:

1. Insufficient amount of hours scheduled to the subject.
2. Attention of school teachers is biased towards study of information technology.
3. Poorly developed algorithmical, mathematical, and logical thinking skills of the pupils.
4. Bad command of English breaks understanding of notations in programming languages.
5. Highly abstract, and purely scientific style of the presentation of the material on programming in school and detachment from life enhance difficulties of understanding.
6. Enormous number of already available libraries, frameworks, examples, and video lessons which:
    1. Allows a curious pupil to quickly "create" a "professionally looking product" just by mindlessly reproducing steps presented in on-line media.
    2. Encourages reproductive work without need to understand the architecture of the used solutions in the majority of the starting phases.
    3. Results in a high entry barrier, even for an experienced programmer, if one wants or need to rework/re-write/understand any part of the many famous wide used toolkits on his/her own.

The main problem of school teaching programming is the lack of a systematic approach in this matter. The trouble is that the school teaches not to solve problems with the help of programming, not the development of programs, but only the

programming language as such. School lessons are, as a matter of fact, reduced to the study of language constructions and the performance of any tasks for these constructions, but do not teach much more important skill - to apply them to solve problems arising in practice. Those students who have a talent for programming learn it on their own, the rest get the idea of programming as a "boring and tedious lesson for botanists."

But programming is not only necessary for the "elected". At the programming lessons, children learn to work primarily with information, structure it, manage it, and these skills are vital in the face of the ever-increasing "information wall" of modern life. Even an approximate understanding of how the computer works, how it works and executes programs, what its capabilities and limitations are, is an important skill in the current environment, when computers have penetrated literally everywhere and are becoming increasingly magical for the average person ("I only button pressed, and then tako-oh-oe !!!"). Even if the child does not become a programmer, the skills acquired during the programming session will be good for him in the future life. From computers, he will not go anywhere.

This contradiction between the need to improve the quality of training of pupils on computer science, in particular, on algorithms and programming chapters, and the decreasing of their motivation to learn school course of computer science in general, and programming in particular, becomes heavy and complicated over the years.

In this regard, the problem of searching for a new training models which could ease the causes of the decay of pupils' interest in computer science and create conditions for improving the quality of computer training, becomes urgent.

It is seen that the existing class system cannot fully address the problem of low motivation of pupils to learn computer science.

The usage of cluster approach for globalization a learning process is one of the possible ways to increase quality of training of pupils on computer science (Ivkina *et. al.,* 2014).

The goal of the given paper is to present and discuss one of the possible models of "megalessons on programming" which essentially increase pupils' motivation to study computer science, also create conditions for continuous upgrading of skills of school computer science teachers, and implement real continuous pedagogical practice of pedagogical HEIs' students. The megalessons are conducted in international educational cluster which consists of education institutions of Russia and Kazakhstan.

MASS GLOBALIZATION IN THE FIELD OF EDUCATION

Nowadays, there is a pressing need in effective approaches and models of organization of pupils' training in programming in the emerged context of mass

globalization, rapid informatization of education, and integration into the world education space supporting with rapid development of electronic means for educational purposes and distance learning technologies.

It is assumed that the possibilities of individualization of the learner's educational trajectory can motivate him/her to explore new educational possibilities. During the elaboration of this personal educational trajectory, the best educational resources, teachers, and other educational environment goodies will be provided to the learner to form educational product that meet his/her personal needs and requests.

Integration of scientific and educational potential of different education institutions is possible within educational clusters (Ivkina and Pak, 2015).

The cluster approach in education allows to essentially overcoming the shortages of the learning process in separate schools and HEIs due to the integration and direct access to the required resources for any cluster participant (Kirko *et. al.*, 2014).

Current state in the development of information and communication technologies, and its widespread use in education system provide a basis of new innovative teaching methods, new forms and technologies which allow us to speak about the globalization of the field of education with erased borders and established communication with foreign world universities to form joint cooperation. Distance learning in the context of the globalization of education gets larger coverage; it has integrating capability, and achieves the following socially important goals:

1. Increase the level of education of the society, quality of education.
2. Meet the needs of employers in well trained specialists.
3. Develop unified educational space which strips off negative consequences of differences in living place, health status, social status, financial security, and others.
4. Improve social and professional mobility of work-force, its business and social activity, self-esteem and level of self-awareness (Ibragimov, 2005).

It should be noted that computer science teacher bears bigger responsibility, since he/she is responsible for organization and execution of the lesson which should be both interesting and motivating for pupils to meaningfully study the programming. Nevertheless, due to congestion, lack of time for continuous learning and upgrading his/her skills, and so on, the teacher may have difficulty in explaining the theoretical material, in forming of learning tasks on programming with the purpose of to interest the whole class and engage them in active cognitive, creative, educational, and research activities.

Also, a professional training of future computer science teachers should not be left out of consideration. Since programming is an essential component of their subject training, it is important that the students along with study of programming

languages were acquainted with the difficulties faced by the pupils in the study of this theme in school, and be suggested by ways to overcome them.

At the same time, it is very important to establish a dialog and close partnership between pedagogical HEIs and other education institutions, in particular schools, as well as with the representatives of the labor market and society, to provide opportunity to generate useful ideas necessary for curriculums of future teachers (Council of the European Union, 2014) including computer science teachers. Establishment of such connections is quite realizable within educational cluster which integrates education with other necessary institutions to achieve common goals, address problem situations, which directly appear in the context of learning process. Paper (Terek *et. al.*, 2015) notes that the university training of teachers now is mainly directed to form students' theoretical knowledge, which obviously will be insufficient for implementation of professional skills, necessary for successful execution of teaching activity. It is possible to address this problem by creating conditions for continuous real pedagogical practice of students within educational cluster where students can intensively participate in the teaching process of the school, experience and resolve various pedagogical situations, make decisions, offer ideas; that is, be active participants. In addition, educational cluster has opportunity to implement continuous training of teachers' skills through cooperation and interaction with other school teachers, provide early passive access to materials given by community leading professors, scholars, HEIs' educators. Immersion into cluster environment increases pupils' engagement due to involvement into active cognitive creative training, while research activity is accelerated due to sense of accompanying competition. In fact, educational cluster can contribute to the formation and development of pupils' critical thinking/problem-solving, creativity, collaboration, ICT-literacy, leadership, curiosity, initiative and other skills of the XXI century. These skills contribute to become successful and competitive person in the labor market (The Boston Consulting Group, 2015).

In order to study possibilities of globalization of the learning process provided by the international educational cluster, the cluster was formed on the basis of Krasnoyarsk state pedagogical university named after V.P. Astafiev (KSPU, Krasnoyarsk, Russia), Kazakh national pedagogical university named after Abai (KazNPU, Almaty, Kazakhstan), Lesosibirsk pedagogical institute – branch of Siberian federal university (LPI-SFU, Lesosibirsk, Russia) and a number of schools of Krasnoyarsk, Almaty, Lesosibirsk and Achinsk, as well as numeral IT-businesses.

In cluster models of pedagogical education, an educational platform megaclass is considered as the most promising endeavor to improve quality of training of future subject teacher in pedagogical HEI, continuous improvement of skills of teachers for their future professional activity in schools, increasing of pupils' motivation for

cognitive activity and shape their success in the context of e-learning and distance communication based technologies (Ivkina *et. al.,* 2014).

An integrated e-learning, scientific and industrial cloud environment "school-pedagogical HEI-business" is created on the basis of megaclass educational platform, and includes seven modules (see Figure 1):

1. A creative module to increase pupils' interest in learning in school, students' interest in learning in HEI, and teachers' motivation in conducting professional activity.
2. A communicative module to provide on-line and off-line communication channel.
3. A mental module to assist in development of cognitive abilities of pupils and additional structuring of the existing knowledge.
4. An educational module to form modern competences.
5. A research module to support research and project style of thinking.
6. A management module to manage and administrate scientific and learning process in educational cluster.
7. A methodical module to provide information support in organization of training of pupils and students on the technology with an example of megalessons on computer science (Ivkina and Pak, 2015).

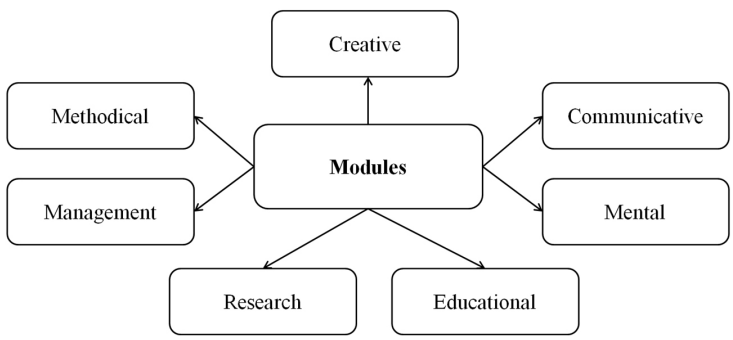

Figure 1: Structure and principal modules of integrated cloud e-learning, scientific and industrial environment "school-pedagogical HEI-business"

The essence of the megaclass educational platform is a specific organization of megalessons running simultaneously with many parties: several schools of the cluster with real-time participation of teachers and students of pedagogical HEIs plus direct involvement of scholars, educators, enterprise specialists in person in real-time as well. The common context is created using video conferencing tools and cloud services. It should be noted that the organization and running of megalesson on computer science compared with traditional lesson requires a lot of time and effort. Not only the teacher is responsible for the quality of the lesson as in traditional

system, yet also all other members of the educational cluster. Each member of the educational cluster has got his/her own role and each of them performs his/her own function. On the whole, all of them are united with common goal – to organize and carry out megalesson on computer science which has cognitive, practice-oriented, creative, and research nature, and also which is supported by learning and using new useful information technology, which they can use to address vital problems further.

All participants of the international educational cluster are involved in collective activity with active using of cloud technology, and various Internet services.

Cloud technology as a data store and a general-purpose tool of these data serves as an effective way of implementing joint network feedback of all participants of the international educational cluster. The usage of cloud services allows creating a unique social and educational environment – an educational "cloud" which is the necessary element of educational environment of megalessons, transforming it into an open project and constantly developing environment, available to all participants of the educational process in the cluster. The cluster participants put all necessary materials for megalessons: megalessons scenarios, electronic books, audio and video materials, illustrative and demonstration materials, methodical recommendations, additional literature, textbooks and etc. in the educational "cloud"; and they as far as access can edit, comment, and read them.

The usage of Internet services which are more appropriate for conducting collective activities of the pupils groups during executing learning tasks contributes to the development of skills of working in a group: communication with group members, division of roles, performing own functions, exchange of opinions, ideas, and etc. There are many such services, for example, Lino it, LearningApps.org, Twiddla, MindMeister, RealtimeBoard, and others. All of them are online services and their standard versions are quite free. They are used as an online blackboards equipped with various hands-on tools, which allow to add record, audio, video materials, pictures, documents of different types, to make notes, to glue stickers, to insert calendar, to visualize ideas, to develop them and share them with others, to invite your friends for joint work, to chat with other participants during working, and etc (Pak *et. al.,* 2016).

MATERIALS AND METHODS

General Information

The research was conducted among the students of KSPU, studying on major "44.03.05 Pedagogical education", profile "Mathematics and Computer science", and the students of KazNPU, studying on specialty "5B011100-Computer science", and the students of LPI-SFU, studying on major "44.03.01 Pedagogical

education", profile "44.03.05.62.33 Computer science", and the pupils of 10th class of Krasnoyarsk, Almaty, Lesosibirsk and Achinsk schools. Also, the teaching staff of pedagogical HEIs, school computer science teachers, and representatives of IT-company took an active part in it. The experiment was conducted from 16 March to 13 April 2016.

International megalessons on programming were envisioned as extension of workshop or scientific conference – blend of learning, research, and scientific activity where participants present and discuss their works, exchange their experiences, share ideas, get acquainted with new people, make contact with them, open something new, generate new ideas, and so forth. It was decided to carry out introductory and final megalessons on programming among 10th class of different cities of Russia and Kazakhstan with group work scheduled in between. The pupils have been anonymously questioned 3 times. The questionnaire was developed via Google Docs Forms.

The Questionnaire before Introductory Megalesson

The purpose of the questionnaire on this stage was to find out the followings:

1. A level of pupils' interest in learning of computer science, including programming.
2. Difficulties in its learning.
3. A level of pupils' satisfaction of their teachers' teaching skills.
4. Learning form, according to pupils, which promotes better assimilation and storage of information.
5. Pupils' suggestions on teaching computer science lessons.

The Questionnaire after Introductory Megalesson

The purpose of the questionnaire on this stage was to find out the followings:

1. How much interesting was to carry out lesson in a form of megalesson?
2. How much useful was the given information at megalesson?
3. Pros and cons of the introductory megalesson.
4. Pupils' suggestions.

The Questionnaire after Final Megalesson

The questionnaire after final megalesson was organized in order to find out the followings:

1. Pupils' general impression from such form of carrying out lessons.
2. What was new and what did they learn.
3. How much useful was to work with tutors?

RESULTS

The results of the first questionnaire show that in general, pupils show great interest in learning of computer science, including programming. At the same time they note difficulties, related to the abstract nature of the learning material, understanding difficulties and insufficient amount of hours to execute practical tasks during computer science lessons. According to many respondents, they prefer to work in small groups and evaluate their teachers' skills relatively positive.

Introductory megalesson is structurally divided into following components:

1. *Information and organization block:* Within this part an acquaintance of all participants of the international educational cluster was carried.
2. *A block of IT-business representatives:* Manager of IT-company gave talk about programmer profession: current state, development trends, and so forth. The main goal of this block is to draw attention and to channel pupils' interest into programmer's activity, to influence on pupils' choice of their future specialty.
3. *An expert's master-class block:* During this part a master-class of professional programmer was carried out. He described and presented the designing stages of game programs, demonstrated technology by implementation of each stage, gave advices to the beginner programmers. The main pedagogical line is to show to the pupils that writing any difficult programs begins with simple steps and simple parts of the code may develop further into subsystems inside bigger programs; that further programming of games or any other programs, is not beyond pupils' strength, but quite an achievable undertaking providing he/she has a desire to works on his/her own.
4. *Tasks block:* By the end of the introductory megalesson, pupils were given a task to design computer game using any desired programming language. To perform the given task pupils of each school were divided into intraschool groups of 2-3 people. Also, one international group was formed; it consists of pupils from different schools of Krasnoyarsk, Almaty, Lesosibirsk, and Achinsk. Each group was supervised by the student-tutor(s) from pedagogical HEIs who played the role of Teaching Assistants, and also educators and experts of HEIs.

According to the results of the next questionnaire, pupils show their satisfaction with the introductory megalesson. In addition, they note that it was very interesting and useful. Pupils suggest to improve the quality of network connection, sound, and also, to increase number of participants (schools).

Within a month pupils performed their tasks in groups by working in partnership with teachers, educators, students who performed the role of tutors - consultants. Participants of the educational cluster communicated remotely using instant

messengers, chats, blogs, forums, social networks and other Internet services. Figure 2 shows the communication scheme of the participants within international educational cluster. KSPU presented by scientific supervisor of the project Doctor of pedagogical sciences, professor *(one of the coauthors)* acted as the management center of the cluster. Master students of KSPU with major in "Computer science in education" and doctoral student of KazNPU were organizers and moderators of the lesson. The students of KazNPU consulted the pupils of the specialized gymnasium No. 12 named after Sh.Ualikhanov (Almaty), the students of LPI-SFU consulted the pupils from the municipal budget education institution "Secondary comprehensive school No. 9" (MBEI "SCS No. 9") (Lesosibirsk), students of KSPU consulted pupils of the municipal budget education institution "Secondary school No. 152" (MBEI "SS No. 152") (Krasnoyarsk) and municipal autonomous general education institution "School No. 3" (MAGI "School No. 3") (Achinsk).

It was assumed that by performing the tasks pupils will extend their knowledge in programming, gain working skills with respect to various Internet applications, networking communication in school and out-of-school activity. The created product can set a basis for further study of the chosen programming language and various techniques or programming paradigms, and also it will be a worthy contribution to the future specialist's portfolio.

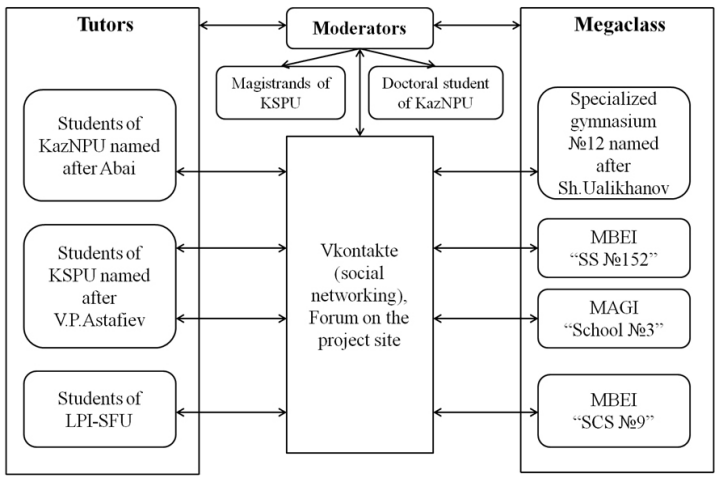

Figure 2: The interaction scheme of international megalesson

Final megalesson was consisted of the following components:

1. *A block of presentations of performed tasks:* In this part each group was given the possibility to:
   1.1. Give a talk about performed work with demonstration of achieved results.

1.2. Discuss the problems which were faced by pupils during performing the tasks, emphasize what they have learnt, what they still could not do.

1.3. Respond to questions of experts, participants of other groups.

2. *Block of analyzing the presented works by the expert:* The expert did some "post-mortem review" of the products presented by the groups, highlighted pupils' remarkable achievements; pupils were nominated on awards in various nominations, such as "modern platform", "Creative decision", "Gaming mechanics", "Optimal technology choice", "Low level programming", and etc.
3. *Sum up block:* At the end of the final megalesson the moderator summed up and encouraged the pupils awarding certificates, diplomas. The business representatives noted particularly gifted youngsters with certificates for further work with them.

Based on the results of the last questionnaire we see that, in general, pupils show positive impression related to such form of lesson, which carries out in network mode. International megalessons gave pupils possibility to learn new programming languages, to get acquainted with pupils from other schools from different cities and countries; there was a possibility to communicate, establish contacts with them, also with experts, company representatives; they have learnt to work with cloud services, communicate via social networking services for learning purposes. In addition, it should be noted that pupils highly evaluate tutors – students of pedagogical HEIs for their help.

DISCUSSION AND CONCLUSION

The results of the conducted survey of pupils have shown that the proposed model of megalessons on programming provides individualism in pupils' collective activity, increases availability and motivation to learn programming, eliminates the following problems:

1. Low level of pupils' ability to work independently.
2. Lack of pupils' interest in learning programming.
3. Lack of conditions for implementation of creative potential of pupils.
4. Insufficient number of practical lessons.

Within the executed megalessons pupils have created products in various programming languages and technologies such as:

1. C# and Unity.
2. C++ and SFML.
3. Python and pygame.
4. C and direct management of text in terminal.
5. Visual Basic and MFC.

In fact, only web-technologies were left uncovered. All programs were done properly and considered to be finished products.

The pupils demonstrated competent presentations of both the product and the technical side of the designing process.

It should be noted a number of difficulties to which one should pay attention when using the proposed model:

1. Creation of forum and web site to coordinate the process of collaborative work practically did not justify itself. In fact, communication between the majorities of groups has been held via instant messaging services (Viber, VKontakte, Skype, WhatsApp, and etc.). In such circumstances it is very important to engage the tutor in conversation as early as possible to open channel to feed in correct practices, tools and to provide help in solving example tasks and/or in overcoming organizational and technical difficulties.
2. Regarding the site of the project, it should be completely prepared and beefed up with all necessary materials to be used for instant feedback to support the pupil on his/her individual trajectory. Increasing of response time for pupil's request to 40 minutes or a few hours means withdrawal of the site from the list of useful resources.
3. At the early stages of the project it is required that the tutors pay more attention to every group, in order to become a full participant of each dialog.
4. School teachers often expect to receive a clear set of instruction or a guide, and when it is absent they can switch to a passive participant mode. In such circumstances the tutors are required both to establish direct dialog with the development teams and to keep the teachers informed about the progress in the work in order to engage them into development.
5. When using cluster, the congestion degree of the teacher is not reduced, but other cluster participants strips off the duty of expert to give him/her an opportunity to participate in master-class of the invited specialists as well, and to rely on the team of students-tutors by delegating to them majority of the technical routine tasks.

High quality and variety of created projects allow to conclude that organization and execution of megalessons on programming within the framework of megaclass educational platform in schools may:

1. Improve quality of preparation and execution of megalesson through collective work of all participants of the educational cluster.
2. Strengthen pupils' motivation, and learning and cognitive activity via networking technologies, and creation of gaming and competitive atmosphere at the lessons.

3. Develop pupils' creative thinking, research skills, skills of working in a group when performing common learning project.
4. Master youngsters' skills of working with problem formulation and with searching for necessary information.
5. Give pupils opportunity to contact with professional programmer or student-tutor(s) in case of hard obstacles to receive additional consultation in both school and out-of-school time.
6. Achieve a pedagogical resonance; that is, pupils' highly motivated individual activity in the collective, and so forth.

It is assumed that such innovative form of the lesson will motivate pupils to do serious learning, will provide an incentive to modernization of the learning process, will support the modernization of the learning process, will enhance the learning process of school computer science, in particular, programming, will increase the competitiveness, mobility, professional competence of all participants of the educational cluster and education in general.

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