

Possibilities of the inquiry based approach to built motivation for studying sciences

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This work is considered the place and role of the Inquiry Based Science Education (IBSE) and tries to describe the opportunities for the formation of different types of motivation. A result of the training using IBSE in five Plovdiv schools and of the survey of the students is described. Conclusions are made, which identified and orient us in opportunities of IBSE approach in building motivation for study science.

Key words: inquiry based science education

ACTUALITY, OBJECTIVE AND TASKS

Inquiry based education is an important approach in the process of natural sciences teaching, which involves the students in exploration and use of data as proof for the answer to the questions asked [1]. It is considered that the inquiry based approach contributes for the formation of scientific literacy and it has the potential to improve the understanding of the educational content of natural sciences, to encourage interest in science and participation in its studying in the classroom, and it is a powerful motivational means.

In this study the main features of the inquiry based approach are reviewed, and an attempt is made on the grounds of the conducted natural sciences education process, to describe its significance and ability to create motivation in students.

This approach was first formulated in the studies of John Dewey in the beginning of 20-th century. His ideas about natural sciences education based on a model, in which the role of the teacher is to encourage the activities of the students, later have been adapted and used as a basis of the educational programme of the USA for the year 1937. In the year 1960 Joseph Schwab introduces the term “inquiry based science education (IBSE)”. In 1996 the educational standards of the USA define IBSE as an important approach (but not the only) in natural science teaching.

Being a pedagogical approach the inquiry based education has its scientific and theoretical roots in the theories of Dewey and Jean Piaget in the constructivist educational paradigm. According to constructivism learning is an active process, of social nature and it allows the students to construct their

own knowledge about the different phenomena and about the path towards scientific knowledge by means of active work, discussion of questions and cooperation between classmates, teachers, scientists, resources and educational environment [2].

The inquiry based education (exploratory approach, heuristic approach, IBSE) uses methods that focus on the student’s motivation and that are the driving force in the learning process. The teaching process is organized by means of questions and problem solving in a student focused inquiry process. The teaching methods, in line with this approach, play a central role in establishing motivation in the students and in the development of their scientific literacy.

WHAT DOES THE APPROACH “INQUIRY BASED EDUCATION” MEAN?

Inquiry based education is an approach applicable to all levels of the educational system: from primary school to university education, and it can be conducted both in class and in out of class educational forms. It includes a system of teaching and learning methods in which the students learn by making an inquiry and discovering themselves certain knowledge. Often students make inquiries in order to answer to problems formulated by them and which are related to a certain educational subject. In the course of the inquiry they use the same methods which the respective science uses.

The inquiry based education allows not only to organize effectively the education in the separate educational subjects, but also to form in students important intellectual qualities and practical skills. The success of this approach is achieved by purposeful involvement of the students with suitable questions and tasks in a stimulating and supportive educational environment.

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It can be applied to all educational subjects, but presently it is most widely researched and applied in the natural sciences education.

The student's inquiries can be small or large scaled, including the entire cycle of scientific knowledge or only separate elements of it. They can include the use of digital resources or appropriate equipment, they can be real-time or on-line, or a combination of both.

Inquiry based education can be reviewed as a variant of the active education, in which the students perform scientific inquiries and so they form new knowledge and skills [Levy and Petrulis 2011].

This approach includes problem-based learning (PBL), and it can be reviewed as a form of project-based learning. Very often the inquiry based education and problem-based education are used as synonyms, but difference between them does exist, taking into account the different forms the problem-based learning can assume. Inquiry based education can be seen as a broader and more flexible concept where the problem-oriented learning can viewed as its subset. For example, while in the problem-based learning the search is made according to a predetermined scenario which the students follow, the inquiry based education includes numerous conditions for study (phenomena or objects), which students independently choose and they have more freedom, to determine the course of the inquiry by being encouraged to ask questions and to observe less instructions in the inquiry process.

There are several characteristic features typical for the inquiry approach and which discern it from the others. They are: appropriately formulated questions, problems or scientific scenario subject to inquiry (often formulated by the students themselves), conducting of inquiries in scientific laboratories or on a terrain, as well as involvement in different kinds of research projects. In this approach the discovery of knowledge is the first priority, while everything else - educational tasks, assessment, resources, educational environment and educational strategies, are intended to support the education through the processes of inquiry and discovery.

The main characteristics of the inquiry based education can be summarized in the following statements:

- The educational process is organized as inquiry and search for answers to questions or solutions

to problems, which is implemented in cooperation with the other students and with the help of ICT (Information and Communication technologies);

- It applies the principles and regularities of the scientific inquiry;
- It can be related to questions and problems which answers and solutions are of open nature;
- The knowledge is gained by the student's activity, critical and creative thinking;
- It attributes new meaning to the learned knowledge and raises the level of the knowledge depth;
- It forms practical skills and knowledge about the methods of scientific learning. It forms scientific literacy, skills for teamwork and reflection skills;
- It helps to build social skills for sharing the results from the inquiry with contemporaries and with the broader audience.
- It is a key to the formation of stable motivation for learning [2,3,4].

METHODOLOGY OF THE STUDY

The implementation of the inquiry based science education was organized within the framework of the project "Chain Reaction: A Sustainable approach to Inquiry Based Science Education" (FP7), in which Bulgaria is involved as a partner. This education was implemented during the educational year 2013 and 2014 in five schools in the city of Plovdiv, where participants were students at the age of 15 – 16 years. The education was organized according to the requirements towards the implementation of this approach and was aimed at fulfilling the project tasks. The Bulgarian team set an additional task to itself to monitor the changes in the motivation of students to study scientific sciences (physics, chemistry and biology).

The initial state of their motivation was determined by two indicators: grades of the students in the respective educational subject and their desire to be involved in the enquiry based education in this subject, declared in the application for participation. At the conclusion of the conducted education two methods were applied for diagnostics of their learning motivation: questionnaire filled by all participants and interview with the teachers.

ABOUT THE PROJECT

The Project “Chain Reaction” is sponsored by the European Commission and it is aimed at training science teachers to apply the approach “inquiry based education”, in which the students are involved in “research work”. It provides interactive training to teachers about the “inquiry based education approach” (IBSE), which contributes to their professional development. The main objective of the project is to organize the science education of students by using applied and practically tested scientific resources related to this approach. Ten teachers, acquainted with the inquiry based approach and with the educational resources provided by the project organized a series of lessons (student focused), in which the students independently researched the suggested topics. The students worked together on the suggested scenarios and thematic reference resources, based on scientific facts, by applying critical thinking and problem solving skills [5,6].

The suggested topics for study are from sectors from the three educational subjects: Physics (Science about Mars, Green light, Space Collisions, Extraterrestrials), Chemistry (Ozone conference, To feed the world), Biology (Plants in cosmos, Science about Mars). The education continued for three months where parts of the lessons were carried out in the laboratories of Plovdiv University.

The choice of topics for study was made by the students themselves based on the interest shown by them. Thus the constructivist principle was observed regarding the right of the student to be involved in the planning of the educational process. Later on the work continued with the organization of meetings for clarification of the key points of the final product of the study and for deciding on the necessity to conduct experiments in different laboratories. The teachers provided instructions for this type of educational process. These instructions were in line with the constructivist principle not to impose ready ideas and solutions, to give only answers to the questions asked by the students and to assist the students only if they need or seek help.

In the educational process lessons were conducted in the laboratories of Optics, Inorganic chemistry and Botany, and Molecular physics of Plovdiv University. The work of the students in these laboratories was conducted in actual scientific environment and the teachers assessed it as very beneficial.

For each separate topic the inquiry results of the students were formed as reports, articles, or as an apparatus constructed by them, or as a brochure, and they were presented at the National student conference “Express yourself” in April 2014 carried out in Plovdiv University.

SOME RESULTS AND CONCLUSIONS FROM THE STUDY

In order to summarize the results and to find the effect of this type of education a questionnaire was filled in by the participants, as well as interview with the teachers who organized the education.

The questionnaire (Fig. 1) was filled in by 78 students who have participated in or attended the National Student Conference. The answers of 76 students (97%) to questions no. 1, no. 2, no. 6, no. 7 and no. 8 are “I agree completely” whereas only two students replied with “I agree”. A little less is the percentage of the replies “I agree completely” (80%), to questions no. 3, no. 4 and no. 5, while the remaining 20% reply positively, but in the more moderate scale.

The analysis of the obtained results showed not only the situation about the project work, but also the self-assessment of the students about the benefits from the conducted education. They share that they have felt responsible in finding the solution to the assigned task, they have learned to work in a team, they have understood in a better way how science is made. They have been interested in the different scientists who have visited their school and they have enjoyed the making of different scientific inquiries. Again positive, but not so definite positive assessment they give to their confidence of presentation at the conference.

In the interview with the teachers, they share that they have been pleasantly surprised by the interest and active involvement of the students which show a good motivation for learning. According to them, education organized in such a way encourages the expression of the best personal qualities of the students, which develops their self-confidence. The opportunity to learn in an environment different from the school, to visit libraries and laboratories, to search information in Internet, is accepted with joy by the students and they willingly participate in the independent solution of the assigned tasks. Thus a feeling of importance and usefulness of the learned knowledge is built, which is an important motivation factor. All teachers who worked on the project and applied this



Chain Reaction: questions to the students at the end of the National Conference

Researchers from the Sheffield Hallam University (the UK) have a request to the students who participated in the National Conference *Express Yourself* to share their experience, **to help the people running it learn how well it has gone**. Your answers will be kept carefully and your personal information will not be used in our reports.

1. Student's information:

Age: _____ Gender? _____

School name: _____

Country: _____

Conference participation:

What did you take part with in the conference?

- poster
- presentation
- both

Please, answer to the following questions to what extend do you agree or disagree with the statements about the National Conference

	Totally agree	Agree	No opinion	Disagree	Totally Disagree
I generally like <i>Express Yourself</i>					
I generally learnt a lot from <i>Express Yourself</i>					
I learnt a lot about team work in the project <i>Express Yourself</i>					
I felt that my team was responsible for the work that was presented in the conference <i>Express Yourself</i>					
I enjoyed making scientific research/ experiments which were presented at the conference					
I felt confident at presenting my work at the conference <i>Express Yourself</i>					
While preparing for the conference, I better realized how science is made					
I was happy to be visited by a real scientist at school					

Fig. 1. The questionnaire filled in by the students after the National Student Conference.

approach find desire and enthusiasm for work in the students, which rarely can be found during the traditional lessons in the classroom.

The inquiry based science education solves also a number of disciplinary tasks. Students learn to be disciplined due to the requirement to observe the deadlines and to follow certain rules. The application of the newest ICT (Skype, Facebook) in the educational process allowed the teachers and scientists to be al-

lowed into the world of teenagers and consolidated and formed in them specific communicative skills and knowledge about the newest information technologies.

The implementation of this approach stimulated the students to be involved in new educational activities, different from those in the conventional educational environment - they express ideas, ask questions, accept other's opinions, comply with the re-

quirements, transform their initial concepts, organize meetings, use scientific literature and learn to quote it and to present results. All these activities contribute for the establishment of the separate elements of scientific literacy.

Interesting and unexpected result from the so conducted education is the increased interaction between parent - student and parent - teacher. The information about the work under the project was spread rapidly among colleague teachers and parents too. The teachers share their surprise from the activeness and support provided by the parents during the education and from their involvement during the entire time. They not only supported the conducting of this type of education, but they shared their observation that the work on the assigned tasks make their children more responsible and inventive.

In the inquiry based education there are involved students with different academic achievements, which is a confirmation of the broad social functions of this approach. In a situation of informal communication the teachers and students got to know each other in a better way and increased the trust in the teacher, while the students themselves got to know each other better and created skills for teamwork.

Along with this, the teachers share their feeling about a change in their role in the educational process. Their role as information intermediary and leader is

transformed into that of a counselor and assistant.

The described results from the conducted inquiry based science education in several schools in Plovdiv allowed us to draw many conclusions about the benefits of its application. Not only did it encourage the independent work and thinking of the students, developed and consolidated their ability to analyze and explore, created skills for independent learning, but it also built a positive attitude towards learning and motivated them to study natural sciences.

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ВЪЗМОЖНОСТИТЕ НА ИЗСЛЕДОВАТЕЛСКИЯ ПОДХОД ЗА ИЗГРАЖДАНЕ НА МОТИВАЦИЯ ЗА УЧЕНЕ ПО ФИЗИКА

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(Резюме)

Ученето чрез изследване е важен подход в преподаването на природните науки, който въвлича учениците в изследване на теми и в използване на данни като доказателство за отговор на поставени въпроси [1]. Смята се, че изследователският подход допринася за формиране на научна грамотност и има потенциал да подобрява разбирането на учебното съдържание по природните науки, да провокира интерес към науката и участие в изучаването ѝ в класната стая и е мощно мотивационно средство [2-5].

Обучаването на учениците да правят научни изследвания всъщност представлява въвличане на учениците от учителите в практикуването на наука. Това включва различни дейности и процеси, за да се отговори на въпроси и да се направят обяснения и модели, като се използва логическо и критично мислене. Включвайки се в научния процес, подобно на учените, учениците използват наблюдения и експерименти, правят заключения, за да дадат обяснения, базирани на доказателства.

Едно от основните предимства на този подход на обучение е, че стимулира самостоятелната работа и мислене на учениците, развива и укрепва способността им да анализират и изследват, създава умение за самостоятелно учене през целия живот, изгражда мотивация за учене и за правене на наука.

В настоящата работата се разглеждат мястото и ролята на изследователския подход в обучението по физика като се прави опит да се опишат значението и възможностите му за формирането на различни видове мотивация.

Описан е резултат от проведено обучението по физика с използването на изследователски подход в четири пловдивски училища и на базата на наблюдения и проведени анкети с учениците са направени изводи, които ориентират и конкретизират възможностите на изследователския подход при изграждане на мотиви за изучаване на физика [3,4].

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