ACCEPTANCE OF IBSE METHOD AMONG CHILDREN, TEACHERS AND STUDENTS ON THE UNIVERSITY AND SOCIETY IN SERBIA

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"The efforts of the world's science academies in promoting inquiry-based science education are relatively new. But these efforts are necessary if we want to instill in future generations a fascination with scientific discovery and a firm understanding and appreciation of scientific endeavors."

– Jorge E. Allende, SCIENCE 2008

Abstract

From 2001, in collaboration with French Academy of Sciences, we have introduced Hands-on within the scope of the IBSE – Inquiry-Based Science Education approach in science education in Serbia. Our strategy was to improve the achievement of scientific literacy for all children by the creation of different educational resources for teachers. Over the past decade, thanks to the numerous training workshops, the Hands on method rapidly become widely known among teachers in Serbia. Several books and Hands on manuals have been translated and published in Serbian, and the fifteen Regional "Experimental Rooms" were supplied with inquiry based educational kits all over country. The Serbian web-site http://rukautestu.vinca.rs, the semi-mirror of the French site La main à la pâte (www.inrp.fr/lamap) has been in use since the end of 2008. Serbian schools participate in the international Fibonacci and Greenwave projects. Hands on activities in Serbia are increasing social awareness to the issues connected with science education and put the children in the active role in researching and experimentation.

Key words: Serbia, IBSE, Hands on, training workshops, educational kits

Introduction

Having in mind how science is presented in Serbian schools, and bad results of our students on the PISA test, we have tried to change the situation. From 2001, by the individual efforts and in collaboration with French Academy of Sciences, we have introduced *Hands-on*, within the scope of the IBSE – Inquiry-Based Science Education approach in school-science education. It was immediately supported by the Serbian Physics Society and over time, has been taken up by many teachers and supported by public opinion throughout Serbia. The Project has been implemented in Serbia in order to uplift and revitalize teaching of the natural sciences in Primary Schools and to enhance personal engagement by the pupils in different topics. This project aimed also at renovating science education in elementary schools, allowing exchanges and enhancing the development of good practices: teacher's training, evaluation, on-line projects and dissemination.

Our strategy was, in the first place, the achievement of scientific literacy for all children by the creation of different educational resources for teachers. This idea in Serbia was the new one, and at the beginning, we did not have strong formal support. For that reason we decided to translate as many of the books as possible for teachers and parents, created by the *La main à la pâte* team (about 20 books have been translated so far). In this way, we fulfilled two goals: we started the communication between French and Serbian scientific/educational community, and provided good scientific and educational material for Serbian teachers. During these activities, we have achieved an excellent cooperation with a number of university professors, institute researchers and school teachers around the country. Also, we have very much taken into account the experience of some other worldwide organizations: *USA with Hands-on, France with La main à la pâte, Sweden with NCF, China - Learning by doing, England with XXI Century Science* etc, and the academicians Pierre Léna and Yves Quéré. The French team "*La main à la pâte*" have been of particular help.

The introduction of science into lower grades of primary school has always been of interest, but also prompts the fear of the unknown. Curriculum for primary education includes, in addition to compulsory subjects, electives and study. One possibility is the study of the subject called "*Hands on - Discovering the world*." The basic idea for the introduction of this course is to foster, encourage and develop children's curiosity. The child is in the active role played by research and experimentation, and has good opportunity to meet the world around him. In 2003, the Serbian Ministry of Education decided to put forward an optional course *"Hands on -Discovering the World"* [1] for children from 6 to 8 years old. Course lasts about thirty hours annually and gives Serbian children the opportunity to discover science through initiation into the experimental approach (Jokić, 2007; Bošnjak & Obadović, 2009; Bošnjak, Cvjetićanin, Branković, & Krivokućin, 2010). Thanks to the numerous training workshops, the *Hands on* method rapidly become widely known among teachers in Serbia. During these training sessions, teachers are placed in the same pedagogical situation as children and implement inquiry-based science teaching in their classrooms later. To date, fifty international workshops about application of IBSME for Southeastern Europe in our country have been done, during which participants shared results and educational, pedagogical and scientific resources.

Resources for teachers

Several books and *Hands on* manuals for teachers and parents have been translated and published in Serbian. Some of them are: *La main à la pâte, Seeds of Science* 1, 2, 3, 4 and 5, *Teaching Science at School, Discovering the World at Nursery School, Europe, Land of Discoveries*. Several others are in preparation. Over the past five years we have implemented a number of workshops accredited by the Serbian Ministry of Education (8 hours of training), with about 3,000 preschool and primary school teachers and tutors all over Serbia. We have chosen schools geographically close to one another for a better involvement of the local actors. We cover almost all areas of Serbia, which is very important for the dissemination of IBSE across the country.

During the 2010/11 training, more than 1000 teachers and tutors have resolved problems by applying IBSE, like their pupils, with material easily found around, and by using our *Pedagogical Kits* (see later). Our workshops are provided in about 30 places all over the Serbia, with preschool, elementary and sciences teachers working together. In this way we have try to develop the team's work in the schools, bridging the gap between sciences, and to show how is possible to achieve it in each school. During the project, trainers/tutors are in touch, and each of them is responsible for up to 10 teachers. We also get support from students of the Teacher Faculties who do their practical training in our schools. In addition, we have created specific resources for the classroom, containing material kits and guidelines for teachers. As result, at the end of 2010, the fifteen Regional "Experimental Rooms" were supplied with inquiry based educational kits all over Serbia (see fig.1), giving the model of research in the classroom. Each Experimental Room is supplied with 5 experimental boxes containing 20 experiments for the classes' activities and 10 books. In this way, about hundred primary school teachers are given a model of research and implementation of IBSME. In this way, we enabled inquiry-based process to be implemented in a convenient place with convenient tools.



Fig. 1. Tutorial training for work with activity books and Experimental Kits

The Serbian web-site <u>http://rukautestu.vinca.rs</u>, the semi-mirror of the French site *La main à la pâte* (<u>www.inrp.fr/lamap</u>) has been in use since the end of 2008 and now contains about 2500 pages, on which teachers can find many important resources for the work in classes: numbers of modules for the activity in the class, some of them created by Serbian teachers and researchers (Miličić, Žnidaršič, Pavković-Lučić, Lučić & Jokić, 2010). Teachers can also find many important resources and ideas, collaborative and interdisciplinary projects such as *By the Foots of Eratosthenes, European discoveries, Matter and materials, Energy and Energies, Greenwave - the signs of spring*. The website also includes pedagogical documents about bridging from elementary to lower secondary school (*Integral teaching of science*). The site includes approximately 500 pages of resources, offers description of different experimental activities in physics, biology, ecology and other topics (see Miličić et al., 2010), as well as extensive documentation written by different specialists. Recently, the possibility of exchanging opinions between scientists and teachers through the web-site has been developed.

IBSME collaboration and partnerships

During our activities on the implementation of IBSME in Serbia we have developed many domestic and international partnerships: with Academy of Sciences and Arts (support in the society, ALLEA, International workshops); Serbian Physician Society; Serbian Ministry of Education (accreditation of our workshops, introduction of the optional subject *Hands-on Discovering of the World*); Eurosciences (help for International workshops); School Publishing House *Zavod za udžbenike* (all above mentioned books are published by this Publisher); Weekly educational journal *Prosvetni pregled* (published books and more than 10 appendixes about IBSE); IAP and French Academy of Sciences (signed official collaboration for our project with Serbian Academy and University of Belgrade); French Embassy in Serbia (support our activities). Five South East European workshops for *Hands on* primary science education (2005-2010) <u>http://rukautestu.vin.bg.ac.rs/handson4/</u>, as well as the ISDTF 2011 Conference – Improving Specific Subject Didactics at the Teacher Training Faculties were organized in Belgrade with participation of members of Fibonacci Project, scientists, science educators and education experts, professional advisors and policy makers.

International projects

Besides the translation of various resources for teachers into Serbian, we have focused on establishing a network of Serbian schools interested in participating in the Fibonacci and Greenwave projects (<u>www.fibonacci-project.eu</u>). Nearly 50 schools, primary and secondary, have joined the Greenwave project (<u>www.greenwave-europe.eu</u>). As a part of FIBONACCI, the Greenwave is designed to allow a clear and exciting demonstration of how spring moves across the continent. During the 2011, for the first time, schools from Serbia could participate, in company with 15 countries across Europe. From the late January to the end of June, pupils monitored the indicators of the arrival of spring: the common

European frogspawn and the swallow, and also two local trees: ash and the horse chestnut. During the work on the project, students have successfully applied process of observation, experimentation, and construction of the measuring instruments. They have also tried using digital camera and processing images to the web site Gallery. About 150 teachers of different skills (biologists, physicists, IT specialists, chemists, teachers in primary schools, and the pre-school teachers...) have been involved in the Greenwave Serbia. Sixty seven Serbian schools registered on the website, and about 66 percent of them sent data and measurements (Miličić, 2012).

Students could submit the species sightings in two ways: as an Official Records, or as Observations. The total number of records submitted from Serbia in 2011 was 724 (72 Official Records and 652 Observations). Pupils also measured air temperature on a daily basis, and sent data from handmade rain gauges and anemometers (figs. 2 and 3). The significant value of the Greenwave is the multi-disciplinary approach, as well as dissemination and practical implementation of IBSME. With the great help of teachers participating in Greenwave, there was also a Weather Folklore Page on the Serbian's web-site. This content links the Greenwave activities with curricula of the class "National folk tradition" in the primary schools. A very important aspect about participation in Fibonacci and Greenwave is the fact that Serbian scholars were able to communicate using the website, which makes their information accessible to all European participants. According to the official data (Fibonacci Newsletter, 2011) Serbia, Romania and Slovenia were the most active countries in the Project in 2011.



Fig. 2. Serbian data (in multicolors) and the overall European records and sightings (in blue). (source <u>www.greenwave-europe.eu</u>)



Fig. 3. *Example of table and graph sent by schools. Serbian official weather data are marked in red* (source <u>www.greenwave-europe.eu</u>)

Research results and feedback

Five years after the elective course *Hands-on Discovering of the World* (in further text only *Hands On*) had been introduced in our educational system, local analyses were carried out in order to determine the extent and the way this subject was implemented in Serbia. The analysis was carried out in 16 schools of the West-Bačka District. Specially designed questionnaire was given to a sample of 137 teachers. The analysis showed that only 13.14% of the questioned teachers are teaching or taught the optional subject *Hands On*, which means that it is not used enough in teaching practice of the West-Bačka District (fig. 4).



Fig. 4: Proportional share of teachers who taught or teach the optional subject Hands On in the total sample

The results of the questionnaire show also that 33.33% of pupils, who chose the optional subject Hands On, were better in learning the contents of the compulsory subjects *The World Around Us* and *Nature and Society*. About 38.89% showed partial progress, while 16.67% of pupils did not show any improvement within the compulsory subjects (fig. 5). As more than 2/3 of pupils show some kind of improvement, we can conclude that the optional subject *Hands On* has a positive effect on pupils' progress in learning the contents of the compulsory subjects *The World Around Us* and *Nature and Society*.



Fig. 5: Proportional shares of success which pupils who chose the optional subject Hands On showed in learning the contents of the compulsory subjects The World Around Us and Nature and Society.

The analysis of the factors which influence the choice of the optional course Hands on shows that its rather poor presence in schools is due to the lack of information and weak interest of parents and pupils, but also to the widespread opinion that teaching of this subject requires special equipment and a laboratory. Obtained results show that, despite many books, as well as plenty of Hands On seminars and lectures on natural sciences in teaching practice, a large percentage of teachers, parents and pupils of the West-Bačka District are still not familiar enough with the basic principles and teaching of the Hands On, which obviously leads to its poor presence in teaching practice. Teacher's affinities and poor knowledge of natural sciences have a bit smaller, but not negligible influence. The next study we carried out was about implementation of the IBSE in the compulsory subject, such as Nature and Society for the 4th graders of primary schools. Pupils from 4 experimental classes (86 in total) have been studying Science (mostly including physical phenomena) for two months using the IBSE. One of the instruments of the research was a survey with a purpose of gathering the data on the views and experiences of the pupils regarding the use of this method. Our observations point that during the experimental period, teachers have been using the IBSE method correctly; hence the majority of the pupils were expressing, explaining and exchanging their ideas and suggestions for solving the problems involved. Most pupils (82.56%) found the experiments interesting, but only 39.53% of them enjoyed searching for the solutions on their own. The survey shows, directly or indirectly, that the group work and some experiments have already been planned and involved in the class curriculum, while the IBSE was entirely new method for both the teachers and the pupils. On the other hand, a great motivation and enthusiasm exist with the teaching staff and the children involved, and they would like to continue using of IBSE in compulsory subject Nature and Society.

The most liked experiments

In the last question, pupils stated what they liked or disliked during the experiments. It should be noted that every pupil wrote a comment (some gave elaborate answers, others shorter ones). A part of the answer commented on which experiments they particularly liked. Based upon the answers, favorite experiments of the pupils and the percentage of the pupils that liked them are shown. According to the answers, it can be concluded that the pupils' most favorite experiments were the ones that included constructing something interesting or practical: a car that moves on its own, a submarine, the lighting in the doll house, a winking owl, a compass, a rocket-balloon, etc. (fig. 7). Pupils also like experiments with the elements of play and competition (a car race and 'the Electric Hand'), as well as those with the element of some kind of the 'magic' (candle that 'burns under water', a staple that floats on water or a turned over glass on a sheet of paper that doesn't leak water). Speaking of what they disliked, some pupils stated 'too hard experiments' for which they could not find solutions, or 'too easy experiments' which were boring to them. However, it should be stated that the number of these 'unloved' experiments is extremely low (approx. 6 %).



Fig. 7: Pupils constructing a blinking owl

A huge number of pupils claim that they enjoyed finding the solutions themselves and the fact that they were experimenting. Here are some of the typical answers:

"My favorite part was when we had to do things on our own."

"Experimenting and discovering different things was my favorite part."

" The best part was when we did the experiments without the help of a teacher. "

While some pupils were ecstatic about doing experiments on their own, a certain number of them responded quite negatively to it. Here are some of the answers to illustrate the point:

"I didn't like it when I had to find solutions on my own. "

"... and the rest of them I didn't like because I had to think a lot. "

" I didn't like it because I don't like searching for answers in Science and Social studies, I prefer geography and history. "

Besides the forementioned typical answers, here are some interesting and isolated examples:

"I enjoyed working in a group. "

"I liked all of the experiments because I learned a lot !!! "

To conclude the analysis of the views and experiences of 4th grade pupils in primary school regarding the implementation of the IBSE, here are some humorous answers:

"I didn't bother to think. "

"Most of all, I liked the owl that blinks with the help of electricity and men."

"I didn't like it because I couldn't say what I wanted to say because Vasilisa wouldn't let me. "

According to the data gathered, it can be concluded that there is great interest in this method and that both the teachers and the pupils are motivated to see the continuation of the implementation of the IBSE method in the compulsory subject *Nature and Society*.

Promotion of IBSME and raising social awareness efforts

Throughout 2010/11 team members, teachers and students involved in the Fibonacci Project in Serbia gave several interviews and made guest appearances in broadcasts on Radio Belgrade 1 (Serbian National Broadcasting Corporation). The main goals of those participations and interviews were to present and promote IBSME, the Fibonacci Project in Serbia (including the Greenwave Project), as well as new methods and approaches in the teaching of science. Many appendixes about IBSME activities in Setbia have been made in the Educational weekly journal *Prosvetni pregled*, which is distributed free of charge, to all schools around the country (about 7000 exmp. per edition).

The major promotion events and communication on IBSME in Serbia were also: Festival of sciences in Belgrade and Podgorica (Republic of Montenegro); Summer School for children in one Regional centre; Work with 40 students (14 years old) together with French Ambassador in Belgrade; Workshop with 80 students on the Faculty for teachers in Belgrade, etc.

General conclusions

The main forms of *Hands on* action in Serbia touch a wide range of fields. During ten years of participation in *Hands on* program, Serbia has became a natural intermediary for linking the cooperative activities and workshops of *La main à la pâte* to South-East Europe. Europe has apparently recognized the need for rebuilding scientific education, and we expect that innovation in teaching sciences (especially an IBSME) will give substantial results in Serbia, as well. Participation of our teachers and students in international collaboration (in the frame of the Project FIBONACCI,) is a very important step because, behind the scientific aspect, they could use foreign languages and create some kind of national and international network with others. Present activities in Serbia are also including efforts in increasing social awareness of the issues connected with science education.

Notes

1. Ruka u testu in Serbian.

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