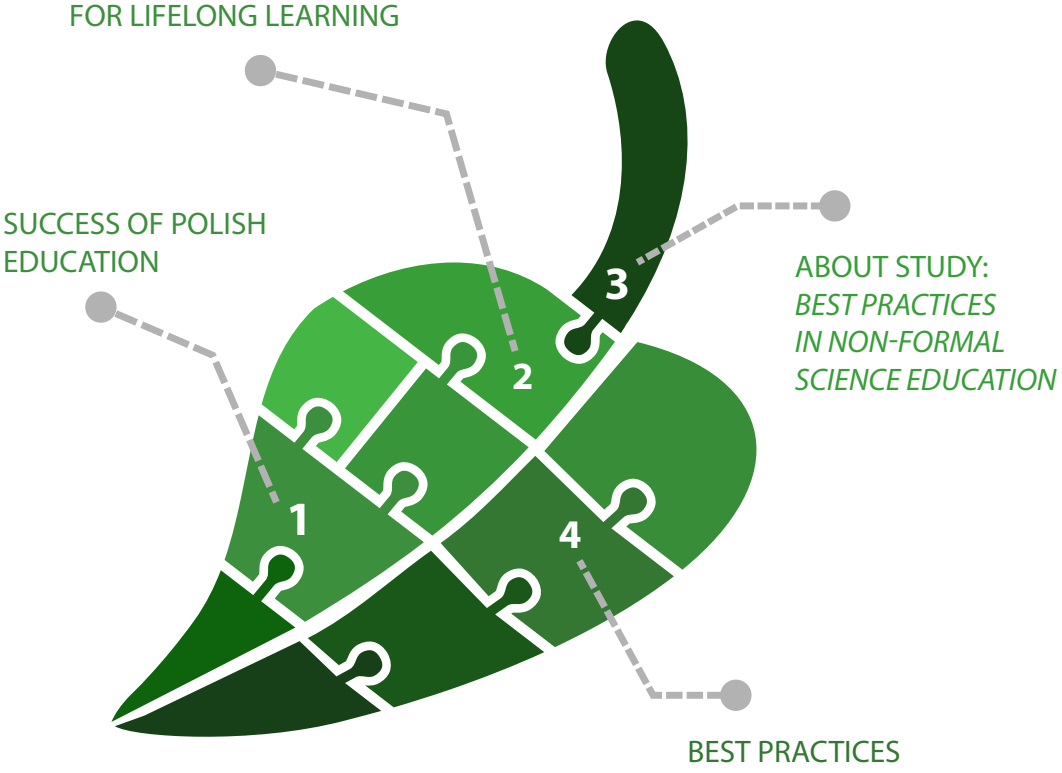
education enthusiasts



Non-Formal Science Education Supports Polish Schools

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The leaflet is co-financed from the European Union funds within the scope of the European Social Fund

Success of Polish Education

The results of international studies (PISA and TIMSS), as well as Polish ones (including *Laboratory of Thinking: Diagnosis of Science Education in Poland*) indicate that pupils from Polish schools deal with scientific reasoning better than before 2009.
Scientific reasoning consists of:

- Recognition of scientific issues;
- Explanation of scientific phenomena using scientific language;
- Interpretation and use of results and scientific evidence.

Expanding such skills leads to higher results obtained in such studies (Table 1). In particular, this refers to teaching on the ISCED 2 level, where programme changes came into force in 2009.

Table 1. Average results scored by pupils during measurement of reasoning skills in science in surveys conducted in years 2006, 2009 and 2012 in the European Union countries, chosen for the research. White background denotes countries whose results were not statistically different from the average result in the OECD countries; yellow colour denotes countries with better than average results and orange colour countries with worse than average results – the position of Poland was indicated by brown colour.

PISA 2006	
Country	Average result
Finland	563
Estonia	531
Holland	525
Slovenia	519
Germany	516
Great Britain	515
Czech Republic	513
Austria	511
Belgium	510
Ireland	508
Hungary	504
Sweden	503
Poland	498
Denmark	496
France	495
Croatia	493
Latvia	490
Slovakia	488
Spain	488

PISA 2009	
Country	Average result
Finland	554
Estonia	528
Holland	522
Germany	520
Great Britain	514
Slovenia	512
Poland	508
Ireland	508
Belgium	507
Hungary	503
Czech Republic	500
Denmark	499
France	498
Sweden	495
Austria	494
Latvia	494
Portugal	493
Lithuania	491
Slovakia	490

PISA 2012	
Country	Average result
Finland	545
Estonia	541
Poland	526
Germany	524
Holland	522
Ireland	522
Slovenia	514
Great Britain	514
Czech Republic	508
Austria	506
Belgium	505
Latvia	502
France	499
Denmark	498
Spain	496
Lithuania	496
Hungary	494
Italy	494
Croatia	491

Significant improvement in average results of Polish middle school pupils in the international surveys is a source of success for the Polish education in an important international Pearson ranking (http://thelearningcurve.pearson.com/index/index-ranking): in 2014, Poland was on the 10th position in comparison to the 16th position in 2012.

This success is an effect of the core curriculum reform which took place in Poland in the year 2009. The reform focuses on application of the scientific method during science classes. Via the objectives, content and recommendations included in the core curriculum, an obligation of carrying out experiments, observations and measurements during science classes was introduced. Recommendations regarding the research method are supplemented by organization of some of the classes outdoors – especially during nature classes (on level ISCED 1), geography and biology (on levels ISCED 2 and 3).

> *Thanks to the core curriculum reform, many teachers and pupils in Polish schools are more aware of the advantages and benefits resulting from this method of teaching and learning of science issues. They emphasize that:*
>
> - *It enables pupils to examine scientific reality, instead of learning it "by heart";*
> - *It shapes research-oriented, creative and dynamic approach to the reality and problems occurring in real life;*
> - *It teaches independent thinking and, through this, responsibility for decisions and activities undertaken by pupils themselves;*
> - *It shapes and develops social competences, due to the fact that it requires cooperation and communication within a team (RoSE, 2013).*

It is clear that changes in the core curriculum quickly brought visible results.

Non-Formal Education: Support for Schools and Opportunity for Lifelong Learning

Success of Polish 15-year olds is a source of joy, yet the Institute also monitors educational processes on the level of middle schools and high schools, including via a study entitled "Laboratory of Thinking", as well as analyzes methods of teachers' work and the impact of the course of classes on pupils' competences. The results of such studies show that during classes, pupils carry out experiments, observations and measurements in an insufficient degree and they rarely participate in outdoor classes. Teachers list such factors as: overcrowded classes,

too few didactic lessons and insufficiently equipped labs as the main culprits of this state of affairs. What is more, teachers themselves have problems with applying the research method or team work of pupils in practice (RoSE 2013).

One of the important means of support for teachers in solving such problems is – apart from relevant forms of professional improvement – wide opening of schools onto non-formal science education. It constitutes valuable supplementation of science education at schools. Read the text entitled: "Good points of non-formal education"

Good points of non-formal education:

- *Educators who are both highly valued specialists in their area of specialization and great enthusiasts who willingly share their knowledge with children and youth and consistently use the research method;*
- *Technical facilities in the form of well equipped classrooms and labs;*
- *Natural facilities in the form of valuable scientific resources present in didactic rooms, museums and outdoors;*
- *Different use of time in comparison to schools – during classes in a non-formal educational centre, a pupil may not only carry out an experiment or an observation, but also plan it, analyze the result, formulate and discuss the conclusions, which is often impossible in Polish schools due to the system of 45-minute classes preferred by the school administration;*
- *Application of lab and project methods more often than at school.*

Non-formal education also plays another important role – it popularizes and promotes the principle of lifelong learning among pupils; this principle is implemented in Poland in an insufficient degree. A statistical adult Pole, after completion of formal education, educates himself and develops his professional skills much less frequently than an average European. Centres of non-formal education, open for everybody, from schoolchildren to adults at any age, may change these, unfavourable for our country, statistics.

Combination of formal and non-formal educational activities with respect to young people already at the school level may offer a chance for developing integrated regional science education, which is both attractive and effective for the recipients. Integration of two tracks of science education: at school and in non-formal science educational centres seems particularly valuable in the context of introducing a modern national qualification system in Poland, based on the effects of learning and its tool, i.e. the Polish Qualification Framework (http://www.kwalifikacje.edu.pl.en/polish-framework).

Therefore, a study entitled "Best Practices in Non-Formal Science Education. Survey of the Offer of Science Activities" implemented in the Science Section of the Educational Research

Institute (IBE) between 2011 and 2012 follows the European and international education trend – both in the area of school education and with respect to the principle of lifelong learning promoted in Europe. This quality review of activities within the scope of support for teaching and learning science is an introduction for an in-depth evaluation of such activities in the future.

About the Study *Best Practices in Non-Formal Science Education*

Activities of the centres of non-formal science education in Poland have been described broadly, for example on the Internet. However, there was no reliable study of such data with respect to availability of classes, their quality, degree of use of the offer by teachers and pupils, efficiency and compliance of classes with teaching objectives written in the core curriculum, and – most importantly – the effects of learning. Furthermore, there was also no clear determination whether classes offered by such centres constitute systematic and long-term activities or whether they are just incidental ones, related, e.g., to the possibility of receiving financial support from EU funds.

In response to such information gaps, the Science Section of implemented the first Polish innovative examination of the area of non-formal education under the name *Best Practices in Non-Formal Science Education. Survey of the Offer of Science Activities* in 2012.

Objective of Survey and Definition of Best Practices

The objective of the survey was determination of the degree in which the offer of non-formal science education centres may be helpful in shaping and developing scientific reasoning and the use of scientific method, described in the objectives of the core curriculum in the science section. The expected result of the study was preparation of a database of non-formal science education centres all over the country, as well as making examples of best practices in this field well-known to the public.

For the purpose of the study, it was assumed that best practices in non-formal science education constitute educational classes and their institutional, organizational and financial conditions, which:

- Allow for formulating and testing research procedures in a scope described in objectives of teaching, recommended experiments and observations of the core curriculum in the section of science;
- Refer to skills important in science education (described by teaching objectives of the core curriculum in science section), relating to scientific reasoning, such as planning and carrying out experiments and observations, formulating conclusions, identifying relationship between causes and effects, distinguishing opinions from facts or standing one's ground with proper arguments.

Methodology and Scope of Study

At the first stage of the study, questionnaires consisting of 19 questions were sent to representatives of 348 centres all over the country. The questions referred to the range of operation of the centre, sources of financing its activities, methods and didactic tools applied during classes. The first stage of the study was conducted in the area of 16 voivodeships (map 1).

The second stage of the study was conducted in 50 centres selected on the basis of criteria (map 1). These centres, according to data obtained from the questionnaire, offered chances for finding examples of best practices.

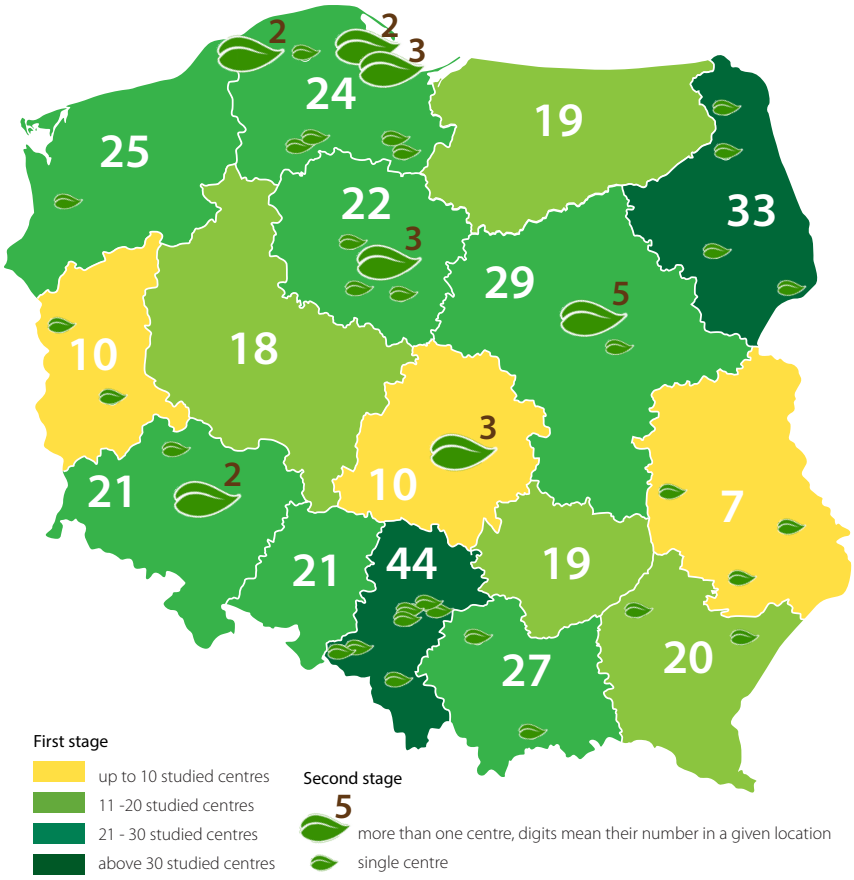
The selection criteria of centres to the second stage of the study, included, inter alia:

- *Taking into account teaching objectives from the science section of the core curriculum while preparing an offer;*
- *Most frequently used methods in the form of workshops, labs, seminars, outdoor classes and other forms activating participants;*
- *Application of didactic tools, in the process of teaching, which induce usage of the scientific method, including formulation of research questions, hypotheses, preparation of an experimental procedure or observation.*

In 50 centres selected on the basis of such criteria:

- Classes were subject to observation (a form and a class observation instruction);
- Teachers and pupils who participated in classes were asked to provide their opinions (questionnaire surveys for pupils and teachers);
- Individual interviews were conducted with teachers, instructors and administrative employees (in-depth individual interview form);
- Didactic tools and core curriculum materials were subject to analysis (analysis sheet of core curriculum documents).

Map 1. Range of study.Stage I. The colour indicates the number of studied centres in each of 16 voivodeships (see description). Stage II. The small leaves denote individual centres, whereas big leaves denote more than one centre in a given location. Digits (brown colour) give their number.



Selected Results, Conclusions and Recommendations

In the first and the second stage of the study, the following information was received:

- Main sources of financing the centres' operation;
- Range of operation of the centres (regional, national, international);
- School subjects supported during classes in the centres (diagram 1);
- Work methods, most often applied in the centres (diagram 2).

Diagram 1. Subjects supported during science classes in non-formal education centres (selection of more than one class was possible). Data received from 348 centres.

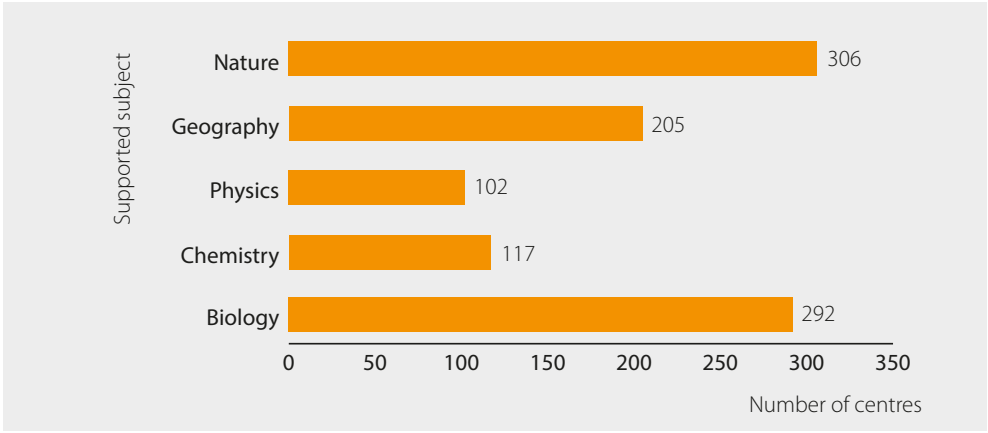
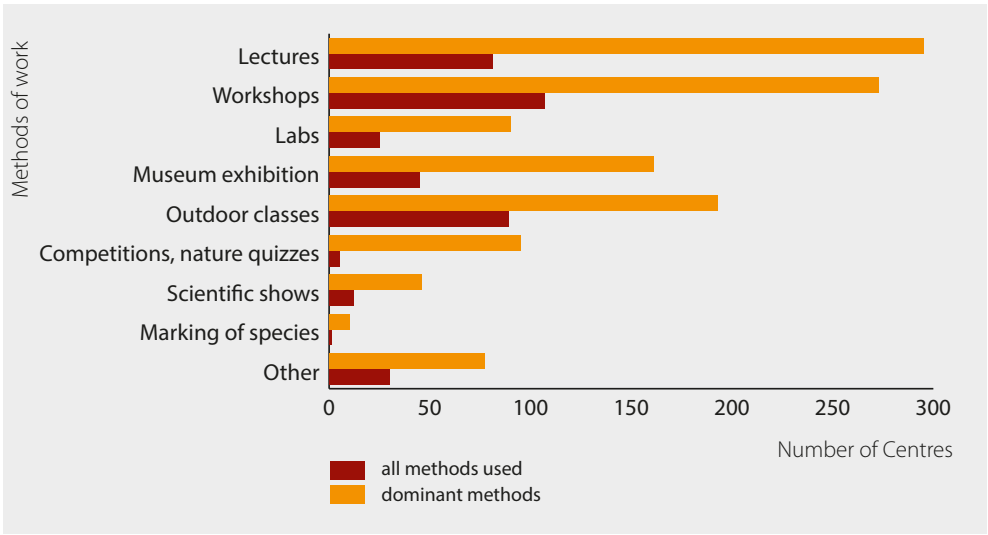


Diagram 2. Methods of work in the teaching process, most often applied in non-formal science education (selection of multiple answers possible). Data received from 348 centres.



In the second stage of the study, in each of 50 participating centres, best practices were identified and described.

They were classified under four areas of operation:

- administration and financing,
- organization of work,
- conducting of classes,
- preparation of didactic and core curriculum materials.

Examples of best practices are presented in a further part of the study.

Major conclusions which were formulated on the basis of analysis of study results include:

- *Declared aims of operation of the centres are consistent with the idea and general requirements of science core curriculum;*
- *Methods and forms of work applied during observed classes are conducive to the shaping of scientific reasoning skills and use of the scientific method;*
- *Organizational solutions applied in the examined cases are conducive to deeper understanding of scientific issues by pupils and – via application of team work – they develop valuable social competences.*

Therefore, classes in non-formal science education centres may constitute valuable supplementation for school education and support implementation of teaching objectives (and often the content of teaching) of the core curriculum of sciences on the ISCED 1, 2 and 3 levels.

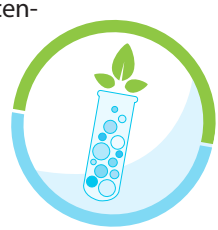
Recommendations resulting from the study are mainly addressed to teachers and employees of centres, yet they also refer to educational administration on all levels – from the Ministry of National Education to headmasters.

Promotion of the centres' offer in schools may be performed both by the centres themselves and by teachers, who, with their pupils, participate in this type of classes and value highly their utility. Promotion may also have a form of additional recommendations of the Ministry of National Education, extending current provisions in the core curriculum (see frame).

Sample provisions of the core curriculum recommending use of non-formal science education centres:
IV. educational stage, basic scope
Recommended exercises, trips and observations. The pupils perform the following exercises or conduct observations: 2) during a trip to the zoological garden, botanical garden or a nature museum – they become acquainted with the issue of protection of species threatened with extinction;
IV. educational stage, extended scope
Recommended conditions and mode of implementation

Within the scope of biology, implemented in an extended scope in the course of the entire cycle of teaching, it is necessary to organize: (…)
2) trips to a nature museum, a botanical garden or a zoological garden which support the teaching of botany and zoology material.

Promotion of core curriculum of science subjects in non-formal educational centres as a document binding for school groups that use the classes may be performed by educators or administrators of centres, but also by teachers who, while booking the classes, should adjust them to the programme of teaching of a given school.



Recommendations directly addressed to centres primarily include guidelines for establishment of a stable network of class recipients, cooperation with schools – potential recipients (in their own regions) and comprehensive cooperation among centres.

An excellent example of fulfillment of both recommendations for centres is the operation of the Partnership for the Barycz Valley Association (http://nasza.barycz.pl/index.php) and its cooperator the Centre of Ecological Education in Krośnice, situated at the border of Lower Silesia and Greater Poland. Both organizations jointly implement the project concerning (among others) close cooperation of non-formal science education centres with schools in the region, as well as establish cooperation with other non-formal science education centres in Poland for the purpose of exchanging experience.

Benefits from cooperation between formal and non-formal education in the field of nature are obvious:

- For schools, this is development and mastering of skills of work via research method and social competences of pupils and teachers;
- For centres, the schools ensure groups of regular recipients, which stimulates educators from the centres to broaden their didactic competences.

Thanks to the participation in science classes in the centres, the teachers can solve problems related to overcrowded classes or lack of equipment in science labs.

For all participants of the process of combining formal and non-formal education, an unquestionable benefit is an increase in the level of knowledge and awareness of the young generation

Best Practices

The study identified examples of best practices in all 50 centres of non-formal science education selected on the basis of criteria.

For example, in administration and financing, an example of good practice was to take advantage of various sources of financing (EU funds, National Fund for Environmental Protection and Water Management, local government funds and others) and provide statistics of people visiting the centre. Such activities give great encouragement to continuation of good teaching practice and guarantee their high quality.

An example of good practice is carrying out classes in small groups, in well equipped science labs, conducted by high specialized enthusiasts, passionate in their field and adjustment of the offer to the needs of the teacher (content suitable for the level of education of the participants).

Photo 1 Outdoor classes for ISCED 3 pupils in the Botanical Garden of the University of Warsaw

In organization of work, an example of good practice is to include purposes of teaching written in the core curriculum in preparing classes for groups of pupils under the supervision of teachers, emphasizing the importance of shaping and developing pupils' skills. Another good practice is also taking advantage of attractive natural environment to conduct outdoor classes, evaluation of classes and cooperation with other non-formal education centres for the purpose of information exchange.

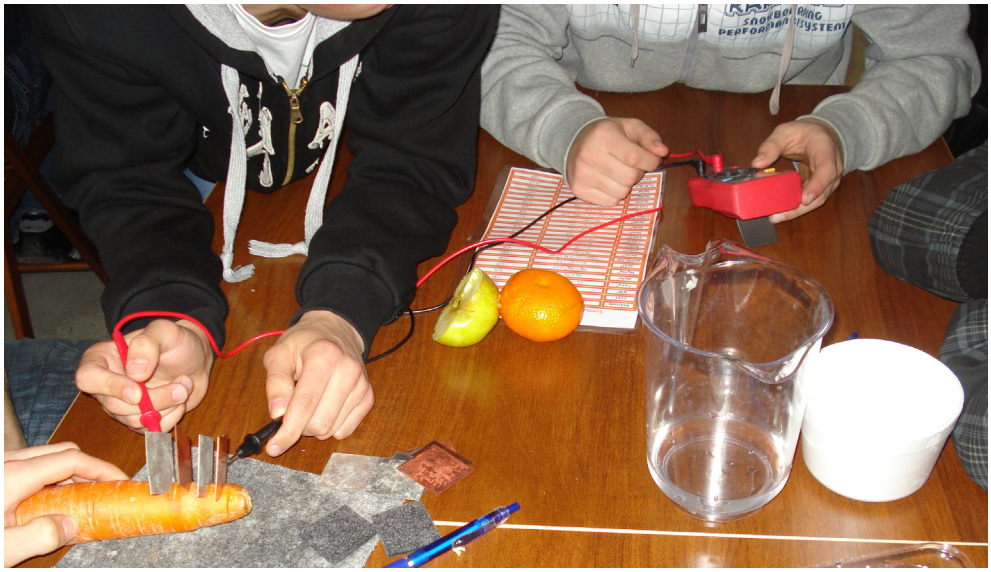


Photo 2. Group work – classes for ISCED 2 pupils in the Museum of Municipal Engineering in Cracow

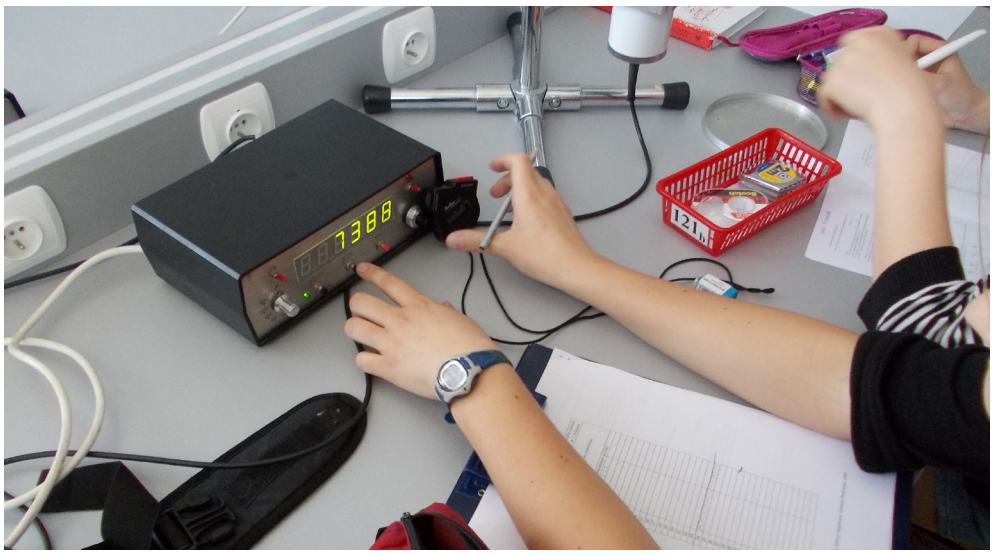


Photo 3. Laboratory classes for pupils of ISCED 3 level at the Physics Department of the University of Warsaw

The Study is Still Alive!

Conferences and seminars

Results, conclusions and recommendations from the study were presented at several seminars and conferences in Poland, inter alia at:

- Seminar addressed to employees of centres and teachers, organized by the Educational Research Institute in December 2012;
- Seminar entitled "New Directions in Ecological Education" for employees of educational divisions of National Parks, organized by the Division of National Parks of the Department of Forestry and Nature Protection of the Ministry of Environment in April 2013;
- Seminar entitled "New Directions in Ecological Education" for employees of educational divisions of National Parks, organized by the Division of National Parks of the Department of Forestry and Nature Protection of the Ministry of Environment in April 2013;

Map of non-formal science education centres

A durable result of the study is a map of non-formal science education centres, available on the Internet under the following address http://eduentuzjasci.pl/badania.110-badanie/556-dobre-praktyki-w-przyrodniczej-edukacji-pozaformalnej-badania-oferty-zajec-przyrodniczych.html map XXX, where the locations of over 340 centres are marked, along with address data and websites which give broad information about the offer of science classes. The map features three types of centres –those participating in the first stage of the study, those in the second stage of the study and the ones that submitted their data after the study and were added to the map. The map constitutes an open pool; the centres that conduct science classes for groups of pupils under the supervision of teachers may provide information via e-mail (opep@ibe.edu.pl), along with some basic information about them. Information is verified by the employees of the Science Section.

Map 2. The location of non-formal science education in Poland. Yellow symbols indicate the centres participated in the first stage of the study, red – the centres participated in the second stage of the study, white – the centres that submitted their data to the Science Section of IBE after the study.

Cooperation

Popularization of study results, conclusions and recommendations bore fruit in the form of cooperation of the Science Section of IBE with:

- The Ministry of Environment, within the scope of constructing criteria of evaluation for competition applications submitted to the National Fund for Environmental Protection and Water Management by centres of non-formal science education. In the proposal of changes criteria of evaluation, the importance of the science method in submitted projects was emphasized;
- The Association Partnership for the Barycz Valley, where a cooperation project between schools and non-formal education centres has been implemented, which is compliant with recommendations formulated on the basis of study result analysis.

Publication

The materials collected in the study were used to prepare a guidebook for teachers entitled *Science subjects outside school, i.e. how to use, consciously and reasonably, the offer of non-formal science education* available in an electronic version on the website of the Educational Research Institute.

A guidebook for centres of non-formal science education is being prepared.

The Science Section is open for cooperation and support for non-formal science education centres in preparation of offer, both for schools and adult recipients – participants of the process of lifelong learning.

Information

The report from the study *Best Practices in Non-Formal Science Education. Survey of the Offer of Science Activities*:
http://eduentuzjasci.pl/badania/110-badanie/556-dobre-praktyki-w-przyrodniczej-edukacji-pozaformalnej-badania-oferty-zajec-przyrodniczych.html (in Polish language version)
http://eduentuzjasci.pl/en/publications/1061-best-practices-in-non-formal-science-education.html (in English language version)

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Educational Research Institute

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In Poland, the Institute participates in implementation of international research projects, including PIAAC, PISA, TALIS, ESLC, SHARE, TIMSS and PIRLS as well as system projects co-financed by the European Union from the European Social Fund.

The publication was printed on recycled paper.

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