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Non-formal Science Education Supports Schools in Poland

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Abstract
Non-formal education centres in Poland have significant potential and offer a variety of extra activities for groups of students supervised by a teacher. The centres' educational activities are not subject to the regulations of the official education system as are schools. The Science Section of the Educational Research Institute (IBE) conducted a research study entitled Best practices in non-formal science education. A survey of the offer of science activities. The main objective of the research was to determine how the science activities offered by centres of non-formal education to groups of students supervised by teachers can contribute to promote and develop scientific reasoning, a skill described in the science core curriculum. The first stage of study was conducted in 348 centres, while 50 centres participated in the second stage, a more in-depth study. A result of the study was the development a national database of centres of non-formal education. They offer support for teachers in implementing solutions required by the science core curriculum in their teaching and promote examples of good practices in this area. The majority of centres that took part in the research conduct activities by applying methods of scientific reasoning in groups, activate and motivate students. The classes develop students' research skills as well as their social skills, including communication and presentation techniques. This way, activities promote the implementation of core curriculum requirements.

1. Introduction
The results of international studies (PISA and TIMSS), as well as Polish research, indicate that students from Polish schools are better able to apply scientific reasoning than before 2009 [1]. In the PISA study scientific reasoning is understood as:

- Identifying scientific issues
- Explaining phenomena scientifically
- Using scientific evidence [2].

Significant improvement in the average results of Polish middle school students in international surveys is considered a success for Polish education in an important international Pearson ranking: in 2014, Poland was in 10th position in comparison to the 16th position in 2012 [3]. This success could be the effect of core curriculum reform which took place in Poland in 2009. The reform focuses on the application of the scientific method during science classes. Through the objectives, content and recommendations included in the new science curriculum (NSC), the requirement to carry out experiments, observations and measurements during science classes was introduced. Success of Polish 15-year olds is a source of joy, yet the Educational Research Institute (IBE) also monitors educational processes in middle and high schools, including through a study entitled *Laboratory of Thinking* [4], as well as analyzes methods of teachers' work and the impact of the course of classes on students' competences. The results of such studies show that during classes, students are insufficiently involved in carrying out experiments, making observations and measurements 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 reasons for this state of affairs. What is more, teachers themselves have problems in applying the research method or promoting the team work of students in practice [5]. One of the important means of supporting teachers in solving such problems is – apart from relevant forms of professional improvement – broadly opening schools to non-formal science education.

2. Research question and definition of best practices
The Educational Research Institute prepared a study entitled *Best Practices in Non-Formal Science Education. Survey of the Offer of Science Activities* on the operation of non-formal education centres conducting science activities for groups of students supervised by teachers. The purpose of the study was to obtain information about the manner in which science activities

offered by centres of non-formal education to groups of students supervised by teachers can contribute to promoting and developing scientific reasoning. As a consequence of obtaining such information, examples of good practices in this area were selected. The results of the study will be used to promote methodological, programmatic and organizational solutions conducive to developing the skills of scientific reasoning, and therefore consistent with the promises of the new science curriculum.

In this study, best practices are understood as such activities and determinants related to them (institutional, organizational and financial), which:

- allow for the formulation of research procedures and their testing within the scope described in the education objectives, recommended experiments and observations of the new science curriculum;
- refer to skills important in science education – related to scientific reasoning, such as planning and implementation of experiments and observations, formulation of conclusions, determination of cause-and-effect relations, distinguishing opinions from facts or supporting one's own position with substantive arguments.

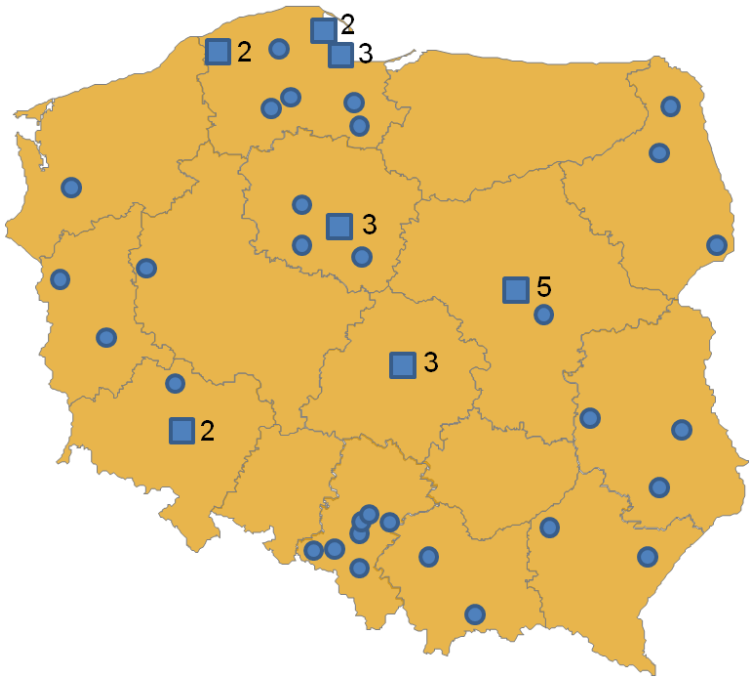
3. Methodology

The study consisted of two stages. In the first stage (provision of data about 348 science education centres), two objectives were met:

- a picture was obtained of non-formal science education in Poland with special attention given to the consistency of activities undertaken by non-formal education centres with the teaching objectives of the new science curriculum (NSC);
- criteria-based selection was made for an in-depth study of this centres in the of the second stage of the study that may potentially contribute to shaping and developing the skills of scientific reasoning.

The second stage consisted in an in-depth analysis of best practices in the area of science education, with special attention given to activities supporting the implementation of the educational objectives of the new science curriculum and addressed to groups of students supervised by teachers.

Map 1. *Location of 50 centres where quality studies were conducted.*
Legend of map: - one centre; - several centres in one location.



The second stage included 50 science centres, which were chosen on the basis of several criteria, for example the preferred methods of work with students and relating their work to the new curriculum. In every centre the following tasks were performed:

- observation of two science activities using activity observation instructions by a trained observer – a teacher familiar with the NSC;
- conducting in-depth interviews with persons responsible for the professional and administrative operations of a centre, according to an interview scenario by an experienced moderator;
- evaluation of classes with respect to their utility in the teaching of science and development of students' interests in the subject – questionnaire study of the teacher/ group supervisor and students/class participants;
- analysis of the didactic materials used by the centre during the observed activities with respect to their relation to the teaching objectives described in the NSC, performed according to an analysis form of didactic materials by a trained observer – a teacher familiar with the NSC;
- analysis of the centre's documents constituting the basis for the conducted activities (programme documents) with respect to their relation to the teaching objectives, described in the science curriculum, performed according to an analysis form of programme documents by a trained observer – a teacher familiar with the NSC.

4. Results

The study offers the basis for formulating a hypothesis that the sector of non-formal education centres in Poland has significant potential and could be an enriching supplement for the formal education sector.

The potential of the non-formal education sector is related to slightly different specifics those the characteristic for the operation of schools. Non-formal education centres rely on the potential of other institutions – including universities and academic centres, State Forest and National Park units or non-governmental organizations. In this way, they acquire access to resources and potential not often encountered in schools. Among the most important are:

- scientific and didactic personnel: employees involved in research activities with the newest knowledge in the area of sciences and access to new publications, and scientific discoveries;
- infrastructure and equipment: access to modern, equipment and infrastructure (e.g. laboratories) and the potential (and justification) invest in such resources;
- scientific aids, museum exhibits;
- natural resources: access to parks, nature reserves, reservoirs, bird habitats, etc.;
- the possibility of conducting gainful activity and investing in the development of their units;
- the possibility of applying methods and activities other than those conducted in school teaching of the sciences, using their own ideas or models from the sources.

The non-formal education centres have various aspirations; however, they have a common purpose of operation: they aim to popularize the sciences or a selected area of science. Among the remaining aspirations, they have specific objectives, often related to the characteristics of the centre or the ideas of its founders and employees:

- to awaken students' interest in science, showing science as useful from the point of view of every-day life;
- to expand and systematize the knowledge of students, breaking down erroneous beliefs about the natural world;
- to show the world of nature as a complex whole, which may be viewed from various perspectives;
- to enable students to independently study and experience nature;
- to bring the local resources of nature, culture and society closer together with the context of science education.

It is worth noting that such aspirations are partially consistent with the general requirements of the new science curriculum – this is a signal that the non-formal education sector and schools can have common objectives.

In relation to the educational system, the centres usually adopt one of two strategies:

- cooperation and support of schools;
- separateness based on the principle of contrast with the school.

These two points of view simultaneously differentiate the approach to the new science curriculum. For the first group, the document is an important point of reference to which the cetres adapt their offer; for the second group of centres, the NSC is only a source of information about the level of knowledge that they can expect from students at a given educational stage and the extent to which their offer exceeds the school programme.
The main purpose of the study was to identify examples of best practices within the scope of science activities implemented by non-formal education centres.
To systematize the analysis four areas were determined, where examples that at least partially complied with the adopted definition were indicated. Areas of analysis included:
1. Administration and financing
2. Organization of the centre's activities
3. Performance of activities
4. Didactic and programme materials.
A detailed description of the study and the best practices can be found in the report of the study [6]. However, it is necessary to emphasise that the adopted categorization is arbitrary – in reality, these areas are inter-connected and pervade each other.

Table 1. *An example of the description of good practices.*

Area in which the centre is an example of best practice	Justification
1. Administration and financing 2. Organization 3. Performance of activities 4. Didactic and programme materials	1: maintenance of statistics of groups visiting the centre; 2: procurement of feedback from group supervisors after each activity; the activities rely on the provisions of the NSC and supplement the school programme; 3: selection of persons conducting the activities solely among experts and astronomy enthusiasts; compliance of observed activities with the NSC teaching objectives and possibility of teaching skills related to scientific reasoning; 4: compliance of didactic materials with general requirements of the NSC for science.

5.Selected conclusions and recommendations

According to the qualitative study, non-formal science education may be described in three words: passion, holism, practice. In order to improve the effectiveness of the cooperation between non-formal science education centres with the formal education system, it may be useful to consider the following activities:

- to take the centres into account in the new science curriculum requirements;
- to create a database – a portal presenting basic information about non-formal education centres with the ability to browse it according to selected criteria – e.g. location, school subjects supported by the activities, scope of curriculum content, skills developed during activities, for example map of Non-Formal Science Educational Centres in Poland, IBE [8]
- to promote, among teachers, the possibility of supplementing the school education programme with the offer of the centres (for example, *within the scope of conducting* experiments as required in the NSC) – to encourage the adoption of a more active stance in using the offer of non-formal education centres.

The combination of formal and non-formal educational activities for young people at the school level may offer a chance for developing integrated regional science education, which is both attractive and effective for learners. The 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 qualifications system in Poland, based on learning outcomes and its tool, the Polish Qualification Framework [7].

References

[1] PISA 2012 Results In Focus, What 15-year old know and what they can do with what they know, OECD, 2012,
[2] Assessing Scientific, Reading and Mathematical Literacy, A Framework for PISA 2006, OECD, 2006,
[3] The Learning Curve, Education and Skills for Life, Report 2014, Pearson, 2014 http://thelearningcurve.pearson.com/index/index-ranking
[4] Laboratory of Thinking – Diagnosis of Science Education in Poland - http://eduentuzjasci.pl/en/en-badania-naukowe/120-english-categories/research/512-laboratory-of-thinking-diagnosis-of-science-education-in-poland.html
[5] Liczą sie nauczyciele. Raport o stanie edukacji 2014, Educational Research Institute, Warsaw, 2014 (only Polish lanquage),
[6] Best Practices in Non-Formal Education, Educational Research Institute, 2013, (http://eduentuzjasci.pl/en/publications/1061-best-practices-in-non-formal-science-education.html
[7] Polish Qualification Framework, http://www.kwalifikacje.edu.pl.en/polish-framework
[8] Brochure Non formal Science Education supports polish schools, http://eduentuzjasci.pl/en/publications/1113-non-formal-science-education-supports-polish-schools.html
[9] Map of Non-formal Science Educational Centres in Poland, https://pep.ibe.edu.pl/mapa/