EDUCATIONAL STRATEGIES APPLIED AT MUSEUMS AND CENTRES OF SCIENCE. POLISH EXPERIENCE IN COMPARISON TO EUROPEAN EXPERIENCE

Strategie edukacyjne stosowane w muzeach i centrach nauki. Doświadczenia polskie na tle doświadczeń europejskich

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Abstract

The article presents a discussion on strategies applied in museum education and interactive didactics that can take place at museums. Arranging some planned and adequate situations that allow museums to combine their own experience with information that is provided and own reflection, can become an efficient cognitive educational tool. At museums, cognitive activities are activated unexpectedly, often with some thoughts arising during a visit. Hence, the Authors believe, that an interactive didactic model should be applied more broadly, with the use of educational strategies intended for museums. The Authors describe their observations collected over many years of visual ethnographic research done at various museums, scientific centres and schools. They presented their research– travel report of collected impressions and experiences in selected museums and science centers in Europe. In this way, the Authors have been able to compare various educational strategies and their efficiency. The results of the research encourage to develop a concept of interactive exhibitions that will be interesting for visitors because of their educational and cultural values.

Keywords: educational strategy, museum of science, scientific centre, interactive didactics.

Streszczenie

Artykuł przedstawia dyskusję na temat strategii stosowanych w edukacji muzealnej i interaktywnej dydaktyce, która zachodzi w muzeach. Zaplanowanie i zaaranżowanie pewnych adekwatnych sytuacji, które pozwalają muzealnikom połączyć własne doświadczenie z dostarczonymi informacjami i własną refleksją, może stać się skutecznym narzędziem edukacji poznawczej. W muzeach działania poznawcze zachodzą nieoczekiwanie, często w ich trakcie pojawiają się pewne przemyślenia. Stąd autorzy uważają, że interaktywny model dydaktyczny powinien być stosowany szerzej, z wykorzystaniem strategii edukacyjnych przeznaczonych dla muzeów. Autorzy opisują swoje obserwacje zebrane podczas wieloletnich wizualnych badań etnograficznych prowadzonych w różnych muzeach, ośrodkach naukowych i szkołach. Zaprezentowali swój raport z podróży badawczej po wybranych muzeach i centrach nauki w Europie, porównując różne strategie edukacyjne i ich skuteczność. Wyniki badań zachęcają do opracowania koncepcji interaktywnych wystaw, które będą interesujące dla zwiedzających ze względu na ich walory edukacyjne i kulturowe.

Słowa kluczowe: strategia edukacyjna, muzeum nauki, centrum naukowe, dydaktyka interaktywna.

Introduction – educational strategies

The aim of the article is to provide a synthetic presentation of observations and reflections collected over many years on learning at museums that specialise in the popularisation of knowledge. This group of museums includes museums of science, but also, in a sense, scientific centres. Including the latter ones into the research is related with extending the narrow definition of a museum restraining it to an institution that keeps, provides conservation and presents its collections of exhibits. An important element of each activity undertaken by a museum is education reflected in a particular strategy pursued by this institution that is in line with its specific character. During their numerous visits to various museums and centres of science, the Authors' attention has been drawn to the approach toward education presented by traditional museums that has turned out to be quite different from the approach presented by scientific centres and museums of science. Different approaches toward the forms of visiting museums and the ways of activating visitors observed at those two types of institutions have been particulary striking. At traditional museums, forms of education usually come down to more or less static exhibitions of collected items. Scientific centres and museums of science adopt a different strategy which is based on constant activation of visitors, who become involved into the processes of exploration, experimentation, or at least, observation of how things work at a particular station (White et al., 2021). This results from different assumptions adopted by the discussed institutions. Having defined their mission and strategies, museums that popularise science apply more advanced didactic forms where providing knowledge is not a sufficient method, even if it activates visitors in a certain sense. A significant differentiating didactic element is the arrangement of a situation which provides conditions for cognitive experience that comes as a sum of research activities, combination of personal knowledge and infor-

mation acquired at a particular station of an exhibition and also visitors' own reflections. To make such an experience happen, a well-thought message form is required. In this article it is referred to as an educational strategy. The characteristic features of such a strategy are discussed below.

In the theory of education, the problem of educational strategies is set in the field of teaching methods. Considering this particular area, pedagogues point out an aspect that belongs to the notion of a strategy, which is – first of all – related to the methodological context. The notion of an educational strategy, however, comprises more issues than just methods and models of education. Pedagogues often define a strategy "as a combination of various activities that are aimed at providing support to individual learning" (Gołębniak, 2003, p. 172).

In reference to museums and centres of science, the context pertaining to educational strategies that are applied there should be significantly expanded. The field of museum didactics should include issues such as: interactive learning, experimentation, museum exploration, methods based on activities in accordance with instructions, or independent discovering without instructions. The Authors believe, that all the above-mentioned elements provide a semantic area for the notion of an educational strategy applied at museums.

Defined in such a way, the field of research can find its substantiation in a broader formulation of aims for museum operation. The International Council of Museums (ICOM) defines such aims as collecting, maintaining and exhibiting collected items to the public, but also as providing an interactive formula for presenting them and restoring their original technical operational efficiency in order to popularise them. Considering this definition, museum employees are generally unanimous, despite some increasing complications (Pedersen-Guzman, 2020).

The main aim of the conducted research was to follow and describe the strategies and methods which, organizers of interactive exhibitions use to present phenomena important for understanding the laws of nature, issues of technology and other spheres of human activity that make up material civilization. The researcher's intention was to identify the essence of the educational activities carried out in science centers and museums, and to establish their significance for changing traditional strategies of knowledge transmission.

During their visits and observations at museum, the Authors focused their attention on the question about the essence of educational strategies applied there, along with the forms of exhibiting collected items and methods of using them at properly arranged educational stations.

1. The aims and the scope of the research

<u>Phase one:</u> the research on education at museums of science and scientific centres was implemented in two phases. The first phase included the following European centres and museums: Museo Nazionale della Scienza edella Tecnologia "Leonardo Da Vinci" – The National Museum of Science and Technology Leonardo Da Vinci in Milan, Museo Tridentino Di Scienze Naturali –The Science Museum in Trento, La Villette – The City of Science and Industry in Paris, Science Museum in London, Deutsches Museum – German Museum in Munich,The Spectrum Science Centre in Berlin, Experimentarium in Peenemünde.

This phase was implemented between 2008–2016, and as a result was a publication of a book (Karwasz & Kruk, 2012). At that time, the aim of the research was to define the essence and specificity of educational strategies applied at museums of science, scientific centres, and also at museums with interactive exhibitions. During that phase of the research the following questions had to be answered: (1)what were educational aims and strategies implemented by the organisers of interactive exhibitions at the museums?; (2)did the concepts of exhibitions, the layout of stations and the arrangement of exhibits correspond to the structure and to the particular divisions of scientific disciplines?; (3)could the model based on a collection be observed at interactive exhibitions, or was it replaced by other forms of presentation?; (4)what kind of cognitive activities dominated at the visited museums? Was that experimentation and systematic exploration, or were there any other forms of activities, such as learning by the trial-and-error method, the lack of any cognitive-oriented activities or randomness?; (5)what features of educational strategies that had been observed fostered visitors' in-depth activities?; (6)which elements of the interactive methods can be used in planning didactic paths (also in the conditions of institutional education)?; (7) what trends prevail in museum education today? Which of them are developing in Poland; what are the favorable conditions for the development of this field in our country? Which of the European experiences are worth using in this regard?

After the one phase, we wanted to make a broader analysis in other museums and compare different educational strategies, which are carried out during exhibitions. We have chosen science centers and museums in major Polish cities with an established museum tradition. We wanted to present the variety of strategies and methods of presenting the posts and facilities. These indications determined the selection of five museums in phase two.

<u>Phase two:</u> since the beginning of 2017, until the present moment, all the abovementioned issues pertaining to learning at museums of science and scientific centres have been continued and analysed in Poland. At this phase, the research is running based on partner discussions with some newly established national scientific centres, organisers of seasonal interactive exhibitions and representatives of the following scientific

centres: Experimentarium in Szczecin; The Museum Of Urban Engineering in Kraków; Hevelianum in Gdańsk; Experimentarium in Gdynia, Copernicus Science Centre in Warsaw.

The main aim of that phase has been to elaborate on the results obtained during the first phase, with the focus on the following areas: the mission and tasks of museums and centres of science; the layout of stations and their compliance with scientific disciplines they represent; the arrangement of exhibitions; the role of instructions and forms of work performed by instructors; cooperation with local communities and schools.

The authors were provided with additional methodological support while gaining experience during the laboratory of early education that they ran with the use of the principles of interactive didactics (Kruk, 2010).

That was an interesting research experience which involved application of various didactic means in education of the youngest children. While collecting their research materials based on their own observations, and observations provided by other teachers, the authors were able to confront and develop conclusions on educational strategies taking place at museums of science and scientific centres and also to compare them to traditional education centres, such as nurseries and schools. Combining those areas allowed the authors to enhance and to complete information that was acquired. It also helped to explain educational strategies observed at museums and centres of science.

2. Visual ethnography as a method applied in the research on educational strategies at museums

Visual ethnography was the main research strategy used to collect materials. Photography has been used in ethnography for many years to supplement research materials collected with the use of other various tools. Among other researchers, between 1915 and 1918, B. Malinowski applied photography in his field research. In 1942 also G. Bateson and M. Mead documented Balinese culture with their photographs (Pink, 2013). The project developed by S. Worth and J. Adair, *Through Navajo Eyes* of the 1960s, was pioneer work as far as the use of photography in social research was concerned (Banks, 2001). Anthropologists, such as J. Ruby (2000), M. Banks (2001), A. Grimshaw (2001), F. El Guindi (2004), S. Pink, L. Kürti, A. I. Afonso (2004), D. Mac Dougall (2005), and S. Pink (2006) contributed to the development of visual ethnography. Sociologists, including M. Emmison and P. Smith (2000), C. Knowles and P. Sweetman (2004), and Ch. Pole (2004) tried to create intellectual atmosphere fostering the development of visual methods in social research. The scientific studies of the above-mentioned authors have implemented visual ethnography into academic practice and revealed new opportunities in reaching the surveyed (Pink, 2013).

It would be advisable to consider what makes images so exceptional in the research process and helps to understand the reality that is observed. First of all, pictures have been omnipresent in the society. Starting from drawings, sketches and ending with contemporary photographs or films, pictures describe and – what is more – display the society. Therefore, it is worth resorting to them whenever the reality is to be described. "Additionally, the analysis and inclusion of pictures into the process of creating and collecting data may offer a possibility of obtaining a kind of knowledge about the society that cannot be obtained with the use of any other tools" (Banks, 2009, pp. 23–24). These are the arguments that have already encouraged numerous scholars to use visualisation in their research, including the Authors of the article. The interdisciplinary character of visual ethnography is often discussed. It is applied in numerous research disciplines and practice that expand theoretical visions of the world. At the same time, it is explained through various scientific disciplines that provide analysis of pictures (photographs or drawings), audio-visual media (videos), mobile technologies and digital media (Pink et al., 2004; Pink, 2013).

According to the considerations presented by S. Pink (2013), visual ethnography refers to reflective ethnography that is focused on subjectivity, creativity and self-awareness. Using pictures and modern visual technologies, this method may be helpful to acquire knowledge about culture that has been analysed by scientists.

> Visual ethnography is understood as a field of practice. Those research studies are dynamic, reflective and give possibilities to researchers with visual, digital methods and media to seek, create and share new ways of acquiring and developing knowledge that is related to specific research questions and agendas. (p. 39)

> Visual elements of the world are inseparable from other elements of sensory experience and they can be experienced in relation to the ways of knowing that acknowledge this interrelatedness of the senses. (p. 42)

M. Banks (2001) divides visual research methods into three broad activities:

− making visual representations – studying the society by producing images;

− examining pre-existing visual representations – studying images for information about the society;

− collaborating with social actors in the production of visual representations.

At present, these three ways of documenting the reality can be enhanced by the following strategies, namely: creating (or co-creating with participants) visual interventions, using the visual as a mode of 'cultural brokerage' between different groups, or as contestation and applying methods of visual dissemination as a mode of public scholarship. (Pink 2013, pp. 59–60).

Visual methods should be used where appropriate, providing that appropriateness will not always be obvious in advance (Morphy & Banks, 1997, p. 14). Sometimes,

it may be discovered by accident and retrospectively defined as visual methods. Ethnographers might repeat such activities (sometimes in collaboration with informants), thus developing and refining the method throughout the research. The ethnographer needs to consider both local photographic conventions and the personal meanings, and both economic and exchange values that photographs might have in any given research context (Pink, 2013).

It is a good practice to ask permission to photograph in any public context or event, as well as to seek the consent of the individuals photographed. In some situations an official permission is required. A permission to photograph and video during public events may be granted in a variety of ways (Pink, 2013).

Ethical conditions are highly significant, however, they depend on the way in which photographs or films are going to be taken or made and then used. During the research process, S. Pink (2013) describes the following strategies:

1. Getting started: taking the first picture: Taking the first photograph during the implementation of a research project depends on the type of the research. Sometimes it is possible to initiate the research and sometimes it is better to refrain and to hand the camera over to the participants of the research project.

2. Taking photographs (in) the environment – from the survey to the tour: The research carried out with the use of photographs may visualize the environment that is observed. Photographs enhance the research materials and, at the same time, they provide in-depth ways to delve into the analysed spaces, to know and to preserve them.

3. Participatory and collaborative photography: Photographs may be taken by a photographers themselves, with a single informant or a group, within a community. When photographs are taken by more than one photographer, the intentions of the photographer-ethnographer and the intentions of the participants must be reconciled. Sometimes negotiations are needed.

4. Returning the gaze: ethnographer as photographee: The research scientist can be also a person who is filmed, photographed and recorded in the research project. In this way, the research scientist becomes a part of the research project and constructs the reality that they want to describe with other participants.

5. Viewing ethnographers' photographs: interviewing with images: Sometimes a photograph may become an interesting start or an inspiration for a talk. It can help to open the topic, to recall various important things, or even to realize a reality that can be significant to the research.

6. Viewing other people's photographic collections – interviewing with images: Similarly, a photograph from a private collection of a participant of the project can enhance an interview with this person as it helps to understand some aspects of the analysed world.

7. Participant-produced images: When one wishes not only to hear about the analysed space, but also to see it from the perspective of the participant of the research project,

it is possible to hand the camera over to the participant's hands. This is quite a different strategy of visual ethnography that opens the research scientist to other images than those they would create and that would be significant to them.

While starting their research on education at museums of science and scientific centres, the Authors decided to apply the method of scientific research described in item 2 above. As stated, the research scientist documents the reality they observe through photographs. Photographs become valuable scientific materials which can supplement the observations. Furthermore, a thorough analysis of photographs can be helpful in explaining numerous educational processes that take place in the space that has been examined.

During their research, the Authors collected the required data through the targeted observation and collection of photographs with interviews conducted with the organisers of interactive exhibitions and also the analysis of the documents that included educational programmes formulated in the analysed institutions. During Authors' stay in the institutions, they also have left written interview questionnaires for visitors. In the course of conducting observations with photo recording at the selected institutions, they also collected as much information as possible using analysis of the museum' websites and during interviews with staff according to the adopted thematic threads: main objectives of the exhibition; scope of cooperation with schools; publishing activities; specifics of the visiting process (number of visitors, whether tours or individual visitors prevail); thematic issues pursued at the exhibitions; the number of exhibits and how they are made; the role of instructors and other employees of the institution; the way in which participants use the instructions; questions most frequently asked by visitors.

During the second phase of the research, the photographic record of the museum space and exhibitions was run. Interviews with museum employees (such as exhibition curators and employees responsible for exhibition arrangement) and visitors (there were the separate sets of interview guidelines for employees and for visitors). Coding and interpreting the results of the research was based on the recorded materials, including the photograph collections (Hammersley& Atkinson, 2000). So far, during both phases of the project, there have been over 800 photographs taken at all the institutions. The photographs have been selected and the number of the exposures that represent features specific for the particular exhibitions has been established. Eventually, there have been over 120 photographs described and interpreted.

During the second phase, the observation was oriented by the features distinguished during the first phase of the research studies on educational strategies.

1. <u>Strategies based on realistic presentation</u>: with simultaneous limitation to the context of the exhibition; originating from the tradition of museums of science and technology and referring to the collective concept of knowledge.

2. <u>Strategies based on simulation</u>: they are based on the principle of maximal and perfect digitalization of the message that is composed of exhibits and well-developed arrangement of the exhibition. Such strategies are used by traditional museums and by some scientific centres in their interactive offers.

3. <u>Reconstruction strategies</u>: they involve virtual techniques and realistic exhibitions; they are aimed at encouraging visitors to develop independent reflections on the experience and to gain some distance to the exhibition. Such strategies allow visitors to reconstruct the problem by assigning it with the meaning and setting it in the context or by solving the problem, for example, a structural problem.

4. <u>Ludic strategies</u>: their main objective is to simplify the message, to intensify the stimuli, and to attract a high number of visitors at the cost of resignation from passing some in-depth knowledge. Hence, the *ludic* term is applied to emphasize the aspect mainly related to unrestrained fun where methodological correctness is not stressed.

3. Educational strategies applied at museums of science and scientific centres –an overview of the first phase of the research project

Based on the analysis of the visual data and information obtained from interviews and documents in the first phase of the research, it is possible to state that in practical operation of museums and centres of science two opposite types of exhibition can be usually observed. They are characterised with the following features:

− *traditional exhibitions* – according to the structure of the discipline in question (it particularly refers to geology, zoology or physics, for example), they present achievements in the particular fields of knowledge;

− *interactive exhibitions* – they include not only natural sciences but also knowledge referring to the fields of social sciences and humanities; they are based on activities performed by visitors.

Photo 1.
A traditional exhibition (the Museum of Science in Milan, Section on the History of Aviation)

Photo 2.
An interactive exhibition (Experimentarium at the Physics Faculty at the University of Szczecin)

Further oriented observation and in-depth analysis and interpretation of the visual materials allowed the Authors to distinguish specific elements that *indicate* the use of the following strategies at the analysed institutions:

1. At all the analysed institution realistic strategy was observed. This type of strategy is characterised by emphasis put on a concise message, without any context. The concept of exhibitions displayed with the use of realistic strategy clearly refers to the domains of the particular disciplines; the stations and arrangement of exhibits reflect their structure and the message is expected to create a logical scheme for visitors. This type of strategy seems to be a basic method applied by the museums to convey their message.

Photo 3.
Realistic strategy (Deutsches Museum in Munich, Section of Measuring Instruments)

2. Simulation strategy that refers to the virtualized message and is usually combined with other strategies, such as realistic strategy; this form is used for constructing a reinforced, iconic and symbolic message to convey knowledge.

Photo 4.
Simulation strategy (Science Museum in London; Flight to the Moon)

3. Reconstruction strategy can be observed in all the visited institutions. The organisers apply numerous means to facilitate independent exploration activities for visitors. The cognitive value of this type of strategy is very high, considering the full use of the didactic potential included and available at the particular stations, experiments and experience referring to visitors' invention and not restraining them to the instructions that are provided; visitors are given an opportunity to individually verify a higher number of hypotheses by themselves.

Photo 5.
Reconstruction strategy (Museum of Science in Milan; a fragment of Magellan's vessel – reconstruction)

4. Ludic strategies can be observed less often, to a minor extent – it is rather possible to discuss mixed strategies: ludic and simulation, and ludic and reconstruction. This type of strategy is characterised by the intensification of stimuli, a simple message, various techniques that are applied to make visits at the museum more attractive and to attract the highest numbers of visitors.

The assumption referring to the application of eclectic, combined strategies pertaining to various conventions was also confirmed. A specific feature of the research processes, that were initiated by the particular strategies, referred to the following elements:

− elements and/or schemes of direct cognition (preliminary recognition, verification, supplementary experience);

− cognitive motivation (accidental observation, suprising results, emotional elements);

− logical operations on the results obtained during the experiments (deduction, reduction to absurdity, working hypothesis).

While comparing the material collected during the observation, it was possible to notice a significant similarity between the activities undertaken by visitors at the analysed centres of science to activities performed by children who are taught in accordance with the Montessori method (Miksza, 2014). The similarity was observed,

first of all, in independent exploration combined with long-time analysis of the possibilities provided at a particular experimentation station at the museum or of assistance. During the observation, it was possible to notice that visitors were highly involved in activities and were strongly motivated to overcome difficulties that occurred during various stages of the experiments. At the same time, it was also possible to observe a characteristic feature of learning at museums and centres of science that could be observed during lessons conducted according to the Montessori method: it particularly referred to unconstrained activities, controlled by internal motivation – in a way that was different from what would be usually observed in the traditional methods applied at school to teaching. Montessori (1913, p. 40) defined this trait as polarization of attention.

The research and queries carried out at the analysed institutions allowed the Authors to realize that the initial assumptions separating the discussed strategies (namely: realistic, simulatory, reconstructive and ludic) were not fully accurate. It turned out that combined strategies could be observed most often: a combination of realistic, reconstructive strategies along with elements of simulation and, to a small extent, with ludic elements. The element observed most frequently in various activities undertaken by visitors at the analysed centres of science was characterised by engagement and willingness to understand the essence of analysed phenomena. During their visits, visitors usually asked questions to the staff when they were not able to perform particular experiments themselves. If possible, the entire sequence of activities was performed independently or with the assistance of other participants – children were assisted by their adult companions.

The Authors believe that the material collected during that phase of the research project can be useful to develop a concept of interactive exhibitions. Considering interactive exhibitions that have been developing more and more intensively in Europe and in Poland, the Authors also believe that there is a need for developing didactic and methodological reflection on their forms and improvement possibilities.

4. Polish museums and centres of science – new research questions in the second phase of the project

Coming as an elaboration on the Authors' European observations, the second phase of the research was aimed at the in-depth analysis of the answers obtained to the research questions posed during the first phase. Apart from the identification and description of four educational strategies, the second phase of the research brought some new observations. A question referring to behaviour of people visiting the analysed exhibitions and appearing in all the described strategies seems to be particularly in-

teresting. The Authors believe, that the discussed behaviour is related to both the arrangement of the exhibitions and experimentation stations and also to the way visitors experience them. During the exhibitions organised at 'Eureka' in Szczecin, 'Hevelianum' in Gdańsk, 'Copernicus Science Centre' in Warsaw and 'Experyment' Science Centre in Gdynia, apart from usual interest and some more advanced attempts made at solving problems, it was possible to observe other interesting types of behaviour. They were expressed by visitors' relaxation, lack of overreaction and a slower pace of undertaken activities. Undoubtedly, such behaviour could be observed at European museums, however, the intimate atmosphere of Polish institutions allowed the Authors to observe it in more detail. It was possible to observe a considerable similarity to "the Montessorian polarisation of attention or to a psychological definition of deep focus" (Kabat-Zinn, 2016, p.9; Montessori, 1913, p. 40).

Photo 6.
Engagement, focus and cooperation (the Museum of Urban Engineering, Kraków)

The Authors believe that there is a lot of developmental potential for education at museums that is related to the particular type of learning. It involves analysis of particular phenomena owing to concentration, or even contemplation of the objects of interest. However, favourable conditions for that are not always possible to be achieved, especially it is hard to observe them at large centres of science that are visited by many people. Niche centres can provide better conditions because the number of visitors who are present there at the same time is much lower. The situation became more difficult when the Covid-19 pandemic broke out in 2019. At first, museums were closed in numerous countries and then numbers of visitors were gradually limited when these institutions became slowly opened again. Thus, while in centres of science the contemplation of objects of interests can be still difficult, despite the minimal number of visitors defined by sanitary restrictions, the process has been facilitated at small centres. Furthermore, a research report (Benoit-Bryan et al., 2020, p.12.) published in December 2020, indicates that "most Americans believe arts and culture organizations can help their communities during crises like the coronavirus by helping people laugh, relax, and stay connected*"*. Hence, visiting museums has become not only an educational experience but also a therapeutic one. Surely, concentration and contemplation occur much more often at traditional museums that are oriented towards the reception of exhibits by visitors, without any necessity to undertake activities described in the instructions. It seems that there is a number of opportunities to optimize experience at centres and museums of science, where the emphasis on quick action, with the use of, for example, the trial-and-error method, or with the use of instructions, can eliminate advantages resulting from reflection. Thinking about problems that pose cognitive challenges to visitors at a particular moment can be quickly blocked and replaced by sometimes thoughtless activities, not supported by any prior assumptions and hypotheses formulated by the participants involved in experimentation.

At this point, it would be advisable to discuss some examples of behaviour observed in visitors of The Experyment Science Centre in Gdynia. At a station dedicated to properties of liquids all the visitors' fascination with the experiments could be clearly observed. It was also possible to notice the participants' cooperation and mutual explanations given in relation to particular activities, which harmonised with the constructivist nature of that station. After a while the small group of dam constructors was replaced by some new participants who initially continued the previous constructors' work and then moved to their own solutions. When the continuity and logic of the particular stages was maintained, it was possible to observe progress in the construction of the dam. However, after some time the situation changed as new participants joined in. The leader of the group was no longer there, all the participants acted impulsively and results were far from promising. Occasionally, the participants referred to the instructions, but it required some patience – first, the instructions had to be read, explained and then the obtained information had to be applied. It seemed that

starting some more coordinated actions would have been possible, if the participants had had more free space for their initiatives and they had not been subject to the imperatives of action. Excessive activities without any prior planning were cognitively inefficient, although ludic elements observed during the activities could be clearly beneficial too.

5. Possibilities of applying the principles of interactive didactics in relations to school and museum education

Interactive didactics stems from the active school theory, which was initiated by the New Upbringing (progressive education) movement in Europe and the intuitions formulated in relation to the active role of learners in the process of knowledge construction. One of the significant achievements of that time was drawing attention to the principle of visualisation in the relations of learners and their material surroundings, things and their cognitive role in knowledge construction. Pedagogues of the New Upbringing rejected the assumption referring to the reflecting function of the principle of visualisation, according to which learners – in a way – reflect things they experience in their environment in their minds. It has been noted that knowledge developed in relation to the environment is constructed with the use of numerous mental operations which come as tools of thinking processes (Piaget,1966, 1993; Wygotski, 1971, 1978, 1989). Active didactics treats learning as a process in which learners construct knowledge with the use of mental operations during independent research activities.

The achievements of the New Upbringing have underlain the modern paradigm of interactive didactics in which the current assumptions on the nature of learning and efficiency of the visualisation principle have been verified. At present, it is assumed that this principle requires more specification in terms of the psychological context in which the discussed process can be observed. Considering a constructivist approach, learning environment is significant along with interactions that take place among participants. During the activity, objects are assigned with meanings (symbolic interactionism). Conditions provided at museums come as the ideal environment for various interactions observed on 'the stage of common attention', where the relations between humans and exhibits are enhanced with interaction and they create new meanings and ways in which the analysed objects work (Tomasello, 1999). Experiments at centres of science are of usually simplified nature or they have the character of a targeted measurement of particular objects. According to a statement formulated by Ian Hacking, "an intervention in the analysed object is a formula for contemporary scientific experiments" (Hacking, 1985, p.135).

Photo 7.
Don't look at it-just do it! (Phänomenta Experimentarium)

Interactive didactics is naturally interwoven in visiting museums. Things are different in school education, where strict rules are applied to control the process. The research shows that history museums are the most trusted sources of history, more than even history professors, teachers or books (Rosenzweig & Thelen, 1998). Considering how an interactive model can function in institutional didactics, it is advisable to pay attention to several problems. This form is impossible to be applied in mass education that is strongly related to economic conditions, where the priority is efficient transmission of knowledge, often at the cost of learners' opportunities for independent discovering. Rejecting unification that is very common in mass education, saving on teaching resources and research equipment must result in rejecting the reacting strategy that is based on simple transmission of knowledge. The interactive model states different requirements for organisers of education processes. It would be also necessary to eliminate both administrative and mental barriers. Schools need a wide and easy access to educational software for conducting experiments. It would be also recommendable to implement more exemplary interactive classes to the methodology of school courses. Closer cooperation between schools and museums in the forms of various exhibitions, festivals of science or engagement of volunteers could become a real chance to enhance the offers provided by both types of institutions.

Considering general recommendations that could be useful in education at school and outside school, it should be noted, that despite the differences between schools and museums, there are also common elements as well. After having observed research activities carried out by the participants, the Authors believe that the following observations made at the museums and centres of science are beneficial for the school didactic process:

– learning is an active process in which new information is related to the previous knowledge. Previous knowledge affects the quality and the course of cognitive processes;

– learning processes do not always follow any planned and orderly sequences. Problems that must be faced by the participants come as opportunities to follow various research paths, where the systematic testing of hypotheses does not always dominate; blindfold tests without any well-thought strategy occur equally often. Every independent trial, however has its cognitive value, regardless of the final result;

– different people learn in different ways. The learning process depends each time on what form of perception, what social interaction is preferred; age and many other factors play a significant role, influencing the individual learning style;

When organizing an exhibition, it is worth designing the stands in such a way that the information is communicated gradually, in the form of layers of increasing complexity. This way, visitors visiting them for the first time will not feel discouraged and overloaded with information. On their next visit, as their knowledge grows, they can participate in acquiring knowledge at a deeper level of sophistication.

Conclusions

A practical dimension of the research project on education at museums and centres of science was an attempt at the systematisation of the current knowledge on learning at the analysed institutions. At the same time an assumption was made that educational values implemented there could become factors of a change to educational strategies pursued by schools. Therefore, the observations made at Polish museums allowed the Authors to orientate the way in which both phases of the research project became combined into a set of common thematic problems, where the crucial question was about a possibility of saturating the theory of learning with interactive solutions (Kruk, 2010).

Learning at museums and centres of science is a diversified process that very often refers to its participants' imagination and resourcefulness. In order to enhance cognitive results that have been obtained, the educational strategies distinguished during the research project should be applied. Under those strategies, the organisers

working at the analysed institutions developed conditions for displaying the exhibitions. The main aim of the discussed strategies – whether it was reconstruction, simulation, or game – was to achieve the maximal advantage from the adequately developed transmission of knowledge. It should be also noted that there are often situations where the research process is not activated and the participants' activity is very low. This is inscribed into the nature of museum education where – as opposed to school didactics – lessons are not organised in accordance with a planned and systematic schedule and there are no teachers to provide constant supervision.[1]

Based on the materials obtained during the research, namely: photos, recorded observation and interviews with the organisers, the Authors state that the interactive model could become a practical example for education at museum institutions, considering wide possibilities of organising active research participation for visitors. Developed on the basis of an object/device/exhibit and an adequate context that triggers research activities, the material and psychological conditions for learning form common environment at museums and centres of science. Such environment is not always available at schools where teachers do not have proper conditions to organise a full sequence of exploration activities for their pupils. In the interactive didactic model applied at museums, the only predictable elements are conditions developed by the organisers of a particular exhibition, whereas the course of the cognitive process is not controlled, assessed and directed as it is at schools. Similarly to numerous everyday situations, cognitive activities at museums are activated somehow incidentally, regardless of visitors' age, previous knowledge and level of preparation. The school and museum schemes of learning differ despite their similar didactic aim, that is namely: enhancement and improvement of knowledge in the participants of the process.

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[1] The Authors refer to a typical visit to a museum that – as opposed to museum lessons – is characterised by activities freely undertaken by visitors.

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