CONDUCTING EXPERIMENTS IN GEOGRAPHY TRAINING

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Abstract. It is beyond dispute that conducting experiments in geography training provides many opportunities. As such we could point out the possibilities: to visualize certain topics and improve practical experience in training; to cultivate children's experimental abilities, and afterwards – develop experimental literacy via mastering methods and mechanisms of the experimental algorithm; to build up correct notions in children's minds; to acquire critical attitude towards scientific knowledge of Nature; to stimulate the motivation and pupils' interest for studying; to encourage the pupils' independence and get them accustomed to a problem-centered approach in geography training; to improve pupils' social and communication skills (working together in small groups) and even develop children's personalities.

Although all these positive scenarios have been proven in geography training practice (especially in countries with well-developed educational system), experimenting has not yet been acknowledged neither in the theory of geography didactics in Bulgaria, nor in real educational environment in Bulgarian schools. This might be a consequence of the fact that geography didactics in Bulgaria has not facilitated the teachers with clear enough methods for experimenting in the training process or of the fact that the training experiment requires serious preparation (in theoretical and applied aspect). Probably it is also due to the fact that conducting experiments in geography training is time consuming and, on the other hand, there is a shortage of working materials (often they are even missing). Whatever reasons we might identify, there are not enough arguments to continue ignoring the whole above-mentioned potential of experimenting. That is why in this paper it is proposed to move further and make one more common didactic-methodical characteristic of experimenting that matches the goals of geography training. To describe the experiment, we have to analyze it in several steps: nature and significance; classification and types; and implementation in the training process.

In the paper we refer to the experience in countries with well-developed educational systems, and present an algorithm for conducting experiments in geography training. Furthermore, we elaborate future possibilities for planning and its implementation in scenario planning of a geography lesson. We also investigate the position of experiment in the training process, i.e. its position in a particular topic or geography lesson. It is done in accordance with the goals which we pursue and also in line with the functions which experimenting in geography training fulfills.

The current paper is only a small and initial part of a far bigger research concerning the problems of carrying out experiments in geography training, which is subject of a future publication.

Keywords: geography training, experimenting, training methodic.

Experiment and experimenting are not defined unambiguously in didactics. According to some authors the experiment is a part of technical media representing visualization, working and learning tool (Salzmann, W., 1986, p. 4) but for others – a part of action forms in training and is specific activity in the training process (Haubrich, H., 1997, p. 204-207). The experiment is defined also as a social form in lesson/training alongside with projects, games, co-work and team work (Theissen, U., 1986, p. 241-247). In our considerations we are adhere more closely to the notion of Rinschede (2007, p. 291) according to whom the experiments should not be considered as media but as a methodical approach in training and methodic form of training organization. Our opinion is based upon the fact that an experiment tackles not only the social or action form of training but it determines the whole process of training as well.

Experimenting in geography training is an approach used to examine, verify and define the notions of important geographic processes and most often for natural phenomena. These processes or phenomena are isolated initially in artificial models or appropriate objects; they are observed and afterwards explained. The experiments themselves have some specific features: they are carried out in an artificial environment, they could be repeated when appropriate, and the regularities that appeared can be controlled in experimental environment (Meyer, H., 1994, p. 313). Experimenting in geography training is restricted primarily to the thematic area of natural geography and

ecology. The training experiment quite naturally occupies intermediate position between scientific and everyday life experience.

The main didactical value of experimenting is due to the fact that it incorporates ways of working with different complexity (observation, description, analysis, comparison, assessment and also protocol) with different aspects of learning (cognitive, instrumental, affective and social), (Otto, K.-H., 2015, p.144). The experiments pique children's curiosity and develop their skills for observation, and they are one of the pupils' favorite training methods.

Carrying out experiments in geography training might pursue and accomplish different goals (cognitive, instrumental, affective and social) which are proved in numerous studies (Arning, H. & Lethmate, J., 2003, p.35-39; Hemmer, M., 2001, p. 86-87; Otto, K.-H., 2003, p. 6-7; Salzmann, W., 1981).

As cognitive goals we can identify, e.g. acquired particular and reliable knowledge and clear notions about on-going geographic processes; simulation of natural processes on a smaller scale and in restricted time; clear problem representation which enforces pupils' casual, functional and abstract thinking; creative thinking; and empirical proof. The instrumental goals which we can achieve are: to cultivate pupils' practical skills; to overcome their language deficit via verbal expression during the experimental planning and assessment; to view the methods of scientific knowledge and identify general patterns (induction); to enhance discovery, research and a systematic way of thinking; to study the scientific propaedeutic methodology (in discovery projects); to derive and test the hypothesis (Arning, H. & Lethmate, J., 2003, p. 35-39; Otto, K.-H., 2003, p.5). As affective goals we could list: high motivation and interest in geography topics; heighten the perceived notions as correct ones; and also – change in attitude/behavior (e.g. ecological experiments). The social goals which we achieve conducting the experiment in geography training are related to team and co-working by which are acquired and practiced joint planning and activity.

The experiments in geography training are classified according to different criteria: type of experimental organization (experimenting using models; experimenting using real objects); type of methodical organization (demonstrated by teacher; demonstrated by pupils); time period pace for conducting the experiment (short-term, long-term); type of themes of experimental work (geological and geomorphologic, climatic, ecological); type of didactical function which they accomplish (to introduce/to be problem-centered, to discover/research, to control or to exercise); type of result assessment (qualitative and quantitative experiments).

Using models in experimental work means that geographic processes can be presented as naturally and accurately as possible. The glacial process for example can be represented with the help of an ice block, rubble, small stones and sand; using a projector we can show the duration of the day and night, of polar day and night etc. According to the model used in experiments we can distinguish: imitating/artificially created models (globe or plastic models); models constructed from natural geographic elements (e.g. limestone, sand, soil); models with chemical components and models used in physics training (e.g. visualization of air flow). The model-experiments require an analogy with reality in the final stage, i.e. the feedback with natural object so the pupils could make comparisons. The real object is always simplified and is represented very often as an ideal image. And that poses the danger of reality distortion and problems with misunderstanding. On the other hand, this is an opportunity to master the knowledge transfer in the training process (Wilhelmi, V., 2000, p.5).

Experimenting with real objects might be done outside the school as well as using smaller natural objects in the classroom, e.g. evaluation of erosion processes in wine region, measurement of sand pile (dune) even in the school yard. We can extend the classification when conducting this type of experiment: experimenting with real macro-scale objects (artificial influence on already on-going natural process outside/in natural environment, e.g. size and direction of river flow); experimenting with micro-scale objects (e.g. experimental observation, measurement and analysis of physical structure and chemical content of soil sample, analyzing the limestone content in hydrochloric acid solution). "Natural" experiments often require more serious organization but they offer to pupils a direct view of reality. That is why these experiments are more useful for younger pupils, substantially simplifying the reflection of real processes (Wilhelmi, V., 2000, p. 5).

The demonstration experiments are presented by the teacher predominantly but there are possibilities for them to be presented by pupils. They display a particular process in front of the class (frontal instruction). The pupils observe and describe. This type of experiment is appropriate for demonstration of especially complex processes, and in cases when the pupils could be put in danger if the experiment went wrong, e.g. the impact of hydrochloric acids. The experiment organization is often done on the previous day. The pupils could take part in it, e.g. by providing materials (clay, sand etc.)

The pupils' experiments are often organized in groups so children can actively participate in the training process. These experiments allow not only visualization of complex interrelations and processes but also cultivate pupils' independence and eagerness to act on their own via build up and development of particular skills and abilities. All groups of pupils can work together on the same topic or on subtopics of a common complex one. The teacher helps with preliminary preparation, facilitates the presentation and seeks to bind it with theoretical content.(Wilhelmi, V., 2000, p. 7).

The short-term experiments can be carried out in a short time (from 10-20 minutes to 2 training hours). They are prepared and thought by teacher as demonstration experiments for introducing terms which then will be learnt in lesson, for improvement of real pace of on-going events and processes and to prove them. At the same time long-term experiments last several days (even weeks). Many bio-geographical and ecological processes run very slow and therefore there's more needed time for observation (e.g. experiments on topics like "Impact of acid rains on plants and quality of drinking water" or "Impact of the extent of contamination of water on the plant growth".

In long-term experiments the pupils are required to be more independent about methods, gathering and processing the information. The researched problem is presented by the teacher and via experiment pupils find out interrelations and hypothesis which then are discussed but are not checked immediately. Because long-term experiments are time consuming, it is better not be conducted very often otherwise the pupils will lost their interest (Berck, K.-H., 1999, p.121).

The experiments concern different topics from natural geography including ecological themes. As example we can point out geological and geomorphologic topics (origin of Balkan mountain, glacial processes); soil (to research soil features); climatic (evaporation, atmospheric circulation); hydro-geographic (water salinity; water flow); bio-geographical (climate impact on plants and animals); ecological (filtrating effect of plants, combination of different means for purification of natural environment).

According to result assessment experiments can be divided in quantitative and qualitative. As a rule, in geography training dominates the qualitative ones due to their easier implementation and delineation in the frames of certain process or event. The goal of such experiments is demonstration and proof of a particular effect, e.g. showing the influence of warming (rise of temperature) on air pressure by using a plastic bottle.

Qualitative experiments aim at numerical and measurable data and results, e.g. to indentify the nitrate content in water. Such experiments suppose the usage of measuring instruments or tools so they are restricted to upper school classes (Killermann, W., 1995, p. 210). At the same time, their application in geography training is rare because they demand more amount of work and experimental result (effect) is already known.

We should also answer the question where is the didactic position of experiment in geography training? There is no common position for correct and effective experiment introduction and implementation in geography lesson. Its position is defined according to the training goals, respectively the goals of particular lesson. Experiment is planned concerning the function which it will accomplish in certain lesson or thematic section. All forms of experiment allow their easily usage in geography training. In general, there are four possibilities for implementing the geographical experiment in geography training - in introduction stage, in stage for presenting new knowledge, stage of strengthening and as homework.

For lesson beginning stage are appropriated introduction or problem-centered experiments which should fulfill motivation functions. They aim at pique the pupils' curiosity and refer to problematic situation that helps to fill the gaps in pupils' knowledge or promptly and unambiguously clarify an un-known effect, or make short presentation. Introduction experiment might be also the first step to a discovery one, to formulate hypothesis and to reinforce following working steps. Often it is experiment presented by the teacher but it is also possible to be done by pupils. Generally experimenting in introduction stage is not assessed highly because the level of experimental work is rather low. In any case, the innovation and unconventionally of approach could attract the attention and rise pupils' interest. That's why these experiments are preferred and are more appropriate for lower classes (e.g. "the volcano eruption" in relief study in 5^{th} class), (Birk, W., 2000, p. 9-12).

The explaining and discovery experiments are used to solve stated problems and questions. The initially processed hypothesis should be checked for their accuracy from teacher and pupils, i.e. to be affirmed or rejected. At this stage experiment unfolds its great impact. Frequently the degree of teacher's supervision is high because he is responsible for ensuring the materials and technical activities. The pupils' opportunities to take part in the construction and fulfillment of experiment (in co-working or team working) are quite great. The didactical value of discovery type of experiment is mostly in cultivating the pupils' willingness to act on their own initiative and in independent way and

in its potential for problem solving. (Arning, H. & Lethmate, J., 2003, p. 39; Otto, K.-H., 2003, p. 2-7; Killermann, W., 1995, p. 211-212).

The listed above experiments for applying, control and exercise have a motivating influence on pupils and helps for repetition, accomplishment and improvement of what has been already learnt. They strengthen the already acquired knowledge once again and the result (in contrary to discovery experiment) is known – so we can check the already received results or offer further evidence. The experiment plays mainly role as visualization in this final stage, i.e. the acquired knowledge is already deepen and heighten from pupils using consequent visual processing.

To use the practice experiments is very helpful when an obvious suggestion should be proved in experience (e.g. evidence for transformation of water during evaporation). Experiments in strengthening stage of lesson facilitate acquiring of certain abilities and allow implementation of lesson control (Killermann, W., 1995, p. 212).

The experiments which are appropriate for homework are those that could be carry out with simple means and are safe for children. They could be done by pupils and even developed by them. These experiments are used as preparation and for further deepening of lesson (Bruhn, J., 1993, p.439).

As consequence of what has been said, experiments could outspread their didactical potential and effectiveness only when they are adequately set in lesson, and cohere with previous or following step in study unit. Although the experiments offer visual experience (unlike spatial reality), they present abstraction. Thus the feedback with geographic reality should be always kept using different sources of displaying information and media (photos, drawings, maps etc.), (Bruhn, J.,1993, p. 439).

It is important to specify which aspects of experiment methodic planning teacher should take in consideration:

- *The choice of experiment*: it should demonstrate precisely the most important details/aspects; additional tools must be simple and user-friendly, i.e. usual objects from pupils' everyday life; to use simple actions during the experiment; experiment shouldn't last very long as to correspond with lesson organizational framework; to be in sync with pupils' knowledge level and to improve it; results should be stated also in written form to facilitate the training process.
- *Methodical planning of lesson unit:* description of experiment should be briefly and summarized presented to pupils; social form of training ought to be under teacher's supervision (during the time of experiment); to supply enough working materials for team and co-working; to ensure the best opportunities for observation; teacher determines the correct training and observation tasks; to obtain if needed help from other teachers (from different subjects); the outside experiments should be provided with previously prepared "working field".
- *The particular position in lesson/stage of lesson*: the experiment should be made in advance so to be determined the needed time for its implementation; to estimate the possibilities for experiment improvement and needed materials; the feedback with other colleagues is demand when share common materials and school facilities; permission and supervising person is a must for outside experiments.
- *During the experimenting* pupils should have the opportunity to use materials which they bring by themselves; it is needed clear visibility for all pupils when the experiment is demonstrated; the teacher must participate mainly as consultant in pupils' experiments; experiment should be repeated in case of failure; also there should be a discussion on questions which arise during the experiment.
- *When finishing experiment in lesson*: teacher and pupils should discuss whether the experiment was successful, to reaffirm the results of experimenting according to the written notes made by pupils, graphic presentation etc.; when experiment is finished it is appropriate the teacher to reflect the possibilities for its improvement in written form.

The experiment which we use in geography training consists of several stages (Salzmann, W. 1986, p. 5-6):

1. *Introduction (preparation) stage* – the goal is to direct pupils to questions which answers should be searched during experimental work. The first step is to determine the problem situation and then to define it. Then we should formulate hypothesis according to existing pupils' notions and suggestions for solving the problem. Experimental possibilities for problem solution are tackled so later to be summarized into description and explanation of the course of experimental activity. Thus pupils realize the meaning of experiment (tool for problem solution)
2.

3. *Explanatory stage* – pupils make the transfer between geographical reality and constructing the experiment at this stage. Guiding questions which support the process are: what should be visualized using the experiment? How to visualize the position of geographic objects? What should be surveyed during the experiment? Thus the pupils' observation activity is guided and managed.

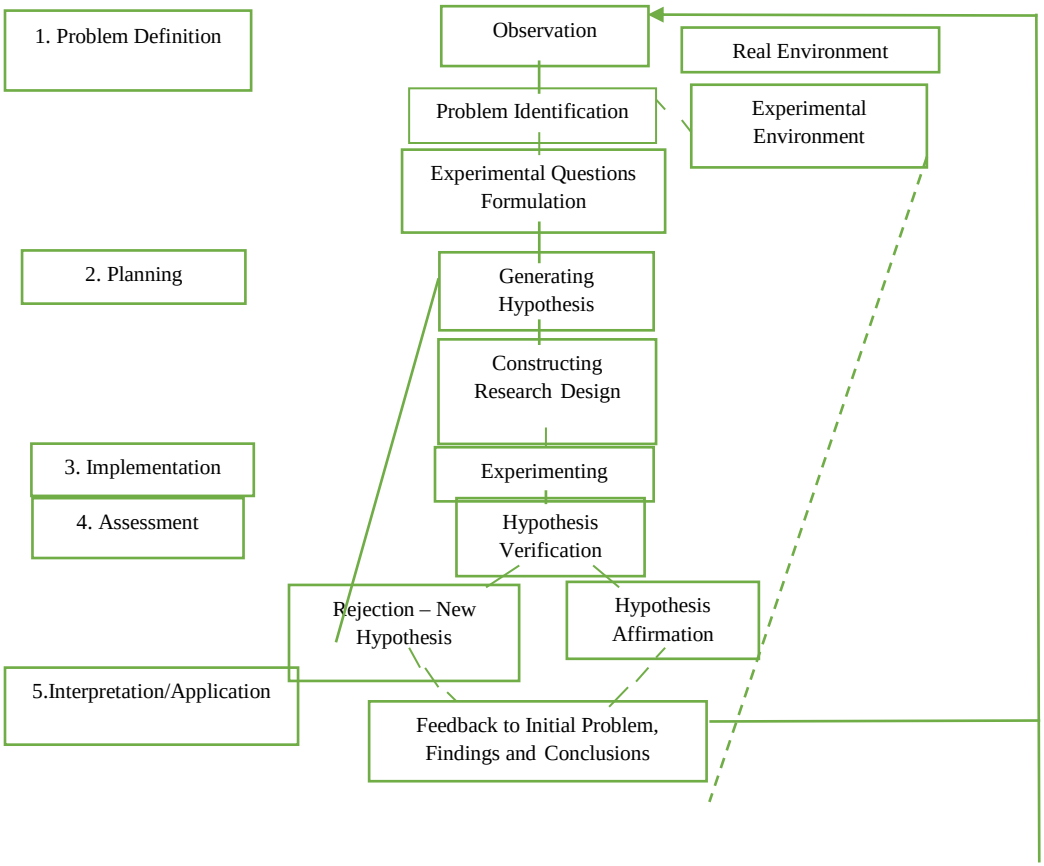

Figure. 1. Experimental algorithm (Source: K.-H. Otto, Experimente. In: Reinfried, S. u. H. Haubrich (Hg.) Geographie unterrichten lernen. Berlin (Cornelsen), p. 145, 2015)

4. *Experimental stage* - during this stage we conduct the experiment. The pupils' keenness to observe and be independent will increase via purposeful advice and tasks for observation during the experiment construction, its implementation and results. More complicated experiment can be divided in several experiments (stages). When one of sub-goals is achieved there is need of intermediate description, assessment and strengthening. We ought to repeat the experiment when the results are not satisfactory and not all processes are observed by pupils, respectively they are not understood. The difficulties of experiment repeating are determined by additional time costs and lack of enough materials.
5. *Assessment and result stage* – after finishing the experiment, pupils describe and explain the committed observation and measured results using their notes; then it should be made an abstraction and summary of main notions, interrelations and laws; pupils should derive feedback to questions and hypothesis which are stated in the initial stage of experiment (affirmation or rejection); and at the end – assessment of experiment progress.
6. *Transfer stage* – received results during the experiment are correlated with geographical reality at this stage. The pupils make a comparison with the real natural conditions.

7. *Stage of heightening and deepening* - in this last stage is needed an oral results revision and their written reaffirmation (e.g. using experimental protocol).

The listed stages are in accordance with the classical algorithm for carrying out experiment in training in countries with well-developed educational systems (figure 1). The algorithm is of a considerable importance for geography training in Bulgaria because it will facilitate planning and conducting experiments in geography education practice in our country and improve the potential of experiment in geography training at substantial degree.

In conclusion, we should point out that all the above-mentioned is sufficient basis to further deepen our scientific research in training experimenting problems for the goals of geography education in Bulgaria.

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