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# SCHOOL GEOGRAPHIC POLYGON: A CASE STUDY

*Andrej Vujnić[1], Anja Nišić[2]*

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**ABSTRACT:** *A geographic polygon is a type of geographic laboratory under the open sky. The basic goal of the school geographic polygon is to acquire practical skills and habits from geography. A polygon can contain different instruments, especially those for the formation of spatial performance, instruments used in the formation of spatial orientation skills, astronomical equipment, meteorological equipment and others. By using these instruments and equipment, students are enabled to acquire geographical education through their own activity and develop a geographical opinion. This paper presents the possibility of creating one of a number of instruments that can be found on a geographic polygon, and it is on the geography professors themselves to look at the possibilities of installing all of these polygon elements.*

**Keywords:** *Geographic polygon, geographic education, sundial clock*

## INTRODUCTION

*If the active participation of children in teaching is the most important, if it is our wish to make children think, to understand more and remember less, then we have to look for concrete and effective ways to raise children's interests and activate them.*

*Dušan Radović*

A geographic polygon is a type of geographic laboratory under the open sky. The basic goal of the school geographic polygon is to acquire practical skills and habits from geography. Polygon can contain different instruments, especially those for the formation of spatial performance, instruments used in the formation of spatial orientation skills, astronomical equipment, meteorological equipment and others.

One of the basic tasks of contemporary geography teaching is geographical education and the development of geographical thinking among students. An effective way to accom-

[1] Public Institution Gymnasium „Vaso Pelagić" Brčko, Brčko District, Bosnia and Herzegovina, contact: vujnica85@hotmail.com

[2] Anja Nišić, Public Institution "Second Primary School" Brčko, Brčko distrikt, BiH

plish this is to take students out from a closed classroom on an equipped school geographic polygon, where they would acquire basic knowledge about orientation in space, certain astronomical and meteorological phenomena and processes on the Earth's surface.

This arises, above all, from the fact that in the school geographic polygon there are extraordinary conditions for applying the method of demonstration, where a teacher can use any of the instruments on the polygon, and which is in the function of realization of a particular teaching unit. Also, it is possible to organize simple physical-geography experiments on the polygon, which the students themselves would perform, and where the teacher would play the role of "an active observer."

Numerous studies in the field of contemporary (active) teaching show that students learn much faster and better, and remember if they are able to play, to try,to touch, to see, and feel the information. One such study shows that students remember only 10% of what they read, 20% of what they hear, and even 90% of what they see and apply at the same time (Ivić, 2001).

## RESULTS OF PREVIOUS RESEARCH

Although geographic polygons play an important role in the development of practical knowledge among students, there are only a few isolated examples of the arrangement of school geographic polygons in Serbia.

Unlike our geographers, methodologists in the former USSR and Russia were dealing with the issue of organizing classes in an equipped geographic outdoor laboratory:

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Except the above mentioned, which are primarily related to the theoretical consideration of the significance of the teaching of geography under the "open sky," and which represent an important source of information and ideas, not only for geography teachers, there are examples of practical work, ie. an arrangement of geographic polygons in the school yard. As previously stated, there are positive examples of equipping the geo-

graphic polygons and in some schools in Serbia, which certainly affects the modernization and adaptation of geography teaching to the contemporary needs of students.

Some schools in Serbia have one or two elements in their school yards that can be found on geographic polygons (usually they are sundial clocks and / or signs), which can seem as a good motivation for geography teachers to encourage the implementation of other elements of the geographic polygon in the school yards of these schools. Some of these schools are: elementary school „Banović Strahinja" in Belgrade, elementary schools „Žikica Jovanović Španac" and „Andrija Rašo" in Valjevo, elementary school „Sonja Marinković" and Gymnasium in Zrenjanin, High School Center in the town of Štrpce in the extreme south of Serbia and others. (Petrović, 2009.)

## FUNCTIONS, FORMATION AND ELEMENTS OF A GEOGRAPHIC POLYGON

Nowadays, the transition from the information model of education to the individual model is directed towards the individual, the transition from the school of memory to the school of thinking and acting. In this regard, one of the main tasks of geography in schools is to develop important competences such as - the willingness of students to use their knowledge, skills and ways of working in daily life to solve practical problems. The educational process was built so that knowledge became the basis for practical work, that is, it became more efficient.

One way to achieve this is to use an approach that is oriented to practical work. The geography school already has a huge potential for realization of this approach by focusing on practical work, measuring, observation, fieldwork and professional excursions.

Such an approach, however, is not easy to apply because the practical part of the school program does not have the necessary equipment, which prevents the efficient organization of practical work and direct observation of nature. At the same time, younger students could hardly work with abstract concepts such as square and cubic meters, they hardly understood terms such as orientation, relief, etc.

All this leads to the conclusion that, today, it is necessary to equip a geographic polygon in schools, first of all because geography is the one that is best studied in the geographic area outside the classroom. It is necessary for pupils to comprehend the numerous phenomena and processes that are best seen in their natural form. There are a number of teaching units in the curriculum whose tasks can be realized on the equipped geographic polygon. This, certailny, also depends on the will and motivation of teachers to bring geography closer and to make it a more interesting subject.

## FUNCTIONS OF THE GEOGRAPHIC POLYGON

As already stated, the basic purpose of the geographic polygon is the realization of the curriculum by student participation in practical work, the result of which will be the

formation of concrete performances and the acquisition of habits of working with tools. On this basis, the geographic polygon can be used in the following way (Golov, 1987):

***For occasional observations*** – This form of observation forms the idea of space. Being on the polygon, students pay attention to objects such as square and cubic meters, distance markers, altimeter, polar star indicator, etc. Organizing activities in these facilities are carried out in the lower grades of elementary school, and in the higher grades it is carried out optionally. Without great effort, students develop the ability to perceive, acquire knowledge about the absolute altitude, geographic coordinate points, master the skills of searching for a polar star in the sky, etc.

***For a one-time practical work and observation*** – It is a work with portable tools and instruments, as well as equipment stationed on the polygon (gnomon, solar equatorial and horizontal clock, model of meridian and parallels, etc.). These observations and works are planned by the curriculum and should be carried out in all the schools. They are performed during school hours. After students master the technique of working with tools and instruments of this kind, observations in this stage of training are completed. Practical work and observations also include exercises of the study of geographical coordinates. In the lower grades, the direction of the daylight shadow is determined with the help of the gnomon, and cardinal and intercardinal directions are determined. Students in higher grades of elementary school work with the model of the place meridian and parallels. The goal of these activities is to concretize the knowledge of latitude and longitude.

Also, from grade VI, at the beginning of each school year, activities should be carried out to deepen and supplement knowledge of geographic coordinates, in order for students to determine their knowledge in determining latitude and longitude in the local area.

***For systematic observations*** – This type of observation is very important in the teaching of geography. From grade V students study, and accordingly, they should constantly observe the time, the height of the afternoon Sun above the horizon, and so on. By performing these observations, students master the capabilities of working with meteorological tools and angle measuring instruments, learn to improve their observations, use the results of measurement and research, generalize observations through geographic expression. It is particularly important that in the process of systematic observation students get acquainted with meteorological phenomena, they come to know how the climatic factors affect the climate of a place, etc. So the systematic observation is necessary for students to acquire information on issues related to the study of weather and climate.

Successful use of the geographic polygon is unthinkable without a clear organization of the work. In the process of performing practical work and observation all the students have to be involved. To thatend, the teacher should divide the students into groups, where each student will be responsible for carrying out certain activity. Then,

groups are given tasks written on cards where they write the content of the activities and the order of their performance.

It is the duty of teachers to control the performance of practical work and observation, to give the necessary instructions for installation and use of equipment, to explain the technique of tool work and etc.

## THE FORMATION OF THE GEOGRAPHIC POLYGON

Realization of individual lessons in geography, primarily from physical geography, it is most effective to perform on a geographic polygon. Certain field measurements, modeling of some natural processes and phenomena, astronomical observations, orientation in space, and other, it is advisable to implement in a natural laboratory equipped for learning. Work on the geographic polygon helps children develop a concept to concretize their knowledge, to develop practical skills and to become familiar with the methods of scientific research, which is an effective way to improve the efficiency of teaching.

Materials obtained by working on a geographic polygon are an important means of improving the work of the local community. On these grounds, a geographic stone foundation is often created, which can later become a regional setting or even a museum. Therefore, the work on geographic polygon appears as the school's need arising from the nature of the educational process and content of the curriculum of physical geography. Pedagogical sciences and teaching methods place a geographic polygon in the systematization of material equipment in the line with a cabinet or a local museum (Golov, 1987).

The formation of a school geographic polygon can be divided into three stages: *preparatory, organizational and final* (Suhorukova, 1958). Of course, in the construction process, it is necessary to address all the issues regardless of the stage to which they relate, and from this point of view, the division into stages is very conditional. However, in general, all tasks are solved together in all stages.

At the ***preparatory stage***, it is necessary to determine the composition of the equipment on the polygon, to make a list of the necessary materials, to make a plan for the procurement or making of the missing devices and instruments, to estimate the costs, to determine the approximate workload, to make a plan for the construction of the polygon. Most of the work in the preparatory stage is done directly by teachers.

After elaborating the plan of the polygon, the work has primarily an ***organizational*** character. A list of necessary materials for the construction of a polygon is considered and approved by the school principal, and he is most responsible for the doing of all types of works. At this stage it is necessary to obtain support from the competent authorities - the Teachers' Council, the School Board, the Chamber of Parents, etc. The approval of the plan by the School Board, can immediately switch to the direct formation of a polygon, which includes: *selection of the polygon location, the definition of its boundaries and the leveling of the terrain*. The location selected for the polygon must be, if possible, away from buildings, communications, high trees, which interfere with the movement of air and disturb the heat regime. In addition, it is desirable for the sides in the

north and south to be open and, if possible, to see the horizon lines. Once the location for the polygon is selected, the boundaries of the polygon should be determined. Although the existing literature lists the desirable dimensions of the geographic polygons (one of them is 12x12 meters, mentioned by Suhorukov), it should be pointed out that they should be adapted to the conditions provided by the school yard of the school in which the geographic polygon is placed. The sides of the polygon should be directed to the cardinal directions. The surface should be carefully aligned, irregularities and distortions should be eliminated.

***The final stage*** involves the formation of polygons and setting fixed equipment and tools for portable devices and instruments. This step is the most important in shaping the polygon. When setting up instruments and tools, it is necessary to take into account that they are facing the cardinal directions or are mounted to the latitude. When placing tools, it should be taken into account that the pillars are buried deep, and then the holes are covered with concrete to make them as stable as possible.

The last stage is about the implementation of "fine" works, which involves the setting of a fence on the polygon, sanding the tracks between the device with sand or gravel, and so on. Also, the polygon fence can also serve as an instrument for measuring the length, so that its segments at a meter's length would be painted alternately, say, in black and white.

## ELEMENTS OF A GEOGRAPHIC POLYGON

When compiling a list of equipment of a geographic polygon, it is necessary to consider primarily the scientific-pedagogical factors, and the total economic costs. An important criterion for scientific-pedagogical assessment of equipment of a geographic polygon is its suitability for realization of program activities and contents. In addition, we should consider the possibility of performing extracurricular activities and optional teaching at the polygon.

In the literature that deals with this topic, recommendations are given on how to equip a school geographic polygon. One of the models of the geographic polygon was elaborated by A. B. Suhorukov, who suggested that it should be done on the formation of a spatial representation and embracing the habit of space orientation, observing meteorological and astronomical objects and phenomena, studying geological elements, reliefs, surface waters and topographic elements. To solve these tasks, it is recommended to use more than 40 items of educational equipment, such as: models, devices, instruments, tools, natural objects (Suhorukova, 1958).

Elements that one school geographic polygon should include: tools for the formation of spatial performances, instruments and models used in the process of acquiring knowledge and skills from space orientation, astronomical equipment and meteorological equipment (Semakin, 1973).

Also, elements of the geographic polygon can be divided into two basic groups: measuring instruments and tools and supplies that can not be called instruments.

**Table 1.** Elements of school geographic polygon

| | | |
|---|---|---|
| MEASURING INSTRUMENTS | Meteorological | *Thermometer*<br>*Barometer*<br>*Hygrometer*<br>*Psychrometer*<br>*Pluviometer*<br>*Snow gauge*<br>*Weather vane*<br>*Anemometer* |
| | Angle meters | *Vertical angle meters (eclimeters)*<br>*Dioptra* |
| | Sundial clocks | *Horizontal*<br>*Vertical*<br>*Analemmatic* |
| OTHER TOOLS AND INSTALLATIONS | Roadsign<br>Compass rose<br>Imaginary line<br>Orient Globe<br>North Star Indicator<br>Sandbox | |

## CASE STUDY: SUNDIAL CLOCK (GNOMON) – VERTICAL

**The vertical sundial clock** shown in this paper is located on the geographic polygon of the Public Institution "IX elementary school" Maoča in Brčko District of Bosnia and Herzegovina. This type of sundial is usually set on the southern walls of the buildings. The times are being read by the shadow cast by a bar placed parallel to the rotational axis of the Earth. In fact, celestial axis is materialized with this bar , so the entire celestial sphere goes around it, from the east to the west. The Sun rotates together with the celestial sphere, a bar shadow faithfully reproduces the Sun walk and shows the times of the day with its direction.With the help of this element, students with their teacher, can obviously process temporal orientation and clarify a number of concepts such as: *Earth's axis, celestial sphere, celestial axis, geographical pole, celestial pole, time system, solar time, medium sunny weather, not clear weather and Central European time* (Tadić, 2004).

To make a vertical sundial clock, it is necessary, therefore, to know the geographic coordinates of the respective post, as well as the azimuth of the appropriate wall of the building. In this case, the geographic latitude of Maoca (a village in the Brčko District of Bosnia and Herzegovina in which the Public Institution "IX Elementary School" is located) is 44˚46'12" N, the geographic length is 18˚39'36" E, while the azimuth of the board on which the clock is set, checked by manual busol on site, is 56.5˚. On this basis, we get information on the angle that the shadow cast is locked with a step, which is fixed along the line with a vertical closing the angle of -29°05'27".The time shadow angles are

applied from the vertical that starts from the poles of the sundial clock (the point where the bar is casting the shadow). The positive direction is to the right of the vertical.

**Table 2.** The angle of the shadow tossed by the vertical sundial clock

| Hours | Shadow angle |
|---|---|
| 6 | -72˚ 40' 26" |
| 7 | -58˚ 05' 28" |
| 8 | -46˚ 38' 39" |
| 9 | -36˚ 56' 42" |
| 10 | -27˚ 58' 32" |
| 11 | -18˚ 54' 17" |
| 12 | -8˚ 52' 28" |
| 13 | 3˚ 12' 45" |
| 14 | 18˚ 50' 26" |
| 15 | 39˚ 25' 27" |
| 16 | 64˚ 05' 17" |
| 17 | 88˚ 03' 06" |

## Construction of a sundial clock

**Place:** Public Institution "IX Elemetary School" Maoča, Brčko District of Bosnia and Herzegovina

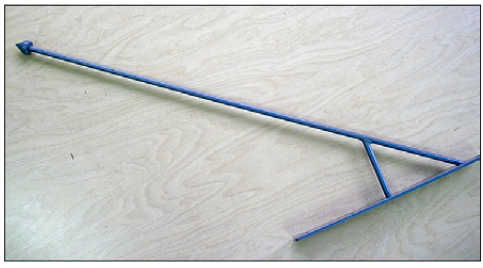
**Geographical coordinates of the place:** 44°46'12" N, 18°39'36" E

**Space:** school yard

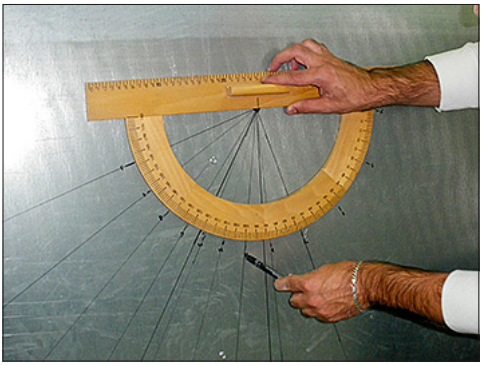
**Required resources:** Metallic board (dimensions 1.5 m x 1.5 m), bar (shadow cast), metal numbers, waterproof marker, marker, school protractor, school compas, school triangle, two iron pillars – clock supporter (high 3.5 m).

**Procedure:**

1. *Shadow Cast Construction*: The shadow cast is constructed on the basis of the geographic coordinates of the particular site (Maoča). In our case, the shadow cast rate is 35 cm long, and with a bar that closes the angle of α = 36˚ 18. The bar, 80 cm long, set at an angle b = -29˚ 05 ' in relation to the vertical passing through the pole of the clock.



2. *Determining the position of time lines:* Shadow angles (tab. 2) are applied using a school protractor from the vertical passing through the pole of the clock. School protractor is positioned so that its base is situated along a horizontal line that passes through the pole of the clock; a zero partition of 90˚ is taken, from which the angles are further measured. The angle at which the shadow cast is placed is also determined in relation to the vertical.



3. *Fixing shadow cast and figures:* It is usual to write the name and geographic coordinates of the place next to the clock. Having determined the angles of shadows, it is approached by fixing a pre-prepared shadow cast and figures.



4. *Mounting the clock board:* Although it is usual for the vertical clock to be located on the southern walls of the building / school, we decided to have the clock mounted on a metal panel that was built on two pillars, as an integral part of the polygon in the yard of "IX Elementary School" in Maoca.
After all the timer elements are fastened, the sundial clock plate is mounted on specially prepared supporters.


5. *The use in teaching:* The installed clock is ready for use in geography teaching as well as in teaching related subjects. Vertical sundial can be used in the processing of teaching units within the teaching topics: *Universe and Earth, Geographical map, Earth motion, Atmosphere and others.*



## CONCLUSION

Working on a geographical field is the need of a school that comes out from the nature of the educational process and the content of the geography curriculum. Installation of geographic polygons in school yards has a great significance, especially since their introduction into practical training promotes polytechnic education in teaching, improves interdisciplinary connectivity, improves learning, and so on.

A geographic polygon is a necessary element in the material equipping of geography teaching, because it enables the successful solution of educational tasks that are set in the teaching of geography, and secondly, its equipment is designed for performing practical work, experiments and observations. From an economic point of view, it is important to emphasize that the construction and acquisition of instruments that form an integral part of the polygons do not require large material resources.

The content of the curriculum for elementary and high schools is suitable for realization at the geographic polygon. Students are able to see and learn clearly different concepts, phenomena and processes related to the study of geography. And not only geog-

raphy, the geographic polygon can equally effectively be used by classroom teachers, teachers of mathematics, physics and craft. This is the reason why they all should work together with a geography teacher during the planning and construction of a geographic polygon.

It should be emphasized that the realization of the project of the school geographic polygon must not be (primarily) in the function of arranging the school yard, where the students will pass by during recess or will be used as an illustration of what the teacher is talking about. The school polygon should serve primarily for the realization of educational goals, in a way that students learn something new with the help of teachers, and with their own activity (independently). Thereby, the devices and their demonstration on the polygon should not be the purpose of teaching geography, but only the means by which students will learn something new more effectively and identify previously acquired.

Finally, it should be emphasized that only a well-designed and pedagogically designed school yard can be a complementary space with other school spaces and, as such, can contribute to the realization of goals that are related to all areas of personality development. And for themselves, these spaces will be educational, much more than a number of tips and lectures on the well behavior and culture of life.

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