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## ORIENTATION IN SPATIAL LAYOUT OF THE EARTH IN THE LIGHT OF GEOGRAPHICAL COMPETITIONS RESULTS

Shaping the orientation in the spatial layout of the Earth is one important element of geography teaching. This orientation is usually acquired with the help of general maps which are most frequently used in teaching geography. Its level can be measured by, among other methods, assessing students' ability to use the scale of a map, directions, geographical coordinates and map signs. In this study answers to questions of seven geographical competitions' finals were analyzed.

### RESEARCH METHOD

#### **Characteristics of the Pupils' Group**

Geographical competitions organized in Poland annually since 1974, involve secondary school pupils with geographical interests. The participation is voluntary. Out of 8,405 pupils who took part in the competitions in the years 1974—1981, 464 of them entered the finals after a 3-step competition. Their age ranged between 16 and 19 years. Most of them were the 4th class pupils (19 year old—64%) and 3rd class (18 year old—30%) i.e. those who have completed the secondary school course in geography. Younger, from 1st and 2nd classes (16—17 year old) were less frequent participants and fewer of them enter the finals. This was understandable since the competitions questions covered the whole secondary school geography course which it is hard to learn on one's own.

The finalists came from various social environments and different parts of Poland. Their schools were located in big cities of more than 500,000 inhabitants (21.5%) and between 100,000 and 500,000 inhabitants (24.8%), from towns of 50,000—100,000 people (17.9%) and 20,000—50,000 (11.9%) and from small towns and localities of less than 20,000 people (23.9%). They attended 98 different schools which constitutes 11% of all comprehensive secondary schools in Poland. Technical schools pupils take part in competitions rarely.

One common feature of the pupils in question is that they all achieved excellent results in the competitions thanks to their great ambition, competing zeal, abilities, deep geographical interests and enormous own effort. Additional comparative studies revealed that their knowledge by far exceeded the average secondary school level. Therefore, the results these pupils achieved may be considered as the maximum they could reach in the present educational system.

### Materials

The finalists' written works which were subject to this analysis consisted of replies to questions prepared for the finals. Just like all other questions of geographical competitions, these too were prepared by a special commission composed of leading Polish geographers and geography teachers. The questions were—as far as their contents is concerned—similar to those found in secondary school manuals but their difficulty level was usually higher. The participants could use, if it was necessary, general geographical maps of different scales (including generally available maps and contour maps prepared specially for them).

The answers were analyzed from the viewpoint of kind and frequency of mistakes (qualitative and quantitative analysis). The number of answers differed from one question to another depending on the number of finalists in different years and on whether the same question was repeated in various competitions. To make comparisons easy, the results of this analysis will be presented in percentage form alongside information about the number of works.

### RESULTS OF THE ANALYSIS

The first group of questions was designed to check students' ability to use map scales. In question 1 they were asked to calculate the scale of a map on the basis of real distance between two points and the corresponding distance on a map. In question 2 pupils should have made the necessary measurements on the map and calculated the distance between given points (Table 1).

In questions 3 and 4 students were asked to calculate areas. In question 3 the corresponding area on a different map and this map's scale was given, while in questions 4 they had to make their own measurements. The results were not satisfactory. There were more correct answers (61--67%) to questions 1 and 3 where all data was given, but in the case of other questions, which necessitated additional measurements, the results were much poorer dropping to 55% correct answers in calculating the distance and 25% in calculating the area. Measurement inaccuracies were present in 22% of answers to both questions.

Table 1

Answers to questions 1, 2, 3 and 4 (in percent)

Kind of answer	Quest. 1	Quest. 2	Quest. 3	Quest. 4
Correct answer . . . . .	66.9	54.5	71.2	24.7
Partly wrong answer — correct calculation of the scale minor measurement inaccuracies . . . . .	—	21.5	—	21.9
arithmetical errors in scale calculating . . . . .	16.9	8.4	7.5	20.5
Completely wrong answers or lack of answers . . . . .	16.2	15.6	21.8	32.9
<b>Total . . . . .</b>	<b>100%</b>	<b>100%</b>	<b>100%</b>	<b>100%</b>
(number of works)	(183)	(143)	(136)	(73)

It is striking that a considerable group of students did not answer at all the questions or gave a completely wrong answer. The questions about distance and its use received fewer such answers (16%) but as far as the area questions were concerned, the percentage of students who failed to answer them ranged between 22 and 33%. The difference can probably be explained by the fact that the number of area questions in geography manuals is much smaller than that about distance and, most probably, the teachers interpret this as a hint to practice fewer such problems in their classes.

Another group of pupils ranging from 8 to 20% made arithmetical errors most of which were mistakes in the number of zeros. These errors were sometimes serious indeed; for instance, in calculating the distance between two towns in Poland the students—instead of the correct figure 74 km—replied 7,400 km or 74 m. This indicates that they were calculating the answer quite mechanically without realizing the proportions of size and distance and without imagining what these figures and the maps scale were standing for.

The last in this group of problems consisted of drawing a linear scale. This question was answered correctly by 2 participants (3%) only (Table 2).

In spite of the fact that teaching curricula of three subjects (geography, mathematics and military training) envisage the drawing of plans, some 30% finalists failed to find any answers to this question.

Some 60% pupils made mistakes using either no base division or a base which was inconvenient to use in practice. Completely wrong answers resulted from wrong position of the 0 point on the scale or from incorrect placing of the base division, which indicates that students lack any knowledge of the purpose of placing the additional unit on the left of 0 point.

The second group of questions concerned the use of map graticule to locate definite points with the help of geographical directions and

Table 2

Answers to question 5		
	Kind of Answer	%
1:1250		2.9
1:1200		
1:1200		
1:1000		60.0
1:1000		7.1
Lack of answer		30.0
Total (number of works)		100.0 (70)

coordinates. In question 6 pupils were instructed to indicate a point situated north of another given point on a map with conical projection and high convergence of meridians towards the North Pole. This elementary question was quite a big problem even to the finalists (Table 3) since 5% of pupils either failed to answer it or arrived at a direction which was incompatible with the position of meridians. This kind of mistakes is particularly interesting since it was repeated by different pupils' groups and occurred with even greater frequency on the pre-final stages. In semifinals 7% of participants (69 pupils) repeated the same mistake. It can be probably explained by the fact that most of them are used

Table 3

Answers to questions 6, 7 and 8 (in per cent)

Kind of Answer	Quest 6	Quest 7	Quest 8
Correct answer	94.6	96.9	82.4
ref. quest 8 — inaccuracies of less than 1	—	—	12.5
Completely wrong answer or lack of answer	5.4	3.1	5.1
Total (number of works)	100.0 (144)	100.0 (173)	100.0 (216)

to rely on maps' frames to indicate directions since the notion of direction on a map is introduced to them prior to that of the map graticule.

Locating places with the help of geographical coordinates (question 7) and indicating geographical position (question 8) posed no difficulty to the finalists (Table 3). although both teachers and students maintain that these problems are the most difficult in the school curriculum. 3—5% of pupils gave entirely wrong answers or failed to answer the questions. The relatively small proportion (15%) of correct answers to question 8 was caused by reading inaccuracies of less than 1. These inaccuracies probably resulted from poorly shaped habit of careful reading and calculating.

The position of different objects on the map can also be stated by identification them and locating in relation to other objects or places. Pupils' ability to do so was tested by asking them to place some objects on a contour map (Table 4). These were: the Ethna (question 9), the Vesuvius (question 10), the Stromboli (question 11), the Upper Silesian coal basin (question 12), the Ruhr coal basin (question 12) and the Donetsk coal basin (question 14). The positions of the Ethna and European coal basins were remembered by all finalists with different degrees of accuracy, however.

The absence of answers to questions about the Vesuvius (15%) and the Stromboli (18%) may indicate that in spite of the fact that these examples were frequently mentioned at schools, the pupils did not remember their location in a sufficient degree.

Table 4

Answers to questions 9, 10, 11, 12, 13 and 14

Kind of Answer	Quest 9	Quest 10	Quest 11	Quest 12	Quest 13	Quest 14
Correct answer	64.6	41.7	10.4	52.1	22.9	16.7
Dislocation of by up to 1 cm on map (up to 120 km)	27.1	22.9	64.6	45.8	47.9	14.6
Dislocation by up to 2 cm on map (up to 240 km)	—	—	—	2.1	14.6	27.1
Completely wrong	8.3	20.8	6.2	—	14.6	41.6
Lack of answer	—	14.6	18.8	—	—	—
Total (number of works)	100.0 (48)	100.0 (48)	100.0 (48)	100.0 (48)	100.0 (48)	100.0 (48)

Those answers where dislocations were greater than 1 cm with regard to volcanoes and 2 cm to coal basins were considered as completely wrong. There are no such mistakes concerning the Upper Silesian coal basin, which was understandable among Polish pupils. As far as other questions were concerned, the most frequent mistakes included: placing the Ruhr and the Donetsk coal basins on the other rivers or e.g. Donetsk basin in different industrial districts in the USSR, the Ethna and the Stromboli

on other islands and the Vesuvius close to Rome instead of Naples. These mistakes indicate that pupils remember the general location but mix up the points of reference (rivers, islands, state borders). Similar explanation can be given to those answers in which dislocation was under 1 cm to mention moving the Ruhr basin along the Rhine, mainly towards the South. One interesting mistake in this group of answers was placing volcano signs close to concentrically drawn contour lines, which indicates that surface configuration represented by those lines does not help some pupils or is disregarded by them.

In answer to questions about coal basins some 15–20% of participants made error by drawing a sign with a large diameter. When multiplied into the real distance the longer diameter of the oval sign marking the position of the Upper Silesian basin exceeded 100 km, the Ruhr basin — 200 km and the Donetsk basin — 300 km. Just like in the case of questions concerning map scales this may indicate that pupils lack the ability to imagine the proportions of size and distance which change depending on map scale.

#### CONCLUSIONS

The above-presented results scored by geographical competitions' finalists indicate that even the most gifted pupils having much of geographical knowledge, sometimes come across serious difficulties concerning the orientation in spatial layouts. These difficulties were manifest in all answers analyzed above but they affected them in varying degrees. The finalists had relatively fewest problems with locating the given place with the help of geographical coordinates. Besides, the mistakes which they made in that area do not point to any definite didactical mistake which could have caused them. Neither did the defining of geographical directions produce many problems but the repeating mistake of defining the directions according to the map's frame rather than the graticule indicates that greater attention should be paid to avoiding teaching mistakes resulting from over-simplified introduction of the notion of direction at the moment of pupils' first contacts with maps.

The poorest results were recorded in participants' ability to use map scales. The kinds of mistakes that they made in calculating the scale, distance and area and locating coal basins indicate that maps do not recall the proper picture of reality to pupils' imagination. The essential virtue of maps allowing man to reach, thanks to reduction of dimensions, beyond his regular field of vision and imagine the location of places and phenomena on large areas remains something abstract to most pupils. This may be attributed to the lack of properly shaped sense of size and distance or to their disability to imagine that reduction of size and distance on maps with the help of scales.