



ANALYSIS AND ASSESSMENT OF STUDENTS' COMPETENCY TO EXPLAIN GEOGRAPHICAL PROCESSES

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Abstract. In this study we seek to analyse the ability of students to explain, exemplify and outline geographical processes, as well as to assess their competencies by using an evaluation grid. Therefore, we tested two types of hypotheses. The first one regards the fact that it becomes more difficult for students to represent a previously learned geographical process in writing, than to outline it graphically. The second Hypothesis highlights the fact that the ability to graphically represent a geographical process is more difficult to achieve, than the ability to represent a previously learned geographical process through sketches. We went through several steps such as: the preliminary analysis of students' products; writing the text; setting up the criteria of analysis for products; grouping the products on the specific criteria; organizing the evaluation grid of competencies; inserting data in the tables; and the elaboration of the paper. We chose this type of approach due to the lack in evaluation grids, which we created according to the analysis of products. We used both qualitative and quantitative type of analysis, as well as data collecting, processing and interpretation. What is important to mention is that the students find it easier to represent a geographical phenomenon through a sketch previously learned rather than by using a written discourse. The sample of evaluation grid that resulted from this study can be used by the professionals in didactics, but it can be developed a new one, specific to students. Based on this research study the learning process at the students' level can be improved.

Key words: drawing, sketch, written text, item, objective, graphical representation, mental image.

1. Introduction

In this study we attempt to evaluate the competency to explain a geographical process, which represents an essential ability both for a geographer and a teacher of geography. Hence, we involved the students in the second year of study, at Faculty of Geography, specialization *Geography* and the *Geography of Tourism*. All of them attended the courses included in the psychology-pedagogy module, necessary for them to become teachers of geography. Their competency was tested through a written paper that was requested after attending the course of *Didactics of Geography*, June, 2007.

The basics of this study are represented by the issues identified when approaching the competencies such as: lack of knowledge in theories and practices regarding the competencies of teachers and authors of school curriculum, syllabi, school textbooks, university courses; the difficulty of students to explain geographical process. In Romania, after 2004, school curriculum in high school stipulates the competencies as a means of replacing the main and reference objectives, whereas the university curriculum stipulates that the students should gain competencies, yet these being defined, understood and formulated in various forms, while their proper assimilation by the students being questionable and controversial.

This study is based on the competency formulated by R. Brien (p. 244, 1997) as: "the ability of an individual to solve a given task; a set of declarative and procedural knowledge and attitudes, which are activated during the execution of a given task". Roegiers (2000) identifies 5 characteristics of a competency: *the activation of a set of resources* by a person; *finish character* (creating a product, execution of an action, solving a problem); *the relation with a set of situations*; *an often disciplinary character*; *the capacity of evaluation*. Much more, we added *the level of competency*, meaning the

fact that a person may have a competency, which is developed to a certain level and we defined the competency as “a set of declarative and procedural knowledge and attitudes a person can have, which are activated (transformed and integrated) in activities of planning and execution of a featured task, in a given field, in a certain context that needs a significant number of operations” (Dulamă, p. 396, 2009a).

Having these, we tried to accomplish the following objectives: 1) to analyse the competencies and sub-competencies of the students from the Faculty of Geography to explain a geographical process; 2) to analyse the graphical representations of the students on certain geographical process; to assess the competency of students to explain geographical process through an evaluation grid.

2. Theoretical background

The theoretical aspects of this study are based on the competency of explaining a geographical process. First, we have to make the distinction between the concepts of phenomenon and process. *Phenomena* represent the transformations substances suffer (Julean, Moșutiu, p. 18, 2008). There are two types of phenomena: *chemical phenomena*, through which the composition of substances changes, thus becoming substances carrying new proprieties (carbonation); *physical phenomena*, through which substances do not modify their composition (dissolution, water evaporation, condensation). *The process* represents a succession of phenomena, which have a strong reciprocal relationship, that follow a certain development pattern, leading to a specific result (Todiraș, p. 218, 1999). Therefore, the process consists in several successive operations, consecutive actions or phenomena, organized through stages, the system going through several phases and distinctive shapes. *The stage* represents each of the time distinctive, successive periods in the development of a natural or social phenomenon, characterized by significant actions or events. Throughout a stage, the system evolves or goes backward, reaching a certain level of development – a *phase* in which the system has certain specific features, a certain shape, through which it becomes quite differentiated by its previous shapes, it steps forward and enters a new stage of evolution or regression. The phase represents a structural element of the process, a distinctive moment in the development of the process, considered isolated from the previous and the subsequent one. *The phase* is each one of the *shapes (states)* – the status of a body or of a system, determined by its structure, and the outside conditions and defined through certain sizes and parameters of a transformation in the evolution of the process.

In our previous studies we stated that, in the situation of explaining a geographical phenomenon, we have to reconstruct the pattern we follow: cause – carrying out – effects, thus clarifying several aspects like: location in space, location in time, the going through according to time periods, classification of causes, of conditions, and of the factors involved and their consequences (Dulamă, p. 55, 2001). The aspect regarding the *location in space (where?)* presupposes to specify the following aspects: geographical location, size and limits of the space in which it occurs, the geospheres it affects. Therefore, we can argue the reason for it has the specific spatial extension. The aspect regarding the *location in time (When?)* states the following: *the moment* when the process begins and ends and whether the condition described is in present, past or future; *the duration* - the time interval between the moment the process starts and the moment it ends; *the frequency* - the time sequence that indicates how many times a phenomenon occurs in a time period, *the period* - the time after which a phenomenon or process is repeated, by successively reproducing the values of a characteristic feature of that phenomenon or process. *The analysis of the integrated components involved in the process* is done by decomposing all the components, by characterizing each component, by identifying the relationships between elements and between the elements and the whole. When *analyzing the course of the process (How is produced?)* we identify the successive stages in the process, either by observing the event in reality or based on a graphic, photographic or cartographic support. In *identifying the cause (Why?)* it is established the phenomenon or a complex of phenomena (*cause*) that foregoes and, under certain specified conditions, what causes the emergence of another phenomenon, called *effect*, to which it serves as a starting point. The cause represents the relationship between two events or states, which means that one determines the other. The explanation specifies the force/forces, the agent/agents, the factor/factors that determine the occurrence of the process or phenomenon and the objects on which these act. It also specifies if a cause is permanent or temporary,

or if acting under certain circumstances. In most cases, the shape of objects, the external expression of phenomena or processes, the running events and effects are visible, but the causes are hidden. By the *identification of conditions*, there are established the facts or circumstances (*conditions*) on which the appearance of a phenomenon depends. They can influence the carrying out of an action, therefore being able to delay, stimulate or even stop it. Conditions affect both qualitatively and quantitatively the phenomenon. In *identifying the effects (consequences, outcomes, and tracks)* there are established the phenomena that result from a particular cause, being in an unbreakable connection with it. An effect of a phenomenon may become the cause for producing another phenomenon (Dulamă, p. 121-122, 2008).

In our opinion, given the characteristics of competency outlined above, a person who has the ability to explain the geographical process should enable more knowledge:

Table 1 Knowledge integrated into the competency to explain a geographical process

Declarative knowledge	Procedural knowledge	Attitudinal knowledge
Phenomenon, process, cause, circumstances, effects, progress, stages, time, duration, frequency, period, time phase	Establishing <i>the location</i> of geographical process, where it actually occurs and its representation (through photography, maps, and drawings). Establishing <i>the moment, duration, frequency and period</i> of the geographical process Establishing <i>the steps (stages)</i> in the production of the geographical process. Establishing <i>the phases</i> in the production of the geographical process. Setting <i>the steps</i> in the production of the geographical process, in reality and through photography, maps, and drawings. Establishing <i>the conditions</i> under which the process occurs in reality and through cartographical representations (photography, maps, and drawings). Establishing <i>the cause/causes</i> of the geographical process. Establishing <i>the elements</i> involved in the geographic process in reality and through graphical representations (photography, maps, and drawings). Identifying <i>the effects</i> of the geographical process in reality and through graphical representations (photography, maps, and drawings). Determining the <i>type/types</i> of processes and phenomena involved. Defining notions Classifying elements, phenomena, and processes involved. Graphically representing the steps and stages of the geographical process through successive drawings. Exposing or writing an explanatory text about the geographical process. Graphically representing the geographical process through diagrams (graphic organizers)	To represent <i>correctly</i> by drawing or mapping a geographical process. To explain <i>completely</i> a geographical process, <i>at a scientific level</i> , orally or through a written text. To use the knowledge about geographical processes, in a practical manner. <i>To take measures</i> for preventing or combating the negative consequences of some geographical processes.

The competency to explain geographical processes is used in various situations, such as: for explaining some geographical processes directly perceived in reality, for explaining geographical processes indirectly perceived on television, in films, photos; for explaining geographical processes in scientific works (i.e. bachelor, master, PhD, papers).

Each person develops its subjective images (representations) about geographical processes, as a result of direct or indirect visual perception of reality or through the conversion of verbal messages in images. M. Zlate considers that design represents "a graphic (re)production of an object or event, in that it is the material revision of the content of a mental representation"(1999, p. 187). Nevertheless, M. Miclea uses the term of mental image, as "a cognitive representation that contains information about the shape and

spatial configuration (the relative position) of a multitude of objects, in the absence of visual stimuli over the specific receptors” (1999, p. 160). Mental picture “succeeds the downward analysis of the visual stimuli and depends on the knowledge regarding the cognitive system”(Miclea, 1999, p. 166), meaning the prior knowledge. “Unlike the physical picture (drawing, photo), which can be reviewed and broken down into parts, other than the initial ones, the mental image can be decomposed exclusively or predominantly according to the elements of the previous process (Miclea, 1999, p. 167). The author claims that “the reproduction of figures and scenes from memory reveal the addition of mental images to their specific categories and semantic processing” (Miclea, 1999, p. 168). Eysenck and Keane (1992) reveal a grouping of representations from a psycho-cognitive perspective. In their opinion there are external pictographic and linguistic representations as well as internal, mental representations, which can be symbolic (analogical and propositional) and distributed. M. Zlate defines these representations. The external representations can be made of any signs, any set of symbols, which re-present something in the absence of that something. The sign, the symbol, the physical object can be re-presented (meaning a repeated action) either as a pictographic representation (drawing, diagram), or as a linguistic representation (through words) (1999, p. 207).

Internal or mental representations are those in the mind of a person. Analogous symbolic representations have images while sentence symbolic representations have ideational content (1999, p. 208). Distributed representations present the information as networks or connections between elements or characteristics of an object (visual, olfactory), and they constitute a high level of representation because they present the information sub-symbolically, with a certain degree of abstraction. Piaget and Inhelder (1966) use the term *image-copy* for the re-presentation of the model when the model is seen by the subject's eyes or it was seen a moment before, “a mere material imitation (graphically or by gestures), in opposition to the mental image, which is an internalized imitation ”(1969, p. 61). A person who has the ability to represent the process through schematic design, it operates with all these types of images or representations.

3. Material and method

The material of research represents the papers written at the final evaluation in June 2007, to which 69 students in the second year of study attended. Students were given to solve all three assignments in two hours. The first assignment, which is the subject of our analysis, was the following: 1) Explain a geographical process by answering the following questions: Where? When? How? Under what conditions? What caused it? What effects occur? 2) Represent the production of the process by drawing 3) Develop a graphic organizer regarding the approached geographical process. During the preparation for papers, the students chose a geographical process to explain and represent by drawing. Students had already studied the geographical processes, by attending courses, such as: Geomorphology, Meteorology, and Hydrology. Before evaluation, students were given explicit information about the concept of competency, along with details and examples of the competency to explain a geographical process.

The study was realized in April 2009, in order to achieve the above mentioned objectives. The main research method was the analysis of products realized by students. The research had several stages, organized in the following order: 1) analyzing the students' products (written texts, drawings, graphic organizers) so as to identify their characteristics, manner of representing the processes, blanks, errors, difficulties in their approach, 2) creating the text with a view to the analysis of products; 3) establishing the criteria for analysing the students' products; 4) clustering the products according to these criteria and registering data in tables; 5) setting an evaluation grid for assessing the competency to explain geographical processes based on levels of competency and performance standards; 6) assessing the products (competencies) according to the grid; 7) registering the statistical data in tables, 8) elaborating the paper. We chose this algorithm of analysis because we had not previously designed an evaluation grid and we considered necessary a thorough analysis, so as we could identify the essential issues for a proper evaluation of products.

The research hypotheses are the following:

- the sub-competency to explain a geographical process through written text is more difficult to achieve than the sub-competency to represent a geographical process through a previously studied schematic design.

- the sub-competency to represent a geographical process through a graphical organizer is more difficult to achieve than the sub-competency to represent a geographical process through a previously studied schematic design.

Enunciating the research hypotheses was completed during the research process because the initial assumption was that students have difficulties in explaining the geographical processes, but we did not have enough evidence, processed analytically and interpretatively about these difficulties.

4. Results

First, we present a part of the statistical results. About 69 papers were subject of our analysis. Seven students chose to represent and explain natural phenomena such as: the rainbow, the radar effect, the Coriolis force - 2 cases), the structure of the atmosphere, the slopes, and the explosion at Chernobyl. These works have not been subjected to our analysis.

Students enrolled in the Geography specialization selected the following processes: landslides (6 papers), the formation of torrents (1), suffusion (1), mud volcanoes (1), creeping (1), the orogeny (1), the formation of caldera (1), the volcanism, volcanic eruption or the formation of volcano vent (8), earthquakes (1) glacial erosion (1) tsunami waves (2), floods (1), avalanches (1), the formation of delta (3), the formation of the estuary (1) mountain breezes (1), sea breezes (6), the formation of Bora wind (4), the Föhn effect (6), the formation of clouds and rain (1), the El Nino phenomenon (1) the greenhouse effect (1), tornadoes (3), atmospheric fronts (1), desertification (1), suburbanisation (1). The 6 students from the specialization of geography of tourism chose to explain the following processes: the formation of the glacier, the formation of volcano vent, the wave formation, the water cycle in nature, the formation of delta, landslides.

In Tables 2 and 3 we present the statistical information regarding the schematic drawings and the graphic organizers realized by the students. After a first analysis of the papers for each type of product, we established several categories (classes) in which we classified (included), categories that had not been established at the beginning of research.

Table 2 Representations of the geographical processes through drawings, in the 62 papers

Papers without drawings	Papers with drawings with great errors	Papers with only one drawing	Papers with processes represented by successive drawings (by stages)			
			2 stages	3 stages	4 stages	5 stages
2	11	10	30	4	3	2

Table 3 Types of graphic organizers developed in the 62 papers

Papers with graphic organizers					Papers without the essential graphic organizers for the subject
Tables	Systemic	Linear scheme of cause-effect	Tree scheme	Cluster scheme	31
2	1	2	4	22	

Table 4 The evaluation grid for assessing the competencies to analyse a geographical process

Assessed product (sub-competency)	Standards of performance		
	High level (expert)	Medium level	Low level (incompetent)
Text	Correct Coherent Brief Complete - it answers the questions of the set of requirements	Correct + incorrect Coherent + incoherent Inconsistent/incomplete Incomplete - partly responding to the questions in the requirements	Incorrect incoherent Diffuse (?) Incomplete – it does not respond to the questions detailed in the requirements
Schematic drawing	Correctly represented It includes the main stages of the process It respects the conventional signs It has title, legend Information written in a condensed/concise form	partially correctly represented It includes some stages of the process It respects some conventional signs It has / does not have any title, legend Some information written in a concise form	Incorrectly represented It does not include the main stages of the process It does not respect the conventional signs It does not have any title, legend The information is not written in a concise form
Graphic organizer	Key Information correct information Information in a concise form Information systematized by logical criteria	Essential information + minor information Correct + incorrect information Concise + diffuse information Data partially systematized by logical criteria or unsystematized	Insignificant information Incorrect information Diffuse information Information unsystematized by logical criteria

In table 4 we present the evaluation grid for assessing the competency to explain geographical processes based on levels of competency and performance standards. The grid was designed to be used by people with superior competence level in Geography and Didactics of Geography, not being recommended to be applied, for example, by students in self-evaluation or inter-evaluation. We aim to establish an evaluation grid regarding the student's competency to explain a geographical process, but in a future study.

In Tables 5 and 6 we present the results of the assessment of students' products, by using the evaluation grid, which proves their sub-competencies and abilities to explain geographical processes. Table 6 presents the results of evaluation of texts, schematic drawings and graphic organizers of each paper. Each product was included in one of the following categories: high level (expert), medium level or low level (incompetent). We scored each level of competency.

Table 5 The evaluation of the sub-competency level for explaining geographical phenomena

Name of the product	The level of competency			Papers that do not contain the product
	The number of products of high level (expert) and the ratio of the total number of papers	The number of products of medium level and the ratio of the total number of papers	The number of products of low level (incompetent) and the ratio of the total number of papers	
Written text	5 – 8%	29 – 47%	28 – 46%	–
Sketch	15 – 25%	24 – 38%	22 – 35%	1 – 1%
Graphic organizer	–	10 – 16%	21 – 35%	31 – 50%

Table 6 The evaluation of the level of the individual competency to explain a geographical process

The level of sub-competency			Total score	The number of papers containing these sub-competencies	Total number of papers according to the score
Written text	Sketch	Graphic organizer			
M	S	M	4	5	9 papers - 14%
S	S	I	4	1	
S	S	No	4	3	
M	S	I	3	3	10 papers - 16%
M	S	No	3	3	
M	M	M	3	3	
S	M	No	3	1	12 papers - 19%
M	M	I	2	4	
M	M	No	2	8	
I	M	I	1	3	12 papers - 19%
I	M	No	1	3	
I	I	M	1	2	
M	I	No	1	1	
I	M	I	1	2	
M	No	I	1	1	
I	I	I	0	7	
I	I	No	0	12	19 papers - 30%

Note. S – high level (expert) = 2 points; M – medium level = 1 point; I – low level (incompetent) = 0 points; Not the case; No – the paper does not contain the product.

5. Observations and discussions

Subsequently, we analyse the competencies and sub-competencies of the students to explain a process and the geographical representations that they gave about some geographical processes

5.1. Observations on the explanations regarding geographical processes in a written text

By analysing the texts written in the students' papers, we evaluated the given definitions, the manner in which they explained the geographical processes and met the given requirements, as well as the structures of information they presented (classifications), analogies and examples.

- *Definitions.* Without having the logic knowledge about the process of defining notions, students included some of the terms (species) in the gender (category) to which they belong, “tornado represents a weather phenomenon, ”climatic phenomenon that presents risk” „Bora - katabatic cold wind, volcanoes - a subsoil phenomenon (!)”.

Without knowing the fact that there are several types of definitions, the students gave *illustrative-descriptive definitions*, in which they reveal characteristics of concepts: “volcanoes are cracks in the earth's crust through which magma, gas, ash and steam erupt”; “Caldera represents a giant crater that appears as a depression with a diameter of over 5 km”; “the tornado in contact with water is called gush”; “volcanism represents all phenomena and events that occur after the magma and its products erupt”.

Students formulated *functional definitions*, in which they described the process: tornado – “geographical phenomenon which appears like a violent storm”; mud volcanoes – “active volcanoes that expel mud”; “landslides - geodynamic phenomenon produced by the massive movement of a portion of the slope at a relatively high inclination of the slope”; “flood - the process by which a dry land is temporarily covered by water”; “suffusion - complex, mechanical process that consists of the dislocation of the fine particles of some friable rocks, by the temporary action of water”; tornado – “cone-shaped wind vortex”.

Students formulated *genetic definitions*, in which case they mentioned the possible cause of the process, "the desertification represents the phenomenon of expanding the desert region or area due to deforestation activities and action of other external agents" (the cause - deforestation and external agents); "landslides represent massive movements of land under the influence of gravity" (the cause - gravity).

Some definitions are combined: landslides - "massive land movements on the slope, produced under the influence of gravity and water (!) on areas of demarcation called plan of sliding (*genetic-functional definition*), delta - "a complex accumulation of land into the sea; Föhn - "a warm and dry air, a warm and dry wind that blows from peaks to valley" (*enumeration-descriptive - functional definitions*).

Definitions are predominantly empirical, have blanks and errors, fact which proves that students operate with empirical concepts, not with certified notions. In this study we tested the hypothesis according to which "students are able to formulate concepts based on the text of dictionaries and school textbooks, which are considered correct only on certain conditions: providing specialized dictionaries of good quality; assessing the concepts formulations by the teacher; providing additional information by the teacher after the first formulation; the teacher suggesting the necessary cognitive strategies to be used in conceptualizing (comparison of concepts) (Dulamă, 2009b). By the present research we obtained new information about conceptualizing - construction of definitions - information that should be used in the future teaching activities of students.

In formulating the requirement no. 1 students were asked to explain the geographical process by answering the following questions: Where? When? How? Under what conditions? Wherefore? What effects occur? However, they generally answered partially to these questions.

- *Localisation*. Students had various options to choose for the localization of the geographical processes. They located some processes in the world ("volcanoes - Pacific fire circle; mainly in areas of contact between tectonic plates, but also in places where the earth's crust is very thin or presents cracks - Hawaii Islands"), on continents ("tornado - North America"), within continents (Bora - the Dalmatian Coast of the Adriatic Sea, the Caucasian Coast of the Black Sea, the Baikal Lake), within a country, in certain regions (tornado - located in Florida peninsula - incorrect) relief units ("mud volcanoes in the area of curvature of the Sub-Carpathians"; suffusion located in Bărăgan Plain, Dobrogea, Moldova Plain, Transylvania), in some form of relief ("floods - usually in the meadows"), at the contact areas (sea breeze - at average latitudes, day breezes may go 30-40 km over the sea, while during night they may go only 10-15 km above the land; in the coast areas, at the contact between the land and sea/ocean), punctually, in certain localities (the mud volcanoes at Berca-Arbănași, Romania). In most cases, the localization is incomplete and a causal relationship between location and process is rarely being established.

- *Time/period*. Students made few references regarding the moment the processes occur. For example, they noted *the moment* a tsunami produces in Indonesia - on December 26th, 2004, *the frequency* tornado phenomena in North America - 800 tornadoes a year, *the period* the sea breezes appear - day and night breezes.

- *The description of processes*. Students proved to have some erroneous conceptions about the production of geographical processes: in the air, the carbon dioxide and other gases cause *the greenhouse effect* by storing the hot air which initially went upstream"; "volcanism represents all activities that lead to the outburst of magma and its elements to Earth's surface (make confusion with the definition of magmatism)"; "mud volcanoes - when in the roof that encloses the gas appear cracks in which water leaks and dissolves the clay (!), then, the oozy material can be raised to the surface and spread, like the process of a small volcano";

Some explanations of processes are incoherent: Föhn - "when climbing the exposed slope, up to the level of condensation, the air cools adiabatically, according to the dry gradient and from the condensation level to the peak, the cooling is made according to the wet adiabatic gradient. When descending, the air is heated only according to adiabatic gradient dry. As a result, the air reaches the sheltered slope warmer and drier than it was before it started to climb the mountain".

Some presentations of the process are incomplete, "tornadoes form at subtropical latitudes by going through lower latitudes of polar cold air, fact that causes the sudden rise of the tropical hot air"; tornadoes – "by rising, the warm air meets the cold air masses"; delta – "at the mouth of the river the flow speed decreases abruptly, hence the alluvial deposits being favoured, them being impediments for the current upstream. Therefore, the slope decreases, the water course prolong and spread into several arms"; the day breeze – "the land is warmer than the sea, fact that determines the breeze to blow from the sea to the land; at night, the sea is warmer than the land, which determines the breeze to blow from the shore to the sea".

Few descriptions of the processes are predominantly correct, more complete, being presented in a chronological order, as well. For example: *tsunami* – "by the sudden release of the plate subjected to tension, it raises and along with it the amount of water above. New waves start to circularly spread, their wavelengths reaching sizes up to several hundred kilometres and amplitudes smaller than of the waves generated by wind. They become dangerous when approaching the shore, because, once the depth decreases, the speed decreases, as well. Thus, it behaves like a train derailing. The front section slows down, while the back section continues to push with a great speed. There is a compression of energy, the wave rising; *bora* – "the air, that initially is very cold, which is gathered/stored behind a mountain. After some time, the very cold air mass succeeds to go beyond the orographic barrier. During the downward movement, the air fails to warm enough due to high speed of descent. Thus, reaching the warmer areas, bora keeps its character of cold wind and its very violent nature. The stages in the formation of bora wind: the accumulation of very cold air behind the mountain, the fall of cold air over the ridge towards the coastal areas, reaching high speed (40-60m/s, or 145-215 km/h); "the *suffusion* - after rainfalls, the water forms infiltration routes in the friable rock, by the dislocations and dissolution of fine particles; reaching the layer of clay, the water floods the loess layer and moves along the direction of the slope up to the slope, where it forms the suffusion spring; holes are formed, which expand over time, therefore resulting in the following forms: surface funnels that collect water, internally, the holes develop vertically – like chimneys and horizontally – like suffusion tunnels. Once these holes form, the water no longer moves by dripping, but by flowing, thus becoming aggressive and pulling materials from the walls. In time, it reaches an instability level, causing subsidence; by the fall of the tunnel ceiling a suffusion valley is formed. By extending and joining the suffusion valleys, a suffusion plain is formed, which represents the last stage of evolution"; *caldera* – at the beginning is a quiet eruptive activity. Due to the accumulation of magma and its consolidation in the upper crust, as well as because of the large quantity of gas and the high pressure, they determine a major explosive activity. These explosions result in widening the crater and the vent. The upper sector of the magma basin is partially cleared, while the upper sector of the vent cannot be supported anymore. Due to these explosions the vent structure cracks. Without any stability, the upper part of the cone collapses in the magma basin and forms the caldera".

Therefore, we notice that students have difficulties in presenting the production of geographical processes. Their texts contain **wrong** conceptions, blanks, errors and few descriptions of processes are predominantly *accurate, more complete, and presented in chronological order*. They do not demonstrate the knowledge of scientific methods for presenting a geographical process, in which to explicitly outline the stages of evolution, the steps/phases of evolution and their states, fact that makes us find, in the near future, new teaching models for scientifically explaining them.

- *Conditions*. Students identify some conditions in which processes occur: for the formation of mud volcanoes "three conditions are required, the existence in the same place: emanations of gas, "mud" rocks (clay, **shale**) and water for infiltration or the presence of water on the direction of emanations"; volcanism – "in the areas with very intense seismic and tectonic activity"; tornadoes – the place where the earth expands"; delta - low **tidal** action, rich alluvial flow, reduced depth of the sea in that area"; suffusion – "friable, loose, breathable, rock lying on a horizontal or cvasi-horizontal plan (i.e. loess); the base rock has to be impermeable, slightly angled to drain the water and to cross a slope; the climate has to prove alternative periods of high rainfall with droughts; "caldeira is formed in the magmatic relief of destruction; it especially appears in the case of volcanoes with **viscous** lava and with high level of gas emissions. It is obvious that they do not give appropriate attention to the role of

both the conditions and factors in the evolution of geographical process, showing a poor knowledge, conceptually and methodologically.

- *Causes.* Students often indicated causes incorrectly. For example, the cause of floods is not “the large quantities of precipitations” and “the snow melting”, but rather the fact that the water does not fit in the riverbed or the meadow. If, human settlements, agricultural crops and transport routes were not located in the riverbed or meadow, we would not consider them affected by floods. The waves are not “the results of the movement of the sea currents”. Sometimes they make the confusion between conditions and causes. For example, the causes of landslides are considered to be the following: a) the massive deforestation, the intensive grazing, the rich precipitations, the over-pasturing b) preparatory causes, related with geology stratum (permeable and impermeable rocks), anthropogenic actions, causes (seismic movements, the erosion action exerted on the slope of a river, precipitations). Sometimes they correctly explain the causes: volcanic eruptions occur when magma, under pressure, breaks and reaches the earth surface; the cause of landslides – gravity; the cause of sea breezes is the different manner the water heats in comparison with the land, hence a different distribution of pressure. Some students underline the cause-effect relationships: “during daytime the land heats faster (than the sea!), hence, the pressure is lower; on the sea, the situation is reversed: the sea has lower temperatures, hence a higher pressure; the air masses move each time from regions with higher pressure to regions with lower pressure, therefore the day breeze blows from sea to land”.

- *Effects.* Students identify many of the processes’ effects, they having high visibility level, being directly perceptible: desertification – “reducing the amount of oxygen in nature, decreasing the quantity of precipitations, the lack of hydrographical network or the deep phreatic layer”; volcanic eruptions – “soils with high fertility, burning clouds, earthquakes, bombs”; landslides – “the destruction of houses, transport routes, the relocation of villages, casualties, the appearance of lakes and wetlands”; floods – “destroy houses, crops, vegetation”; Föhn – “increasing air temperatures, decreasing air humidity, snow melting; Bora – “very high waves, ice deposits on facilities in ports and on ships, land spreading”; sea breeze – “decreasing temperature, increasing the level of nebulosity”; mud volcanoes – “bad lands”.

- *Classifications.* Even if it was not necessary, some students presented some classifications of the processes. Some of them do not have the classification criterion: “quiet eruptions in which the lava has basic character and explosive eruptions in which the lava has acid character; “landslides: detruing (top-down occurrence); (bottom-up by parallel breaking)”. Other students give details about the classification criteria: “according to the period in which they formed: active volcanoes, which still have eruptive activity and inactive volcanoes that currently have no activity, but there is evidence of their activity; inactive volcanoes from which we still notice the residual traces of their existence. The most comprehensive classification presented, yet, done outside the subject requirements, is represented by the weather fronts, such as: a) according to the direction of air: warm fronts, cold fronts, occlusive fronts, stationary fronts, b) according to their extension vertically: ground fronts, elevation fronts, troposphere fronts, c) according to the size of the horizontal thermal gradient: major fronts, secondary fronts, d) according to the movement of warm air over the front surface: anafonts, katafronts, mixed fronts.

In Table 5 we observe that all papers included at least a written text about the chosen geographical process. Only 5 students (8% of the papers reviewed) wrote a text which was assessed as of high level (expert), while 29 students (47%) wrote texts of medium quality, and 28 (46%) proved the lowest level of competency. By applying the evaluation grid and after making the punctual observations on the evaluated texts, we point out that students have difficulties in explaining the geographical processes in a written text.

5.2. Observations on the graphic representation of geographical processes, by drawing

Table 5 reveals the fact that one paper did not include any a schematic drawing, 15 students (about 25% of the papers reviewed) made a single one schematic drawing, which was considered of a high level (expert), 24 students (about 38%) fit into the category of medium quality, while 22 (about 35%) proved the lowest level of competency. The assessment according to the evaluation grid and the

observation points on schematic drawings reveals the difficulties students have when representing geographical processes. As compared to the formulation of explanatory texts, students got better results regarding the representation by drawing, ability that can be explained not by the talent students have in drawing, but by the fact that the human mind works predominantly with images and memorises them a lot easier, as compared to texts, even if they did not fully understand their significance. Images are more easily recalled than words, which are encoded in a single code (M. Miclea, 1999). Based on *dual coding theory* of Alan Paivio (1986), the same author believes that keeping accurate picture in the long-term memory can be explained by the contribution of three codes: imagistic, linguistic and semantic (*the hypothesis of the triadic code*).

Students who did not make their drawings correctly can be situated in different contexts: they might have not found their process drawn in a reference source, therefore they tried to represent it mentally (i.e. desertification, sub-urbanisation); they might have found the process graphically represented in a bibliographic source, but they did not studied it carefully, therefore they did not understand and remember it (i.e. the confusion between representation of landslides and that of a stream); or, some students did not attend classes and subsequently, they were not suitably prepared for solving the assessment module.

By assessing the graphical representation of geographical processes, we found several types of errors:

- the absence of title and legend;
- the misuse of conventional signs: arrows reversed from drawing to text (Fig. 1); not knowing the conventional signs for sand, clay, marl, loess (Fig. 1), etc.
- the extended writing, without brevity;
- the misrepresentation of some elements: the crest represented between the cirque glacier and the mountain peak (Fig. 4);
- the wrong placement of some elements (parts of a landslide in Fig. 1) and structure (Fig. 1);
- the preference for representation by drawing, not by sketches (i.e. tornado);
- the insignificant representation of some elements, such as: a transversal section across the desert, without any significance for desertification process; the Danube Delta – represented by three lines, corresponding to the arms and a few circles standing for accumulations (Fig. 3);
- the misrepresentation of some sections of the drawing (in Fig. 2 the mountain is not represented like a barrier against the mass of cold air);
- the wrong description of certain elements (the elements of a flood/torrent; the use of term “stones” instead of volcanic bombs; the terms of “latent lava”, reception basin, slope tributary, the slope of the slip and vent” associated with a text about landslides.

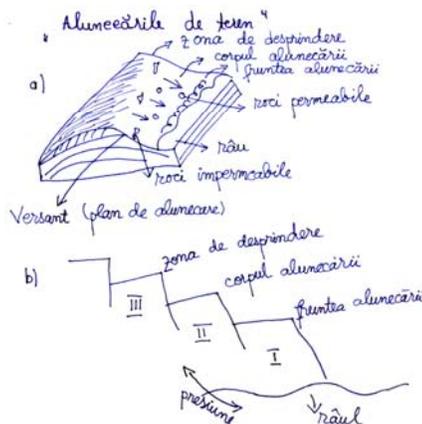


Figure 1 Landslides

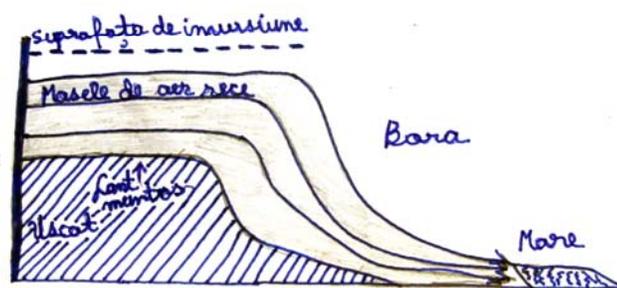


Figure 2 Bora Wind

The relatively correctly executed drawings are based on mentally stored representations from the university courses (classes) or from other sources (i.e. Fig. 6, 7, 8, 11, 13), except for one, that of mud volcanoes (Fig. 10), an original design, not being represented this way in any other source. In Fig. 5, the formation of delta is presented rather briefly. In Fig. 7 the sign (+), which actually means high pressure, not high temperature and the sign (-), which actually means low pressure, not low temperature are inverted. In Fig. 9 the condensation and freezing levels in the atmosphere are not represented. It is presented a clarification by using improper words, “low temperature”, or “optimum temperature”. It is used an unconventional system of signs to represent sedimentary rocks and oil and gas accumulations. It is made an analogy with a vent by transferring its parts (chimney and vent) and by using the term of “mud eruptions”. The “mud flows” and the “mud accumulations” are represented by overlapped layers. In Fig. 12 we notice other few mistakes: the non-use, along with the misuse of conventional signs, inaccuracies in the representation of magmatic bodies (Dike, Sill), and a discontinuity of the route of magmatic reservoir of magma to the surface by using lines.

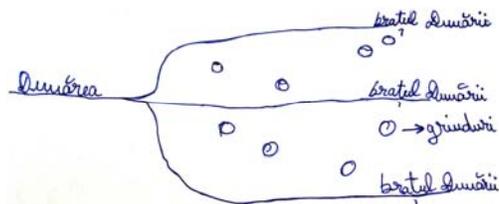


Figure 3 The Danube Delta

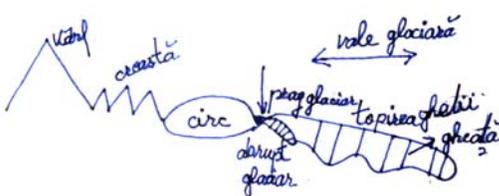


Figure 4 The formation of Glacier cirques



Figure 5 The formation of delta

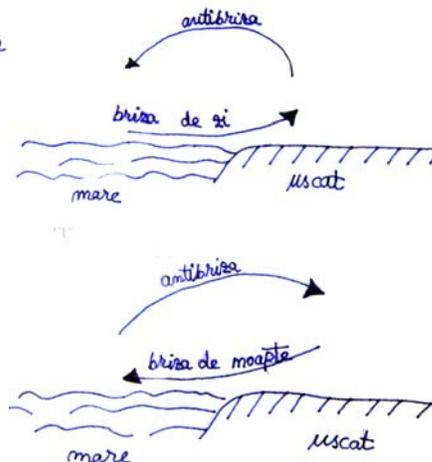


Figure 6 The sea breeze

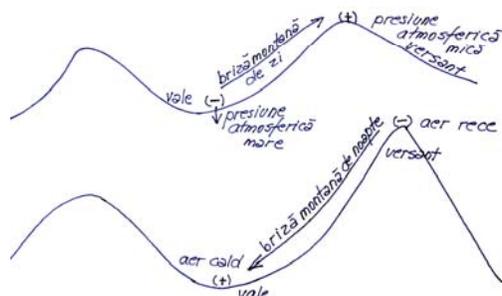
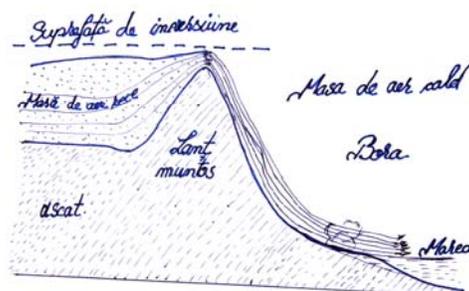


Figure 7 The Mountain breeze



Mecanismul formării bori (după Gh. Pop, 1988)
Figure 8 The formation of bora wind

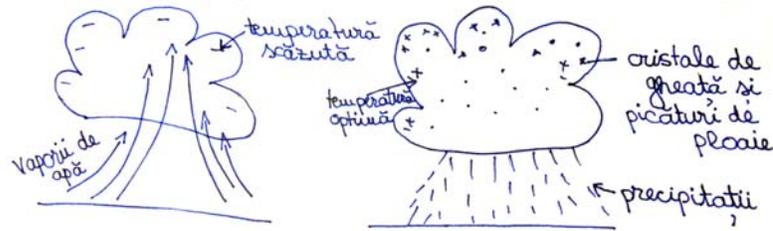


Figure 9 The formation of clouds and rainfall

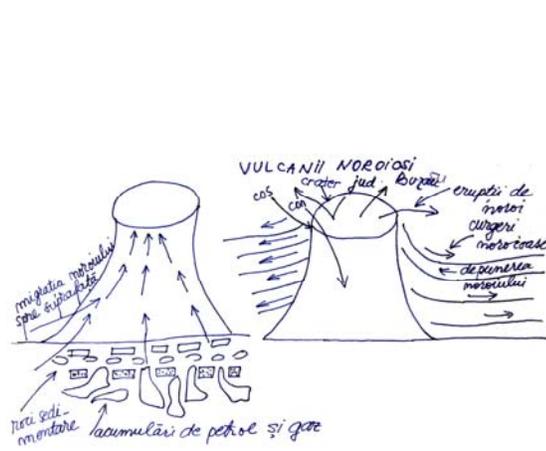


Figure 10 The mud volcanoes

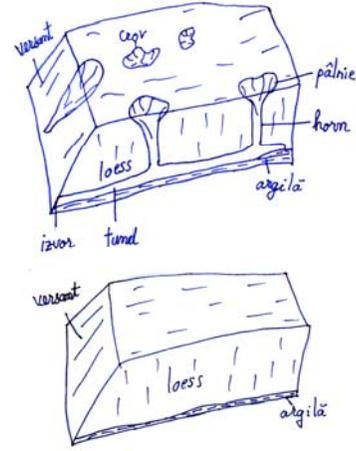


Figure 11 The suffusion

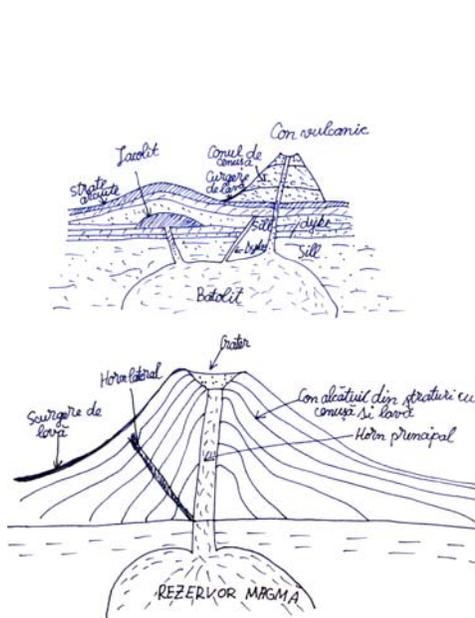


Figure 12 Volcanoes

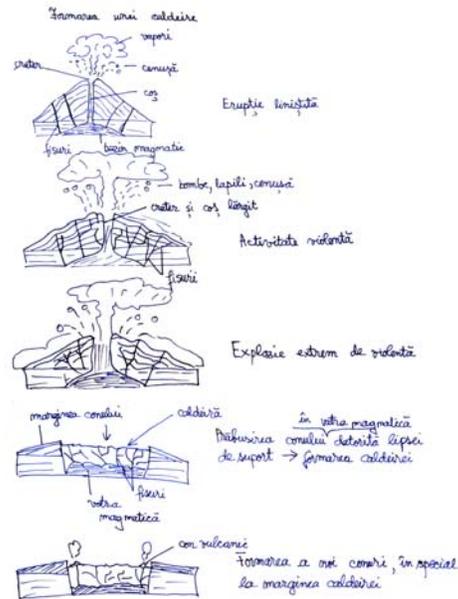


Figure 13 The formation of caldera

We highly notice that students who represented a geographical process by drawing, explained it partly in the text in an incomplete, incoherent manner, with mistakes, fact that proves their poor knowledge about the process. Students who represented the process by two drawings, explained the process more fully and correctly than those who made only one drawing, but less well than those who represented graphically 3 to 5 drawings. Therefore, we concluded that if the students represent a process through several successive drawings, they also manage to explain the text better. From the educational perspective, we concluded that, for students to acquire skills to explain the geographical processes at a high level, they should either consider to represent these processes by successive drawings or helped

by their teachers (by drawing on the blackboard) or to have as a start point well written texts. In a study based on the drawings realized during the seminar organized for the course of *Teaching Geography*, we established that students succeeded to represent landslides at a medium level of competency starting from a comprehensive explanatory text, without having any previously made drawings available (Dulamă, Ilovan, 2009). The fact that students have difficulties in explaining the geographical processes are also determined by the fact that they are generally not fully and clearly explained and represented in school textbooks, courses, lessons and seminars.

5.3. Observations on the representation of geographical processes, in the graphic organizers elaborated by students

In table 3 we notice that students realized graphic organizers of various types: tables (2), systemic graphs (1), linear layout scheme of cause and effect type (2), tree (4), cluster (22), while 31 students did not manage to create illustrative sketches. In Table 5, we note that no student achieved the upper level of competency in the case of sketches, 10 students (16% of total) were rated at a medium level of competency, 21 students (35% of total) situated at a low level of competency. These data show that students have difficulties in carrying out graphic drawings, these being explained by the fact that education curricula in Romania rarely underlines the importance of realizing graphic pictures and the course of *Teaching Geography* mentioned this subject in only one lecture, which was proved to be insufficient for the students to achieve these sub-competencies. We also notice that Table 7, which was drawn by a student, has data only in the first row, while Table 8 contains incorrect information (laccolith and batholith are not elements of the volcano) and information unstructured by logical criteria (there is a mixture between the products of the volcanic activity - lava flow - with the elements of volcanic device).

Table 7 Volcanism

Volcanism	Definition	Location	Formation	Specific processes	Specific forms of relief

Table 8 The elements of a volcano

The elements of a volcano	
<ul style="list-style-type: none"> - vent - laccolith - curved strata - lava flow - lateral chimney 	<ul style="list-style-type: none"> - main chimney - batholith - magma reservoir - vent made of ash layers and lava

We notice that in fig 14 there could be included more phases for detailing the progress of the process.

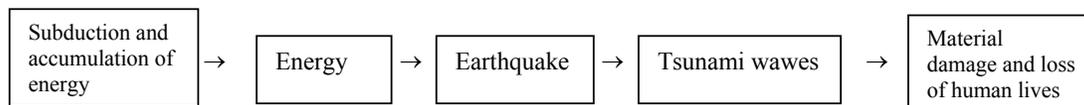


Figure 14. Linear horizontal scheme of cause-effect

Out of the cluster schemes accomplished, 12 are simple, with a single set of rings. In some rings, one word is predominantly included. Yet, rings should represent the satellites for other information. In other drawings, too many words are written in the rings, which prove that students do not have the necessary capacity to create such synthetic schemes. In many rings, information was inserted randomly, without being ordered by logical criteria, which proves the inability of students to select the essential information that may be related to the keyword in the centre. For example, in a cluster, the word Föhn was related to the following: a) decreasing humidity, condensation, altitude, peak, cooling, heating; b) increasing temperature, hot and dry wind, decreasing humidity, semi-desert regions, the emergence in the mountain areas, which negatively affects people; c) unexposed slopes,

mountain regions, katabatic warm and dry wind, snow eater, semi-desert landscape, Argentinean Andes, Switzerland Plateau, Făgăras Massif. In case of the sea breeze, rings were related to elements such as: a) local wind specific to coastal area, day breeze, night breeze, temperature and pressure differences, increasing rainfall, increasing the cloudiness, moderating temperatures, b) the offshore, day breeze, night breeze, day breeze on 30-40 km, night breeze on 10-15 km, the wind that blows over Romania, 4 -7m/s day breeze, the 3m/s night breeze, sea; c) coastal area, alternating direction, different distribution of pressure, moderating high temperatures, increasing cloudiness, perceived up to altitudes of 1500-3000 m. In case of flood, the scheme provided the following information: covers the land, is determined by snow melting and excessive raining, is not permanent, it damages vegetation and crops, thus affecting the community. Figure 15 shows how both accurate and inaccurate information was included (not just soil slides! Only clay soil slides!).

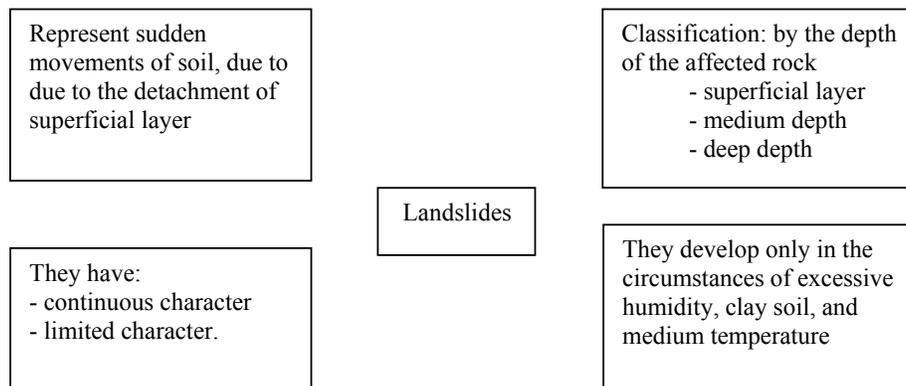


Figure 15 Cluster scheme: Landslides

In 10 of these cluster diagrams we notice a certain type of information organizing by logical criteria. As we asked the students to organize their explanation into six questions (and provide answers), we expected them to bring together the information around these questions or keywords (location, time, cause, condition, performance, effects), but our hypothesis was not confirmed.

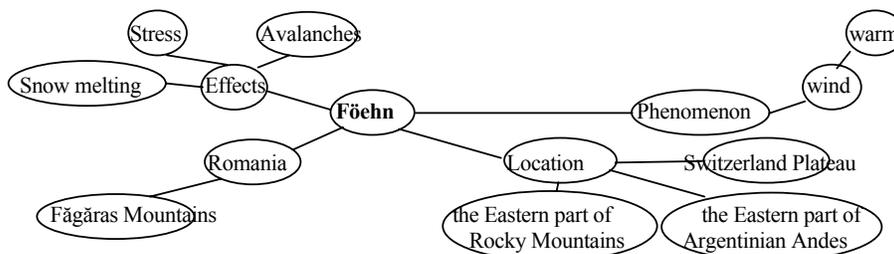


Figure 16 (a) Cluster scheme: Föhn

The **orogeny** was explained through a tree scheme in which its stages and phases are described.

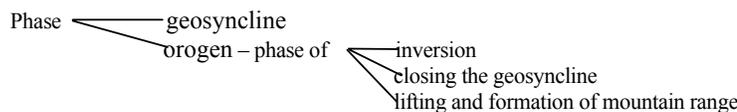


Figure 16 (b) Tree scheme: The **orogeny**

The systemic scheme of volcanism presents the situation in which eruptions are associated with **magmatic** bodies formed within the earth, when in fact they may form and without eruption. The scheme reveals that pressure and earthquakes cause the genesis of volcanism, without distinguishing between causes and conditions. They wrongly induce that the formation of batholith's neck, causes the formation of dike, and subsequently the rift and syll.

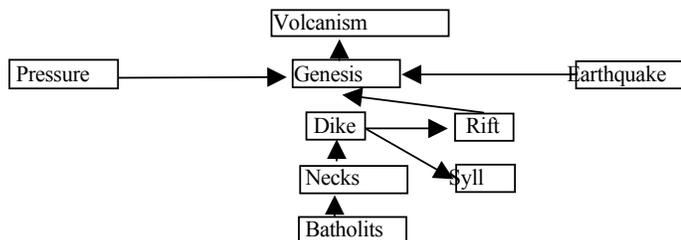


Figure 17 Systemic drawing: Volcanism

However, the scheme of the Danube Delta is more successfully done, which states the most originally, along with the connection lines: location, elements, age and status.

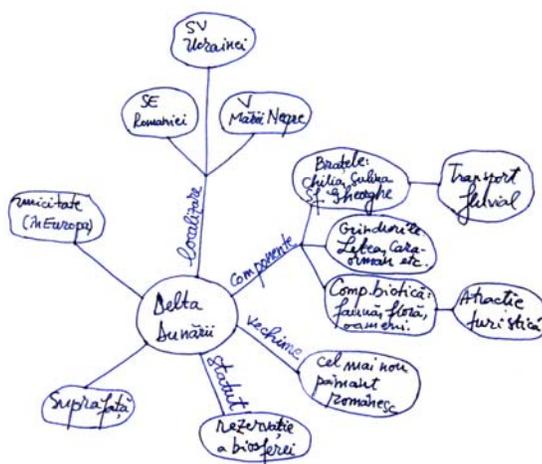


Figure 18 Cluster: The Danube Delta

We will point out several *types of errors* that frequently occur in the representation of information:

- they are not grouped by logical criteria, for example, they do not include: classifications, criterion for classification and classes; the stages of processes that are represented graphically, the relationships between systems elements (be them spatial, dynamic, cause and effect);
- they are not presented in the most concise manner, fact that makes it more difficult to observe as a whole; however, the aim of the scheme is not achieved;
- the essential information is not underlined and it cannot be distinguished from the non-essential one;
- some information is wrong.

We conclude that students have serious difficulties in representing geographic processes through sketches, even more difficult than writing a text and create a graphic drawing. These difficulties are explained by the fact that students do not understand the scientific level of geographical processes, or they do not prove the necessary abilities like comparison, synthesis, abstraction, evaluation, at a high level. Much more, they do not know sufficient models of schemes and techniques for their

representation. Therefore, in the following studies we plan to give more importance to forming the skills of the students to create schemes.

6. Conclusions

1. We achieved our research objectives by: analyzing skills and sub-competencies of the students to explain a geographical process; analyzing the representations of some geographical processes and the assessment of skills and sub-competencies to explain the geographical processes by an evaluation grid. All papers evaluated were written in June 2007, by second year students attending the course of *Teaching Geography*, lectured at Faculty of Geography, for two specializations, *Geography* and *Geography of Tourism*. The whole group of students attend the lectures, which are parts of the psychology –pedagogy module to become teachers of geography.

2. After analyzing the sub-competency of students to explain a geographical process in writing we state the following:

- use predominantly empirical definitions, which prove that they operate with empirical concepts, not with concepts formulated by logical criteria;

- without knowing that there are several types of definitions, they formulated: *enumerative-descriptive definitions*, *functional definitions*, mixed definitions (*genetic-functional definitions*, *enumerative-descriptive-functional definitions*), fact that is explained by the specific logical development of human thinking;

- they have difficulties in describing the production of geographical processes, according to specific conditions, time and place, thus finding in their texts incorrect conceptions, blanks, errors. Few descriptions are *predominantly correct*, *more complete*, *being listed in chronological order*. They demonstrate lack of knowledge regarding the scientific methods of presenting a geographical process, in which to be explicitly detailed its stages of evolution and their states. Therefore, we conclude that our future research shall insist on finding new scientific models to be used by students in their explanations.

- they often show the causes incorrectly, they rarely identify the cause-effect relationships between phenomena, and sometimes confuse the conditions with the causes. They identify a multitude of effects due to their high level of visibility, them being directly perceptible.

- even if it was not necessary, some students presented classifications of geographical processes, but without mentioning the classification criterion, which proved a poor level of knowledge both conceptually and methodologically.

In assessing this sub-competency based on the evaluation grid designed for this study, we state that few of the students (5 students - 8% of total) wrote a text, at a superior level of competency (expert), most of them formulating the text at a medium (29 students - 47%) or low level of competency (incompetent) (28 - 46%). Results confirm that students have difficulties in explaining the geographical processes in writing.

3. In case of evaluation of drawings we notice the following:

- the relatively correct drawings are based on mentally stored representations from various sources, except for one (that of mud volcanoes);

- if the geographical process is represented through several successive drawings, it is more correctly and fully explained in the text;

- some students did not execute correctly their drawings for different reasons (either they did not find a reference work in which the process was represented by drawing, therefore they tried to represent it mentally, or, they found the process represented by drawing in a reference source, but did not studied it carefully, did not understand it and did not learn it; another cause may be the fact that they did not attend classes, therefore they were not quite ready to solve these assessment tasks), thus demonstrating that they have the lowest level of sub-competency (incompetent);

- some representations have blanks and mistakes of various kinds, which proves again the lack of knowledge about the process.

By using the evaluation grid, in this case we observe that 15 students (25% of all the analyzed papers) achieved a schematic drawing at a high level of competency (expert), 24 students (38%) accomplished their task at a medium level and 22 of them (35%), reached the lowest level of competency. As compared to the explanatory texts, students achieved better results through drawing representations, thus confirming the first hypothesis of our research: the ability to explain a geographical process in writing is more difficult to achieve than the sub-sub-competency to represent a geographical process through a previously studied schematic drawing.

4. In the analysis of the sub-competency students have to illustrate geographical processes through graphic representations, we underline the following:

- 31 students made graphic representations of various types (tables, systemic drawing, linear scheme of cause and effect type, tree and cluster diagrams) while 31 of them did not manage to realize proper graphic drawings;
- only 10 drawings, proved that students attempted to sort the information by logical criteria, which demonstrates that they are yet competent to organize the information graphically, synthetically and systematically;
- the information is rarely presented in a condensed form, so they have not yet developed their ability to highly summarize;
- the essential information is not selective and differentiated from the unessential, which proves their poor capacity for abstraction and conceptualization;
- some of the information is incorrect.

By assessing this competency based on the evaluation grid, we conclude that no student achieved the high level of competency in the case of drawings, 10 students (16% of total) were rated at a medium level of competency, while 21 students (35% of total) were situated at a low level of competency. Based on qualitative and quantitative analysis and evaluation of drawing, we can confirm our second hypothesis: the sub-competency to illustrate a graphic representation of a geographical process proves to be more difficult than the sub-competency to represent a geographical process through a previously studied schematic drawing. This is explained by the fact that students do not understand the geographical processes at a scientific level, they do not have the necessary abilities, developed to a high level (so that they should be able to compare, synthesize, theorize, evaluate) and they cannot properly identify the models and techniques of representation.

By the comments made on students' papers, we prove that they have the ability to explain geographical processes at a medium and low level and that they have many difficulties, some of which we highlighted in this study. These observations are useful for improving the methodology of studying geographical processes during lectures and seminars of *Teaching Geography* and other subjects, this representing the objective of further studies. In the following studies we shall also list the entire information set that can be integrated in the competency to explain the geographical processes, which was detailed in this paper. The evaluation grid for assessing the competency to explain the geographical processes, based on levels of competency and performance standards, which is explained in this study, is recommended to be used by experienced persons at a superior level of competency in subjects like *Geography* and *Teaching Geography*, not suited to be used, for example, by students in self-evaluation. In this case, we aim at establishing more detailed evaluation grids.

References

- [1] Brien, R. (1997), *Science cognitive & formation*, Presses de l'Université de Québec
- [2] Dulamă, Maria Eliza, (2001), *Elemente din didactica geografiei*, Cluj-Napoca, Editura Clusium
- [3] Dulamă, Maria Eliza, (2008), *Elemente de didactică. Teorie și aplicații*, Editura Clusium, Cluj-Napoca

-
- [4] Dulamă, Maria Eliza, (2009a), *Caracteristicile si competentele profesorului într-o societate a cunoasterii*, în Maria Eliza Dulamă, Florin Bucilă, Oana Ramona Ilovan, *Tendinte actuale în predarea si invatarea geografiei. Contemporary trends in teaching and learning geography*, Editura Presa Universitară Clujeană, Cluj-Napoca
- [5] Dulamă, Maria Eliza, (2009b), *Studiul conceptualizării cu studentii*, în Maria Eliza Dulamă, Liliana Ciascai, Oana Ramona Ilovan,
- [6] Dulamă, Maria Eliza, Ilovan, Oana-Ramona, (2009), *Study on students' representations starting from texts about geomorphological processes*, în *Universitas Babes-Bolyai, Psychologia-Paedagogia*, LIV, 1, p. 133-142, Cluj-Napoca
- [7] Eysenck, M.W., Keane, M.T., (1992), *Cognitive Psychology*, Hillsdale, Lawrence Erlbaum Associates Publishers, London
- [8] Julean, Livia, Mosutiu, Gabriela (2008), *ABC-ul chimiei*, Editura Eikon, Cluj-Napoca
- [9] Miclea, M. (1999), *Psihologie cognitivă. Modele teoretico-experimentale*, Editura Polirom, Iasi
- [10] Paivio, Allan, (1986), *Mental representation: A dual coding approach*, Oxford University Press, Oxford
- [11] Piaget, J., Inhelder, B., (1969), *Psihologia copilului*, Editura Didactică si Pedagogică, Bucuresti
- [12] Roegiers, X. (2000), *Une pédagogie de l'integration*, Paris-Bruxelles: De Boeck Université
- [13] Todiras, Alexandru-Dan, (1999), *Dictionar de geografie*, Editura A. D. Todiras, Iasi
- [14] Zlate, Mielu, (1999), *Psihologia mecanismelor cognitive*, Editura Polirom, Iasi

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