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DEVELOPING ANALYTICAL THINKING THROUGH THE USE OF MAPS IN GEOGRAPHY

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ABSTRACT

The purpose of the study is to investigate the effects on students' analytical thinking of a learning activity based on the analysis of flowing waters, represented on a hypsometric map. 20 students from the 8th grade participated in the study. The experimental design included three stages: in the first stage in which the students were asked to analyze flowing waters based on a map; in the second stage the students analyzed, in groups, the flowing waters represented on a hypsometric map using a worksheet; in the third stage the students solved the task received in the first stage. The results show that the students, after the formative intervention, have a higher level of competence in analyzing flowing waters on the hypsometric map and that the worksheet determined the increase in the level of competence and contributed to the development of analytical thinking.

Keywords: competence, thinking operation, hypsometric map, worksheet, watershed

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INTRODUCTION

To design and organize learning activities in which students practice analytical thinking, geography teachers should understand its characteristics. Analytical thinking is built on the basis of analysis, a term for which a series of attributes are mentioned in dictionaries and specialized works. Analysis is considered a fundamental operation of thinking (Golu, 2007; Zlate, 1999), a method of scientific research (Romanian Academy, 2009, 2010), a major category of objectives in the cognitive domain (Bloom et al., 1956) and a cognitive process (Anderson et al., 2001).

In dictionaries, to analyze means to examine a whole or a phenomenon by looking at each element (Romanian Academy, 2009). This examination of a fact, body, or situation is carried out meticulously, through physical or chemical means, after breaking them down into their elements or component parts (Romanian Academy, 2010). Analysis is also a scientific research method involving the systematic study of each element separately, detailed examination of a problem (Romanian Academy, 2009), exploring processes and objects in reality after breaking them down into their constitutive parts (Marcu, 2000). Analysis proceeds from effect to cause, from compound to simple, from general to specific (Romanian Academy, 2010).

Analysis as a cognitive operation. In psychology, analysis (along with comparison as an auxiliary) is a fundamental general operation of thinking, alongside synthesis (with classification as an auxiliary), abstraction, and generalization (Golu, 2007). Through this operation of thinking, a "whole" (a construct of information) is dissociated or broken down in the mental plane into parts and component elements (Golu, 2007). An object is mentally dismembered into its elements or its component parts, with the aim of determining its essential properties and the significance of each element within the whole (Zlate, 1999). Analysis is an operation used in approaching and resolving tasks aimed at knowledge across all domains (Golu, 2007).

Through this intellectual-reflexive type of analysis, the aim is to achieve a cognitive-theoretical or applied goal, seeking answers to certain questions ("what?" and "how?"). The activity of knowledge penetrates into the interior of objects, revealing their specific internal structure and the relationships or connections between the parts that make them up (Golu, 2007). Object decomposition is done to describe its internal structure by identifying the characteristics of its component elements and the interactions between them. The analysis is conducted based on certain logical criteria and is referenced to a model or a standard (Golu, 2007). Through analysis, the necessary is distinguished from the accidental, the essential from the non-essential, internal properties specific to the object are selected, and the non-essential, accidental properties and conditions are eliminated (Zlate, 1999).

Sensory analysis is the action performed at the level of the non-essential attributes of objects and phenomena, concrete, material (Zlate 1999). At the level of thought, analysis moves into abstraction. As an operation of thought, analysis involves action in the mental plane, with the essential attributes of objects and phenomena, and leads to the construction of "mental objects," general, without a counterpart in reality (Zlate 1999). Accompanied by comparison, evaluation, and hierarchy, analysis plays an essential role in the process of thinking to discover the essential and what is lawful in reality or to find solutions to problems (Golu, 2007).

Analysis in the taxonomy of objectives. In the field of education sciences, analysis is one of the major categories of objectives in the cognitive domain in the original taxonomy developed by Bloom et al. (1956). The taxonomy includes six categories of cognitive objectives, hierarchically ordered from simple to complex and from concrete to abstract: "Knowledge"; "Comprehension"; "Application"; "Analysis"; "Synthesis"; "Evaluation". The taxonomy represents a cumulative hierarchy, as mastery of each category is a prerequisite for mastering the next, which is more complex (Krathwohl, 2002). The Analysis category includes three subcategories: "Analysis of elements"; "Analysis of relationships"; "Analysis of organizational principles" (Krathwohl, 2002).

Anderson et al. (2001) revised Bloom's taxonomy and organized it into two dimensions: the knowledge dimension and the cognitive process dimension (Amer, 2006). The structure of the cognitive process dimension includes six processes: "Remember," "Understand," "Apply," "Analyze," "Evaluate," "Create" (Krathwohl, 2002). "Analyze" means to break down the material into its constituent parts, identify the way the parts are linked, and the structure. The process "Analyze" involves: "Differentiating," "Organizing," "Attributing."

In the structure of the knowledge dimension, the process of "Analyze" focuses on: factual knowledge (terminology; details and specific elements), conceptual knowledge (classifications and categories; principles and generalizations; theories, models, and structures), procedural knowledge (specific skills of the discipline; specific techniques and methods of the subject; criteria), metacognitive knowledge (strategic knowledge, knowledge about cognitive tasks, context and conditions, self-knowledge) (Krathwohl, 2002).

Analysis within analytical thinking. Analytical thinking is considered in literature as a thinking tool (Amer, 2005), skill (Amer, 2005; Bednarz et al., 2013; Fitriani et al., 2021; Parta, 2016), capacity (Amer, 2005; Gregory, 1988), competency (Perdana & Rosana, 2019). Amer (2005) considers that analytical thinking is: a thinking tool used to understand the parts of a situation; the ability to analyze and decompose facts and ideas and to identify their strengths and weaknesses; the capacity to think judiciously, rationally, with discernment, in data analysis, problem solving, remembering, and utilizing information.

Analytical thinking is described as the ability of a person to tackle problems by deconstructing their parts in a methodical way, with attention to detail, gathering as much information as possible to clarify things and reach logical conclusions based on facts, planning before deciding (Gregory, 1988). Amer (2005) warns that breaking down a whole into increasingly smaller components implies the risk of not perceiving the interactions between them.

Analytical thinking is used in various contexts: in ambiguous situations where students should identify or create a problem for solving (Robbins, 2011); in analyzing phenomena and solving real-world problems (Fitriani et al., 2021); in learning to obtain, evaluate, collect, and process information from diverse sources appropriately (Meisandy et al., 2021); in problem-solving processes (Parta, 2016). Analytical thinking is delineated by several "indicators": problem identification, analysis of the causes (factors) of a phenomenon, forecasting possible problems, proposing solutions, and developing analytical scientific text (Setiawati Rokhis, 2018).

Amer (2005) presents analytical thinking in relation to various types of thinking (synthetic, systemic, critical, creative) and problem-solving. Bednarz et al. (2013) emphasize that students should possess analytical thinking skills to address diverse and complex challenges in the environment. With the help of analytical thinking skills, students should be able to solve environmental problems "wisely" using technology (Meisandy et al., 2021). The competence to think analytically is a requirement that should be fulfilled in modern education (Perdana & Rosana, 2019).

The competence to analyze. In the works of geography didactics in Romania, analysis is described as an essential operation of thinking (Dulamă, 1996, 2001), as a step in describing and exemplifying Bloom's taxonomy (Dulamă, 1996, 2001). The competence to analyze is associated with certain contents (for example, the competence to analyze the geographic cover) (Dulamă, 2010d) and external visual representations: the competence to analyze a photograph (Antal, 2020; Dulamă, 2010d), the competence to analyze a map, the competence to analyze a chorematic representation (Dulamă, 2010d), the competence to analyze a diagram (Dulamă, 2010d; Dulamă, 2011b).

Brien (1997) defines competence as a set of declarative knowledge, procedural knowledge, and attitudes possessed by a person, which are activated in the planning and execution of a task in a specific situation within a domain. Dulamă (2010b, 2010d, 2011b) extends the definition of competence, considering it as a complex capacity and an action or process through which a person mobilizes and processes (selects, transforms, combines, integrates) appropriately, efficiently, in a timely manner, an ensemble of internal resources (knowledge, abilities, skills from the individual's own repertoire) and external resources, to plan and execute, independently, a complex task or a group of tasks within a certain domain, carrying out a large number of operations and reaching a visible and evaluable result (Dulamă, 2010b, 2010d, 2011b).

In the works of geography didactics in Romania, regarding the development of specific geographical competences and the evaluation of the competence level of students, a model in tabular structure was presented that includes the knowledge (declarative, procedural, and attitudinal) integrated within a competence and the procedural approach (Dulamă, 2009, 2010d). In several studies in Romania, this tabular structure has been used to describe certain specific geographical competences and the formation of those competences has been investigated: the competence to elaborate a tourist plan (Osaci-Costache et al., 2013c), to elaborate a column diagram (Osaci-Costache et al., 2013b), to elaborate a topographic profile (Osaci-Costache et al., 2013a), to elaborate the plan of a real building (Dulamă, 2011a), to elaborate a land use plan for a watershed (Dulamă et al., 2016), to elaborate a map sketch (Dulamă & Ilovan, 2016). In assessing the level of competence, in the mentioned studies, dichotomous evaluation grids of an analytic type were used, which were organized based on several criteria and indicators associated with these criteria.

The competence to analyze hydrographic units. The development of this skill is initiated by acquiring the first knowledge about water. Children acquire knowledge about flowing waters in preschool education, in learning activities in the field of "science" (Dulamă 2012), and in primary education in the subjects of "Mathematics and Environmental Exploration" (Dulamă 2010a) and in "Geography" (Dulamă 2011c). In the fifth grade, in the subject of "Geography," students acquire knowledge about the hydrosphere (Dulamă, 2007, 2010e). In middle school, students develop the skill of analyzing hydrographic units located on continents and in different countries (Dulamă, 2010b; Ilovan et al, 2010), as well as by studying their place of residence (Dulamă, 2010c).

The flowing waters of Romania have been investigated from multiple perspectives by researchers, with all these studies being based on analytical thinking, analysis as a research method, and requiring the use of a higher level of expertise in analytical competence. Various issues related to flowing waters have been researched: the multiannual average flow in the Tur River basin (Pop & Horváth, 2009), the seasonal flow regime of small rivers in the eastern Apuseni Mountains (Sorocovschi et al., 2014) and in the southwestern Apuseni Mountains (Sorocovschi et al., 2015), the flow regime in the Mureș Corridor between the confluence with the Arieș and the city of Reghin (Conțiu, 2006), the characteristics of high-flow periods on rivers in the Căliman Mountains (Hârlav & Sorocovschi, 2020), the water balance in the Someșan Plateau (Sorocovschi et al., 2009) and in the Căliman Mountains (Sorocovschi et al., Horvath & Hârlav, 2018), the potential of the average liquid flow in the Someșan Plateau (Sorocovschi & Horvat, 2007). Floods have been investigated in cities in the Târnava River basin (Conțiu & Conțiu, 2007a), natural hazards in the locality of Izvorul Crișului (Roșian et al., 2021), and the effects of relief on the flow of rivers in the Căliman Mountains (Hârlav, 2023b).

Through remote sensing, the hydrological impact of changes in forested areas has been studied (Sidău et al., 2021), and floodplain bands have been digitally mapped using statistics, hydraulic calculations and GIS spatial analysis (Bilașco & Horváth, 2016). Some studies have been dedicated to researching the dynamics of the Mureş river bed (Pandi & Horváth, 2012). In a few studies, the residents' perceptions regarding the risks induced by floods in the Gurghiu basin (Conţiu & Conţiu, 2017), in the Târnava basin (Conţiu & Conţiu, 2007b), in the Mures corridor (Conţiu & Conţiu, 2005) were analyzed and interpreted.

Some studies have focused on the research of flowing waters together or by students, for instance, dysfunctions in the territory of the Galda de Jos commune, Alba county (Popa et al., 2017), the relationship between the Iara River and other components of the environment in the Ierii Valley (Rus et al., 2019; Rus et al., 2020), the project for the development of the Someșul Mic River "Someș Delivery" (Ilovan et al., 2020).

Purpose, variables and research hypothesis

Starting from these findings, the purpose of our study is to investigate the effects on the analytical thinking of students during a learning activity based on the analysis of flowing waters represented on a hypsometric map. In this regard, the variables of our study are as follows: the observation and analysis on the hypsometric map of the flowing waters in a mountainous unit, guided through a worksheet developed by the teacher (independent variable) and the volume of information about the flowing waters extracted by students from the hypsometric map (dependent variable). For the study, the following research hypothesis was formulated: the volume of information about the flowing waters extracted by students through analyzing a hypsometric map of a mountainous unit, guided by a worksheet developed by the teacher, is greater than before this learning activity.

METHODOLOGY

Participants. In the study, 20 students from the 8th grade at the Theoretical High School "Radu Petrescu" in the town of Prundu Bârgăului, Bistrița-Năsăud county, participated. The students have an average age of 13-15 years, of both genders. The school selection was based on criteria: located in Bistrița-Năsăud county; regular attendance of school by students. The class selection was based on criteria: the geography teacher in the class is the organizer of the learning activity and a co-author of the research. The students were selected based on four criteria: belonging to a class selected for research; regular school attendance by students; informed consent; voluntary participation in all activities organized in the study (pre-test, formative intervention, post-test), without rewards or grades. Student consent was obtained after informing them about the research objectives, the conditions under which the research is conducted, the requirements they need to adhere to, and after clarifying certain issues requested by the students. From the parents of the students involved in the study, after informing them, consent for their children's participation in the research was obtained and this consent was recorded in a written agreement. All legal and ethical requirements mentioned in the "General Data Protection Regulation" (GDPR) were respected in conducting the study, and the confidentiality of personal data regarding students was maintained.

Procedure. The study took place in the year 2023. The experimental design consisted of three stages: the first stage where students were asked to solve a written task; the formative intervention stage where the learning activity in class was organized; the third stage where students were asked to solve the task given in the first stage.

Didactic activity. After solving the task from the first stage, the students received the following task: In groups of four you will analyze the "Hypsometric Map of the Călimani Mountains". You will proceed by following the procedures and indications specified in the "Worksheet" (Table 1). You have 20 minutes to complete the task. After analyzing the map, each student will write another text.

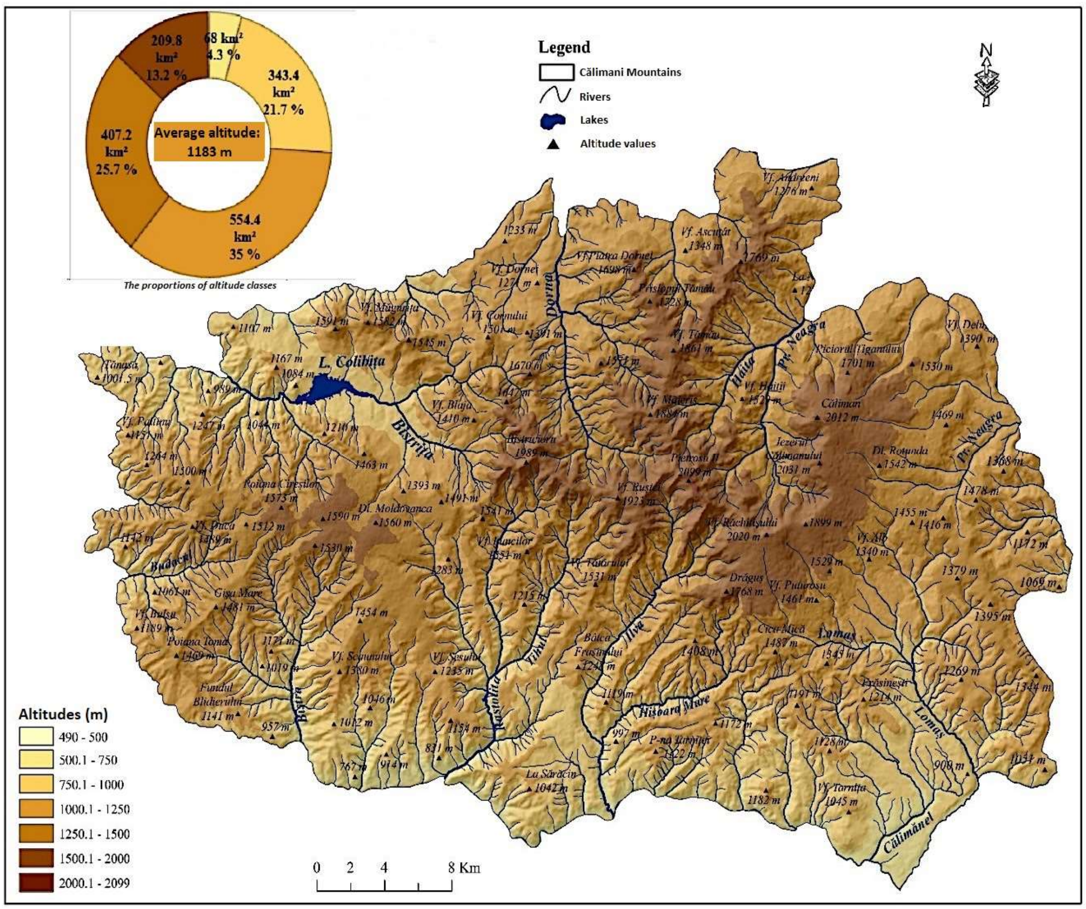
Table 1
Worksheet

Fear	Actions
1. General characteristics of the hydrographic network within the territorial unit.	1.1. Identify the main rivers that collect water from the territorial unit. 1.2. Identify for each main river whether it originates in the territorial unit (autochthonous river) or in another unit (allochthonous river). 1.3. Identify the places/areas where the sources of the main rivers are located. 1.4. Identify the direction of flow of the main rivers.
2. Characteristics of the main flowing waters	2.1. Identify for each main stream of water the component parts and their characteristics: the source, the characteristics of the river course (the direction of water flow, the appearance/sinuosity of the route, length), the mouth of discharge. 2.2. Identify the tributaries of each main watercourse and their characteristics (density and their position in relation to the right or left side of the collecting river, length).

3. Characteristics of the hydrographic basins of the main flowing waters	3.1. Analyze the shape and orientation of the hydrographic basin for each main watercourse. 3.2. Analyze for each hydrographic basin the collecting river, the density, and the position of tributaries.
4. The relationships between flowing waters and the terrain.	4.1. Identify the predominant relief form (and those with smaller extensions) in the territorial unit over which the hydrographic network is developed. 4.2. Identify the characteristics of the predominant landform (maximum altitude, minimum altitude, orientation of the main ridges).

Figura 1

Hypsometric map of the Călimani Mountains (Hârlav, 2023a, p. 31)



Instruments. As a data collection instrument, an evaluation form (Table 2) was used, which was designed for this research and validated by an expert in geography didactics. The content of the evaluation form is correlated with that of the map analyzed by the students in the formative intervention stage. 100 points were awarded to students for completing the task. Scores were calculated for each student. To verify if there are significant differences between the two experimental stages, the group mean was calculated at each test, and the results were compared. In both testing stages, students were asked to complete the following task: Observe the "Hypsometric Map of the Călimani Mountains". Analyze the flowing waters represented on the map. Write a text titled "Flowing Waters in the Călimani Mountains".

Table 2
Evaluation form/sheet

Content elements	Microelements of content	Score	Score total
1. General characteristics of the hydrographic network	1.1. The names of the main rivers	2.5	10
	1.2. Native rivers/foreign rivers	2.5	
	1.3. The areas with springs	2.5	
	1.4. The direction of river flow	2.5	
2. The characteristics of main flowing waters	2.1. The component parts and their characteristics	30	60
	2.2. Characteristics of the tributaries	30	
3. Characteristics of the main hydrographic basins	3.1. The shape and orientation of hydrographic basins	10	20
	3.2. The density and position of the tributaries in the hydrographic basins		
4. The relationships between flowing waters and terrain.	5.1. The predominant landform	2.5	10
	5.2. Characteristics of the predominant landform	7.5	

The evaluation sheet was designed based on the prior knowledge of the eighth-grade students and the integrated knowledge of the competence to analyze flowing waters within a territorial unit. (Table 3). In this table are included the essential knowledge that students need to analyze the flowing waters on a hypsometric map of a mountain unit, as well as some relevant knowledge for this competence.

Table 3
The integrated knowledge of the competence to analyze flowing waters within a territorial unit

The type of knowledge	Integrated knowledge
Declarative	*Concepts:* power source, flow rate, riverbed, water speed, flow, flood, overflow *Classifications*: category of running waters (brook, river, stream), forms of fluvial relief (thalweg, riverbank, minor riverbed, major riverbed, terraces, slopes), category of hydrographic units (running water, groundwater, etc.) *Structures*: flowing water (spring, river course, river mouth), hydrographic basin (tributary, confluence, watershed, collecting river)
Attitude	The correct, complete, systematic analysis of running waters, respecting the specified requirements. The correct use of concepts
Procedural	Map analysis procedure for a flowing water Map analysis procedure for a watershed Map analysis procedure for the relationships between flowing waters Map analysis procedure for the relationships between flowing waters and terrain
Procedural approach	**Stage 1. Development of the analysis plan structure** Step 1. Analysis of flowing waters on the map Step 2. Analysis of hydrographic basins on the map Step 3. Analysis of the relationships among flowing waters on the map Step 4. Analysis of the relationships between flowing waters and relief on the map **Stage 2. Analysis of flowing waters on the map** Step 1. Analysis of each native river (name; components: source, flow direction, mouth; length, sinuosity/meandering Step 2. Analysis of the tributaries of each native river (source, flow direction, mouth, length, sinuosity/meandering, density) Step 3. Analysis of each non-native river (name, source, flow direction, mouth, length, sinuosity/meandering)

	Step 4: Analyzing the tributaries of each allochthonous river (source, flow direction, mouth, length, sinuosity/meandering, density) **Stage 3: Analysis on the map of the hydrographic basins** Step 1: Analysis of the organization of each hydrographic basin (name, shape of the hydrographic basin, configuration of the hydrographic network, organization mode, density of the hydrographic network) Step 2: Analysis of the morphometric characteristics of each hydrographic basin (dimensions of the hydrographic basin: length, width, surface area extension; maximum and minimum altitude) **Stage 4. Analysis of relationships between flowing waters** Step 1. Identifying on the map the main river and its tributaries **Stage 5. Analysis of relationships between flowing waters and terrain** Step 1. Identifying on the map the maximum altitude (source) Step 2. Identifying on the map the minimum altitude (confluence, mouth of the river, exit from the surveyed territory Step 3. Identifying on the map the straight watercourses and those with a high degree of sinuosity Step 4. Identifying on the map the flow directions of the rivers (predominant direction, hydrographic network shape)

RESULTS

After analyzing the map the students' elaboration of texts, they were evaluated according to the grading criteria. In the two stages, students obtained the results mentioned in Table 4. Following the analysis of the results obtained by students before the learning activity, it is observed that the amount of information identified through the analysis of flowing waters represented on the "Hypsometric Map of the Călimani Mountains" by the 20 students varies, with the majority of them (70%) scoring below 60. From the analysis of the texts elaborated in this stage, it is noted that students identified the names of the main flowing waters, the source area, the flow direction, and the presence of tributaries. The texts created differ from each other based on how the information is structured.

In the third stage, the students elaborated more comprehensive texts and organized the information using the structure provided in the worksheet, which they had access to throughout the task. The volume of information identified by the students, after guided analysis through the worksheet, regarding the flowing waters represented on the "Hypsometric Map of the Călimani Mountains," varies, with the majority of them (90%) scoring above 60. The results support the confirmation of the tested hypothesis.

Table 4
The results of the students

	Under 50		51-69		70-89		90-100	
	Stage 1	Stage 2	Stage 1	Stage 2	Stage 1	Stage 2	Stage 1	Stage 2
Number of students	4	-	10	2	6	6	-	12
%	20	-	50	10	30	30	-	60

DISCUSSIONS AND CONCLUSIONS

Discussions on the competence to analyze flowing waters within a territorial unit. In order to select the integrated knowledge of this competence, certain information from the presentation of the competence to analyze a river hydrographic system (Dulamă, 2010c) was analyzed and selected. Although the competence to analyze maps and interpret maps is generally described in the didactics works of geography in Romania (Dulamă, 2006, 2010c), this research refers to the competence to analyze a specific map ("hypsometric map") and a single content element represented on this map ("flowing waters"). This approach was determined by the achievement of the proposed instructional goal (for students to learn to systematically analyze flowing waters on a map) and the research goal (to establish the effects of learning activities on students' analytical thinking).

Regarding the competence to analyze flowing waters within a territorial unit, it is emphasized that in its description, other knowledge could also be included to represent a higher level of competence. Additionally, it is noted that some knowledge is mentioned in multiple boxes of the table to provide a more precise description and facilitate understanding of its content by other teachers. Regarding the procedural approach, it has been detailed in relation to the mentioned procedures, but in the activity of integrating competence, teachers and students could carry out actions in a different chronological order.

From the perspective of the competence to analyze, by comparing scores with competency levels suggested in the literature (for example, Osaci-Costache et al., 2013a, b, c), the 20% of students, who obtained a score below 50 in the first stage, could be included in the category of those with poorly developed competence (incompetent level) to analyze the running waters of a territorial unit. 50% of students who scored from 51-69 have an inferior level of competence. 30% of students who scored from 71-89 have a medium level of competence. The fact that 60% of students scored 90-100 after the learning activity indicates that they have a high level of competence and that the worksheet used to guide the analysis of flowing waters on a map by students led to an increase in the level of competence, thus being effective.

Discussions about the development of students' analytical thinking. Amer (2005) argues that analytical thinking is the "easiest" and that people know how to use it from birth. Our study shows that students can learn to use analytical thinking at a higher level of competence, through mediation by the geography teacher through the use of worksheets and by situating the task proposed to the students in the "Zone of Proximal Development" (Vygotsky, 1962, 1978).

The analysis of running waters, conducted by students based on the map, is primarily a sensory analysis (Zlate, 1999) because students visually perceive the map and observe essential and non-essential characteristics of the running waters. When students are able to identify and differentiate, for example, the rivers, tributaries, and their visible properties on the map, it can be considered that the analysis is at an abstract level because they distinguish between a river and its tributaries. Although the tools created aimed to differentiate the analysis from other cognitive operations and processes, in this case, it is noted that students analyzed the running waters but were actually asked to compare them (for example, the main river and tributary), to evaluate them (for example, the length), and to rank them hierarchically (for example, stream, river) (Zlate 1999).

In the analysis of flowing waters represented on the hypsometric map, students responded to the question "What?" (Golu, 2007) when we identified the names of rivers, tributaries, the source, confluences, and other observable elements on the map, which they can recognize only if they have the necessary prior knowledge in long-term memory. Students responded to the question "How?" (Golu, 2007) when they analyzed the organization of the hydrographic network in each hydrographic basin (for example, the shape and orientation of the hydrographic basin, the main river, the density and position of tributaries), thus, they analyzed the component elements in the structure of the hydrographic basin.

The analysis was carried out by students based on logical criteria (Golu, 2007): for example, comparing the dimensions of flowing waters by their length, by the direction of flow. Although the students were not given a text as a model regarding flowing waters from another mountain unit, in order for them to learn a systematic analysis procedure of flowing waters from a territorial unit, they were guided through the "Working sheet" towards a specific model or standard (Golu, 2007) suggested by the professor

The task of analyzing flowing waters within a territorial unit was more complicated than analyzing a hydrographic basin since the flowing waters of the Călimani Mountains were included in multiple hydrographic basins, each with a specific structure and certain characteristics. To carry out a high-quality analysis, students need to have a large volume of knowledge (concepts, classifications, hierarchies, etc.) stored in long-term memory, which they can quickly use for the cognitive processing of verbal and visual information.

Analyzing the relationships between component elements (Golu, 2007) (for example, between flowing waters in a hydrographic basin) is more challenging than analyzing components and identifying properties. Students can easily establish, visually, the spatial relationship between a tributary and the main river, but to establish the causal relationship (cause-effect type), they should understand and explain why the tributary flows into the main river and establish the connection between the altitude, the slope of the terrain, and the direction of water flow.

The analysis of flowing waters within a territorial unit may seem like a simple task because the waters are represented on the map, but the "empirical," sensory analysis can be limited to identifying names, flow direction, source and mouth, length, and the course aspect (e.g., meandering). Analysis, as a thinking process carried out at an abstract level (analytical thinking), revealing the specific internal structure and relationships between the parts that make it up (Golu, 2007) and between different structures (for example, between the structure and characteristics of the relief and the hydrographic network), requires students to operate with concepts. For a student, it is difficult to correctly evaluate the knowledge or representations they have in long-term memory or based on their own knowledge. For example, a student who observes the meandering course of a river and has the "incorrect" conception that rivers meander across the plains' surface may deduce that there are portions of plains in the analyzed territory, instead of areas with a slight slope of the terrain.

In order to form correct representations and acquire concepts, that is, to internalize them, students need mediation (Vygotsky, 1962, 1978) from teachers with a high level of competence in geography, psychology, and geography didactics. By involving students in particular learning activities, teachers can help students differentiate the essential from the non-essential, the necessary from the random or accidental (Zlate, 1999). For instance, students need guidance to deeply understand the relationship between the length of a stream, the surface area of its hydrographic basin, the large amount of precipitation that falls in a short period of time, the water level rise, and the occurrence of floods.

All authors contributed equally to the development of this study.

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