MOTIVATING STUDENTS' LEARNING USING WORD ASSOCIATION TEST AND CONCEPT MAPS

Zdravka KOSTOVA
University of Sofia,
Blagovesta RADOYNOVSKA
New Bulgarian University

Abstract. The paper presents the effect of a free word association test, content analysis and concept mapping on students' achievements in human biology. The free word association test was used for revealing the scientific conceptual structures of 8th grade and 12th grade students, around a stimulus word – human being – and for motivating them to study human biology. The stimulus word retrieved a cluster of associations most of which were based on science education and experience. Associations with the stimulus word were analyzed and classified according to predetermined criteria and structured by means of a concept map. The stimulus word 'human being' was quantitatively assessed in order to find out the balance between the associations with its different aspects. On the basis of the results some connections between biology and other sciences studying the human being, were worked out. Each new topic in human biology was studied by using content analysis of the textbook and concept mapping as study tools and thus maintaining students' motivation. Achievements of students were assessed by means of tests, observation

and concept maps evaluation. The obtained data was also valuable in clarifying the complex nature of the human being, and confirming the statement that biology cannot answer all questions, concerning human nature. Inferences were made about the word association test combined with content analysis and concept map construction as an educational strategy.

Keywords: motivation, word association test, human being, concept maps, content analysis, human biology

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Aims

The study was directed to finding the answer to the following questions: What are the differences between the associations of 12th grade students and those of 8th grade students to the stimulus word *human being*? How do concept maps of associations motivate students to learn? Does content analysis and construction of concept maps, followed by discussion, support motivation and engage students in productive work?

Introduction

The number of students that lack motivation for learning has been increasing of late (McInerney, 2000) and this problem is attracting more and more researchers to study and attempt to solve it. One of the possible reasons for this motivational problem is that they do not possess the skills to learn successfully and find "learning of abstract and highly conceptual nature of science very difficult" (BouJaoude & Attieh, 2008).

Motives are widely defined; at one end they can be incentives or provocations to action, because they induce a person to act (Davidov, 1983). At the other, they can be little more than "hypothetical constructs used to explain why people are doing what they are doing" (Brophy, 2004). On the other hand, the term motivation is a basic category in modern psychology and ethology (Dessev, 1996). Biological motivation is regarded as a complex of

compensatory reactions of animals to disturbances in their homeostasis, e.g. thirst, hunger, breeding and parental behaviors, etc. (McFarland, 1985). Psychological motivation is regarded as a "theoretical construct used to explain the initiation, direction, intensity, persistence and quality of behavior, especially goal directed behavior" (Brophy, 2004). It is caused by a number of motives, such as needs, interests, desires, fears, emotions, attitudes, ideals and values (Davidov, 1983). Each of these motives impels towards achieving one's desired or intended goals (Stamboliev, 1996). The boundaries between affective ("feelings connoting emotional or visceral reactions") and cognitive ("thinking") variables of motivation are considered to be "rather blurry" (O'Neil & Drillings, 1994) though the two are very often contrasted. Certain kinds of behavior are repeated if they remove stress and danger and are assisted with positive feelings as "seeking pleasure is a reflex response built into our genes for the preservation of the species" (Gilbert, 2002). Motivation is a very complex phenomenon, playing a crucial role in learning, whose different aspects are studied by many scholars. Some concentrate on physiological basis of behavior (Maslow, 1943; Levine, 2000, pp. 41-94), others look for the effects of educational motivation (Brophy, 2004); still others study the mechanism of motivation (Gilbert, 2002; Graham, 1994). Motivation is regarded as intrinsic or extrinsic (Schunk et al., 2008) affected by goals, goal orientation and goal settings (Alderman, 2004), directed to achievement and competence (Elliot & Dweck, 2005), essential for classroom activities (Gilbert, 2002), dependant on attribution beliefs, social factors and the social climate in the classroom (Alderman, 2004), etc.

The understanding of motivation is based on knowledge of motivational variables and task characteristics (O'Neil & Drillings, 1994), social mediation of motivational variables (Rueda & Moll, 1994), cognitive control of affective states (Schunk et al., 2008), praise versus blame and reflective self-awareness (Graham, 1994), measures of motivation (McCombs, 1994),

motivation of individuals in team teaching (Swezey et al., 1994) importance of curiosity and exploration (Lehwald, 1991) and so on.

Snow & Jackson (1994) come to the conclusion that instructional learning involves a mixture of cognition, conation and affection or of knowledge, feelings and action. McCombs (1994) studies the role of volition in motivation and proves the importance of persistence (the energy with which an individual pursues a goal) and values (the significance of the goal that the individual will pursue) as key constructs. Rueda &. Moll (1994) study the interpersonal processes within which individual activity occurs. Pintrich (1999) investigates the effect of motivation on self-regulated learning.

The importance of motivation in all aspects of human life and especially in education is the reason for such a great interest in it and for the many theories proposed for its understanding. Based on clarification of motivation from the studied literature, our search was directed to the effect of cognitive motivation on students' learning achievements in human biology by using a word association test as the beginning followed by content analysis, concept map construction and discussion.

Method

Often students are not internally motivated and need situated motivation, created by teachers through special environmental conditions in the classroom. Such motivational conditions were created using word association test. However, arousing motivation at the beginning of the studies is not sufficient for successful learning; motivation should be sustained throughout the whole course of the study. This problem was solved by succeeding word association test with the use of content analysis and concept map construction. The three methods were used consecutively in the process of studying human biology, followed by discussion.

Participants

The sample of investigation involved 80 students in the 8th grade (the end of middle school, 14-15 years old) and 40 students in the 12th grade (the end of high school of secondary schools in Bulgaria). The investigation covered the 2006/2007 school year and was repeated during 2007/2008 school year with students from two secondary schools in Sofia. The 12th grade students participated in the word association test, not in the study of human biology in which the content analysis and concept map construction methods were used. They studied human biology when they were in the 8th grade and enlarged their knowledge of the human being in general biology courses and in humanitarian and technological subjects in the 9th-12th grades. Through the mental picture of a human being that was on top of their minds at the end of secondary school later in life they would percept people they meet. Comparing the mind maps of 12th grade and 8th grade students we wanted to see the dimensions of development of the fundamental concept human being.

Variables: The 8th grade students were divided into three groups (variables): B1 (20 students) – use of word associations for motivation; B2 (30 students) – use of word associations for motivation and demonstrations of concept maps in teachers' presentations; B3 (30 students) – use of word associations, concept mapping by the students for homework, discussion and concept maps improvement in the classroom (see procedure).

Instruments

Free word association test

This is a reliable technique used as a procedure for measuring number, direction and strengths of connections (Novak & Govin, 1984; Mervis & Rosh, 1981).

The ability of the brain to make associations and facilitate learning and intellectual development has been studied and elucidated by many scientists.

Some studied the nature of associations and the mechanisms of their building by the brain (Bain, 1894; Pavlov, 1927). Others directed their investigations to associative memory (Maki, 2007), associability (Suret & McLaren, 2005), associative learning (Levine, 2000, pp. 41-94; Wills, 2005). Still others were attracted by word association technique, cluster analysis and concept or mind map construction in teaching (Smith & Heise, 1992; DiCarlo, 2006; BouJaoude & Attieh, 2007), or by association of emotions and thinking (Field, 2005).

Free word association test requires responses that are not restricted to any specific category or class of words. In tests of discrete word association, each participant is asked to produce only a single associate to each word, while in tests of continuous association, the stimulus word or the list of stimulus words is presented to the respondents only once and they are asked to give as many associations as they can in a pre-specified period of time.

Concept Mapping

Concept mapping is a promising teaching and learning method that enhances students' achievements by helping them to acquire structured knowledge. The human conceptual system is characterized by two main concepts – category and schema (Smith & Heise, 1992; Mervis & Rosh, 1981). The visual representations of these concepts are concept maps (Novak & Govin, 1984), mind maps (Buzan & Buzan, 1993), intellectual maps (Kostova, 1998, 2000). Psychologists, like geneticists who map the genes, map the connections among words which are learned as a result of everyday experience (Nelson, 1996). Maps, especially concept maps, aid learning in all subjects (BouJaoude & Attieh, 2008; DiCarlo, 2006; Smith & Heise, 1992; Marzano, 1997; Suret & McLaren, 2005). In this activity several mental processes are involved: comparison, analysis, comprehension, model construction, elaboration, retrieval, etc. (Bruner, 1960). Conceptual mapping organizes

learning at the level of conceptualization in the sense of the theory of constructivism, the foundations of which were laid by Piaget (1951), (Pintrich, 1999; Rueda & Moll, 1994; Ducret, 2001).

Buzan & Buzan (1993) worked out the basic rules for successful construction of mind maps, incorporating the use of the two hemispheres – logical thinking and imagination. Marzano (1997) proposed different graphical organizers for visual construction of concept maps. Zaller (1992) investigated the dependence of word association test on information (knowledge) and predisposition of the respondents. Word association test creates a stimulating environment for concept mapping. Authors give different wording of a concept map explanation: "a nonlinear diagrammatic representation of meaningful relationships between concepts" (DiCarlo, 2006), "a mental model, a schematic representation, which is a hierarchical structure from interconnected words, ideas, problems, solutions, arranged around a key word in radial circles" (Buzan & Buzan, 1993). We stick to the definition of Buzan & Buzan (1993) and use a concept map as a study tool.

The concept map can represent a structure of concepts, derived from a textbook by means of content analysis or retrieved from the memory by means of association test or brain storming (Novak & Govin, 1984). Concept maps are used to enhance meaningful learning (DiCarlo, 2008) by providing "fixture", support, construction of interconnected scientific words (Suret & McLaren, 2005; Bandura, 1997).

Procedure

*First Step***:** Word association test with 12th grade students at the end of school year 2005/2006 and concept map construction (all students).

Data collecting was done by requiring respondents to write associations with a given word. Each respondent was presented with a sheet of paper and a pencil and was instructed to be ready to write his or her *responses*

(words, phrases, ideas) that came to mind in the same succession as they appeared when hearing a given word. That is, respondents wrote words coming on top of their minds as driven by the *stimulus*. When told the words 'human being'**,** they began making their list for the duration of three minutes. The papers were collected, analyzed (Table 1), concept maps were constructed (Fig.1) using the students' associations with the key word according to chosen criteria. Thus a picture of a 'human being' as seen by 12th grade students was constructed around chosen criteria.

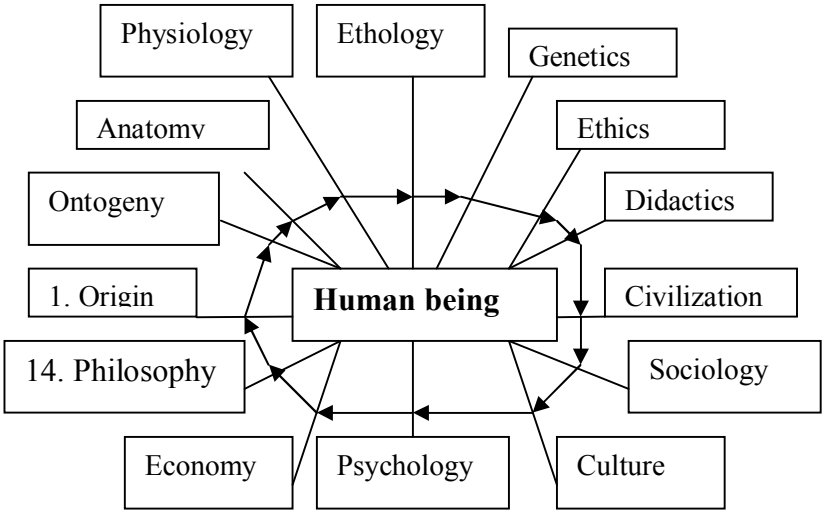

Fig 1. A simplified model of the concept map of 12th grade students' associations

Second step: Word association test, concept mapping and discussion (Groups B1, B2 and B3) at the beginning of school year 2006/2007.

The stimulus words, 'human being', were presented to the target group (the three variables of 8th grade students: B1 – 20, B2 – 30 and B3 – 30) at the beginning of the school year in the biology classrooms of three classes. This was at the first school period of studying the course in human biology, mainly concerned with human anatomy, physiology and hygiene. Students had studied some aspects of the human body in the previous seven grades. Papers were

collected and a concept map for each class of 8th grade students was constructed and visualized. The concept maps of 8th grades were simpler, each not more than 25-30 associations (Table 1).

Table 1. Classification of 12th grade (first figure) and 8th grade (second figure) students' associations with the stimulus word Human being. (No denotes the number of words; figures in brackets denote the repetition number of the word)

Criteria	%	No	Examples	
			12th grade	8th grade
1. Origin and evolution	11/ 8.8	34/8	Struggle for existence, natural selection, living thing (4), adaptation, survival, biological species (5), living system, animal kingdom, mammals (2), monkeys, apes, hominoids, Homo sapiens (6), paleontology, anthropology, history, races, superior creature (3), evolution	living thing (5), animal kingdom, mammals
2. Individual development	4.5/ 9.9	14/9	Man, woman, fertilization, pregnancy, birth, growth, embryo, child, young, youth, adolescent, puberty, adult, death	Man, woman, child, growth, pregnancy birth, young, adult, death
3. Anatomy	8.7/ 16.4	27/15	Complex structure, cell, cellular structure, tissues, organs (4), systems, locomotion system, limbs, skeleton, cranium, cardio-vascular system, respiratory system, alimentary system, excretory system, reproductive system (2), nervous system (3), endocrine system, sensory systems, high functions of the nervous system, brain (2)	Cellular structure, tissues, organs (4), systems, limbs, lungs, stomach (3), kidneys, sex organs, nerves
4. Physiology	10.6/ 17.5	33/16	Living processes, nutrition (2), respiration (2), excretion (2), reproduction, growth, development, irrita-	Nutrition (4), respiration, excretion, reproduction, growth,

			bility, movement (3), memory (logi- cal, visual, short-term memory, long-term memory), thinking, sleeping, dreams, homeosta- sis (temperature, mineral salts, osmotic pressure, hormones, glucose), health (5)	movement (3), health (5)
5. Ethology	5.8/ 4.4	18/4	Values, behavior (in nature, in school, in nature), collaboration**,** tolerance, ethical behavior, respect, care, relationships between men and women, with other people, maternity, playing, cruelty, killer, smile, self-destruction	Behavior, collabo- ration, cruelty, smile
6. Genetics	3.8/ 0	12	Generation, up-bringing, genetic engineering, heredity, variation, gene, dominance, dominant, recessive, karyogram, hereditary diseases, therapy	
7. Ethics	14.5/ 12	45/11	Values, respect of adults, moral, open-minded, caring, gentle, good-natured, responsible, beautiful, learned, optimistic, dedicated, honest, amiable, wise, creative, experimenter, ambitious, innovator**,** strong, researcher, hard working, good, willful, ready to help, bad, obstinate, lazy, idiot, ugly, evil, egoist, dishonest, cynical, distrustful, selfish, narrow-minded, unjust, unpleasant, coward, hypocrite, prudent, pompous, irresponsible, aggressive	Beautiful, honest, strong, good, bad, ugly, selfish, un- just, unpleasant, cow- ard, aggressive
8. Didactics, peda- gogy	6.5/ 5.6	20/5	Upbringing, family, parents**,** text-book, encyclopedia, human rights, history, humanity, development, culture, nursery, school, university, teachers, terrorism, genocide, democracy, anarchy, despotism, pressure	Family, text-book, encyclopedia, teachers, school
9. Civilization	8.4/ 6.6	26/6	Society, history (old, new),	War (2), plants,

			ancient, contemporary, struggle for freedom, war, state (democratic, social), government (2), technology, independence, equality, victim, information, technique, modeling, internet, destruction of nature, plants, animals, food, goods	animals, food, goods
10. Sociology	5.5/ 6.6	17/6	Humanity, society, people, overpopulation, feeding, dependence, home, family, work (job), social creature, thinking being, rich, poor, survival, unemployment, poverty	People, home, feeding, work, unemployment, poverty
11. Culture	5.2/ 5.6	16/5	Music, art, religion, God, reading, writing, language, alphabet, experience, science, writer, profession (3), novelist, studying	Music, art, studying (3)
12. Psychology	9.4/ 4.4	29/4	Psyche, sense, wisdom, soul, stupidity, intellect, thinking (6), cleverness, consciousness, anxiety, emotions, feelings, mind, mistake, wit, fear, help, speech, communication, stress, distress, pleasure, enjoyment, realization	Stupidity, wit, Cleverness, speech
13. Economy	1.6/ 1.1	5/1	Industry, agriculture, budget, financial policy, money	Money
14. Philosophy, Aesthetics	4.5/ 1.1	14/1	Micro-cosmos, conscience, consciousness (3), sensibility (5), world, environment, beautiful, ugly,	Environment
Total	100/ 100	310/91	Average = 7.75	Average = 1.14

For a comparison, the concept map of 12th grade students was presented and then discussed (Table 2). The discussion directed students towards formulation of a hypothesis about the expected benefit from studying human biology.

Table 2. Discussion on the results from the word association test

Questions	Shortened answers
1. How do the two mind maps of 12th grade and 8th grade students differ?	They differ in scope and range. 12th grade students show broader understanding and conceptualization of a human being.
2. What are the reasons for the difference?	Knowledge and experience of 12th grade students are higher.
3. Can biology give all the answers concerning human beings?	No. Many branches of science study human beings (more than 48).
4. What major aspects of a human being should be studied in a course of human biology?	About the origin, structures, functions, and hygiene of the human body and the healthy way of life as well as regulation, integration and responsible behavior.
5. What one might gain from studying human biology?	Knowledge and competences to understand the human body, be healthy and control behavior.

Third step: Studying the introductory lesson to Human biology with the help of content analysis, concept mapping and discussion (Group B1, B2 and B3).

Students in B1 formed four groups of five persons each. The text of the lesson was divided into four paragraphs, one for each group, and ten minutes were given to read and five minutes to discuss and clarify the information between them. They used content analysis but not concept structuring. One member of each group had to explain the studied paragraph and the other members listened carefully and corrected or added points they thought were missing. At the end of the period the teacher then drew their attention to mis-understandings and wrong interpretations.

Students in B2 were given a lecture by the teacher using a concept map (Fig 2), stopping after each paragraph and directing them to the textbook. They were asked to find the correspondence between map and paragraph and write down the concepts, explained by the teacher. Guided in this way they followed first the map, then the explanations and finally the textbook.

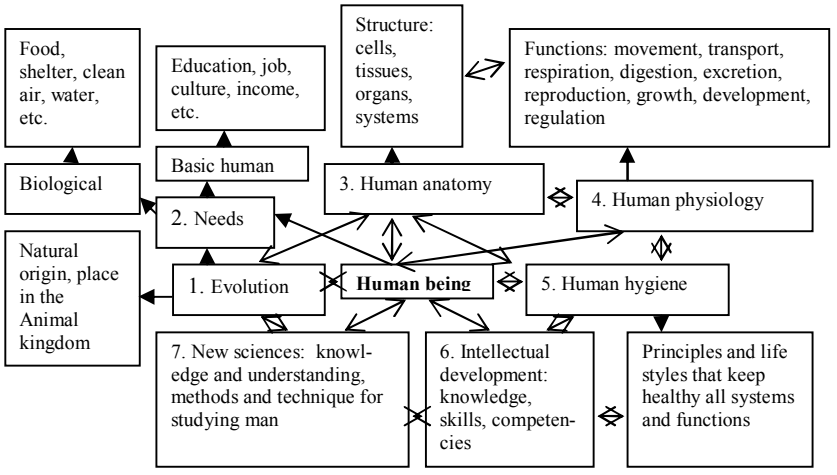

Fig 2. A generalized concept map on the introductory lesson to Human biology, presented by the teacher in G2.

Students in B3 read quickly trough the text, determined the core concept and then with help from the teacher, scanned each paragraph, clarified the concepts, and structured them into a concept map. Then they compared it with the teacher's concept map (Fig 2). A discussion followed to correct students' maps and to enrich each concept with the information added by the teacher. Students' attention was drawn to the associations for a comparison (Fig 1, Table 1). The conclusion they reached from the comparison was that the studies to follow would intend to fill in the gap between the concept map of the introductory lesson and that of 12^{th} grade students' associations helping them understand themselves and others better and keep a healthy life style. This step acquainted students with concept mapping and structuring. It was followed by discussion (Table 3).

Table 3. Discussion on the concept map of the Introduction

Questions	Shortened answers
1. What are the arguments for the natural origin of man?	The similarities in the structure and functions of the bodies of animals and human beings.
2. What are the arguments for the uniqueness of man?	Man can study nature and the whole surrounding world including him and can develop values and action plans.
3. What interrelated sciences give knowledge of man?	Human biology (anatomy, physiology, hygiene, etc.), psychology, cognitive sciences, technology, medicine, etc.
4. What relations between concepts are missing?	Between: biological and basic human needs, evolution and new sciences, etc.
5. What conclusions from the map can you draw?	The human being is an interrelated entity of structures, functions, behavior, emotions and ambitions. He is a unique creature.

Fourth step: Analysis and concept mapping of the topic "The Cell" in the textbook (Group B3).

Students in B3 worked in small groups of two, read the information in the textbook; wrote the concepts in the workbooks and constructed maps (Fig. 3).

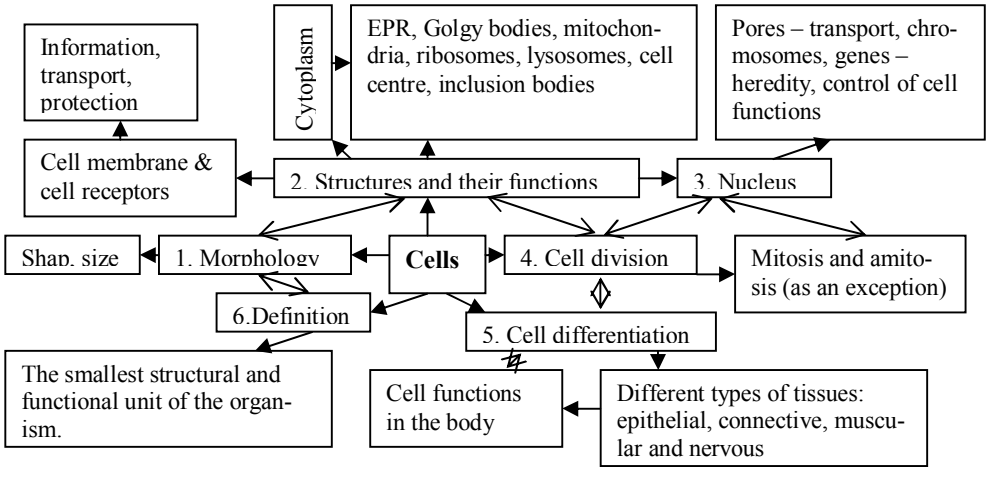

Fig 3. Concept map of the topic"The Cell". There are 32 concepts in the textbook

Following this, a discussion was initiated for clarifying the core concept, the hierarchy of concepts and the connections between them. Each group

participated in the discussion which consisted of presenting its results in analyzing/listing the cognitive structure, making the necessary corrections and reaching more or less a consensus about the concept map structure. All concepts in the map were explained and visualized. Groups B1 and B2 continued to work as in the third step.

Fifth step: Analysis and concept mapping of the topic "The Human skeleton and the bones" (Group B3).

Work was divided between home and classroom. *Work at home*: Each student read the text in the textbook, underlined the concepts and constructed a concept map. 2. *Work in the classroom*: A class discussion based upon prepared questions and directed by the teacher, led to the construction of a consensus concept map and clarification of concepts (Fig 4)

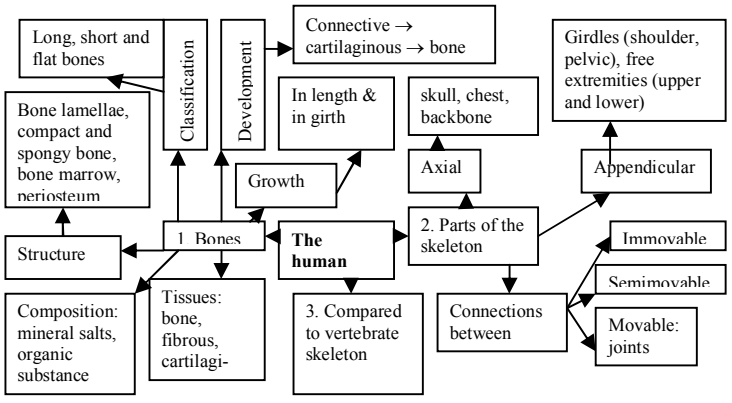

Fig 4. A concept map of the topic 'The Human Skeleton'

Some students illustrated their concept maps with drawings, using Paint Brush or colored pencils of their choice. The concept map helped students in making associations and remembering the structured information, which was evident from their participation in the studies and discussions to follow. Groups B1 and B2 continued to work as in the third step.

Sixth step: Successive studies of the topics in the course "Human Biology" using content analysis, concept map construction and discussion. In the discussion on the bases of the concept maps, connections with other branches of science were made (Table 4).

Table 4. Concept maps constructed throughout the course on Human biology, elaborated by the students in B3 and demonstrated by the teacher to B2 (No – number of concepts in each topic)

Concept maps on topics:	No	Connections with other sciences
1. Locomotive system	55	Evolution, history, taxonomy, technology, chemistry, ethics
2. Cardio-vascular system	48	Medicine, evolution, environment, healthy way of life, ethics
3. Respiratory system	21	Evolution, medicine, physics (diffusion) , chemistry (gases)
4. Alimentary system	42	Evolution, medicine, food, technology, trade, dentistry, diet, alcohol and tobacco trade, etc.
5. Excretory system and Homeostasis	22	Evolution, medicine, technology, cosmetics, fashion, homeostasis, physics, (temperature regulation), etc.
6. Reproductive system and Development	45	Evolution, medicine, birth control, demography, ontology, gerontology, ethology, ethics, sexual abuse, culture, etc.
7. Nervous system	48	Evolution, medicine, drugs, addiction, psychology, cognitive science, ethology, etc.
8. Endocrine system	38	Evolution, medicine, individual development, anabolic steroids, aggression, etc.
9. Sensory systems	60	Evolution, medicine, internet, information sciences, visualization, ethology, ethics, etc.
10. Higher functions of the Nervous system	16	Psychology, didactics, pedagogy, cognition, medicine, ethics, philosophy, media, computer, physics (sound and noise), etc.
Total: 395; Human anatomy: 210; Human physiology: 120; Human hygiene: 65		

The concept map of each chapter integrated scientific concepts of all topics in it, which helped the associative learning and long-term memory. Groups B1 and B2 continued to work as in the third step.

Evaluation instruments

Observation and assessment of students' learning behavior

The learning behavior of students in the three learning conditions was assessed and evaluated using predetermined five criteria included in a specially constructed checklist: responsibility, attention, activity, persistence and valuing of tasks. Assessment of *responsibility* was based on positive attitude to and in-time solution of learning tasks (Schunk et al., 2008) and personal desire for success (Elliot & Dweck, 2005). *Attention* was assessed on the grounds of: focus on tasks, desire for competence (Elliot & Dweck, 2005), enjoyment and willingness to engage in learning activities (Deci & Ryan, 1995; Wright, 1987), intention of acquiring knowledge and self-satisfaction of curiosity (Maslow, 1943). The characteristics of *activity* were: engagement in productive work and supporting the motivational climate in the classroom (Marzano, 1997), competence in concrete learning actions, collaboration and effective communication (Brophy, 2004). *Persistence* was regarded as: need in achieving goals (Maslow, 1943), seeking competence (Elliot & Dweck, 2005), perseverance and self-regulation in pursuing the task to the end (Artino, 2008; Bandura, 1997), esteem needs and confidence in ones ability (Maslow, 1943). *Valuing of tasks* was assessed on the grounds of learning behaviors, such as: valuing outcomes (a grade on a product – test, map, effective participation in discussion), intended learning benefits (conscious competence) (Guilbert, 2002; Nelson, 1996), satisfying the competence need (Field, 2005), and creative self-expression (Maslow, 1943). Each criterion was assessed, a personal quotient was estimated and the results were converted into marks using a scale in order to be comparable with the results from tests and concept maps evaluation. Marking was done using six-point scale from 1 – the lowest to 6 – the highest (Table 5).

Concept map scoring rubric

The concept map is radial, spatial, with increasing concentric circles from groups of words, coming out from a central key word or words as a structure by means of subordination (Buzan & Buzan, 1993).

The skills and competences of students in concept map construction were assessed using six criteria included in a checklist and arranged in levels according to successive actions and difficulty. 1) *Core concept correctly chosen*: After reading and analyzing the text, the students identified the main concept (clarified by all other concepts), and placed it at the centre of the map. In some cases they used more than one core concept at the center of the map. For example in the concept map on human excretory system they used two core concepts – kidneys and skin, and made two clusters of concepts on the map. 2) *All concepts correctly chosen* and included in the map: Students had to find out the concepts, pertaining to core concept and the topic, explained in the text and clarifying the main ideas. They retrieved the concepts from the studied text but not from a given list of words (BouJaoude & Attieh, 2008) and arranged them in a map. This they did by reading, copying the concepts in the workbooks and trying to understand the meaningful connections between them. 3) *Concept hierarchy correct*: Around the core concept students arranged the auxiliary concepts directly connected with it, in the first circle. They gave a sign of the beginning of the circle (for example, Fig 2, "1. Evolution"), which corresponded to the first paragraph of the text. Then they arranged the concepts usually clockwise, thus indicating how the map should be read. Some students (very few) arranged the concepts in the opposite direction, which was also considered correct. After that they arranged the concepts of the second circle, which clarified the concepts in the first circle and so on. 4) *Connections correct*: Using arrows, students showed connections between concepts. The direction of the arrows indicated causal direction of influence and logical structure of the concept map. This is the heuristic value of the

map. The map as a tool of visual construction helped them discover the links of concepts in a unified conceptual structure. 5) *Successive structure according to text correct*: this was accomplished by careful reading and comprehension of the information in the text by comparison, analysis, synthesis, abstraction, generalization. The development of the map corresponded to the logic of the discussed main scientific problem. 6) *Aesthetical visualization*: the signs by means of which the map attracted attention – letters, arrangement, graphic organizers, illustrations, drawings, pictures, etc. Students were warned not to overburden the maps, but to make them readable and useful in facilitating text understanding and comprehension (A picture is worth thousand words). Each criterion was assessed and an individual scoring was devised. According to a scale, each student achieved a mark from one to six, thus individual concept map mean scorings were obtained. On the bases of individual mean scorings the total mean of each group was calculated (Table 6).

Biology achievement tests

Pretest (Appendix 1) and Posttest (Appendix 2) were used to measure students' achievements. Each test contained 30 items (5 items for each level of Bloom (1969) Taxonomy of educational objectives. The characteristics of the tests were assessed (Table 7) and the items having unreliable characteristics discarded. The pretest was applied at the beginning of the course and the posttest – at the end. The two tests were given to the three variables under the same conditions. The results were assessed for each level of Bloom's taxonomy (Table 8).

Results and interpretations

Associations with the words 'human being'

The stimulus words 'human being' evoked lots of connections to other words. The total number of them was 310 and the average number of associa-

tions per a 12th grade student was 7.75 (Table 1, Fig. 1). The total number of associations for 8th grade students was 91 and the average number 1.14. All students responded to the test according to their individual flexibility of remembering, knowledge and type of memory. Some students started to write at once, others were delayed with the response. The reason probably was the very complex meaning of the stimulus word, discussed in many school subjects – biology, history, geography, psychology, philosophy, technology, etc.

The analysis of concept maps of 12th grade and 8th grade students based on their associations is represented in Figs 5 - 7.

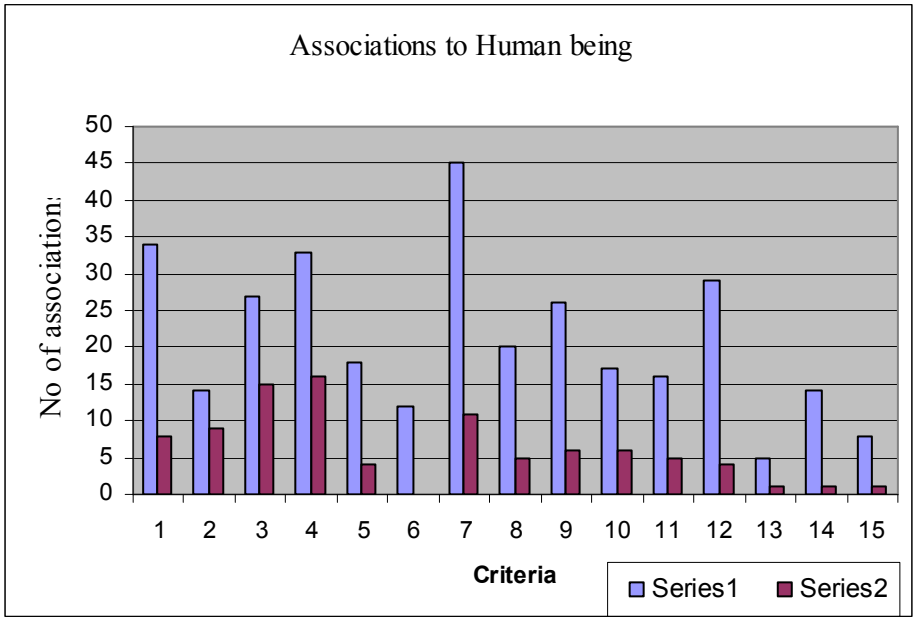

Fig. 5. Number of associations to the stimulus words 'human being': series 1. 12th grade; series 2. 8th grade; Criterion 15 – average of the associations of 12th and 8th grade students

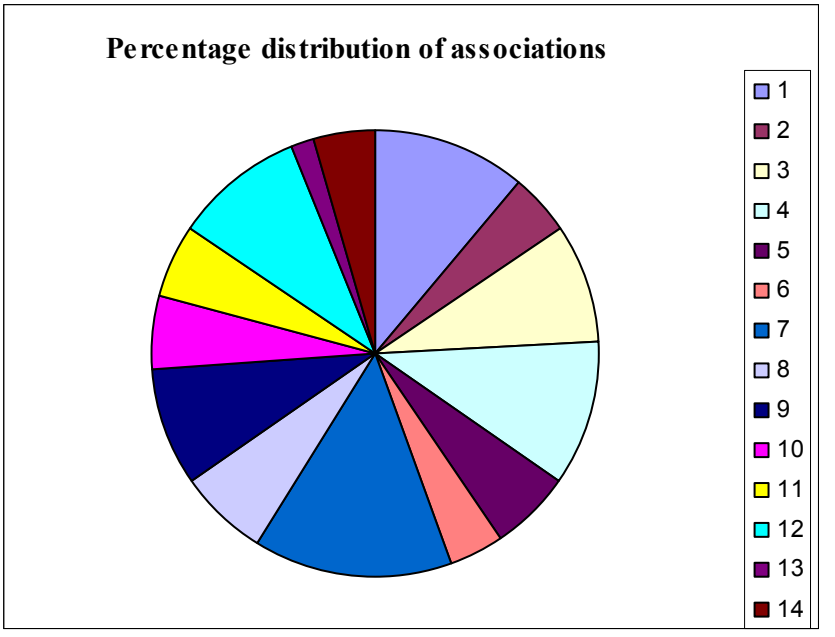

Fig 6. Percentage distribution of associations of 12th grade students

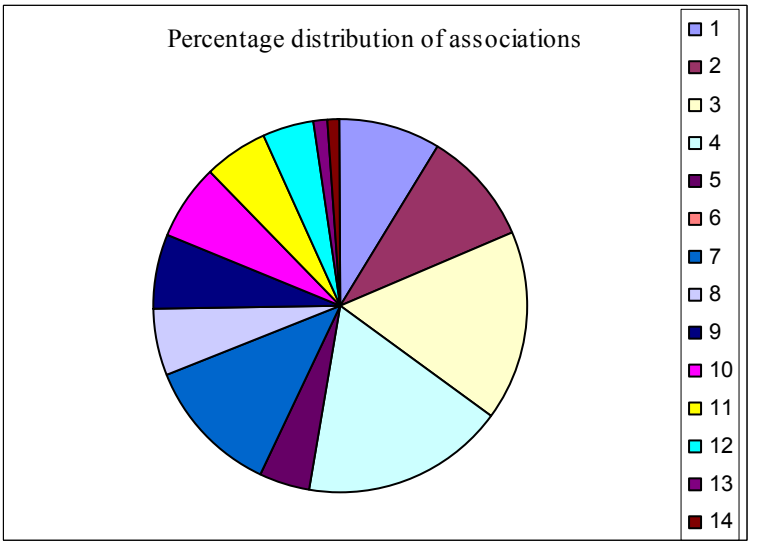

Fig 7. Percentage distribution of associations of 8th grade students (There no associations with genetics – No 6)

The word association test shows the different pictures of a human being of high school and middle school students. High school students value personal characteristics, moral aspects of human behavior, relation to and treatment of others. These characteristics of human beings are dominant in their associations. Second place occupy associations with the natural origin, dominated by living nature and sensibility of human beings, then follow associations with physiology and civilization aspects.

Middle school students remember better the physiological and anatomical aspects, followed by moral characteristics, individual development and natural origin. Those aspects predominate in the textbooks. They did not show any association with genetics. Comparison with high school students showed them an attainable perspective, awakened their need of competence and made learning goals personally relevant.

Content analysis, concept map construction and discussion

The concept map of the introductory lesson made by students in B3 and corrected by the teacher (Fig 2) and the discussion that followed (Table 3), directed them to the forthcoming studies, outlined the boundaries and limitations of the course and stressed the necessity to relate biology studies with those of other school subjects for better understanding of human beings.

The same was repeated with the second lesson, discussing the cell structure (Fig 3). It is a basic lesson in human biology. The map was constructed around the main cell characteristics – external appearance under a microscope, structure, cell division and cell differentiation. Definition was formulated as a generalization based on discussion. Working in groups of two was beneficial for developing students' abilities to interact and to pursue team goals (Swezey et al., 1994). Communication within the groups and in the class discussion was beneficial for overcoming the difficulties in studying abstract and complex science concepts. Integrating them into well structured cognitive

framework facilitated students' learning and improved their self-confidence (Schunk et al., 2008).

In the lesson "Human skeleton and the bones" 55 biological terms were counted. Students did their best to make a map (Fig 4). After making the first drafts some of them gathered and tried to overcome the difficulties and distinguish between essential and non-essential terms in studies, between main and subordinate knowledge. The preparatory work insured their competence in the classroom discussion, in making decisions and in correcting misunderstandings. They compared their concept maps and by reflection and self-reflection learned not only from the textbook and the teacher, but also from one another. Each concept on the map was explained by students' presentations. Misunderstandings were corrected by the teacher (Suret & McLaren, 2005). Some students used additional resources besides the textbook: atlases of the human body, internet images, models, etc. In the classroom discussion a plastic model of the human skeleton was used to help students get better impressions of the subject of study (Smith & Heise, 1992; DiCarlo, 2006).

Each student in B3 prepared a portfolio with the concept maps and used them in making a quick revision at the end of a given chapter (Table 4) and the school year. With each map they improved their skills for content analysis and concept construction. This gave them satisfaction and developed their self-esteem (Deci & Ryan, 1995; Novak & Govin, 1984). Students were motivated to learn by their success in learning. There were about 395 scientific concepts in the textbook, 5 new concepts per school learning period, which were not evenly distributed because of time allocated to practical work, revision, examination, project development, etc. Anatomical concepts predominated over those of physiology and hygiene. This ratio was not quite satisfactory.

Concept maps, used as demonstrations by the teacher gave students structured knowledge and a model of studying and memorizing (Suret &

McLaren, 2005). Some students in B2 decided to imitate the teacher and made concept maps while studying the lessons at home. The teacher's model maps attracted their attention, increased their curiosity, engaged them in active learning and stimulated their willful efforts in higher achievements (Graham, 1994). That explains the better results in B2 than in B1. In the latter students were given only a hint for the benefit from concept mapping. Very few students episodically tried concept mapping and seeing the difficulties easily gave up. That helped them understand the reasons for lack of persistence. The new method of learning in B3 challenged students, lifted the veil of monotony and lack of action and opened new horizons for intellectual development. Gradually the motivation from outside turned into motivation from inside as competence, positive thinking, enjoyment and self-confidence increased.

The behavior of the students in the classroom was significantly modified by the teaching methods (Table 5). What students did in class was considered valuable by many of them. Students liked to finish the school period with concrete visible products (Ormrod, 2003; Gilbert, 2002; Graham, 1994).

Table 5. Evaluation of students learning behavior in the classroom

Criteria	B1	B2	B3
1. Responsibility to learning tasks	3	4	5
2. Attention concentration	4	4	5
3. Activity	2	3	6
4. Persistence	2	4	5
5. Valuing of tasks	3	4	5
Mean	2.8	3.8	5.2

Skills in concept mapping developed gradually (Suret & McLaren, 2005). The difference in competency between B1 and B2 is higher than that between B2 and B3 (Table 6). Teacher's concept maps did make a difference

and challenged the students to successful learning. They were not only listening but also looking, thinking, connecting, comparing, asking questions, making notes and comprehending. The models set by the teacher were valuable and stimulating (Fig 8). Concept mapping proved to be a difficult endeavor and not accepted by everyone (McInerney, 2000). Most of the students were eager to start and do it, to be active in their learning process. They improved their reading and comprehension abilities and were fascinated preparing computer models. Self perception of ability worked as a strong intrinsic motivational force. Few others were not so eager and preferred the old way of learning.

Table 6. Evaluation of concept mapping skills as shown by the mean value

Level	Criteria /Mean value of each variable	B1	B2	B3
I	Core concept (concepts) correctly chosen	2.25	3.98	5.32
II	All concepts correctly underlined and included in the map	2.05	3.95	5.12
III	Concept hierarchy correct (1^{st}, 2^{nd}, 3^{rd} circle around the core)	1.85	3.86	4.45
IV	Connections correct (pointed by arrows)	1.60	3.79	4.40
V	Successive structure according to text correct (clockwise)	1.20	3.40	4.85
VI	Aesthetically visualized with illustrations	3.10	3.39	4.35
Mean		2.01	3.73	4.74

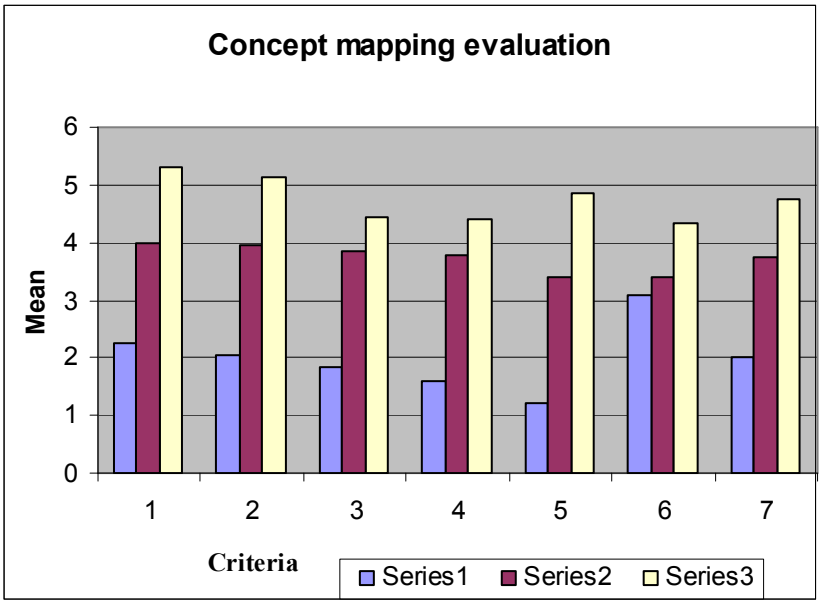

Fig 8. Graphical presentation of students mapping achievements: series 1 (B1), series 2 (b2), series 3 (B3); criterion 7 – mean value for each variable.

Results from achievement tests confirmed the results from observation and maps evaluation. First the psychometric characteristics of tests were assessed and inappropriate items rejected (Table 7). The difficulty of each item of the two tests was assessed. The range of difficulty is between 0.45 and 0.72, which means that the items of the pretest are with moderate difficulty, nearer to the range of the easy items. The same is true for the items of the posttest but they are less easy than those of the pretest (range between 0.50 and 0.62). Discrimination of pretest ranges between 0.35 and 0.50 (high discrimination, and of the post test it ranges between 0.40 and 0.65 (high discrimination). There are some items with moderate discriminative value. The pretest has high reliability, but the reliability of the posttest is questionable, near the high. The validity of both pretest and posttest is high which means that the two tests measure what they are intended to measure.

Table 7. Assessment of psychometric characteristics of tests

Reliability (R)		Validity (Vc)		Difficulty (P)		Discrimination (D)	
Pretest	Posttest	Pretest	Posttest	Pretest	Posttest	Pretest	Post-test
0.85	0. 78	0.85	0.79	0.61	0.52	0.42	0.53

Concept maps improved achievement at the level of analysis and synthesis and at the level of evaluation, i.e. they stimulated the development of higher order thinking skills. Students could memorize using other learning skills, but discovering connections and cause and effect relationships was very well helped by mapping and discussion (Table 8, Fig 9).

Group work and discussions stimulated reflective self-awareness of each student and lifted performance at a higher level. Achieving educational goals satisfied learning motives (Fig 10).

Table 8. Means of achievement tests of the variables

Levels	Pretest			Posttest		
	B1	B2	B3	B1	B2	B3
Knowledge	3.60	3.46	3.55	4.50	5.40	5.60
Understanding	3.45	3.35	3.48	4.35	5.10	5.35
Application	3.29	3.25	3.15	4.28	4.85	5.15
Analysis	3.18	3.10	2.93	3.50	4.65	4.95
Synthesis	2.95	2.85	2.82	3.30	3.90	4.65
Evaluation	2.65	2.30	2.16	3.25	3.60	4.28
Mean	3.18	3.05	3.02	3.86	4.58	4.99

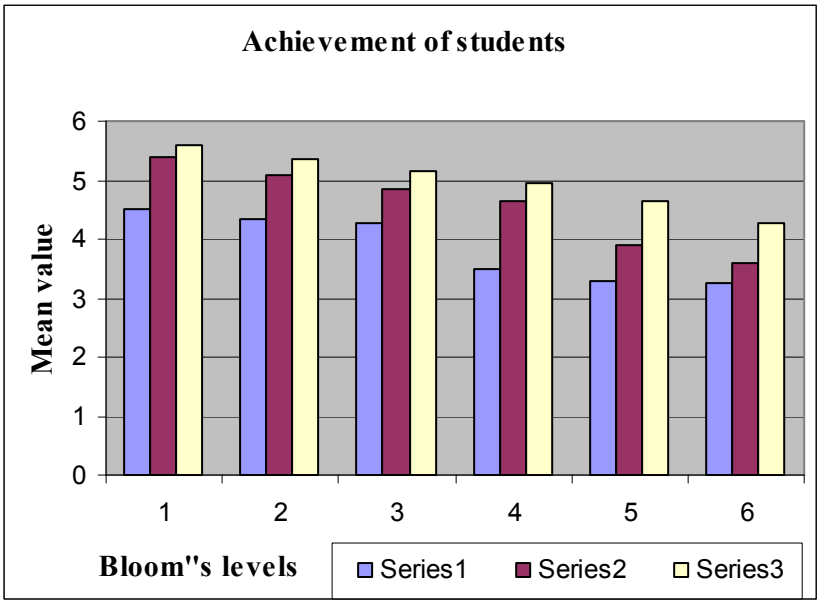

Fig 9. Levels of students' achievements: knowledge, understanding, application, analysis, synthesis, evaluation.

The successive use of word association test, content analysis, concept construction and discussion in the classroom ensured effective learning, motivated and stimulated students to enrich their spare time at home with meaningful work. Discussion and improvement of concept maps in the classroom helped students to correct their misunderstandings before they have memorized them as wrong (Table 9). Collaboration in team work was beneficial for drawing a clear picture and incorporating new knowledge.

Table 9. Comparative results from tests, observation and map evaluation

Variables	N	Pretest	Posttest	Observation	Map Evaluation	Mean
B1	20	3.18	3.86	2.8	2.01	2.89
B2	30	3.05	4.58	3.8	3.73	4.04
B3	30	3.02	4.99	5.2	4.74	4.98

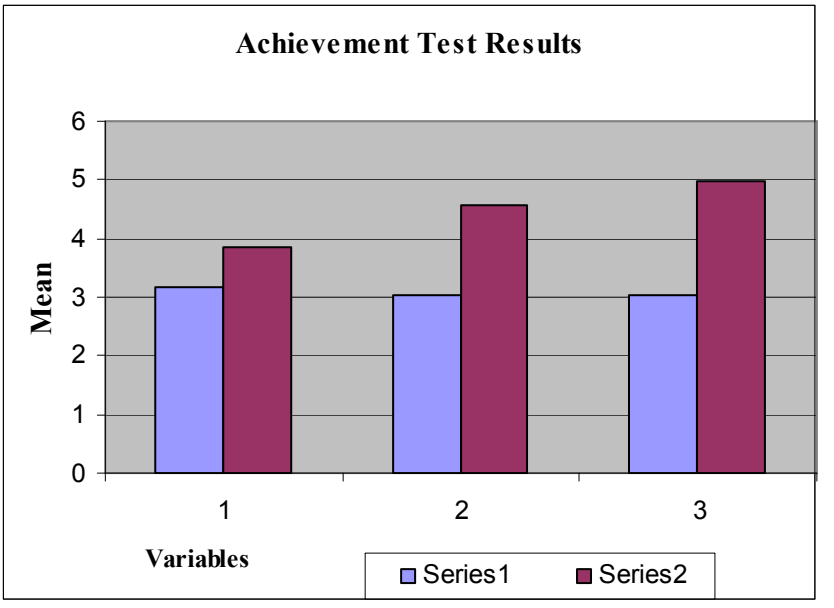

Fig 10. Graphical presentation of students' achievements: series 1 (Pretest), series 2 (Posttest) Variables: B1, B2, B3

Conclusions

The continuous word association test, combined with concept mapping and discussion, as applied in this study was successful in revealing the conceptual structures of 12th and 8th grade students to the stimulus words 'human being'. The concept maps were discussed with students in order to draw inferences about their knowledge and about the importance of the forthcoming studies in the new course Human biology in the 8th grade. The discussion awakened students' desire to learn more about themselves and other human beings. Such maps enhanced concept clarification and cognitive motivation. Although the response terms given by the participants varied at some aspects, areas of similarity emerged, and with little exceptions the criteria for the associations were covered. The target groups showed good informational orientation, concerning the stimulus word and responsibility in answering the test.

The investigation revealed the difference in the disposition of the target groups, the connection between concepts and feelings and the role of education in concept and intellectual development. Associative processes took place at different levels of learning. They were those processes that lead to the development and maintenance of cognitive connections (associations) between events, behaviors, feelings, thoughts, visual images, etc.

The word presented to the target people acted as a stimulus activating the memory and extracting the associated with it words which were on the top of their minds (Zaller, 1992). A dynamic associative structure was created in memory that involved representations of the words themselves as well as connections to other words. This structure of scientific terms played a crucial role in any task involving familiar words. Students could not create and retrieve representations involving familiar words, without relying on pre-existing associative structures created as a result of past experience. Thus the word association test was of benefit as a tool, used to reveal scientific conceptual structures.

Constructing concept (intellectual) maps systematically throughout the whole course of study in Human biology was a useful teaching and learning method for motivating, systematizing and organizing not only the concepts under study, but also the already learned concepts. It created a context for incorporation of new knowledge, for reconstruction of already acquired cognitive knowledge and experience (Bruner, 1960), and for building a new system of meanings of the studied object (Vigotsky, 1982-1984) as a conscious tendency to achievement.

There was a difference between the ways and the duration concept maps were used as study tools. Best achievement was accomplished in the variable (B3) in which students constructed concept maps throughout the school year. In doing that they acquired skills to study accurately, to think and rethink the studied information and to conceptualize it on a higher level (Mar-

zano, 1997). In the process of studying their attitude to learning changed and became more intellectually involving and satisfying (Field, 2005; Lehwald, 1991). The produced portfolio of concept maps of the studied topics on human biology was of great help to students in making a revision of the different chapters and the whole course. Thus the results of the word association test, content analysis and the concept mapping were used for constructing scientific knowledge and for learning associations in a conscious, intentional and effortful way (Wills, 2005). Concept mapping in each topic of human biology helped students brush up and organize their knowledge in a constructive hierarchical way (Smith & Heise, 1992; Swezey et al., 1994). This activity, done as homework, followed by discussion and elaboration in the classroom, directed students' behavior towards cognitive goals, increased effort and persistence in learning and improved their performance (Ormrod, 2003). Students not only learned the subject material, but they also learned how to learn. Active learning combined ability and effort and increased their efficacy (Bandura, 1986).

The good and structured representation of Human biology concepts in the teacher' concept maps in B2, attracted attention, directed students to cognitive goals and facilitated their learning. With the aid of the concept maps, associations were classified, structured, visualized and logical connections between them determined. A compact, wholesome and generalized picture of the key concepts was created, that facilitated learning, memorizing and remembering. The mind seeks clarity and completion and the map as a wholesome picture stimulated the "discovery" of new links between concepts, the generation of new ideas and enhanced its own improvement. Besides that, the association maps stimulated reflection and self-reflection and enhanced studies of the key concepts, using other sources besides the textbook.

Word association test motivated students in B1 too, but their motivation was not sustained after that and gradually faded. That brought us to the

conclusion that motivation should be constantly cared for and sustained in the classroom.

The methods – word association test, content analysis, concept map construction and discussion could be used successfully together in teaching, learning and evaluation in human biology education and in other school subjects. Applying them in school practice made students think of human biology as an interesting subject within their intellectual abilities.

This teaching strategy was very rewarding but it did consume much time and effort which students were not always able to spare. Science conceptual structures depend both on science education and culture of the community in which students grow and develop, including the climate and culture within the schools themselves. They are not the result of studying only one subject but integrate studies in all subjects with their everyday experience. Thus if successful learning strategy is employed in more than one branch of studies, achievements will greatly increase as well as self-regulation and self-control.

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APPENDIX A

Achievement Pretest (Examples)

1. Which cellular constituent is the carrier of heredity?
   a) ribosome
   b| cellular centre
   c) nucleus
   d) lysosome

For 2 and 3 correct can be one or more answers. Choose:
   a) 1, 2 and 3;
   b) 1 and 4
   c) 2 and 4
   d) All of the above are true

2. For ribosome is true:
   1) They are compact oval bodies
   2) They can be seen only with electron microscope
   3) They contain RNA and ribosome proteins
   4) They are organelles only of eukaryotic cells

3. For vitamin D is true:
   1) It is synthesized in the colon from bacteria
   2) It is synthesized in the skin in the presence of sunlight
   3) Its absence leads to damage of calcium and iron metabolism
   4) It is taken with food

4. Which connective tissue is characterized with deposition of calcium and phosphorous salts of large quantity?
   a) bone b) cartilaginous c) loose reticular d) compact reticular

5. Movable connection by means of joints is between the bones of:
   a) pelvis b) humerus and scapula c) ribs and breastbone d) the skull

6. In the process of growth the long bones loose:
   a) compact bone b) spongy bone c) yellow bone marrow d) red bone marrow

Correct answers: 1c, 2a, 3c, 4a, 5b, 6d

APPENDIX B

Achievement Posttest (Examples)

1. What is the name of the organ, taking part in the airways of the respiratory system and has three parts?
   a) Larynx b) Trachea c) Pharynx d) Epiglottis

For 2, 3, 4, 5 and 6 correct can be one or more answers. Choose:

a) 1, 2 and 3;
b) 1 and 3
c) 4
d) All of the above are true

2. Which is true for the chest?

1. It takes part in the ventilation of lungs
2. Its volume can increase and decrease
3. It protects the lungs and the other organs in the chest cavity
4. It is connected to nasal and mouth cavity and the larynx by means of three parts

3. For the alveoli it is not true:

1) They are made up of one layer of epithelial cells
2. They are the end parts of the bronchial tree
3. They are constituents of the lungs
4) Their total surface is about 200 m^2

4. Chemoreceptors taking part in breathing regulation are:

1) In close contact with blood
2) Sensitive to increased concentration of CO_2 in the blood
3) Sensitive to increased concentration of O_2 in the blood
4) Send impulses to the respiratory centre along nerves

5. The exchange of gases O_2 and CO_2 takes place in:

1. The tissues of the organism
2. The upper airways
3. Lungs
5. The lower airways

6. Direct and indirect effects of nicotine on the respiratory system are:

1. Accumulation of mucus and obstruction of bronchi
2. Inhibition of the movement of respiratory cilia
3. Repeated lung infections
4. Lung cancer

Correct answers: 1c, 2a, 3c, 4d, 5b, 6d

✉ Dr. Zdravka Kostova, DSc,
Department of Information and In-service Training,
University of Sofia,
224, Tzar Boris III Blvd., Sofia, BULGARIA
E-Mail: zdravkakostova@yahoo.com

✉ Blagovesta Radoynovska,
New Bulgarian University,
21, Montevideo Str., 1618 Sofia, BULGARIA
E-Mail: blagovesta_k@yahoo.com