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DOCTORAL THESIS

1st YEAR GENERAL MEDICINE STUDENTS' LEARNING TECHNIQUE BY TEACHING ANATOMY WITH THE USE OF CONCEPT MAPS: EFFICIENCY, LIMITS, AND PERSPECTIVES

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*Notes.*_____

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CHAPTER 1. THEORETICAL FRAMEWORK

1.1 Introduction and research issues

This study starts from learning based on understanding notions, one of the most important objectives of education in general, but also of medical education, to which this thesis is addressed. Knowledge in the field of medicine has had an accelerating pace in the last century so that it has grown exponentially in the last 50 years. Along with these, the ways of testing the pupils' and the students' knowledge have also evolved, so as to become possible to test as many of the notions acquired as possible. In response, students adapt to the current situation, which implies the need to have as much knowledge as possible, through an increase in memorization effort, even if it involves superficial learning, without fully understanding all the notions, or even learning by heart. In a short time, however, the accumulation of new cognitions will make older knowledge, which was not fully understood, disappear from the memory of these people. As a result, a kind of "intellectual vacuum" will be installed almost automatically, which will make only the most recent knowledge be retained, and even this, without being understood in their depth. As a result, it is not at all surprising why in new circumstances or situations, or when it is not possible to apply some of those acquired notions "like a book", notions, which were not fully understood, that errors of judgment might occur more frequently.

In 1999, the National Institute of Medicine of the United States published a report "To Err is Human: Building a Safer Health System" (Kohn, Corrigan, & Donaldson, 2000) which concludes that annually, between 44,000 and 98,000 deaths, are due to avoidable errors of medical judgment. A few years later (Shojania et al., 2003) in a study of autopsies performed in the United States, it is reported that a diagnosis of major importance remains undetected in at least 8.4% of patients who die in hospitals (71,400 out of 850,000 deaths) and it was estimated that about half of them (4.1%, i.e. 34,850 patients) would have survived at the time of discharge, without those diagnostic errors. It was shown that these errors had as important causes, not so much the poor knowledge of the staff, but the mistakes resulting from the misconduct of clinical problems, associated with cognitive errors in making the diagnosis and management of the existing clinical problem (Croskerry, 2003). The same cognitive errors were described in 2005, in a report published in the Archives of Internal Medicine in the United States, as the most common causes of diagnostic errors (Graber et al., 2005). In fact, in 74 of the 100 cases investigated, the authors mention over 300 cognitive errors. They also conclude that internists generally have sufficient medical knowledge, the problems resulting from inadequate cognitive processing, or poor metacognitive skills. In 2010, a medical education study by the *Carnegie Foundation for the Advancement of Teaching* concluded that a major overview of medical education was needed (Cooke et al., 2010) to improve patient health care, but also for a decrease in medical errors. In this sense, the authors recommend the medical education system to increase the metacognitive abilities of students and residents to develop their critical thinking.

1.2. Relevance of research

The close inter-relationship between metacognition and critical thinking is considered clarified by multiple studies conducted in this regard (Kuhn & Dean, 2004; Black, 2005) (Magno, 2010). Moreover, Brown stipulates that a person would not be able to obtain critical thinking without having metacognitive skills (Brown, 2004). That is how the idea of the need to introduce learning based on concept maps in medical education was born, which by themselves alone would promote the development of metacognitive skills and logic-based

thinking. This method was not new, it had proved its effectiveness in most cases in other fields, and sporadically in medicine, too, but it was time for more detailed investigations on the mode of action, fields, medical specialties, and also the typology of people for whom the method is effective, as well as, the identification and clarification of its limits. Numerous studies (Hsu & Hsich, 2005; Martinez-Canas & Ruiz-Palomino, 2011; Hsu et al., 2016) have confirmed that concept maps exert their effects on changing the students' levels of thinking. However, the results concerning students' academic performance are contradictory. Thus, in some cases (Gonza'lez et al., 2008; Reiska et al., 2015; Jaafarpour et al., 2016) a significant improvement in student outcomes is reported through the use of concept maps, along with students' motivation for learning. (Buldu & Buldu, 2010). In contrast, other authors (Hsu et al., 2016) do not report a significant improvement in multiple-choice test results. Last but not least, there are authors (Buldu & Buldu, 2010; Jaafarpour et al., 2016) who draw attention to the fact that their use would be, in the students' opinion, very time-consuming. All these data must be assessed objectively, to see if the positive effects on the development of critical and reflective thinking, appreciated by all the authors mentioned above, are not counterbalanced by the negative parts (especially by an uncertain effect on academic performance), in the case when they are time-consuming anyway.

1.3. Concept maps or learning by traditional teaching?

In a review that analyzed 25 studies of learning with concept maps (Fiorella & Mayer, 2015) positive effects of the method to test knowledge were found, compared to other learning activities or reading the material, with an effect d = .62. In 23 studies positive effects were recorded. Redford and colleagues found that the process of creating concept maps is also important, which would increase the accuracy of the meta-understanding (Redford et al., 2012) compared to re-reading the material or studying a pre-existing concept map. It would appear that less well-prepared students would benefit more from this method, (Haugwitz et al., 2010; Liu et al., 2010), while some meta-analyses report (Nesbit & Adescope, 2006) an effect size d = .44 for students with low verbal skills, for whom prebuilt maps would also be useful, and a d = -.33 for those with better verbal skills, while other meta-analyses reporting (Fiorella & Mayer, 2015) an effect size d = .45 for students with lower abilities and d = -.08 for students with better abilities. These results led to the conclusion that concept maps would help in particular to organize ideas and to identify goals to be achieved. Thus, concept maps would be useful, being a generative learning technique by identifying the main or important points of the material and respectively, the relationships between concepts, hypotheses that would confirm the cognitive theory of multimedia learning (Mayer, 2002), which provides that selection, organization and material integration would be the most important processes for understanding learning. By arranging and organizing the concepts of the material and defining the relationships between them, it will give sense to the material (Fiorella & Mayer); but it has been observed that the use of concept maps to teach lessons to virtual characters, called agents (Chin et al., 2010), would lead to increases in the performance of those students. Only a few studies have combined the use of concept maps in various stages of the learning-by-teaching technique. A relevant study in this regard (Muis et al., 2015), indicated that those students who expected to be taught in the teaching-learning process developed more rigorous concept maps and performed better than students who had learned without being involved in the learning process by teaching. A different study in which students developed concept maps (Biswas et al., 2005) to be taught to a virtual agent who encouraged students to use self-monitoring strategies (such as asking for help or setting goals by another agent), showed that more elaborate concept maps were developed by those students who asked the agent to appreciate what they had learned. In research as well conducted through a

virtual agent (Segedy et al., 2013), there was reported the development of some more elaborate concept maps for those students who understood and integrated the feedback received from the virtual agent contrary to those who focused only on explaining the material. Learning through concept maps proves to be a useful learning tool, both as an assessment and as a generative learning technique, clarifying to the students the main elements of the material covered but also the relationships between them. It is useful for students untrained in creating concept maps to be guided in this regard (Chang et al., 2002), to be given explanations of the benefits before actually using them (Redford et al., 2012). Note the importance of students' motivation, revealed by some studies (Fiorella & Mayer, 2015), or the clarity of the material used. From the presented material, one can ask the question about the technique that would be more useful in medical education in general and the one of interest for the present research, i.e. for learning anatomy: concept maps or learning by teaching? However, if we resume the way the two techniques work, it can be seen that by creating concept maps learning based on understanding the material would be achieved, increasing students' metacognitive skills, while learning by teaching would increase students' internal motivation, their verbal and cognitive abilities, but not their metacognitive ones. When verifying addressability, from the point of view of the target participants, it can be seen that most studies support the usefulness of concept maps in the case of less well-prepared students, while learning via teaching would work especially for better-prepared students. However, it would seem that the two techniques complement, rather than exclude each other, at least theoretically, thus, a method that combines the two techniques would be welcome. In this way, at least in theory, the benefits of both methods would be combined. As we have shown, there are insufficient studies to combine the two learning techniques, and even these were generally summarized in observing the effect achieved by one technique on the other, or in the case of learning by teaching, it was in most cases a virtual agent. Yet, this role should be mastered by students, for the active role that students' cooperation would have in the learning process, to clarify the notions. We consider this moment to be extremely important because better-prepared students would ask questions, and by discussing them, all students would benefit, with clarification of important objectives and concepts, but also to learn the order of presentation of the material. , which would rebuild and reconsider the concepts with their hierarchy and graphic and then, their mental associations.

CHAPTER II. RESEARCH OBJECTIVES AND GENERAL METHODOLOGY

2.1. **Research objectives**

This thesis presents a theoretical framework that highlights how learning using concept maps and learning by teaching manifest their effects on students, in an attempt to use a method that combines the benefits of both ones. But in addition to their beneficial effects, each method also has certain limits, so it is imperative to know them, because it could result in a multiplication of limits, instead of a decrease. We also tried to identify the predictors involved in obtaining school performance, but also those that can influence the long-term memorization of the notions learned, which inherently implies the existence of a deeper understanding, by drawing at least mentally some associations with other concepts existing in memory. To achieve the objectives listed below, we conducted a number of 4 studies.

The main objectives that we wanted to achieve in this thesis are:

1. A first objective is to analyze whether learning through concept maps has a beneficial effect in the medical field, or in anatomy in particular (Study 1). Since there was enough data

on learning via teaching, we chose the previous direction in the first study. Numerous meta-analyses investigate the impact of concept maps in education. At the beginning of this thesis, one of the most exhaustive meta-analyses, conducted by Nesbit and Adescope, reveals that the method has different effects depending on the subject of study; there are data that they would have beneficial effects in science in general (Nesbit & Adescope, 2006).
2. Through the second objective we want to identify which mediating or moderating factors could influence the results, to adapt our future studies according to them (Study 1).
3. To identify if the proposed method (learning by using concept maps), effects the study of anatomy by 1st-year students of General Medicine and if the factors identified in the case of meta-analysis exert their influence in this case as well (Study 2).
4. The result of applying the 2 methods does not (obligatorily) represent the sum of the 2 methods applied separately. We, therefore, wanted to observe for which subgroup of students, the method is more efficient. In this case, both the overall and the specific effect must be quantified, for example by studying the distribution of grades among students, given the fact that one method would work especially for well-prepared students (learning by teaching), and the other for students who are more poorly prepared. In other studies, we wanted to observe which subgroup of students would be more favored depending on the learning or thinking style. These results were quantified by an analysis of grades distribution among students, both immediately, i.e. in the 1st semester, and after 6 months (Studies 2 and 3).
5. Identifying the practical solutions for implementing the method, this learning method being beneficial if integrated along with the practical ones, in the specific framework of anatomy. (Studies 2 and 4)
6. Noting the limitations of the method, respectively, of a subgroup of students for whom the method has no beneficial effects and how these limits could be exceeded, with the identification of the following directions to be studied (Studies 3 and 4). It should be mentioned that these limitations, which are specifically addressed to the proposed method, need to be further studied and research even needs to be extended, this way other limitations of the method being possible to be identified.

2.2. General methodology

For the mentioned objectives we formulated specific hypotheses. To meet the first two objectives of the thesis, in a first study, we performed a meta-analysis, which included samples with preclinical and clinical subjects, as well as variables such as gender, age, or time of use of concept maps. To achieve the 3rd goal, we developed a quasi-experimental study among 1st year General Medicine students. During the study, we manipulated the learning method, in order to observe if the students' academic performances are influenced by semester testing, but also by the long-term memory, i.e. testing after 6 months. The distribution of series and groups of students learning according to the experimental or traditional method was done randomly, but the order of students in the groups was generally in alphabetical order, and although the procedure was repeated each time, during the 3 years of studying, we could not prove randomization without any doubt. In addition to the overall effect, we studied the effects produced by lines of study (Romanian and English), with the distribution of grades, or using as moderating variables gender or mother tongue (whether the same or not from the language of study). To achieve the fourth objective, we imagined two types of studies. Regarding the effect of the method on better or less well-prepared students, it was performed by Study 2, described above and which was, therefore, a quasi-experimental study. To study how students' learning or thinking style influences their experimental method, we developed a non-experimental, correlational design, in which we studied the effects achieved by each style. For this, the investigation was carried out exclusively on

students who benefitted from the learning method by teaching using concept maps, and as a dependent variable, we used the semester grade and the score after 6 months. To achieve the fifth objective (identification of practical solutions), only one study was initially developed, the second, a quasi-experimental one, described above. In terms of results, somewhat unexpected, recorded during the 4th study, we identified studies to be followed to confirm the results, but also practical measures to be implemented until the results are clarified or to elucidate the mechanisms involved when it will be possible to elaborate objective practical solutions. This study, the fourth one, was also quasi-experimental, having the same limitations in the distribution of participants just like Study 2. The last main objective mentioned (identification of the limits of the method), was achieved by developing two studies. In Study 3, we developed a non-experimental correlational design, through which to identify in the case of which the learning or thinking styles the proposed learning method does not achieve its effects demonstrated by Studies 1 and 2. Besides, we wanted to assess whether and the extent to which motivation is involved in achieving different results. For this, we developed a quasi-experimental study in which we also manipulated the learning method and used the type of motivation as a moderating variable. The research was carried out identically in terms of method and procedure with Study 2, the design being also quasi-experimental, but it was conducted during the academic year 2019-2020, which is why we used as a dependent variable only the testing during the 1st semester. In addition to these general objectives, each of the studies conducted had specific objectives, described separately, in each study. The general methodology of the thesis was developed by testing the learning method designed in different situations. This perspective is developed according to the theories and studies that support each of the learning methods. All the participants of the thesis signed a written consent in which they agreed with the conditions, and the studies were approved by the Ethics Commission of the "Iuliu-Haţieganu" University of Medicine and Pharmacy from Cluj-Napoca.

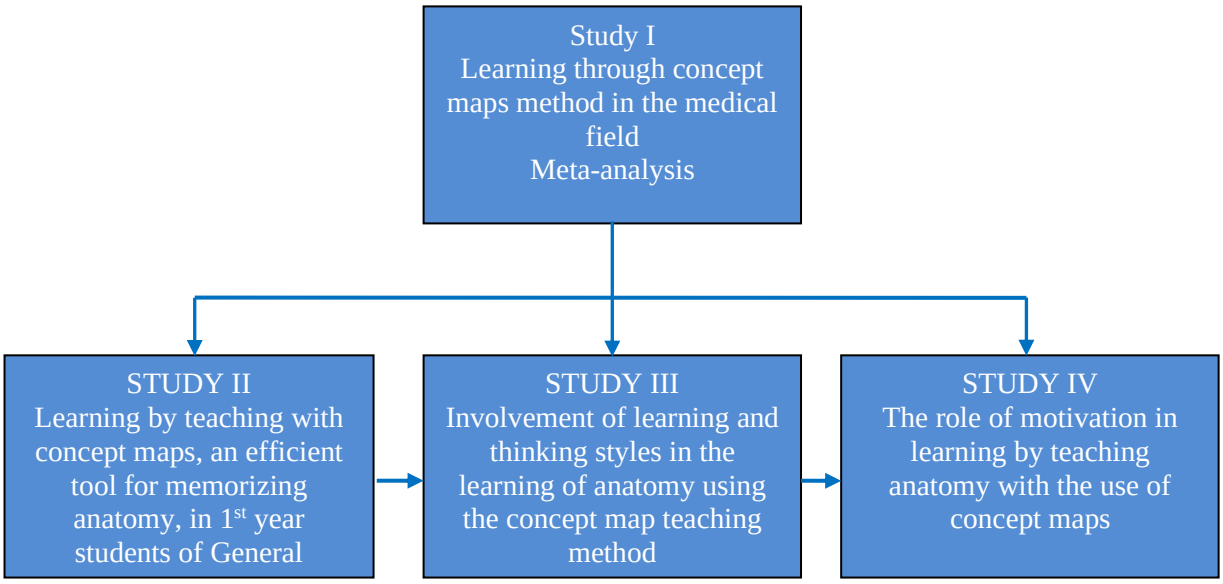


Fig.1. Structural scheme of the project

CHAPTER 3. ORIGINAL RESEARCH CONTRIBUTIONS

Study I: Learning through concept maps method in the medical field - a meta-analysis[1]

3.1.1. Introduction

The purpose of this section of the doctoral thesis is to see if there is a national and international scientific validation to justify the chosen paper, as well as to identify the factors involved, and draw lines of research through the existing base. However, before starting to develop the actual meta-analysis, a part of the terminology used must be defined. Thus, since 1984, some terms such as "concept maps" have been introduced (Novak & Gowin, 1984), or pre-constructed maps, the so-called "knowledge maps" (O'Donnell et al., 2002). These terms have the role of serving in the elaboration of some assemblies or connections between different concepts, respectively knowledge so that through their graphic representation a series of maps would result. By using them, but also by using these concept maps or the previously known ones, the student would be able to make connections or links between different notions faster, and as a result, the whole learning process would run faster and easier. These maps are often used both to communicate various connections within courses but also in different study or collaborative learning materials, (Canas et al., 2003). In fact, in the last 30 years, there has been a great increase in the interest in presenting and using both types of maps to facilitate both teaching and assimilating this new information. This reality was reflected by the change of the teaching methodology, but also in the supports for courses and practical works. The increased interest was also reflected by the appearance of more and more publications and studies that refer to the mentioned map concepts; so that after 1997, through a selective search, more than 500 articles were found in the ERIC and PsycINFO databases (Nesbit & Adescope, 2006). Initially, the graphic organization was used, which represents the two-dimensional visualization of various concepts or processes, through spatial positioning, thus appearing in various tables, diagrams, graphs, schedules, and others. All these were described in 1981 by the effect of the graphic organization (Alvermann, 1981), which has undergone some changes over time, to then show how it can be effectively applied in the teaching of certain subjects (Ives & Hoy, 2003), all being nothing but derivatives of the theory of understanding of learning developed since 1968 (Ausubel, 1968).

Thus, a conceptual map is nothing more than a graphical, organized view of various information, similar to tables, but where there will be points of intersection, which will direct the student to other concepts or theories, depending on the specific situation. These intersection point diagram maps are similar to the diagrams used in communications, learning, or navigation as early as the 13th century, as described by Sowa (2000). Sketches that use intersecting point diagrams ("node-links") can be found in concept maps but also in those that use knowledge. Most learning maps use the method of starting from a central node, which then branches out like the branches of a tree, resulting in a multitude of other situations, concepts, or characteristics, which will require reassessments or direct conclusions, according to theories initially considered as correct, or axioms. This model was designed after Nesbit's educational psychology course (Nesbit & Adescope, 2005) and is used by both teachers and students even though it differs substantially from the original model, i.e. the tree model.

[1] This study has been published:
Nicoara, S.M., Szabo, B.A., Micu, C., & Badea, A.F. (2017). Meta-analyses on the study with concept maps on the medical field, Transylvanian Journal of Psychology, vol 18 no. 2, pp.133-170.

Objectives

The objective of this meta-analysis is to review all studies on the effect of learning by using concept maps, regardless of the experimental or non-experimental nature, as long as they use specific methodological criteria. Due to the existence of considerable diversity of the addressability of these concept maps, but also of the multitude of types of questions found in the literature, the main objectives of the study refer to estimating the effects on the learning process by using concept maps, but also to graduate these effects depending on the conditions of the investigation. The results of this meta-analysis will be useful for future studies in the field, so the objectives must be clearly outlined.

This meta-analysis should answer the following questions:

1. What are the effects of learning on students using these concept maps versus students with traditional learning activities?
2. How do these effects vary depending on the subject of study, at preclinical and clinical level, as well as in other areas of medical learning, with concept maps as a training model, to see if the method is applicable in the medical field?
3. Are there factors, detectable in other meta-analyses that could influence or mediate the students' results, such as the gender or age of the study participants?
4. Are there other traceable factors, less considered by other meta-analyses, that could influence the relevance of the data collected from different studies, and what are they?

3.1.2. Method

The criteria for selecting the studies in the present meta-analysis were imposed after a systematic analysis of the literature, which included all those studies published in English, selected from the databases of Pubmed, ERIC, and others. The studies were identified based on the keywords of concept maps or mapping, knowledge map or mapping, after which they were filtered by using medical education words or learning to eliminate those studies that have nothing to do with the present meta-analysis, respectively with the concept of learning in the medical field. Studies whose full-text, and respectively, obtained data are absent and inaccessible, were also eliminated.

Selection criteria

The criteria for including the studies in the present meta-analysis are:

1) studies published in English;
2) articles published in peer-review journals;
3) concept maps used as a learning method;
4) inclusion of a control group;
5) the study material is used in medicine;
6) data are reported in order to calculate the average effect rate;
7) enrollment of study participants were randomized, or a pretext or other data correlated with the results was used so that there should not be prior differences between groups.

For this, studies with an effect of the pretest $d < -.4$ or $d > .4$ were removed from this study.

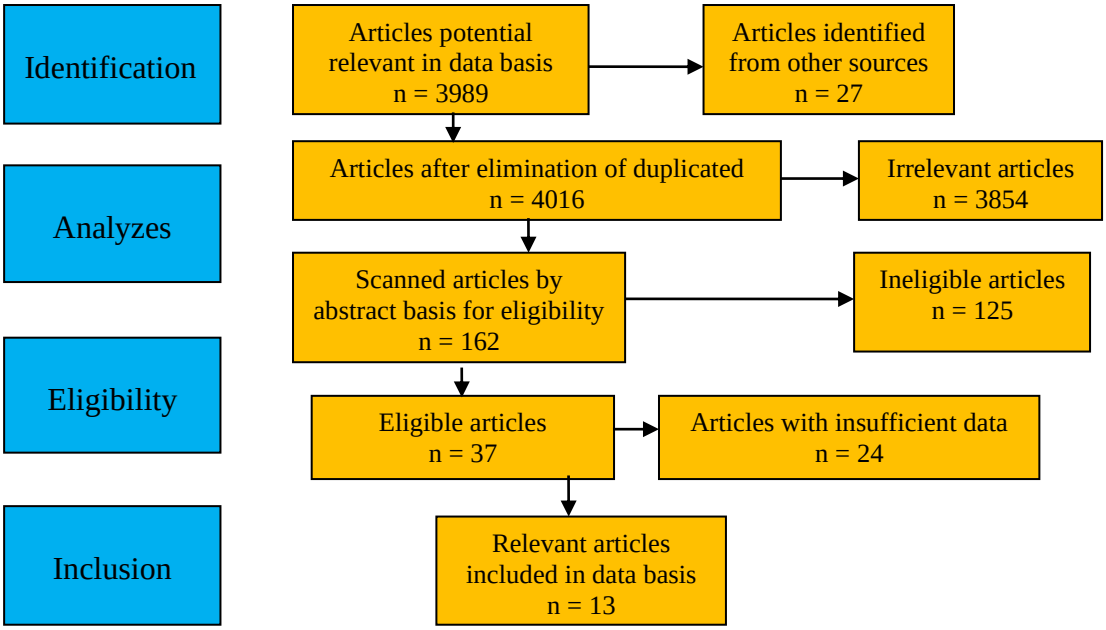


Fig. 2. PRISMA Flow Diagram

a) **Coding procedure**

After identifying those studies that correspond to the above selection criteria and respectively selecting the groups to be compared according to the questions found for the purpose of this meta-analysis, we proceeded to finding the points of order for a correct coding from all points of view of the present meta-analysis. Thus, the coding included the source of origin, the level of study of the students, respectively their gender and age, but also the type of interaction they had, the work topic, the total number of sessions work hours, as well as the hours of implementing the study of concept maps, and/or the duration of the study, the resistance of the subjects to the implemented treatment, the randomized control of the pre-treatment, performed where appropriate, and of course the results obtained by the applied methodology. In addition to these, other codifications were included, which are meant to assess more accurately the results obtained, such as the average rate, given that during the various studies, some treatments implemented had a high rate of fidelity, others medium, and others had low rate, depending, for example, on how the subjects were followed by the teacher during the construction of the concept maps; in some studies, the teacher actively followed the evolution of the work submitted by students, while in other cases, the construction was evaluated only at the end of the session, which resulted in high, medium or low fidelity of the results obtained. The random-effects model was used for data analysis (Borenstein et. al, 2005) (Hunter J., & Schimdt F, 2004). For the different outcomes, Cohen's coefficient d was calculated for the effect size (Cohen, J., 1977) based on the change between the posttest moments in the experimental and the control groups. Several other parameters identified in each study were also taken into account and coded and which by their nature could modulate in one way or another the results of the study with concept maps. All these parameters are illustrated in Table 1, including the data obtained from the pretests of some studies, even if we later gave up their use in the calculations, being uninfluential because of their small values.

Table 1. Parameters and codes of the studies

						Pretest				Posttest			
Authors	Year	Type of intervention	Duration of intervention	Nr. of experim. sub-group	Nr. of control sub-group	Experimental group results	SD exper.	Control group results	SD contr.	Experimental group results	SD exper.	Results of control group	SD contr.
1. Zadeh N.R., et al.	2015	Cleaning Injection Sterilizing	28 ses. 45 min, 2sessions/week CM 4.5 h	35 (15M, 20F) 42.86-57.14%	35 (15M, 20F)	24.5 24.6 24.4	2.54 2.69 2.56	23.8 23.8 23.5	2.62 2.47 2.92	77.9 77.3 77.5	2.62 2.77 2.69	63.70 56.90 61.60	1.94 7.61 3.18
2. Saeidifard F., Heidari K, et al.	2014	Endocrinology courses followed by learning about CM and drawing CM	2 weeks, then 1 session of 2h si 15 min for CM	37 (14M, 23F) 37.84-62.16%	39 (14M, 25F) 35.9-64.1%	15.15	1.87	15.50	1.51	P.P. work. 78.1 P.P. c. 15.15 Diagn. 81.08 Treatment 75.54 Total 78.2	7.30 1.87 11.20 10.50 7.85	72.50 15.54 71.53 71.47 72.50	5.50 1.51 8.10 7.80 5.50
3. Mukhtiar B., Saba T., et al.	2016	Learning about sugar metabolism with CM	1 month, 2 sessions 2h/week, total of CM 3.25h	15	15	-	-	-	-	MCQs: 12.23 SEQs: 11.16 Total: 23.39	.20 .20 .37	MCQs: 11.01 SEQs: 11.06 Total: 22.07	.20 .18 .36
4. D'Antoni A. V., et al.	2010	Study for medical students in groups: Mind Map and Standard Note Taking for analysis: deduction, inductive and deductive understanding and the total	3 hours 25 min. In more sessions of Mind Map 30 min.	66 (31M, 35F) 47-53% (AfroAmer. 3 AngloAmer. 35 AsioAmer. 18 Hispanic 3 Others 5)	65 (32M, 33F) 50,8-49,2% (1 29 23 1 10)	Analysis 4.98 Deduction 3.86 Evaluation 5.31 Ind. und. 7.95 Ded. und. 7.74 Total: 24.07	.88 1.21 .80 1.14 1.52 3.04	4.72 3.78 5.27 7.98 7.43 23.41	1.21 1.30 .89 1.26 1.97 3.69	4.80 3.75 5.31 7.95 7.78 23.97	1.05 1.22 .72 1.24 1.75 3.75	4.87 3.72 5.24 7.96 7.58 23.47	1.05 1.26 1.03 1.26 2.06 3.82
5. Burdo J. & O'Dwyer L.	2015	3 groups: Retrieval Practice, with CM and the traditional one in physiology	12 sessions of 45 min., CM 20 min	RP: 21 CM: 21	102	RP: 10.24 CM: 10.05	2.76 2.56	9.86	3.23	RP: 88.5 CM: 81.49	8.70 8.78	84.36	9.72
6. Chei-Chiang Chiou	2008	2 groups, CM and the control one	24 sessions/1hour, CM 2 hours	62	62	67.51	12.106	68.87	11.217	73.24	15.314	63.31	21.561
7. Lym K.Y. et al.	2008	-2 levels of Self Regul. Learn. skills (High and Low) -3 levels of CM learning (1 group learns with a CM already designed) concerning the human heart	3 weeks, 1session of 1our/week,1 session of 50 min. for. CM	F.L. High: 20 43 Low: 23 46.51- 53.49% P.L. High: 24 41 Low: 17 58.54-41.46%	Exp. gender. 40 High:18 Low: 22 45-55%					Fully learn. gender. CM High: 31.00 Low: 23.00 Part. Learn. Gen. High: 24.92 Low: 23.00	 5.77 9.67 8.43 9.67	Exp. gender. CM High: 22.78 Low: 20.23	 9.40 8.18

8. Cheema A.B.& Mirza M.S.	2013	2 CM groups and classic ones at 3 subjects: biology (40%), chemistry (32%), and physics (28%)	5 months The first 3 weeks of CM preparation	89 (43M, 46F)	78 (38M, 40F)	-	-	-	-	Total: 12.79 Sc boys: 16.41 Sc girls: 9.42	8.86 8.20 8.16	3.41 2.00 4.41	5.85 3.79 7.08
9. Otor E.E.	2013	2 CM groups and classic ones for the study of chemistry, biochemistry in general and related to sexes	6 weeks, 2 sessions of 2 hours/week each, 2 CM sessions	687	670	5,11 Fem.: 4,93 Male: 5,22	1,34	5,06	1,34	15,18 Fem.: 16,56 Male: 14,95	2,02 1,92 2,05	10,84	1.65
10. Ogonnaya U.P. et al.	2016	Effect of CM concerning sciences in general and according to gender	5 sessions of 55minutes of CM, total 1.5h	70 (30M, 40F)	52 (30M, 22F)	-	-	-	-	47.07 Male: 45.30 F: 48.40	11.43 12.81 10.24	37.00	9.42
11. Luchembe D. et al.	2014	Results of CM method evaluated through tests and questionnaires	6 months, 1session of 30 min/ week, CM 1 session	35	35	55.14	12.50	55.06	12.07	69.37	10.70	63.03	13.79
12. Gonzalez et al.	2008	2 CM groups and classic one at physiology with 2 tests: Problem. Solving Exam. And MCQs	8 sessions of 2 hours each, CM 1 hour and 15 min	83	39	-	-	-	-	PSE: 3.60 MCQs: 3.80	1.18 3.80	PSE: 2.79 MCQs: 3.52	1.39 3.52
13. Surapaneni K M & Tekian A	2013	2 groups: CM and classical 3 final tests (MC, SE si SA Qs) in biochemistry	5 months, 2 sessions of 1.5 hours/week CM in total ~ 4hours	75	75	-	-	-	-	T1: 12.33 T2: 13.93 T3: 13.30	3.17 1.67 1.51	T1: 7.99 T2: 8.28 T3: 7.13	2.34 1.40 1.26

Note: Nr. sub.= number of participants; SD exper. = experimental group standard deviation; SD contr. = control group standard deviation; min. = minutes; wk = week; M = masculine gender; F = feminine gender; CM = concept map; P.P. practice = Physiopatology practical works; P.P. c. = Physiopatology course; Diagn. = Diagnosis; Tratam. = Treatment; MCQs = multiple choice questionnaire; SEQs = structured essay questionnaire; AfroAmer. = AfroAmericans; AngloAmer. = AngloAmericans; AsioAmer. = AsioAmericans; Deduc. = Deduction, Ind. Underst, = Inductive Understanding; Ded. Underst.= Deductive Understanding; RP = retrieval practice; gr. = group; F.L. = Fully learn. CM = Fully learner generated (students who learn using the method of generating concept maps); P.L.= Part Learn. Gen = partial learner-generated (students partially learn using the method of generating concept maps); Exp. gener. = experted generated, students learn with classical method but they can visualize some concept maps designed by experts; Oct. = October; Problem. Solv. Exam = PSE = Problem Solving Exam (questionnaire with short answers of problem solving types); MC = multiple choice; SE = structured essay; SA = short answer; Qs = questionnaire; T1 = test time 1; T2 = test time 2; T3 = test time 3

b) **Data analysis**

Data analysis was performed using the software Comprehensive Meta-Analysis version 2.0 (Borenstein et. Al, 2005) and was calculated the effect size for the effectiveness of the concept map model in the experimental groups compared to the classical teaching model in the control groups. The interpretation of the results was based on Cohen's suggestion: an effect size <.20 is considered trivial, an effect size between .20 - .50 is considered small, an effect size between .50 - .80 is considered medium/moderate and one> .80 is considered a large effect size. The Q and I^2 (Borenstein et. al, 2005) statistics were used to test homogeneity. Fail Safe N (Rosenthal, 1991) was used to correct the publication bias, as well as, the one provided by Orwin (Orwin, 1983). The total number of participants was 2,625 of which 1,318 in the experimental groups and 1,307 in the control ones.

Table 2. Number and distribution of participants by studies

Study	Number of participants
Zadeh, N.R., et al., 2015	70
Saeidifard, F., et al., 2014	76
Mukhtiar, B., et al., 2016	30
D'Antoni, A. V., et al., 2010	131
Burdo, J., & O'Dwyer, L., 2015	123
Chei-Chiang Chiou, 2008	124
Lym, K.Y., et al., 2008	83
Cheema, A.B., & Mirza, M.S., 2013	167
Otor, E.E., 2013	1,357
Ogonnaya, U.P., et al., 2016	122
Luchembe, D., et al., 2014	70
Gonzalez, H.L., et al., 2008	122
Surapaneni, K, M., & Tekian, A., 2013	150
Total	2,625

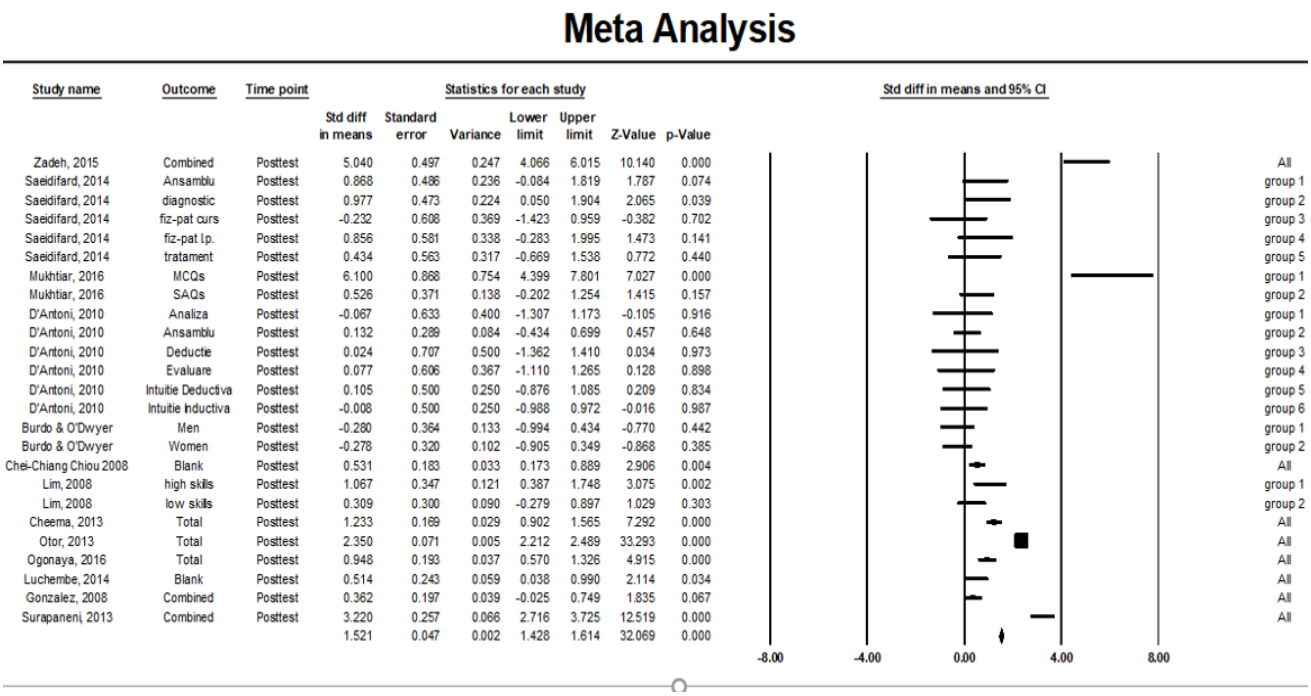
3.1.3. Results

Results on the effect of concept maps

These first results are the ones that answer the main question of the present study, i.e. the effects of learning through the method of concept maps. There are several approaches, the purpose of this paper being to effectively observe the students' academic performance.

a. Overall results

Thus, the size of the overall effect for the comparison between the intervention groups and the control groups, at the posttest, calculated based on the 13 studies is statistically important and significant, d = 1.521; 95% CI [1,428 - 1,614]; p = .000; Q = 507.061; I^2 = 95.267. Fail Safe N = 2195 (Rosenthal, 1991), much larger than $5K + 10^2$, where K represents the number of studies, because Orwin Fail Safe N = 370 (Orwin RG, 1983), calculated for the trivial d of .19, and d hypothetical in studies lacking .1.



Note: Effect of posttest intervention ES = 1.521; 95% CI = [1.428 – 1.614]; p = .000

Fig. 3. The Forest Plot

b. **Preclinical and clinical subjects**

We used similar measuring instruments to see if there are differences from this point of view, too, without studying each subject, due to their large number.

1) Thus, in the case of the groups with object of study the clinical matters the registered results are: d = 1,446; 95% CI = [1,090 - 1,803]; p = .000; Q = .464; I^2 = 93.101. Fail Safe N = 146 (Rosenthal, 1991), greater than 5K + 10^2, k being the number of studies, and Orwin's Fail Safe N = 112 (Orwin RG, 1983), calculated for trivial d of .01, and d hypothetically at studies with lack of .01.

2) Regarding the results of the studies that had as object of activity the preclinical subjects, were also important and statistically significant, obtaining similarly in these cases d = 1,527; 95% CI = [1,431–1,623]; p = .000; Q = 405.415; I^2 = 96,053; and Fail Safe N = 1189, much higher than 5K + 10^2, where K represents the number of studies. In these studies, Orwin's Fail Safe N = 253, also calculated for an index d considered to be trivial at .19, using in these hypothetical studies a value of d equal to .1.

Mediators and moderators of the effect of the intervention

Among the specific mediators used in other meta-analyses, some were impossible to codify, not being used from the beginning, as the language of instruction (in the mother tongue, or not), others generated too many outcomes, each of them having a too-small number of studies to be able to make a correct interpretation (such as the specific subject matter taught or type of test).

The following results were obtained:

- for males d = 1,996; 95% CI = [1,839 - 2,154]; p = .000; Q = 65,913; I^2 = 95,449; and Fail Safe N = 314 (Rosenthal, 1991), much larger than 5K + 10^2, where K represents the number of studies, Orwin's Fail Safe N = 81 (Orwin R. G., 1983), calculated for the trivial d .19.
- for females d = 2,027; 95% CI = [1,834 - 2,219]; p = .000; Q = 178,147; I^2 = 98,316; and Fail Safe N = 223 (Rosenthal, 1991), much larger than 5K + 10^2, where K represents the number of studies, Orwin's Fail Safe N = 82 (Orwin R. G., 1983), calculated for the trivial d .19.

Concerning the use of the meta-regression on the percentage of female in the reported studies, a Slope = .001 index was obtained; 95% CI = [-.026 - 0.029]; p = .921; Q = 0.010; Z = .098.

Regarding the use of age as a moderator, a meta-regression was performed for the studies that took into account this index, obtaining a Slope index = -.05; 95%; respectively CI = [-.329 - .221]; p = .702; Q = .146; Z = -.382.

Other mediators that could influence the results

Given the different length of time in which the study was applied, from 1 week to 6 months, we divided the number of actual working hours with students into 3 categories: up to 5 hours, between 5 and 20 hours, and over 20 hours.

The following results were obtained:

<5 hours d = .562; 95% CI = [.357 - .767]; SE = .105; Z = 5.362; p = .000;
5-20 hours d = .366; 95% CI = [.129 - .603]; SE = .121; Z = 3,030; p = .002;
> 20 hours d = 2,106; 95% CI = [1.990 - 2.222]; SE = .059; Z = 35,540; p = .000.

Subsequently, we proceeded to the analysis, depending on the actual working time, through which the method of concept maps was used.

The results obtained are:

Slope index = .776; SE = .125; 95%; CI = [.530 - 1,023]; p = .000; Q = 38.183; Z = 6.179.

We proceeded to the graphical representation of the meta-regression (Figure 4), to better observe the recorded data, but also for the decision of a subsequent analysis.

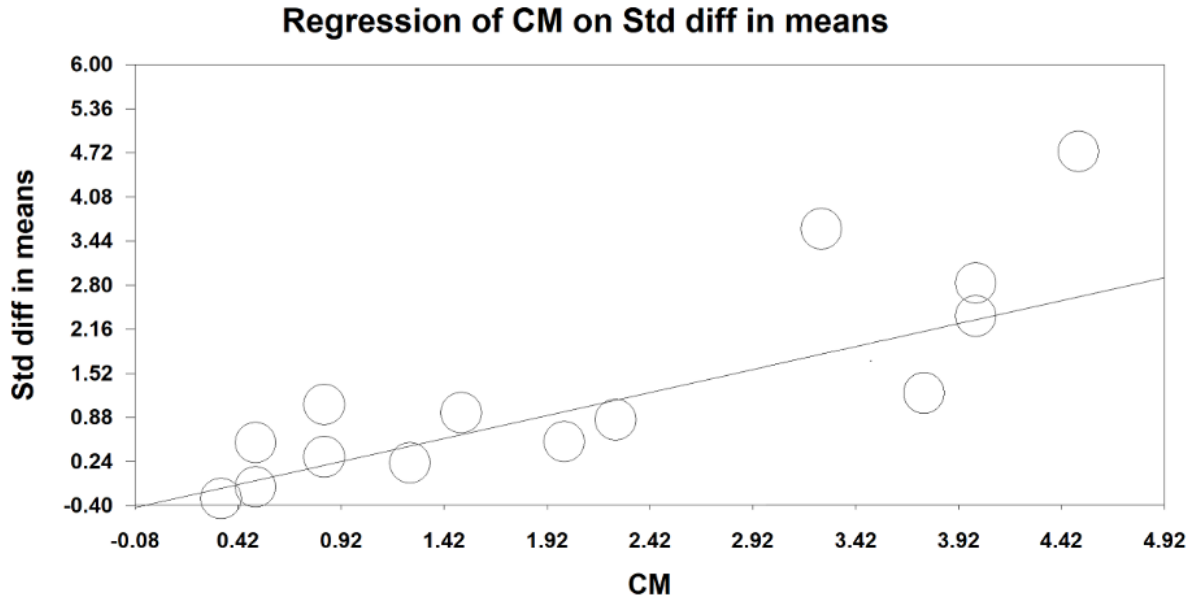


Figure 4. Meta-regression according to the effective duration of CM

From the meta-regression analysis, the effective duration was divided into 3 distinct groups, namely less than 1 hour, between 1-3.5 hours, and more than 3.5 hours. We performed an intentional dichotomization and interpreted the data after this dichotomization, that is, to have clearer reference data of the effects.

<1h d =.225; 95%CI =[.007 – .443]; SE =.111; Z =2.027; p =.043; Q =12.502; I^2 =20.014;
1-3.5h d =.680; 95%CI =[.492 – .868]; SE =.096; Z =7.091; p =.000; Q =47.435; I^2 =81.027;
>3.5h d =2.291; 95%CI =[2.169 – 2.414]; SE =.063; Z=36.574; p=.000; Q=83.443; I^2=96.405

3.1.4. Discussions and conclusions

Assessing the effects of applying the study method with concept maps can be done on students in terms of influencing school or academic performance but also by assessing the

effects on their mental state, how they may or may not better understand and integrate new knowledge, next to the existing one. Another important factor is that represented by motivation and whether it is influenced (especially the intrinsic one) by the way of teaching. These concepts were reiterated by Vink in his paper on integration in science (Vink et al., 2015) and analyzed by McGaghie for pulmonary physiology (McGaghie et al., 2000) as well as by Bergman in the only paper found in the study of conceptual maps in human anatomy (Bergman et al., 2013).

Moreover, in the present thesis, one of the studies will aim at observing a possible change in the motivation of students to study anatomy through the proposed teaching method. However, the main objective of this paper was to see whether teaching according to the concept maps method has or does not have applicability value among the branches of medicine. Secondary objectives, but also extremely important, were represented by its specific applicability on preclinical branches, the anatomy being such a subject matter but also by the identification of additional factors that could influence in one way or another its applicability or effectiveness.

Regarding the overall effectiveness of the concept map method in the field of medicine, the results obtained are statistically significant, d = 1.521; 95% CI = [1,428 - 1,614]; p = .000; Q = 507,061; I^2 = 95.267. Fail Safe N = 2195 (Rosenthal, 1991), much larger than $5K + 10^2$, where K represents the number of studies, because Orwin Fail Safe N = 35 (Orwin R. G., 1983), calculated at a trivial d of .01. These results are even superior to a first meta-analysis conducted by Nesbit and Adescope in 2006 who observed the effect of the study with the concept and pre-constructed maps on students (Nesbit & Adescope, 2006), trying to find as many variables as possible that could influence effectiveness. Thus, one of the elements constantly encountered was the language of instruction, whether or not it was the same as the students' mother tongue. Otherwise, in the above-mentioned study, the authors conclude that the language of instruction is an important mediator, the method of teaching with concept maps being much more efficient in the case of students whose mother tongue differs from the language of instruction.

It is an interesting and noteworthy point of view, especially in the case of the English section of the Faculty of Medicine, where the vast majority of students have a mother tongue other than the language of instruction and which will be taken into account in the study assigned to this sections within the doctoral thesis. Unfortunately, the data recorded in the current meta-analysis were insufficient for an objective analysis from this point of view. Other meta-analyses performed, such as those of Donnely, or by Richardson, Abraham and Bond confirm these benefits of teaching (Donnelly JP, 2016) by the method of concept maps (Richardson et al., 2012), but showing next to Nesbit that the effects in exact subjects, such as mathematics, would be smaller. In the present meta-analysis, we also performed a study on the impact in clinical and preclinical subjects, the results being very close, slightly in favor of preclinical materials in which a Cohen d value of 1,527 was obtained, compared to 1,446 in clinical ones, in both situations p = .00, and I^2 over 90. Most of the above meta-analyses also analyzed the effect of other factors, such as gender, age of participants or making various references on the influence of students' mental status, such as emotion, motivation, improving writing and speaking, or improving organizational qualities (Balaid et al, 2016). In this study, we did not find any differences in the results in terms of gender or age. Other indices common to those of the above-mentioned works have been indicated in too few studies to be analyzed. In contrast, however, we analyzed 2 other indices, not mentioned in the literature studied, such as the duration of training in a particular subject and the actual duration of learning through the method of concept maps. Thus, it was observed that the method of learning with concept maps is really beneficial in the case of subjects whose teaching time exceeds 20 hours, seemingly paradoxical results being obtained in the case of those lasting less than 5 hours and 5-20 hours. In the latter, even lower results were obtained than the total

study time allocated under 5 hours (d = .366 compared to .562). However, the index that was practically identified as the most involved in differentiating the effect on student performance, was the actual study duration of the concept maps.
Thus, in the meta-regression of this factor, 2 “thresholds” were observed: studies with a total working time with the concept maps method of less than 1 hour have the weakest results, and those with a duration of more than 3.5 hours have the best. At the meta-analysis of these studies, indices d = .225, p = .043 were obtained for those under 1 hour, d = .680, p = .000, and I^2 = 81,027 for those between 1 and 3.5 hours, respectively d = 2,291, p = .000, and I^2 = 96,405 for those over 3.5 hours.
These results seem to correspond to the well-known learning curve, so that if the concept map method is actually used for too short a time, the student becomes rather confused by this new method of study and the results in these conditions may be even weaker than by the classical method of learning.
However, this method becomes really effective if it is studied for at least 3.5 hours in total; according to the results of these studies, the student who manages much faster to make more efficient correlations between various parameters thus demonstrates the efficiency of memorizing different characteristics.
In conclusion, the teaching method using concept maps is effective in the case of medical branches for both clinical and preclinical subjects.
It is also a method that can be analyzed during anatomy classes, whose duration is over 20 hours in a semester, provided that the concept map method is applied for at least 3.5 hours. However, there are other parameters that should be studied further, such as the motivational role as shown in the only study in terms of concept maps in teaching anatomy to medical students (Bergman et al., 2013), but also factors such as it would be teaching in the mother tongue or a different language. Also, in the case of the actual study of this method in a certain subject, certain parameters considered inconclusive in the present meta-analysis may be found to be relevant. For example, it would be indicated to research whether the method is effective and if it is, to what extent it is useful to older students, who have chosen to study medicine at the ages of 35-40 years. Finally, other parameters that would influence the results can be identified, as some of the authors of other meta-analyses mentioned above suggest.

Study II. Learning as teaching with conceptual maps, an effective tool for long-term memorization of anatomy, on 1st year General Medicine students[2]

3.2.1. Introduction

The present research had as a starting point the students' need to accumulate new information and skills, which can, at one point, become a hindrance to cognitive development due to their volume and complexity. In fact is about the necessity to learn how to learn. We somehow merged the present and the past in an attempt to generate an idea for the future. Initially, on a previous meta-analysis (Nicoara et al., 2017), was observed that the use of conceptual maps has an effect on students' memory in most medical studies but varies according to the subject studied. The current study starts from the established idea of continuous mental change of information through a constant process of elaborating this information (Reigeluth et al., 1980), (Pressley, 1982), (Mayer, 1984), (Anderson, 1995). In this way, the learning power could be modified by the quality of example development (Stark et al., 2002), or by the quality of personal explanations (Chi et al., 1989), arising from basic principles and less from superficial, short-term ones. Given the existing theoretical basis, the working hypothesis was drawn: H1-students in the experimental groups (learning from the concept mapping method) have different school performances than those in the control groups (who have learned by the traditional method). As far as the objectives of this study are concerned, they are: 1. To observe whether there are differences regarding the memorization of the notions of anatomy, at the time of the examination, between the students who studied according to the method with concept mapping vs. the traditional method. 2. The differences existing in the method of learning depending on the language. 3. The advantages of the method of study after a longer period of time, during the exam in the second semester. 4. To analyse whether there are differences given by teaching method on long-term memory. 5. To study other factors that could moderate or mediate the results.

3.2.2. Methodology

The study involved 1st year students of the General Medicine Faculty "Iuliu-Hatieganu" University of Medicine and Pharmacy,who were studying anatomy. The experimental group students were learning by teaching with the concept mapping method, while the control group used the traditional method. They were subsequently examined through written exams.

The participants

The present study used as inclusion criteria first-year students in the anatomy laboratories. For this purpose, two series of students from the Romanian line of study and three series of students from the English line of study were selected to participate in the study, accounting for a total of 505 students from the 2015-2018 academic years. The exclusion criteria were represented by the failure to sign the above-mentioned agreement, the integration of the students into a complementary year, or the case of having more than 5 absences, considering that in these cases the students did not benefit from any of the learning methods. Students who had less than 5 absences in one semester, were included in the study for that semester. All the students from the English line of study along with 16 others from the Romanian line had a different language of learning from their first language. The participants filled out a form expressing their agreement to be part of the study and thus agreeing to the fact that some personal data could be used according to the law, respectively according to European Union (EU) Regulation, no. 679 of 27 April 2016 [40], on "the protection of natural persons

[2] This study has been published:
Nicoara, S.M., Szamoskozi, S.E., Mitrea, D.A., & Leucuta, D.C. (2020). Concept Mapping, an Effective Tool for Long-Term Memorization of Anatomy—A Quasi-Experimental Research Carried out among 1st Year General Medicine Students. *Eur. J. Investig. Health Psychol. Educ*., 10, 530–543; doi:10.3390/ejihpe10010038

with regard to the processing of personal data and on the free movement of such data" and the protocol was approved by the Ethics Committee of "Iuliu Hatieganu" University of Medicine (no. 9/15.01.2020). The students were divided into 2 groups, an experimental and a control group for both the Romanian and the English line of study.

Data Collection

Several types of data collection were used to evaluate students' knowledge, all of which were conducted only by written tests. The first of these was represented by the grades obtained by the students when being tested in the written exam for each semester; the test contained multiple choice questions and the grades for the practical examination were eliminated. The last testing was performed approximately 6 months later, without students' prior knowledge of the testing. This was carried out during class hours through unannounced testing and for this reason, the number of students tested, was smaller.

Research design

We undertook a quasi-experimental design between subjects. The 489 students admitted into the study came from 2 different lines of study, the English and the Romanian. A random selection of study groups was chosen to participate in the Experimental group, the rest of the groups composed the Control group. The present study involves convenience sampling, all the participants being students at the Faculty of General Medicine. In this way, four groups resulted, both experimental groups used the concept mapping method during learning, according to the procedure, while both control groups benefited only from the classical method of learning. The dependent variables are represented by the grades or number points obtained at the time of the exam, respectively in the test given 6 months later. In addition to this, other moderating or mediating variables that might influence the outcomes, such as those reported in some studies, i.e. gender (Ogonnaya et al., 2016), (Otor, 2013), or age, but also others (number of absences), will be discussed.

Learning method

The difference between the experimental and the control groups is given by the learning method, irrespective of the language of teaching, so in the following we will refer to the aspects of its implementation in the 2 groups. In the experimental groups, concept mapping was discussed after the students teaching presentation by German technique of the subject; the students prepared the concept maps at home. Concept mapping was not introduced from the beginning, but only 4 weeks after the beginning of the academic year, this period being necessary both for the evaluation of the students regarding specific notions of anatomy, and for a monitoring of the metacognitive abilities of each of them.

Thus, within each of these stages, a number of 2-3 topics were discussed, after which the presentations were subjected to a discussion within the groups. In this way, each student had to prepare a presentation every 3 weeks, so that, in the other stages, they could participate together with their colleagues in the discussions on the concept maps presented. In the case of the control group, the students had as assignments the theoretical study of the specific notions, as well as of the anatomical sections or boards, without having to design concept maps. During the laboratory hours, the time allotted to discussing the theoretical notions was used according to the traditional method, respectively by the teacher presenting and explaining the notions of anatomy corresponding to the respective stage of the course. For both groups, developing and presenting practical notions of the traineeship were performed similarly, much like in the total number of hours allocated to the students for studying anatomy during the course and laboratories.

Statistical analysis

Qualitative data were described numerically, by number and percentage. Quantitative data were described by mean and standard deviation, respectively graphically by means graphs. To test for differences between two independent groups of quantitative data, the

Student test (t) was used for independent samples with equal or unequal variances. Equality of variances was assessed using the Levene test. To evaluate whether there are differences between several independent groups of quantitative data, the one-way ANOVA test was used. To evaluate the influence of moderation variables, besides variables of interest in evaluating differences between independent groups, the two-way ANOVA test was used, including for the interaction between the two variables. For all tests, the value of 0.05 was used as the significance threshold and the bilateral p value was taken into account in the tests that offered it. For statistical processing, the IBM SPSS software for computing and graphics version 25.0. was used.

3.2.3. Results

For the Student-t test GPower 3.1.9.4. was used to calculate the difference between the mean values of the two independent groups. The input parameters were p-value (alpha) = 0.05, power = 0.95, effect size (d) = 0.5, allocation ratio N2/N1 = 2.5, respectively Tail(s) - one. It turned out that the sample size should be at least 210 for both groups. A total number of 489 students were taken into consideration, that is, 185 at the Romanian line of study and 304 at the English line of study. Of them, 12 students were excluded from the study either because of their unwillingness to take part in it or due to school dropout; thus we ended up with 183 and 292 students, respectively. A first verification was performed to test the internal validity of the study. We found a Cronbach alpha for each of the lines of study of 0.803, and 0.819, as well as in total 0.801, for all items in the questionnaire.

Results for each line of study

We compared the marks taken by students in each semester, and the 6 months evaluation, between groups (Experimental and control), at both lines of study, Romanian and English. In the same table can be seen that the null hypothesis is rejected for almost all cases.

Tab. 2. Comparative results between groups per lines of study.

Grades/ Test	Line of study	Group (n)	Mean (SD)	Low. grades (4-6)	High grades: (8-10)	p value*	p value 4 groups
Sem. 1	**Rom.**	Control (142)	6.99 (1.485)	33.8 %	37.3%	0.055	0.004
		Experim. (43)	7.47 (1.077)	18.6 %	55.81%		
	Engl.	Control (190)	6.57 (1.855)	33.16 %	18.42%	0.020	
		Experim. (105)	7.11 (2.035)	28.57 %	36.19%		
Sem.2	**Rom.**	Control (142)	5.88 (1.631)	57.04 %	16.9%	0.050	<0.001
		Experim. (41)	6.44 (1.517)	48.78 %	31.71%		
	Engl.	Control (191)	6.48 (1.986)	35.6 %	16.75%	<0.001	
		Experim. (110)	7.42 (1.848)	17.27 %	33.63 %		
After 6 Months	**Rom.**	Control (80)	41.45 (5.105)	37.5%	23.75%	0.001	<0.001
		Experim. (38)	44.71 (4.484)	10.53 %	38 %		
	Engl.	Control (94)	34.45 (4.550)	48.94 %	25.53%	0.002	
		Experim. (44)	37.30 (5.733)	27.27 %	52.27%		

Note: Sem. = Semester; Rom. = Romanian line; Engl. = English line; n = number; Low. = Lower; Experim. = Experimental;

Results according to the language of study

To see extent to which the language of study (same or different from the mother tongue) could have an influence on the cognitive processes of the students, the whole group was divided into 4 groups, one experimental and one control group for each type of language. Subsequently, the students' performance was tested by the 2-way ANOVA testing.

When testing the effects a significant relation was found, given by both variables, group or language and students' grades, without a significant interaction between these 2 variables.

Table 4. Means, Standard Deviations and 2-way ANOVA results by language/group

Testing	Experimental Group		Control Group		ANOVA		
	Mean	SD	Mean	SD	Efect	F	Sig.
Grades Sem 1							
Both languages	7.22	1.813	6.75	1.717	Gr	6.713	.010
Same language	7.47	1.133	7.08	1.409	L	5.584	.019
Different lang.	7.13	1.991	6.53	1.863	Gr×L	.292	.589
Grades Sem 2							
Both Sections	7.15	1.521	6.23	1.864	Gr	13.963	.000
Same language	6.53	1.521	5.96	1.638	L	9.536	.002
Different lang.	7.35	1.859	6.40	1.983	Gr×L	.902	.343
6 month Grades							
Both languages	40.73	.560	37.67	5.940	Gr	24.541	.000
Same language	45.18	.866	41.57	.571	L	112.626	.000
Different lang.	37.73	.711	34.64	.503	Gr×L	.150	.699

Results recorded according to the participants' gender:

Tab.4. Means, standard deviations and 2-way ANOVA for gender/group

Testing	Experimental Group		Control Group		ANOVA		
	Mean	SD	Mean	SD	Efect	F	Sig.
Romanian Section							
Grades Sem 1							
Both Genders	7.47	1.077	6.99	1.485	Gr	3.798	.053
F Gender	7.19	1.123	7.03	1.361	Gen	.754	.386
M Gender	7.73	.985	6.92	1.685	Gr×Gen	1.721	.191
Grades Sem 2							
Both Genders	6.44	1.517	5.88	1.631	Gr	3.873	.050
F Gender	6.15	1.531	5.92	1.554	Gen	.624	.431
M Gender	6.71	1.488	5.81	1.766	Gr×Gen	1.375	.242
6 month Grades							
Both Genders	44.71	4.484	41.45	5.106	Gr	14.036	.000
F Gender	44.21	4.171	42.16	4.634	Gen	.425	.516
M Gender	45.21	4.837	39.88	5.812	Gr×Gen	2.781	.098
English Section							
Grades Sem 1							
Both Genders	7.11	2.035	6.57	1.855	G	6.430	.012
F Gender	6.87	1.979	6.59	1.835	Gen	1.383	.241
M Gender	7.47	2.086	6.55	1.882	G×Gen	1.798	.181
Grades Sem 2							
Both Genders	7.42	1.849	6.48	1.986	G	15.923	.000
F Gender	7.38	1.851	6.70	1.974	Gen	.522	.470
M Gender	7.46	1.865	6.29	1.987	G×Gen	1.108	.293
6 month Grades							
Both Genders	37.30	5.733	34.45	4.550	G	9.655	.002
F Gender	36.71	5.667	34.24	4.367	Gen	.696	.406
M Gender	37.83	5.867	34.65	4.756	G×Gen	.150	.699

Results recorded at both line of study, are as follows (Table 4). In all these cases, there is an insignificant relation given by gender variable. Testing with both variables, group and gender, also reveals an insignificant interaction. The same table shows the presence of a

difference in favor of the experimental groups in all of the cases, greater for males than for females, even though this difference is not significant

3.2.4. Discussions

The testing of the internal validity of the study, had good values, bigger than .8 for common section, and each of them, the biggest values were found for the English section, were Cronbach's alpha had a value of .819.The mode of testing was the same for all the groups and it was performed by using the ANOVA method, which offered significant values, below the threshold value of .05, for all cases.

Discussions about working hypothesis

With regard to the tests for the Romanian and English lines of study, in both cases, the t-Student test was performed on independent samples. Apart from the results for the first semester, in the case of the Romanian line of study, in all other cases, the null hypothesis was rejected.

The problem that arises at this time, is to see why in the case of the 1st semester grades, the null hypothesis could not be rejected. A first explanation is given by the fact that, as we have shown, in the first semester there is a stage of evaluating the students' meta-cognitive capacities, but also of learning how to create concept maps, which takes about 4-5 weeks, that is, about 1/3 of the entire semester; during this period the learning method was the same in both experimental and control groups. A second explanation is given by the language of study, in the sense that it generally enables a more efficient memorization of cognitions if it is the same as the first language. However, within the Romanian line of study, 91.5% of the students had the same language of study as their first language with diminishing the differences in cognitive results given by the method of studying.

These data show the way in which students respond to the new method of study, by the existence of a learning curve. Besides, Aliyari's study on learning with concept maps vs. lecture in cardiac arrest (Aliyari et al., 2019) does not achieve significant results and is in contradiction with other studies by Dong et al. (2015), regarding the application of concept maps on the promotion of learning and interpretation of electrocardiogram, or Cutrer et al. (2011), regarding the patients' diagnostic rates of pulmonary problems. The reason for obtaining different results in these studies seems to be given (as Alyari found out) by the time allocated to study according to the method of concept maps—4 hours in Aliyari's study, respectively 10 h in the other studies. Indeed, Aliyari mentions that: "It seems that the use of concept mapping method requires more time to change the knowledge score." (page 43). All these data are in concordance with the results of the meta-analysis by Nicoara et al. (2017), where it is described that in order to obtain significant results with this method, at least 3.5 h are to be allotted to the new working method.

Discussions about results on each section

At the level of the Romanian line of study, an increase in the differences between the experimental and the control group can be noticed, starting with the results of the first semester until the 6-month testing. For the English line of study, where all students had a different mother tongue, statistically significant differences were recorded in all cases. Roessgera et al. (2018), in a qualitative study on concept mapping, suggest that this method "is a learned skill that improves with repeated opportunities for practice and feedback" (page 20) but it would also improve the relation between concepts. For medical students, Torre et al. (2007) associate this learning method with the improvement of critical thinking, while Chand et al. (2018) appreciate the method as being useful both for teaching and learning, as we found by our research. Absences were analysed by their mean number. Both during the first and the second semesters, there was a greater number of absences in the experimental groups than in the control groups for both lines of study, and yet their results were superior.

Consequently, only the method of study is involved in the results obtained, the method of teaching is not. The explanations for this phenomenon may therefore lie either at the level of adaptability of this method to the students' learning and thinking style, or may be extracurricular, relating to motivation, or reducing the anxiogenic phenomenon through this learning method.

Concept mapping is an antibiotic or a vaccine?

Due to the results obtained 6 months after the implementation of the method, whether the study language was the same or different, we could conclude that this method of study is especially effective with long-term memory. That is, when giving up the actual work with these maps, will students continue to make multiple correlations or not, so is there a change in their style of learning or thinking? In other words, it is worth researching whether these students will continue to work mentally, involuntarily, through the method of concept mapping, even if the actual descriptive work has ceased. Hence, the following question arises: is concept mapping an antibiotic or a vaccine? That is, does this method take effect when effectively implemented (as an antibiotic), or has late effects, when it is no longer used, but has produced changes in the mind (just like a vaccine does in the body).

Discussions about mediator factors

As in the present study there could not be found relevant data according to the age of the subjects, there being a difference of 4 years between the vast majority of the students and only a few cases being located on a level that exceeds 10 years, the research could not be continued in this regard.

Another interesting aspect is that both experimental groups have managed to achieve favourable results, with a higher percentage of students with high grades and a smaller percentage of students with low grades, but in different ways. Thus, in the experimental group that studied in a language different from the first language, there was an initial sharp increase in the number of students with high grades (in the first semester) and a further sharp improvement of those with low grades (in the second semester) and vice-versa for the groups that studied in the same language as the first language. The differences between experimental and control group is highest at 6-month test, on both sections. Many studies found that well prepared students work better with learning by teaching method (Roscoe, 2014; Chi et al., 1989; Fiorella & Mayer, 2014). In the same time, other studies found less prepared students work better with concept mapping learning (Nesbit & Adescope, 2006; Haugwitz et al, 2010; Liu et al., 2010; Lambiote & Dansereau, 1992; Fiorella & Mayer, 2015). That’s why, all students should work better with the proposed method which combine both learning methods.

Regarding language, it was found that there was a constant difference in favour of the experimental groups, whether the language of learning was the same or different from the first language. These results should be compared with those in the literature but only few data were found regarding learning through concept maps in the same vs. different language from the native one. Marriott & Torres (2008) show that students experienced limitations in expressing their ideas when they had to do it in a foreign language. These limitations were reported as being felt in oral communication with other colleagues as well. However, they considered this experience as an opportunity to put into practice their own ideas and prove their speaking skills. It is also shown that this way, students are encouraged to focus more on the connections between concepts (the meaning) than on the final product.

In the 2-way ANOVA testing, having as independent variables the group (experimental or control) and the language of study (different or the same as the mother tongue), a statistically significant relation is noticed ($p < .05$) given by each variable and students’ grades in every semester, as well as in the 6-month testing. If the presence of interference between the variables, even if statistically insignificant, is detected in the semester tests, these interferences disappear completely at 6-months testing. The same 2-way

ANOVA testing, but having as independent variables the gender and the group, yielded favourable results in experimental groups regardless of the line of study or gender, without a statistical influence of the gender on the grades. Even so, these differences between working groups are greater in both males and females in the semester testing in both lines of study, but are reduced in the 6-month testing. These data suggest that the concept mapping method of learning has an effect on both genders, but men are more adaptable to it.

3.2.5. Conclusions

To conclude, learning by teaching with the conceptual map method proves to be efficient especially in the case of the long-term memory regarding the study of anatomy in first-year students. Also, in the short term, the results are statistically significant for subjects who have a different language of study than their first language, while for those with the same language of study as first language, the results grow from statistically insignificant in the first semester to statistically significant at the 6-month testing. At the same time, it can be concluded that language is involved not only in obtaining the aforementioned results, but also in the way the method of learning by teaching with concept maps acts in time on students with different levels of preparation. So, this method of learning is efficient from the beginning in the case of students who are not so well-prepared, if their language of study is the same as their first language, and respectively in that of well-prepared students, if their language of study is different from their first language. As a conclusion, all students are influenced by this method of study in a positive way.

Considering the number of absences, the results have shown that, in spite of their better grades, the students in the experimental groups had more absences than those from the control groups. This leads to the conclusion that the method of learning influences the achievements, and not the teaching method, as proven by the results of the present study.

The gender has at the first sight no influence on student's performance. Male are more adaptable at this method of learning, and their marks are from beginning higher. One of the limitations of the present study is, however, the impossibility of finding relevant data related to the age of the sample. Another limitation is the fact that the number of students could not be the same for the three examinations, either due to the number of absences made during the semester or to the absence on the actual examination. Moreover, as the study was conducted on a specific sample of students, the results cannot be generalized to the whole population and may differ from the results of similar studies but carried out on different samples.

Thus, future studies, such as the implication of motivational, learning and thinking styles or changes in critical thinking when learning with the concept mapping method, would probably explain their mode of action. On the other hand, it would be interesting to see what might happen in terms of student behavior in the learning process when removing this "trigger". What is noticeable from a practical point of view, however, is that by encouraging students, at least general practitioners, to use these tools or learning techniques, they will be able to improve their memory of anatomy. Thus, the student can find his associations alone, either between certain keywords or between concepts.

STUDY 3: Learning and thinking styles involvement in the learning of anatomy using the concept map teaching method

3.3.1. Introduction

The question that arises at the moment is whether certain categories of students would be more advantaged, or on the contrary, more disadvantaged in their learning styles or thinking, by this learning technique. It has been found that learning through the concept map method has proven to be effective for most students, even those with a lower level of training (Haugwtiz et al., 2010; Liu et al., 2010) or a lower attendance at stages. Several learning styles are described (Martinez-Pons, 2001), depending on how various authors (Keefe, 1979; Felder & Silverman, 1988; Myers & McCaulley, 1985) classified them. Kolb (1984) described learning styles as being based on the active processing of information (Kolb, 1984), but which has undergone several changes over time. Thus, depending on the way of involvement in various activities, or the preference to observe contemplatively those activities, he described the active type (concrete activity or CA) and reflector (RO).

These opposite styles are located on the processing continuum axis, or that of how participants perform various things ("how we do things"). On the other axis, that of how participants perceive information ("how we think about things"), they are described as situated at opposite extremes, the theorist style (information analysis, or "abstract conceptualization", abbreviated AC), and the one based on objective perception ("concrete experience" abbreviated EC).

The learning process would take place continuously, starting with the objective perception of information (the pragmatist), contemplation of information (the reflector), theorizing of concepts, and later active application of knowledge into practice. Moreover, McCarthy implemented a curricular model (Guild & Garger, 1988; Armstrong & Parsa-Parsi 2005) that suggests this sequential learning process. Depending on each person's preference for one model or another of learning on the described axes, they resulted in the four learning styles, by combining the results on the processing axis with those based on the perception axis. The accommodator is the participant who combines active style with that of objective perception. Convergent is the participant that combines active style with the theorist. The assimilator combines the reflector with the theorist. Finally, the divergent combines the style of the reflector with that of objective perception.

In medicine, both in terms of specialized education and the profession itself, Kolb describes the participants as integrated into the convergent style (active and theorist at the same time) due to the specifics of the profession, while other authors (Garner, 2000; Furnham et al 1999), classify the same characteristics as personality variables. Kolb's learning styles have been studied at various levels (Chapman & Calhoun, 2006; Lujan & DiCarlo, 2006) and specialties of medical education, which is why he was included in this study. Some research has suggested a correlation with the level of training of students (Engels & de Gara, 2010; Caulley et al., 2012; Jiraporncharoen et al., 2015), medical specialty (Modi et al., 2015; Richard et al., 2014; Quillin et al., 2016), or student gender (Slater et al., 2007; Kim & Gilbert, 2015). Subsequently, the 4-style model was transformed into the 9-learning styles (Kolb & Kolb, 2013), which were formed in addition to the initial styles, active, reflective, theorist and pragmatist (experiencing), completed by recalibrating and renaming the combined styles into initiator (similar to the accommodator), decisive (similar to the convergent), analyzer (similar to the assimilator) and imaginative (similar to the divergent) to which is added the balanced style (balancing), the median.

Sternberg classified people's thinking styles (Sternberg, 2009) by drawing a parallel with the systems of both current and historical general governance of countries, considering that people generated these models of government in terms of their thinking and then, these

systems of government would not it represents something other than styles of thinking. The 13 styles of thinking described were classified from the first point of view, i.e. from that of function, into legislative, executive and judicial; according to the form of monarchic, hierarchic, oligarchic and anarchic government; in terms of global and local level; according to the internal and external scope; and according to leanings in liberal and conservative. All these styles of thinking have specific characteristics.

The legislative one, for example, is the creative, innovative style, the executive one is the one that implements certain decisions, so that the judicial one balances certain ideas, in order to take the correct one. The monarchical style is the one that sets a target goal, then directing all its abilities to achieve it. The hierarchical one is the one that performs categories, ranking the objectives according to importance, urgency, or other criteria. The oligarchic style is a mixture of monarchical and hierarchical styles, having multiple objectives, but to which it gives the same importance, not distinguishing between an important or urgent and another that may be important but could be postponed. Anarchic style is perhaps the most innovative of all styles, but with a great flight of ideas and that is why it is underestimated in general. Global vs. local refers to the overview versus the details. Internal styles vs. external ones are similar to introverted and extroverted people, respectively, but in terms of thinking and source of information. Finally, the liberal style vs. conservative refers to the appreciation that an individual gives to innovative, revolutionary ideas vs. those who appreciate classical ideas, proven effective over time. Multiple studies, some of them conducted by the author himself (Grigorenko & Sternberg, 1995) concluded that the latter classification, the one according to the trend, has significantly positive correlations between the liberal and the legislative styles, as well as between the conservative and the executive styles. In other words, this classification of thinking styles in accordance with the trend would be nothing more than a broader, more general approach to that of the form of government.

For these reasons, this study addresses the first 11 of the 13 styles described by Sternberg, considering (as being admitted even by the author) that most of those with a liberal thinking style fall into the legislative style, most of those with conservative thinking to the executive style, and the median ones (which would fit in both the legislative and the conservative model) would be found in the judicial style.

The objectives of this study are:

1. To identify one or more learning or thinking styles, in which the academic results are different from the other styles while using the same method of study (that of learning by using the concept maps teaching technique).
2. To identify other variables, such as the gender or age of students that could influence the learning or thinking style of students learning according to the concept map method.
3. To observe if there is an influence of the learning or thinking style given by the belonging to one of the teaching lines (in the Romanian teaching line there is a social and cultural quasi uniqueness, compared to the English line, where there is a social and cultural diversity).

As a result, the study hypothesis is: H1- there is at least one learning or thinking style which in the case of those students' academic results, who use them, are different from the ones who use other learning or thinking styles.

3.3.2. Method

The study took place among the 1st year students of the Faculty of General Medicine within the University of Medicine and Pharmacy "Iuliu Haţieganu" Cluj-Napoca, study departments in Romanian and English languages. All students in this study learned the anatomy of the teaching-by-learning method, using concept maps. Subsequently, all students were examined in writing, by testing knowledge in semester 1 and then retesting knowledge after 6 months. In this sense, a number of 120 students were randomly selected from the Romanian and

English lines of study to learn to use the concept map method. The exclusion criteria were represented by the manifestation of the students' desire not to participate in the present study, or not to have completed the questionnaires, thus 105 students being admitted as participants in the study. Of these, one did not complete the thinking style questionnaire, remaining as such only included for the learning questionnaire. Regarding the semester test for the 1st semester, the grades of the students who took that exam were taken into account, while the 6-month test was performed without previous announcement, during a course, meaning that only the students present at that time were tested.

Instruments. For the learning style we used the "Kolb's Learning Style Questionnaire" (Kolb & Kolb, 2006), developed after the "Learning Style Inventory", a variant of 20 questions for each main style (active, reflective, theorist and pragmatist), a total of 80 items. The English version and the translated version were used for the Romanian line. The score (between 0 and 20) provides information on how much one style or another of learning is used, to achieve then, a staging in 5 degrees of the preference to use that style. Subsequently, by combining the stages, the 9 learning styles result, which were established by the author in 2013.

The second questionnaire is the revised "Thinking Style Inventory" model (Sternberg, 1997), with 13 styles of thinking, assessing the degree to which a participant agrees or disagrees with each of these styles. Subsequent studies, including the author's (Sternberg, 2009), found that the division by inclination is included in the division by function, which is why we removed those items from the questionnaire, using the variant with 11 thinking styles, divided by function, form, level, and leaning. The questionnaire used has 88 items, 8 items for each style of thinking. A Lickert scale from 1 = complete disagreement to 7 = complete agreement was used for each item. Subsequently, depending on the student's age (high school or college) and gender (female or male), a staging of each student's thinking styles was performed. For the evaluation of the students' knowledge, 2 types of instruments were used as in the previous study, both being done only by written tests.

Research design. This study is non-experimental, correlational. The main objective is to ascertain the existence of an influence given by the learning or thinking styles of the students and the academic performances of those who studied by using the concept maps method. As all participants are medical students, this study is one of convenience, not reproducible in the general population. The grades obtained in the end-of-the-semester tests, and, respectively, in the 6-month tests, were taken into account with the comparative evaluation of the constituent groups' averages.

Statistical analysis. Procedure. All students benefited from the teaching-learning method that uses concept maps. Introduction and development of concept maps were performed similarly to the previous study, with the explanation of the principles to be considered in drawing concept maps. The method was not introduced from the very beginning, but only 4 weeks after the beginning of the school year, this time being necessary for the metacognitive evaluation of students. Throughout the semester, students were given homework, in which in addition to studying the anatomy classes in the regular way, they were asked to make various concept maps which were then discussed with colleagues, the teaching of the academic subject being done in the following stages. Qualitative data were described by relative and absolute frequencies. Quantitative data were described by the mean and standard deviation. For the evaluation of the internal consistency of the questionnaires, the Cronbach's alpha coefficient with a 95% confidence interval was presented. Comparisons between two or more groups of qualitative data were done by the $\chi 2$ test and the parameter χ and the number of degrees of freedom were presented, or the exact Fisher test (if values above 5 were found in more than 20% of the expected frequencies). Comparisons between two independent groups for quantitative data were made by the t test for independent samples

and the parameter t, degrees of freedom, and the Cohen coefficient was presented. Comparisons between more than two independent groups for quantitative data were made by the ANOVA test and the parameter F, the degrees of freedom, and the coefficient η2 were presented. For the analysis of the connection between learning or thinking styles, and achievements in learning, multiple linear regressions were performed, having as dependent variable the first-semester grade, respectively the score obtained in the test 6 months later, and as independent variables learning or thinking styles, as well as being adjusted according to gender and line of study (Romanian vs. English).

The normality of the residuals was verified (by the quantile-quantile graph), the presence of heteroskedasticity (by the scale-location graph and by the Breusch Pagan test), multicollinearity (by the inflation factor of the variance), the linear functional form (by the partial residual graphs). For each term in the regression, we presented the coefficient B with the 95% confidence interval, the standardized coefficient - beta, the standard error of the coefficient B, the statistic t. For all analyses, the value of p was presented bilaterally and the value of .05 was used as the statistical significance threshold. For statistical processing, the statistical environment for statistical calculations and graphs R version 4.0.1 was used.

3.3.3. Results

For the learning style, we obtained the following results for Cronbach's alpha coefficients: Active .73; Reflector .71; Theorist .75 and Pragmatist .73.

Subsequently, we proceeded to the analysis of the distribution, which revealed the percentage presence of a double number of theorists and analysts in the Romanian line of teaching, respectively of a larger number of active and balanced in the English line students.

The gender distribution showed a higher percentage affinity of the female gender for the active and imaginative styles, and of the male gender for the balanced style.

The average grades obtained by styles varied between 6.67 (theorist) and 8.00 (imaginative) while the score after 6 months varied between 38.00 (pragmatist) and 44.44 (analyzer), in this case, the score for the theorist being immediately the next (43.91).

Subsequently, we proceeded to achieve a simple, unadjusted regression.

Table. 22. Simple regression for learning styles

Variable	Grades Sem. 1				Score after 6 months			
		95% CI				95% CI		
	B	IL	SL	p	B	IL	SL	p
Active	.16	-.84	1.16	.757	-4.01	-9.18	1.15	.126
Reflective	.07	-.86	1.01	.877	-5.44	-9.81	-1.07	.015
Pragmatist	.06	-1.27	1.38	.933	-6.44	-13.82	0.94	.086
Theorist	-.68	-1.61	.26	.153	-0.53	-4.9	3.84	.809
Initiator	-.49	-1.64	.60	.404	-2.61	-8.1	2.88	.347
Decider	-.06	-1.21	1.09	.921	-2.94	-8.43	2.55	.290
Imaginative	.66	-.43	1.75	.235	-3.19	-8.1	1.72	.199
Balanced	-.45	-1.5	.59	.388	-5.94	-10.85	-1.03	.018
Gender (M vs F)	-.26	-.87	.36	.405	1.17	-1.9	4.24	.450
Line of study (Rom. vs Engl.)	-.31	-.87	.26	.284	7.66	5.39	9.94	< .001

Note: IL = Inferior Limit; SL = Superior Limit

Multiple regression reveals statistically significant differences only between study lines and not between styles. Results based on thinking style: Cronbach alpha indices were between .69 (monarchal) and .92 (internal). Analysis of academic performance by style are presented.

Table 27. Averages, standard deviations, and analysis by style and grade.

Style	Exam.	Increased Gr.		Rest of gr.				
		Mean	SD	Mean	SD	t	Cohen d	p
Legislative	Sem. 1	7.26	1.29	7.27	1.45	-.017	.003	.986
	6 months	42.34	6.92	41.52	5.73	.598	.132	.552
Executive	Sem. 1	7.18	1.44	7.36	1.31	-.655	.130	.514
	6 months	42.75	7.16	40.90	4.94	1.393	.300	.168
Judicial	Sem. 1	6.97	1.35	7.39	1.38	-1.417	.308	.160
	6 months	40.96	6.93	42.25	5.90	-.882	.208	.381
Monarchic	Sem. 1	6.94	.97	7.42	1.52	-1.936	.378	.056
	6 months	43.21	5.82	41.19	6.35	1.416	.327	.160
Hierarchic	Sem. 1	7.15	1.32	7.37	1.43	-.820	.163	.414
	6 months	42.42	6.59	41.13	5.86	1.175	.256	.243
Oligarchic	Sem. 1	6.97	1.55	7.44	1.24	-1.689	.344	.094
	6 months	41.43	6.84	42.16	5.80	-.531	.117	.597
Anarchic	Sem. 1	6.41	1.54	7.44	1.29	-2.896	.769	.005
	6 months	41.14	6.24	42.00	6.25	-.469	.137	.640
Global	Sem. 1	7.00	1.37	7.33	1.38	-.927	.236	.356
	6 months	42.11	7.46	41.79	5.91	.193	.051	.848
Local	Sem. 1	7.05	1.38	7.42	1.37	-1.336	.269	.185
	6 months	42.63	6.36	41.32	6.13	.954	.210	.343
Internal	Sem. 1	7.17	1.30	7.38	1.47	-.760	.151	.449
	6 months	42.98	6.45	40.47	5.71	1.873	.409	.065
External	Sem. 1	7.12	1.53	7.32	1.33	-.638	.145	.525
	6 months	39.20	6.84	42.68	5.83	-2.237	.572	.028

Note: gr. = grade; Legis. = legislative; Exec. = executive; Monar. = monarchic; Oligar. = oligarchic; Exam. = examination; Sem. = semester.

There were significant affinities for the legislative, judicial, monarchal, local and internal styles for the Romanian (vs. English) lines, respectively for the hierarchical style for the female gender. The distributions of the high-grade styles calculated by the $\chi 2$ test were found to be significant in favor of the Romanian line for the monarchal, local, internal and external styles and of the hierarchical style for the female gender. Subsequently, we proceeded to the separate analysis by lines of study (Table 28), the grades from the 1st semester, and the number of points after 6 months depending on the high-grade thinking style.

Table 28: Academic performance according to the style of thinking in the study lines

Style	Testing	Romanian line of study					English line of study				
		Incr. Grade		Rest of grade		p	Incr. Grade		Rest of grade		p
		Mean	SD	Mean	SD		Mean	SD	Mean	SD	
Legis.	Sem. 1	7.32	1.08	7.00	1.18	.25	7.09	1.81	7.62	1.70	.406
	after 6m	44.64	4.89	44.48	5.33	.907	33.14	6.36	38.04	4.01	.020
Exec.	Sem. 1	7.08	1.19	7.26	1.06	.532	7.41	1.91	7.50	1.61	.879
	after 6m	45.90	5.25	42.96	4.41	.031	36.00	5.99	37.69	3.98	.365
Judic.	Sem. 1	6.96	1.33	7.26	1.01	.303	7.00	1.53	7.57	1.77	.442
	after 6m	42.6	6.19	45.76	3.85	.045	34.00	5.79	37.48	4.74	.159
Mon.	Sem. 1	7.00	.94	7.26	1.25	.376	6.71	1.11	7.63	1.81	.209
	after 6m	44.8	3.94	44.38	5.80	.748	35.80	7.79	37.12	4.45	.599
Ierar.	Sem. 1	7.18	1.09	7.13	1.20	.868	7.07	1.82	7.70	1.66	.292
	after 6m	44.60	5.67	44.52	4.34	.954	36.44	5.66	37.10	4.83	.750

Olig.	Sem. 1	6.92	1.29	7.31	1.00	.183	7.08	2.02	7.67	1.55	.328
	after 6m	44.00	5.28	45.00	4.94	.473	35.82	6.66	37.53	3.81	.376
Anar.	Sem. 1	6.69	1.44	7.27	1.03	.102	5.50	1.73	7.70	1.59	.014
	after 6m	42.6	3.70	45.12	5.29	.127	32.50	13.44	37.21	4.31	.707
Global	Sem. 1	6.79	1.19	7.25	1.11	.173	7.60	1.82	7.44	1.74	.848
	after 6m	44.2	6.18	44.69	4.75	.742	36.80	8.56	36.92	4.24	.962
Local	Sem. 1	7.12	1.24	7.18	1.04	.842	6.80	1.81	7.70	1.66	.160
	after 6m	44.50	4.69	44.63	5.52	.925	35.14	6.96	37.43	4.29	.296
Int.	Sem. 1	7.28	1.18	6.96	1.06	.280	6.86	1.61	7.83	1.72	.098
	after 6m	45.1	4.75	43.5	5.65	.282	35.20	6.07	37.75	4.29	.193
Ext.	Sem. 1	6.92	1.08	7.21	1.15	.427	7.29	1.86	7.57	1.67	.639
	after 6m	42.8	5.47	44.91	4.97	.251	36.27	6.63	37.26	3.93	.610

Note: Incr. = Increased; Legis. = legislative; Exec. = executive; Judic. = Judicative; Mon. = monarchic; Ierar. = Ierarchic; Oligar. = oligarchic; Anar. = Anarchic; Int. = Internal; Ext. = External.

There is a positive correlation for the Executive style, and a negative one for the Judicial one at the 6-month tests at the Romanian line and negative correlations for the Legislative and Anarchic styles, for the 6-month test, respectively the semester test at the English line.

3.3.4. Discussions

Learning styles. In terms of learning styles, the internal confidence of the questionnaire shows values for Cronbach alpha between .71 and .75. These values are lower than those described by the author of the questionnaire (Kolb & Kolb, 2013), but are close to those reported in other research (Simelane-Mnisi, S., & Mji, A., 2015; van den Berg, 2015; Collins et al., 2018), where values between .63 and .91 are described. When analyzing the distribution of participants, we found the presence of more theorists and analysts in the Romanian line, respectively more active, reflective, and balanced ones in the English line.
These differences were also found in research conducted by Engels and Gara (2010) which describes the fact that medical students are mainly assimilators, while studies in various medical specialties find the presence of surgeons among several accommodators and convergent (Richard et al., 2014; Modi et al., 2015; Quillin et al., 2016), while among internists there would be more assimilators (Adesunloye et al., 2008). When analyzing the distribution by gender, we found that the more active and imaginative people were of the female gender, respectively the balanced style belonging predominantly to males. However, it is specified that these data vary greatly, depending on age, level of education, or socio-cultural background. An interesting finding is that the theorist style has some of the lowest scores in the semester test, but some of the highest in the test 6 months later. These data suggest that the natural depreciation of knowledge, after some time, would be much slowed down by the theorist's style. However, other research is needed to study these results in depth. When performing multiple regression, it is found that the learning style is not involved and the null hypothesis cannot be rejected for the learning style. The results are similar to those in the literature (Laight, 2004; Kostovich et al., 2007).

Thinking styles. When analyzing the internal consistency of the study, the results are very good, obtaining results of Cronbach alpha located between .69 and .92 and the average of .83, the monarchal style registering the lowest values, of .69. Even lower results for the monarchal style have been described in other studies (Chen, & Liu, 2012; Zhang, 2002; Cheng et al., 2016; Black & McCoah, 2008) and significant correlations between them to justify its use.

Multiple differences were found between sections, predictable in fact, due to socio-cultural differences. The Romanian line appreciated the legislative, judicial, monarchal, local, and internal styles more than the English line. Such differences between genres but also due

to other differences such as socio-cultural ones are described by the author (Sternberg, 2009) and in the literature.

Regarding the study hypothesis, the ANOVA results show the existence of 2 thinking styles in which the results are statistically significantly different from the others, for the high-grade anarchic style regarding only the test results from semester 1 and the high-grade external style for the results after 6 months. According to Sternberg's description, the anarchic style is one of the most creative styles, but it is against the rules. Thus, the attempt to impose certain rules on this style will "hit the wall" of high-ranking anarchists. When those models are no longer required (testing after 6 months), the results will be similar to the others. Regarding the external style, in the opinion of the same author (Sternberg, 2009) he is a person who learns by asking colleagues, teachers, acquaintances, looking for the answer to certain questions at other people. But when it is necessary to look for the answer in their own thoughts, the results will be poorer.

The results recorded in each line suggest the existence of better results at 6 months in the Romanian line for the executive style and poorer for the judicial style, yet, of high degrees in both cases. In the English line, there are poorer results in the 6-month test for the legislative style and in the semester test for the anarchic one, high-grade styles. Bernardo et al. (2002) in a study of 429 Filipino students, suggest the existence of 6 styles of thinking correlated with their academic performance: executive, judicial, conservative, hierarchic, anarchic, and internal. Another study, conducted at 2 Chinese universities (Cheng et al., 2016), describes 3 styles of thinking correlated with positive academic results: hierarchic, legislative, and internal. Thus, there is a diversity of styles involved in obtaining academic performance, but these results are greatly influenced by socio-cultural factors, teaching and learning methods, and the field of education involved (Sternberg, 2009; Zhang et al., 2012). The results obtained in the present study suggest that in medical education, learning by using the concept maps method of teaching, is positively correlated with the students' academic performance concerning anatomy, for most thinking styles.

3.3.5. Conclusions and limits

In conclusion, we can appreciate that the learning method described does not generally interfere with the students' thinking or learning style, in what concerns their academic performance at anatomy, but there are some notable exceptions. These exceptions are represented by the theoretical style of learning, which despite the more modest semester results, will have some of the best results in the testing after 6 months.

From among the thinking styles, we find that the anarchist style has significantly poorer results in the semester test, and respectively, it is the same for the external style at the 6-month test. To these overall exceptions, other limits are added for each line (Romanian and English).

Among the general limitations of the present study are mainly the relatively small number of participants studied. The data in the literature are somewhat homogeneous in terms of learning styles, in the sense that there would be no more advantageous or disadvantageous style in terms of student performance. Regarding the thinking styles, on the other hand, the results are extremely heterogeneous, by various studies being identified other styles that would present academic results significantly different from the others. We consider this as an additional reason to consider our data, although somewhat logical, to require multiple other investigations to give a more accurate value to the present study. Since for styles in general it was found that they vary greatly depending on the socio-cultural context, we consider it useful to analyze them for each of these environments.

STUDY IV: The role of motivation in learning anatomy through teaching with the use of concept maps

3.4.1. Introduction

The role of motivation in medical education is widely debated and accepted as an essential factor in professional development. We have identified numerous articles in the specialty literature, which investigate the role of motivation in academic performance (Kusurkar et al., 2013), in the study of anatomy (Meguid et al., 2019), or in the learning process with the use of concept maps (Schaal, 2010), and we obviously wanted to observe the role this factor played in the present thesis.

The basic idea, however, started from research (Isik, et al., 2018), whose working hypothesis was, that self-motivated students should choose a type of learning based more on the understanding of notions and implicitly have academic results superior to students motivated in a controlled way, who should choose a type of learning in the case of which it does not matter if the understanding of notions is achieved or not.

In the study, the null hypothesis could not be rejected, in the sense that positive correlations of autonomous motivation were identified with both the learning strategy based on understanding (deep strategy) as well as the superficial one, without influencing academic performance, results confirmed by other research (Kusurkar et al, 2013) as well. The latter is due to the fact that among the self-motivated students, who realize the importance of learning, there will be some who do not understand very well the notions of the subject and will use any learning technique, including learning by heart, to achieve the objective. Yet, this is exactly the situation that should be avoided according to the facts described at the beginning of this research. But what if, through a different working method, students are given a chance to understand those notions better? Or is there a disruptive factor in self-motivation that is so powerful as to negatively influence performance?

The most significant theories on motivation, at least of the last 30 years, are the theories of value expectations (Wigfield, & Eccles, 2000), of the award (Weiner, 1985), social and cognitive (Bandura, 1994; Zimmerman, 2000; Schunk, 1991), goal-oriented and self-determined ones.

The point of reference in the theory of self-determination (SDT) is the distinction between autonomous and controlled motivation, according to which autonomy implies a voluntary sense of choice. At one extreme there is the described motivation, while at the opposite pole internal motivation is located, which is perfectly autonomous. Between the 2 extremes, there is extrinsic motivation, produced by external factors, associated with the activity, which could generate, depending on the perception, a certain degree of autonomy, through partial internalization:

- external regulation, when internalization is completely absent, the action taking place against one's own will, this regulation being the prototype of the controlled motivation;
- introjected regulation is a form by which regulation itself controls the person, through the ego (self-esteem) and also belongs to controlled motivation;
- identified regulation follows from controlled motivation, through internalization, the person understanding the importance of his work, even though he considers it uninteresting;
- through integrated regulation, people feel and behave autonomously, understanding but also fully appreciating the importance of the work done.

Within SDT, autonomous motivation is considered by Gagne and Deci to include intrinsic motivation and well-internalized extrinsic motivation, which is personified in the integrated regulation, while controlled motivation consists of external and introjected regulations (Gagne & Deci, 2005, p. 340). It can be noted that no reference is made to identified regulation, which is not found in either autonomous or controlled motivation. In

their study (Deci & Ryan, 2000, p. 73), they describe the difference between introjected and identified regulations (they mention studies that assimilate it to autonomous motivation), in the sense that both are associated with a greater effort to avoid anxiety, respectively for more interest and more positive coping styles in the second form of regulation.

In a review based on SDT in health-related professions (Orsini et al, 2016) claim that autonomous motivation lies in the satisfaction or the value of the importance given to the activity, stating that in the case of identified regulation, although behavior results from choice, it would still represent a tool used to achieve a goal.

The present study seeks to observe whether there is a difference in the level of motivation between the experimental group and those in the control group on the one hand, and on the other, to quantify the extent to which there is an interference between students' motivation and academic performance and what fact the interference is due to.

As a result, the following working hypothesis was designed: H1- there is an interference between motivation, learning method, and students' academic performance in at least one of the types of motivations or regulations.

3.4.2. Method

Participants

The present study was carried out in the anatomy laboratories during the 1st year of study.

A number of 222 students of the Romanian and English lines from the academic years 2019-2020 were appointed to take part in the study. They were divided into 2 groups, an experimental and a control group, both of which were taught anatomy, either based on the method of learning anatomy by using concept maps or the traditional model of teaching. The exclusion criteria were the non-completion of the mentioned agreement, the integration of the students in the complementary year, or more than 5 absences, considering that in these cases the students did not benefit from either of the learning methods.

Instruments

Participants were invited to complete the WEIMS questionnaire which contains 18 items. This questionnaire is divided into 6 scales, with 3 items each, for the six types of motivations and regulations postulated in SDT (intrinsic motivation, integrated, identified, introjected, and external regulations, respectively amotivation). All participants assigned to each item an index on the Lickert scale, from 1 (total disagreement) to 7 (total agreement), representing the extent to which the item represents the reason why the person is involved in the work. This questionnaire was completed at the end of the first semester or the beginning of the second after the students worked long enough with the proposed learning method.

A written test was used for the assessment of students' knowledge, for 1st semester only, similar to the one used in Study 2, without taking into account the grade obtained in the practical exam.

Research design

A quasi-experimental study was performed on subjects. The present study is convenient, given the fact that all participants are medical students. The 222 students who took part in the study came from two study lines, 104 students from the English line and 118 from the Romanian line, distributed into an experimental group and a control group.

The moderating variable is represented by motivation, namely by intrinsic motivation, amotivation, and the 4 regulations of extrinsic motivation.

The dependent variable is represented by the grades obtained in the exam, with the evaluation of the averages between the experimental and the control groups.

Procedure

The difference between the population of the experimental group and that of the control group is represented by the learning method, regardless of the language of instruction. Therefore in the following part, the aspects of the implementation of these methods on the 2 groups will be reported. The anatomy classes were identical in terms of the course curriculum for both groups, all students attending the same courses, the difference being only in terms of laboratory classes, similar to Study 2.

Analysis and quantitative presentation of data

Qualitative data were described by relative and absolute frequencies. Quantitative data were described by mean and standard deviation. To evaluate the internal consistency of the questionnaires, the Cronbach's alpha coefficient was presented with 95% reliability. Comparisons between two groups of qualitative data were made by the $\chi 2$ test and the parameter χ was presented. Comparisons between two independent groups for quantitative data were made with the use of the t test for independent samples and parameter t was presented, as well as the degrees of freedom and the Cohen coefficient d.

Dependence between quantitative variables was assessed by the Pearson correlation coefficient and the associated statistical significance test.

To see the connection between the type of learning, the types of motivation and the moderation phenomenon, as well as academic performance, a multiple linear regression was performed, having as dependent variable the grade in the first semester, and as independent variables the type of learning (by concept maps or traditional method), the 6 motivation scales (intrinsic motivation, integrated regulation, identified regulation, introjected regulation, external regulation, amotivation), and the interaction between the type of learning and each of the 6 motivation scales. The motivation scales were rescaled to have values between 0 and 1. The normality of the residuals was verified (by the quantile-quantile graph), the presence of heteroskedasticity (by the scale-location graph and by the Breusch Pagan test), multicollinearity (by the variance inflation factor), the linear functional form (through the graphs of the partial residuals). For each regression term we presented the B coefficient with 95% confidence interval, the standardized beta-coefficient, the standard error of the B coefficient, t statistics, as well as the effect graph (which included simple linear regressions by components, as well as loess - a non-linear approximation of points tendency by locally estimated scatter-plot smoothing technique).

For all analyses, the value of bilateral p was presented and 0.05 was used as a threshold value of statistical significance. For statistical processing the statistical environment for statistical calculations and R graphs, version 4.0.1 was used.

3.4.3. Results

In a first stage, we evaluated the internal consistency of the questionnaire by measuring the Cronbach alpha factor of each item, which should have a value> .60 in order to be considered acceptable. The values of this factor vary between .61 (identified regulation) and .79 (integrated and external regulation) so that in Table 30 the averages and standard deviations be mentioned together with the correlations between the types of motivations used.

Table 30. Mean, standard deviations, and Pearson correlations of motivational variables

Motivation	Mean	SD	1	2	3	4	5	6
1 Intrinsic	5.84	1.05	—					
2 Integr. regul	5.58	1.08	.493**	—				
3 Identif. regul	5.34	1.09	.463**	.442**	—			
4 Introjected regul.	5.05	1.32	.372**	.375**	.480**	—		
5 External regul	4.29	1.35	.258**	.186*	.453**	.431**	—	
6 Amotivation	2.13	1.11	-.011	-.160*	.018	.255**	.152*	—

Note: Regul. = Regulation; Integr. = Integrated; Identif. = Identified.

Subsequently (Table 31), we proceeded to the analysis of the extent to which the students analyzed themselves based on the different types of motivations concerning the working method, for both groups.

Table 31. Motivations with mean and SD, by groups and comparative analysis

Motivation	Experim.		Traditional		p	Female		Male		p
	Mean	SD	Mean	SD		Mean	SD	Mean	SD	
Intrinsic mot	6.04	.90	5.67	1.13	.008	5.97	.94	5.56	1.19	.006
Integr. regul	5.9	.93	5.33	1.12	<.001	5.74	.95	5,28	1.25	.003
Identif. regul	5.59	.90	5.15	1.19	.002	5,47	1.00	1.10	1.22	.018
Intro. regul	5.23	1.26	4.90	1.35	.068	5.14	1.27	4.85	1.40	.119
External regul	4.32	1.23	4.27	1.43	.817	4.28	1.32	4.32	1.41	.806
Amotivation	2.05	1.11	2.19	1.10	.382	2.12	1.08	2.15	1.16	.842
Grade Sem. I	7.20	1.41	6.32	1.45	<.001	6.84	1.43	6.45	1.59	.061

Note: M. = Motivation; R. = Regulation; Intrin. = Intrinsic; Integr. = Integrated; Intro = Introjected; Amot. = Amotivation; Exper. Met. = Experimental Method.

We made a multiple linear regression model (Table 32) predicting the grades according to the learning model (teaching using the concept maps or the traditional method), using the motivation scales as moderating variables (which were scaled to have values between 0 and 1). Testing the statistical significance of the model we obtained p = <0.001 (statistics F = 3.54 and df = 13, 208). The model had a standard residual error = 1.39, a coefficient of determination = 0.18 and an adjusted coefficient of determination = 0.13.

Table 32. Regression of grades according to motivation and motivation + learning method

Variable	B	β	SE	t	CI	p
Intercept	5.07				[3.78 - 6.36]	<.001
Concept map vs. Traditional method	1.68	.56	1.21	1.39	[-.70 - 4.07]	.165
Intrinsic motivation	-.16	-.02	.84	-.19	[-1.82 - 1.50]	.851
Integrated Regulation	-.10	-.01	.83	-.12	[-1.74 - 1.54]	.906
Identified Regulation	1.65	0.2	.89	1.85	[-.11 - 3.41]	.066
Introjected Regulation	1.28	0.19	.71	1.79	[-.13 - 2.68]	.075
External Regulation	-.33	-.05	.66	-.50	[-1.64 - .97]	.615
Amotivation	-1.7	-.21	.74	-2.31	[-3.15 - -.25]	.022
(Map vs. Trad.) x Intrinsic Motiv.	.64	.19	1.40	.46	[-2.11 - 3.40]	.646
(Map vs. Trad.) x Integrated Regul	2.13	.60	1.40	1.52	[-.63 - 4.90]	.130
(Map vs. Trad.) x Identified Regul	-3.91	-1.03	1.43	-2.74	[-6.73 - -1.09]	.007
(Map vs. Trad.) x Introject. Regul	-1.20	-.30	1.13	-1.06	[-3.44 - 1.03]	.289
(Map vs. Trad.) x External Regul	.049	.10	1.01	.49	[-1.50 - 2.48]	.628
(Map vs. Trad.) x Amotivation	1.58	.16	1.15	1.38	[-.68 - 3.84]	.169

Note: Regul. = Regulation; Introject. = Introjected; Motiv. = Motivation; Trad. = Traditional.

It is observed (in the first part of Table 32) that amotivation decreases independently and statistically significantly the grade at the exam. Identified and introjected regulation is close to statistical significance, the estimators indicating the increase of the exam grade. Identified regulation (part 2 of Table 32) is a statistically significant moderator variable in relation to the learning model. Thus, as it can be seen in Fig. 36 for those who learn through concept maps, the value of identified motivation correlates negatively with academic performance.

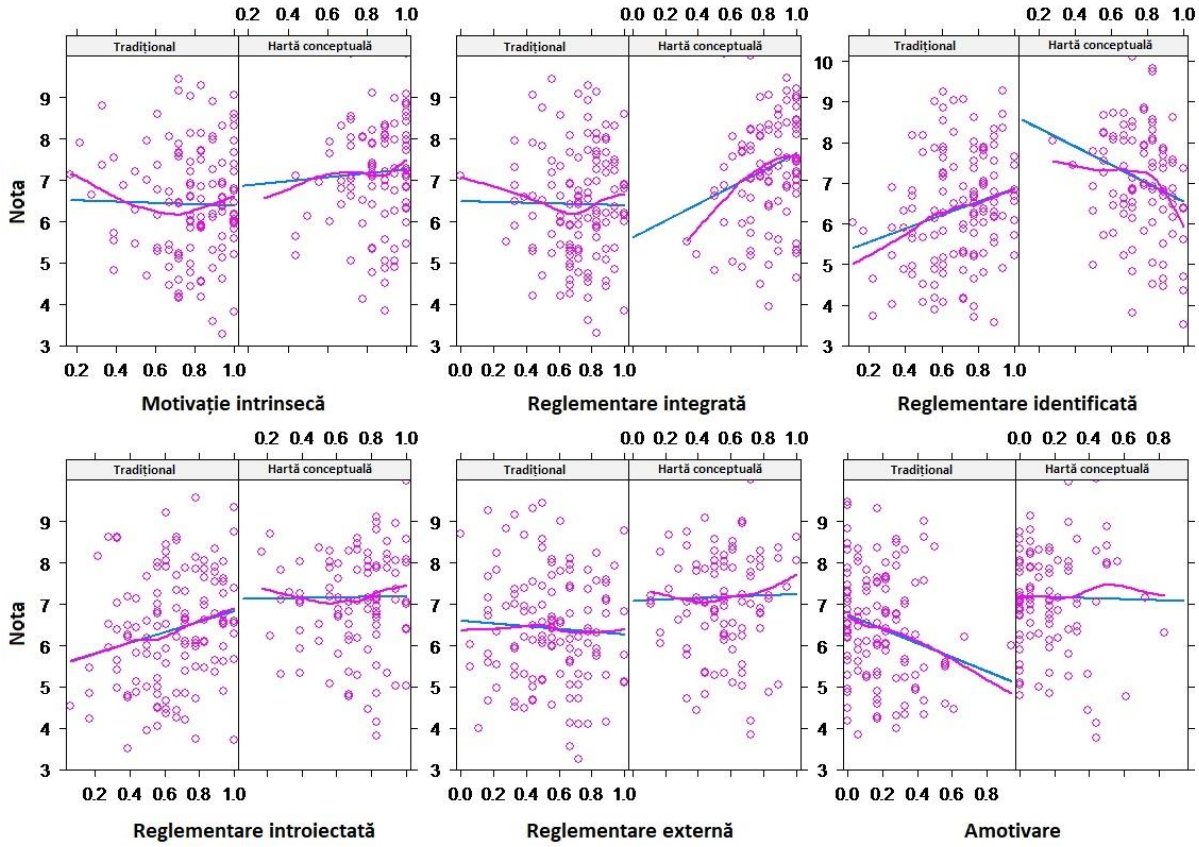


Fig. 36. Graphic analysis of multiple regression

3.4.4. Discussions.

Regarding the internal consistency of the study, the results are very close to those recorded by Tremblay et al. (2009) or Blais et al. (1993). The analysis of correlations shows that they are significant between internal motivation and extrinsic motivation regulations, as well as between these regulations, the level of correlations increasing from external to integrated regulation (due to internalization). Amotivation has negative correlations with integrated and direct regulation with introjected and external regulations. Similar correlations were also identified by Tremblay et al. (2009).

In a study on motivation in medical education (Pelaccia & Viau, 2017), the authors consider that most studies have shown that a strong motivation is related to the beneficial effects on learning, in terms of learning strategies used, perseverance and performance. Thus, amotivation is negatively correlated with academic performance, so that the other types of motivations do not significantly influence them. In a study from 10 medical colleges and universities, explained by economic and family factors, Wu et al. (2020) identify the female gender as more motivated in a controlled way than the male gender. In our study, on the contrary, the female gender was more motivated autonomously than the male one. Schall (2010) describes that learning with concept maps can be very helpful in medical university training, if students are aware of their usefulness, while Fiorella and Mayer (2016) describe that the effectiveness of the concept map method would depend on student motivation and clarity of the subject studied. These results are similar to most studies that use concept maps, in the sense that they do not by themselves increase students' autonomous motivation (Abdul Cader, 2012; Celikoz, 2010). However, the method of learning by teaching traditionally reports beneficial effects on students' motivation for learning, as shown by several studies (Chase et al., 2009; Park & Kim, 2016). In this way, the 2 methods seem to complement each

other, so that what one would lack (motivation, in the case of the concept map method), the other method would bring contribution (learning by teaching traditionally).
The most interesting results were identified when performing the regression. On the one hand, we identified that motivation would act as an independent factor, being negatively correlated with students' academic performance. This result is consistent with those identified in other studies (Kusurkar et al., 2013; Isik et al., 2018) and seems to strengthen the assumption of SDT authors (Deci & Ryan, 2008) that not only quantity but especially the quality of motivation would be important in generating results. Regarding the results of multiple regression concerning motivation and style of learning, there is a variable in the identified regulation that correlates negatively (*Fig. 36*) with academic performance. This finding is somewhat similar to the theory of the novice chess player. According to it, the beginner and the expert have similar moves, to the first from common sense, to the second from knowledge and theorizing of probabilities. The most uninspired moves come from the novice, who, not having at his disposal the memory and the deep understanding of the expert, will make the most number of wrong moves. In our case, there is a subgroup whose members become partially motivated by understanding the notions and their importance. But if this understanding is perceived as sufficient, it will not lead to a deepening of knowledge, and the results of learning in general and academic performance, in particular, will be weaker. Del Ben et al. (2013) report that they did not identify significant correlations between students' motivation (which decreases during the 1st year) and their academic performance, while Belousova and Mochalova (2020) suggest that there would be correlations between motivation and thinking style.

3.4.5. Conclusions and limits

In conclusion, the experimental method would generate effects on extrinsic motivation, favoring internalization, a fact observable by the significant differences between the groups, regarding motivations. This influence would materialize through the concept map, respectively its effects on academic performance, along with learning through traditional teaching. However, there is a subgroup, which shows a negative correlation with the academic performance. This is the field where we consider that in-depth studies are needed, the identified regulation can play a major role in maximizing the potential of the method. If the role played by the identified regulation is confirmed by other research, methods to improve academic performance could be seen. Until then, however, from a practical point of view, for those teachers who choose to offer students this method of learning, it is good to know its seemingly weak points, too, which could be overcome quite easily, by warning students about this "Trojan horse." The method induces clarity in the students' way of thinking, but to understand does not mean to know, thus, only if this “understanding” is followed by the deepening of knowledge, the impact of the method would be maximized. In this context, among the students where the identified regulation would register increasing levels, it would be the place where according to the theory, the motivation focused on the objective, would have the expected effects, and the place of this objective could be identified in the practical field of anatomy.

CHAPTER IV: GENERAL CONCLUSIONS AND DISCUSSIONS

The present research aims at examining whether by combining the method of learning by traditional teaching and that of concept maps, a method that by combining their beneficial effects to have results superior to the traditional method cannot result. For this, we have carried out several types of investigations, so that we can detect if the results are beneficial in the short term, but also in the long term, when the information remains in the students' memory as it was understood, correctly or not, and much less the information stored by heart, but on the other hand observing the limits of this technique.
Given the contributions of concept maps for organizing ideas and to promote the exposure of prepared material, namely those of learning through traditional teaching, including learning through the motivational one, which concept maps lack, we considered extremely beneficial a combination of the two methods. including This is not only in terms of the mode of action, which seems to complement each other, but especially of the beneficiaries, i.e. the students better prepared by the learning method by teaching method, but also those less well prepared, favored by concept maps.

4.1. Theoretical and methodological contributions

The first objective in our study was to observe whether the learning method with the use of concept maps achieves its expected effects in the medical field. This method has been applied in many fields, but the reported results have been heterogeneous so that in the medical field this method has seen an increase in its applicability only since 2010. It was therefore necessary to see if the concept map method is applicable in medical education. In addition, we wanted to investigate whether the effects are achieved in the preclinical or clinical field as well. The results obtained suggest the applicability of this method in both areas, but further investigations are needed to certify the effectiveness of the method for each subject. These results, with quantification in the medical field, respectively clinical and preclinical subjects are encouraging for a wider application of the concept map method.
Within the second objective, we analyzed some variables researched through other meta-analyses, such as gender or age, and due to the dissatisfaction created by the fact that they would be time-consuming, we wanted to observe the duration of the training, as well as the actual duration of working with the concept maps, so that they achieve their expected effects. These last variables were not, as far as we know, followed in other meta-analyses. In fact, two years later, Aliyari and collaborators (2019), by obtaining data different from those in the literature, invoke the different time allotted to working with concept maps, as the most likely factor involved in these differences. From the data we have, the meta-analysis from Study 1 of this thesis would be the first to consider, in the medical field, the existence of a learning curve in terms of learning with concept maps and which also quantifies a minimum number of hours that must be completed for the method to manifests quantifiable beneficial influences.
Within the third objective, we also followed the effects within the two study lines taken into account, Romanian and English, finding that the proposed learning method would have beneficial effects in the case of learning anatomy. In the Romanian line, only in the 1st semester, we found that the working hypothesis could not be confirmed. This prompted us to investigate whether the language of study (same or different from the mother tongue) is not involved in this process. We noticed in the theoretical substantiation that the language of study is involved in the learning process. It is obvious that it is easier to learn in the mother tongue than in a different one, regardless of the method. Therefore, a contribution in this respect, in theory, would be that any new learning method should relate to participants in

terms of their distribution and depending on the language of study, related to the mother tongue (same or different). This objective also includes the observation of the distribution of grades. In this sense, we found each time the percentage of several students with low scores among the control groups and several students with high scores among the experimental groups, which would suggest that the two methods would complement each other. There is little data in the literature to provide comparative data of the two learning methods, depending on the language of study. The fourth objective, the identification of a subgroup of students in which the method would be more effective, was treated from two points of view. On the one hand, due to the data in the literature, in order to benefit a certain type of students (the best, or the least well-prepared students) we did it in the second study, considering, as we have shown, that all students seem to have benefited from this method. The second point of view was to identify a subgroup of students who would be more favored in terms of learning or thinking styles. We did not identify in this case a specific subgroup, but when analyzing the data we noticed that in terms of learning style, theorists would be those who had some of the lowest scores in the immediate, i.e. semester test, but some of the highest at the 6-months testing. This would lead to the idea that those who have this learning style, will have low grades in immediate testing because they place more emphasis on theorizing concepts than on retaining them, which would benefit them in testing long-term memory.

4.2 Practical contributions

The fifth objective of the current thesis was, in case of positive results, to identify practical solutions for the implementation of the method, through two of the mentioned studies.
In the case of the second study, we wanted to see if the results of the method are more effective than the traditional method. For this, we tested both the overall effect and each line of study separately. Both test results suggest superior academic performance, obtained through this learning technique, compared to the traditional method, except for the 1st semester of the Romanian line. The way of combining the two methods was carried out by repeatedly designating all students from the experimental groups, for the preparation of anatomy subjects for teaching, using in this context the concept maps. However, it is essential for the teacher to know in advance the skills of the students involved, to know the degree of complexity of the subject that can be attributed to them for development. For these reasons, in the first 4-5 weeks, it is necessary to do tests to determine not only the students' knowledge of anatomy, but also their metacognitive abilities, or skills of organization for presentation, and if necessary, knowledge of language inclusively. Probably by realizing this combination, that time-consuming attribute, given to the concept maps, loses from its value, further studies being able to bring clarifications in this respect.
In Study 4, we identified other practical solutions, but this time temporary, these being identified by the somewhat surprising results of this study. Thus, in this study, we found that amotivation is an independent factor, which has the effect of decreasing the academic performance of all students. Regarding the identified regulation, however, it was found that there is a positive correlation between the academic performance of the students in the control group and a negative one for students in the experimental group. As we have shown, in this case, the theory of the chess-player novice would apply. According to this theory, the novice and the expert would make similar moves, but for different reasons, the first, out of common sense, the second, from knowledge and experience. But the novice, who has better knowledge than the beginner, will make more wrong moves than the latter, because he relies on that understanding of notions, but not knowing how to give them value through in-depth knowledge. In the present case, through the proposed learning method, a subgroup of students would be recruited from those motivated in a controlled way, who by understanding the

notions, will become regulated identified, but who not deepening our notions and relying only on this understanding, will have poorer performance. In the case of the traditional method, recruiting would be from controlled motivated students, those who identify in anatomy an instrument through which they can achieve their own goals and thus improve their academic performance.
However, until this possible negative correlation and their causes are elucidated, it would be necessary to motivate students on the objective, by introducing into the discussions higher, palpable objectives than the simple need to learn anatomy, with references to achieve positive goals and not to avoid negative goals.

4.3. Limits and future studies

We identified two types of limits, one specific, resulting in the proposed learning method and generated from the objectives of the thesis, and the other type is the general one.
The sixth objective of the current thesis was to identify the limitations of the method. This has been done in Studies 3 and 4. In Study 3, we identified two limitations, both within the thinking style. Thus, according to the results obtained, it would seem that students belonging to the anarchic style, would obtain lower academic performance in the semester testing and those belonging to the external style in the testing after 6 months, but these findings require extensive research, even if at first sight they confirm the theoretical remarks.
Regarding the general limitations, there are those given by each study, but also some general limitations of the thesis in its entirety.
In the first study, the main limitations are generated by the insufficient number of identified studies, which limited the research only for clinical and respectively preclinical subjects failing to assess the effects of learning through specific concept maps in the case of anatomy. Studies 2 and 4 had as one of the limits represented due to the fact that they are quasi-experimental studies and even if there was no intention in manipulating the participants, as evidenced by the measures taken, we failed to prove this, without any trace of doubt. In addition, a limit of Study 2 was the very close age of the participants, preventing further research in this regard. Also, due to the absences of some students, we could not take into account exactly the same students for the 3 examinations.
As perspectives of interest, identified by this study would be represented by the identification of how the language of study (same or different from the mother tongue) manifests its contribution taking into account the different results identified. Another study of interest would be to observe whether in the future these students will continue to use mental associations between the concepts, even if the actual creation of the maps ceased. Study 3 has as its main limit the relatively small number of participants (105), compared to the number of learning or thinking styles. Therefore, the results of Study 3 should be validated by other studies, especially since learning and thinking styles are described as varying greatly in relation to socio-cultural factors.
In Study 4, in which we identified the role of motivation in the proposed method, the main limits were the relatively small number of participants (222) and distribution of participants in which the percentage of females was very high (almost 75%), which could influence the results. The identified data, however, would make extremely interesting future research that could be generated by the identified regulation.
The general limitations of the thesis are that the results are specific to medical education and the participants belong to a single faculty and even if the participants of the English line of study came from the European Union, the results cannot be generalized to medical education and therefore even less to the general population.

Future studies of interest resulting from the present thesis would be represented by the analysis of the role that personality would play in the context of the proposed learning method, on the one hand, due to the learning styles involved and on the other hand of the possible decreases of anxiety and as such, also of neuroticism, in the perspective of examinations, compared to the traditional method.
Another study, perhaps of more special interest, would be related to the possible additional implications that the proposed method would have on emotional intelligence, which can be manipulated but also of the ways in which the learning method can be combined with the practical activity, specific to anatomy.

4.4. General conclusions

The present research aims at identifying a learning method, through which students can learn more easily, but especially that information can be processed, stored, and used practically through an integration of information in the long-term memory so that the working memory could access them as easily as possible. The current approach started after a long experience in the medical education system, from the existing problems in the medical education system, highlighted in the introduction of this thesis, as well as from the need for students to learn how to learn. The following more important conclusions are worth mentioning, derived from this thesis, resulting from our attempts to achieve the above desideratum:
1. The method of learning with the use of concept maps, seems to achieve the effects described in the literature and medical education, both for preclinical and clinical subjects.
2. Through the proposed learning method, the identified results suggest having superior effects on the traditional method in terms of academic performance, but also for long-term memory.
3. Even if the effects are not initially noticeable, they seem obvious for the long-term memory.
4. Apparently, the beneficial effects of the two methods seem to complement each other, this learning method being advantageous for all the students, regardless of their level of training.
5. Students' academic performance does not seem to be influenced by their learning style, while theorists seem to be more advantaged in terms of long-term memory.
6. For the anarchic and external thinking styles the proposed learning technique does not seem to be suitable, but further investigations are needed for clarification.
7. The female gender seems to be more motivated autonomously (at least in this faculty) than the male one by the proposed technique, and the academic performances seem to correlate negatively with the level of the identified regulation.
In conclusion, even if the proposed method requires additional research for the complete construction of the mechanisms involved in producing the effects, we appreciate that the method can be effectively applied in the medical field for learning anatomy. At the same time, it is necessary to identify how the practical activity specific to anatomy can be involved in this process or might be identified as a motivational objective.

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