Published in the Slovak Republic
European Journal of Contemporary Education
E-ISSN 2305-6746
2020, 9(4): 807-818
DOI: 10.13187/ejced.2020.4.807
www.ejournal1.com

Non-Linear Structured Teaching Material as an Attribute Developing Meaningfulness in Students' Mental Representation

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Abstract

Thinking is the essence of human existence, unquestionably the highest product of human evolution. Yet it is not possible to convey coherently to students the sum and attainment of all humanity's knowledge. Students would be incapable of absorbing such an enormous quantity of knowledge (corresponding to current developments in individual academic disciplines), as this is often highly abstract. Therefore educational content must be selected, to the extent that it presents a representative selection of knowledge. One of the most effective selection methods could be the use of conceptual mapping in the educational process. In this study the authors focus on the issue of structured teaching material and its relational association with creating students' mental representation, and have several objectives. The first is to analyze constructivist-oriented teaching processes; the authors also give attention to basic theses by which it is possible to delineate the main pillars of constructivist-oriented teaching. Attention is also given to learning strategies. No less important is the analysis of non-linear structured teaching material and its specific types, with an emphasis on conceptual mapping and its role in the teaching process – in the empirical part the effect of non-linear material in recording topical unit meaningfulness in students' mental representation. In the research undertaken, the methods of conceptual mapping experimenting and testing were used. The consistency of the conceptual maps was evaluated through the relational method using ordinal variables: meaningfulness of conceptual maps. The authors assessed the quality of the conceptual maps with the aid of IRT theory, specifically the latent correlations model. The research sample comprised 96 respondents. Analysis of results showed that the use of non-linear structured teaching material improved students' results in the experimental groups in the researched operationalization parameter.

Keywords: conceptual maps, mental representation of material, meaningfulness, parameter, structured teaching material, strategy.

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1. Introduction

Constructivism in educational practice

We have come to believe that, even where every situation provides students the same information, they are not able to perceive all of it at once; therefore, in the perception process they select that information they assess as the easiest to take in, even as they do not recognize the degree of its importance. This means that even in the same situation, each student takes in varying information. The extent to which students select information depends on their experience, i.e. the more experience they have with selecting information, the better able they are to calibrate this filter. In educational practice the information that is crucial to comprehend the material presented (the knowledge of which is essential) must be analyzed, with selecting out of supplementary information that students can assimilate later. Contemporary education ought not only to guide students in taking in knowledge provided by others, but also in organizing basic information such that it creates a support system for their internal knowledge structure.

To date, much research has been done to quantify the advantages, positive effects and disadvantages of constructivism and other theories of learning in educational practice (Reigeluth, 1989; Yilmaz, 2011, Imenda, 2018; Kirschner et al., 2006; Rymarz, 2012; Ertmer, Newby, 2013; Agarkar, 2019 and others). However, there are many arguments that give attention to the theoretical advantages of constructivism (Karagiorgi, 2005; Hendry, 1996; Ernest, 1995; Fosnot, 1992; Warin et al., 2011; Kwan, 2020). Constructivist conditions and how they are applied in educational practice mainly emphasize the individual interpretation of students' schemata, as each student develops his or her learning mechanism through his or her active construction of knowledge.

We see constructivism in teaching as a reflective educational activity, a construction and reconstruction of the students' internal knowledge system, a focusing of attention on supporting the student's active understanding, and a stimulation of higher cognitive functions. Constructivist education is not the transfer and subsequent acquisition of "pre-processed" knowledge, but rather the construction of one's own meaning for specific knowledge and its subsequent systematization into one's internal knowledge structure.

Teaching and learning is understood in the context of a given orientation as a constructive process, as we can achieve more effective results through teaching with (understanding through the use of relevant practical experience. Direct "transfer" of the information that students are meant to learn is characteristic of traditional teaching; this is not necessarily done in a merely mechanical manner, to the contrary it can function just as meaningfully if the student is reacting to new information – processing it. When the student connects the new information with knowledge already attained, the internal knowledge structure becomes activated – i.e. the traditional learning was meaningful. As long as the student merely remembers information given by the teacher, without seeking connections and mutual relationships, the result of the teaching is clearly mechanic.

Learning strategies

It seems that educational practice in Slovakia pays scant attention to identifying teaching methods or strategies that lead to developing competencies of effective learning. The question of what a successful, and above all functional, model of learning should look like must be asked constantly Schools seem not to realize that the teaching process is more than textual information, and therefore it is incorrect to teach predominantly through the aid of texts. The point is that the human mind is able to comprehend more than abstract information in the text, as learning occurs by the aid of sensory codes (Duchovicova, Fenyvesiova, 2019; Grofcikova et al., 2018; Duchovicova, Kolenakova, 2018, Duchovicova, Tomsik, 2018; Tomsik et al., 2018; Kozarova, Gunisova, 2020).

For students' comprehensive development (remembering always that each student is unique), the educational process must employ a varied palette of teaching strategies. Through them, students obtain effective tools for learning with understanding, problem-solving, and presentation of their own ideas and thoughts. This is also an important part of motivation, where students through various strategies are connected to classroom work and active co-participants in the learning process; moreover, the learning and teaching are not stereotypical (the strategies create a dynamic learning process, with the content its static component). By applying a variety of strategies we can achieve the right teaching methods as chosen by the students, and the development of their metacognition and self-regulation (which create an individual's cognitive

separateness). Last but not least, through varied activities and strategies we can improve how students relate to the given subject, support longer-term remembering of material, expand students' vocabulary, and enhance their creativity.

Importantly, students must be taught to think in broader contexts, to read with comprehension, seek solutions to problems, and present the results of their own efforts. The means of processing information as well as the quality of perception are crucial determinants in the formation and modification of specific learning strategies, as these factors have significant influence on the symbolization, coding and organization of information into functional units, and on work with students' mental representation. A student's learning strategies should always be gauged in the particular context of his or her cognitive antecedents, thinking process, means of processing verbal and non-verbal information, and memory. It is very difficult for students to modify their learning strategies, as learning is often associated with a range of various habits and automatic activities (Anagün, 2018; Bas, 2012; Harrington, Enochs, 2009).

The learning strategies identified by P. A. Ertmer and T. J. Newby (2013) include: structured instruction, instructional explanations, concept mapping, summaries, synthesizers, mnemonics, advance organizers, analogies, demonstrations, and organizing information so as to encourage optimal processing of it. We have analyzed individual teaching strategies in *Metacognitive Development of Students* (Petrova, Kozarova, 2017).

Strategies of structured teaching material

Textbooks have a fixed material content of that the teacher is to communicate to students. We go so far as to maintain that in all but rare cases this text is communicated in linear form (in the composition of sentences in the textbook and in the spoken word). In learning, or the educational process, it is essential to teach students not only individual terms but also the relationships between them – which in textbooks or teachers' presentations often remains hidden. Students, in their effort to comprehend relationships between terms, are often unable to identify the basic structure of material in the text presented – they either construct it for themselves incompletely or include in them inessential or less important relationships. It is important for teachers to guide their students during the educational process so that they prove capable of constructing independently the material's structure, and consequently the whole notional/relational network.

L. Resnick (1996) characterizes three basic indicators that affect the structuring of educational material:

a) how it is taught (teaching methods, planning of lesson);

b) student age (appropriateness of content for students);

c) range of material (mastery of main terms in the material and relationships between them).

Students modify, evaluate and compare the information they take in as they perceive it. The processing of terms occurs through a set of thought operations: abstraction and concretization, analysis and synthesis, generalization, classification, induction and deduction, and comparison. Thus it can be inferred that students' thinking directly conditions the interpretation and structuring of text, as students operate with individual terms and abstract or metaphorical parts of the material. Meanwhile they must respect the symbolic function of texts and adequately construe meaning complexes.

J. Kesselova (2005) points to the importance of constructivist aspects in the effort to comprehend any kind of material. "The level of understanding depends not only on the information in the text and on the way it is presented but also on individual experience and one's knowledge and mental assumptions." We concur with the author's opinions, as it is an individual's cognitive processes that are determinants in analyzing import of material and constructing its content.

A teacher, as an expert in subjects for which he or she has qualified, may regard the structure of the communicated material as transparent and understandable, but students coming in contact with the material for what is often the first time may not "see" the structure or understand its logic.

The teacher's guiding principle should be to explain material to students as pliantly as possible, to put the created "real picture" in language the students understand. A picture thus constructed can be more readily coded into and retrieved from the memory. Schooling in Slovakia seems to have forgotten about techniques that would help students significantly simplify learning. Here we refer to optimally structured teaching material, which forestalls mechanical learning of a

given content while supporting material in a student's own understandable way. It is necessary to heed the patterns and similarities with material students have already learned, to create sufficiently strong associations. This is to penetrate into the structure of the subject being taught.

During lessons teachers present students material with a basic framework, but this is simple transfer of ready knowledge – i.e. of a structure students passively memorize. Any type of structured material is based primarily on the premise of arranging as well as possible the material's key terms and the relations between them. The challenge in current education is that students can often recite the material's facts, data, terms and main ideas, but cannot discern, grasp and interpret relationships between terms, in a so-called notional/relational network. In general we can identify three basic forms of arranging material:

1. linear – teacher's presentation, written text;
2. non-linear – pictorial material;
3. non-linear abstract representation – schemata, graphs, grids.

W. Schnotz and S.P. Ballstaedt (1996) describe the process of comprehension in learning from any text:

1. Students' comprehension in the world of general and symbolic language (analysis of associations as well as overview of the studied text).
2. Mental construction (the purpose of comprehending a text is to develop the capacity to construct or reconstruct an inner understanding of the studied text).
3. Interaction between internal and external influences (interaction between individual layers of the processed information, which could lead to misunderstanding; or reconstruction of earlier-acquired knowledge).
4. Cyclicity of process (comprehension in learning from a text is an open process, as there is a confrontation between new information and that already acquired).
5. Context of the text studied (both original and new information are structured into a specific context).

The conclusion was that teaching ought to occur with the objective of guiding students to comprehension the point of the presented material in an integral context; for the meaning structure and broad-spectrum variability in semantic perception of material fundamentally influence its consequent interpretation.

L. Lederbuchova (2002) stresses that a learner is never a passive receiver of information, but rather always completes the structure and most essential information in the material through his or her perspective – as he or she understands them. In communicating with the material he or she engages his or her perceptional activities, decodes the text's language expressions, and constructs his or her own inner picture. We think that analyzing material and modifying or transforming it is a resource in the search for appropriate methodological procedures in educational processes. As implied above, structured material is important to students' remembering better and more simply (as it provides for higher-quality construction of meanings). Structuring enables us to create conscious links between already-acquired and new knowledge, and can be seen as an active process, in which students create and seek the basic sense; among other things, structuring helps students make learning contextual (they are not learning isolated facts and theories in the abstract, as they are recoded into a more simply memorable form). Moreover, new knowledge cannot be introduced to an internal knowledge structure unless we acquire a certain structure created out of preceding knowledge, as we will show below in our research.

Conceptual mapping

The literature identifies conceptual maps with a variety of names, including: cognitive maps, mind maps, spider webs, network diagrams, knowledge maps, graphic illustration, structured overviews, semantic maps, and cluster arrangements.

Awareness of mapping seems to be relatively low in Slovakia. The literature most often describes conceptual maps as process-oriented teaching, which goes beyond knowledge acquisition to focus conceptually and systematically on how it is acquired. A constructivist conception of teaching is a determining element in using conceptual mapping in the individual phases of a lesson. If students are systematically prepared to construct their knowledge, they will structure the individual aspects of their potential map content even while the teacher is presenting them.

The analysis of relevant bibliographical sources leads us to characterize conceptual mapping as the creation of integrated schemata of structural relationships. It is the organization of a logical structure of certain knowledge, the creation of causal, mutual or final relational levels between a whole and its main parts within school learning (ideas, concepts, hypotheses or principles). We regard the conceptual map as a thought concept at the highest level of thinking. The map is stored in memory as a structure that has accumulated seen and heard data on specific information, together with models of effective negotiation.

The mapping technique draws on the assumption that the human mind stores new information by means of labels and images. It is useful to organize materials according to its sense, to seek associations, and distinguish supplementary from primary information and the unverified from the substantiated. Conceptual mapping as opposed to linear (in the literature called traditional) structuring of information is a system that supports the manner in which the human mind works, as corroborated by considerable meta-analytical research of the cognitive benefits of mapping (Nesbit, Adesope, 2006).

The act of understanding and interpreting conceptual maps is a rigorous and active process with a relational character, as the student identifies his or her own knowledge structure with key elements in the material. Linking information with already-created and functioning networks of knowledge leads by degrees to new forms of understanding. Conceptual mapping can be considered a useful technique for facilitating effective learning and the organization of information received into logical relationships (among terms, ideas and associations), enabling structuring, analysis, synthesis and generalization.

2. Discussion and results

Research problem

Conceptual mapping applied to the teaching process was at the center of our attention for several reasons, particularly because it has the potential to improve current educational practice. Each student is an individual being with preferences for differing ways of processing, systematizing, remembering and presenting information. This research focused on finding the relationship between the teacher's presentation of material, preceded by a didactic analysis of the material, with the resulting student's representation of the material, as illustrated through a conceptual map. The given knowledge students remembered from the material is not the only important aspect. Even more important are the student's comprehension of the presented material, and their ability to work with it, and interconnect associated knowledge (as stored in their internal knowledge structure). The focus was on the relational level of structuring material and students' mental representation of it in the subject of history.

History is considered a subject that students simply have to memorize. We believe that there are procedures and means by which we can explain to students the content of history education with a higher level of understandability, leading to an easier interpretation of given material and lower dependence on memorizing and empty verbalizing.

This study mainly aims at *analyzing the conceptual level of structured teaching material and its associative link to creating upper secondary students' mental representation.*

This research analyzes how the chosen type of structuring material used in communicating the content of the subject influences the conceptualization of students' knowledge, as reflected in the conceptual map. Based on the research objective, we posited the following hypothesis on the causal research problem, addressed through the research method of experimenting:

H: We expect students to whom material was presented by non-linear structuring to achieve a statistically significantly higher level of meaningfulness of the recorded assertions in the process of conceptual mapping compared to students to whom the material was presented by linear structuring.

Experts regard one of the most significant aspects of selecting and arranging material to be developmental psychology, more specifically the age conditions and aptitude of students in managing the material It must be recognized that students' learning capacity has boundaries, which change parallel to their development. In considering target groups, secondary school seemed an optimal environment. It is during secondary school that students gradually attain a state of cognitive development where they are capable of abstraction, working with hypothetical judgments, and thinking in general terms and generalizations. At issue is a formal/abstract way of

thinking, which forms the basis of developing critical thinking. In this period the quality of thought operations changes, and adolescents are able to work with abstract terms and generalizations. The verbal/logical memory comes to predominate over the mechanical. Secondary students also have the mental capacity to construct and reconstruct their internal knowledge structure and the structure of mediated scientific knowledge in the mind. Therefore we deliberately chose an academically-oriented secondary school [gymnázium] in Nitra. In addition to the question of age, the considered criterion was the teaching subject, with the choice primarily determined by the topics contained in the curriculum and the given year group.

In total the research sample comprised 96 students of the given school, four class groups of the first year of four. Due to the character of the research and the hypotheses formulated, the sample had to be divided into two large portions, representing the control and the experimental groups. In the two class groups of the control group, we taught history using a linear-structured material. In the two classes of the experimental group, we taught history using non-linear structuring of material, specifically through conceptual mapping. All research groups were taught throughout the research period by the same instructor: one of this study's authors, a graduate in education with a qualification in teaching History.

Table 1. Student numbers

Group	Number of students
Control group A (linear structuring)	26
Control group B (linear structuring)	23
Experimental group A (non-linear structuring)	23
Experimental group B (non-linear structuring)	24

Research Methods

The effectiveness of the changes was verified through conceptual mapping, using the *experiment* method (research of deliberately induced educational phenomena under controlled conditions prepared in advance). The experiment took place in standard conditions; because of the teaching subject, specific educational content and research objective, we chose the Piaristické gymnázium sv. Jozefa Kalazanského in Nitra. The research focused on experimental examination of how the chosen type of structured teaching material would affect students' mental representation (as expressed in a conceptual map).

We understand structured teaching material to be means (elucidation, explanation and the like) by which educational content is communicated/explained/made accessible to students. It is the teacher's ability to create analogies between what the students already know and the ideas of experts of various academic disciplines. In presenting material to students, the teacher considers the content's structure, choice of key material elements, and how to make it accessible, with regard to the students' mental and developmental level. Here the teaching lasted about 5 months – September to February (enough to cover the given topical unit) – and for all class groups was in instruction of history.

The selection of the type of school is intentional; the choice criterion is a grammar school (gymnázium) as a general educational institution. Within the school the year of study is randomly chosen. In the designated year a thematic unit was chosen for experimental verification in order to avoid possible influence of content on the results. The placement of learners into groups is based on natural conditions of school classroom formation. In order not to affect the results due to unnatural formation of educational group we worked with regular classes. Primarily we relied on how students were divided into classes during the regular classes. The control and experimental classes were determined by random selection as the classes were equivalent.

The work within the experiment was divided into two portions. In the control groups, when explaining the new material (the Ancient World topical unit) the linear structured teaching material to which most students are accustomed was used, with procedures based on traditional teaching methods – i.e. verbal (spoken explanation). The dominant form was frontal teaching,

though elements of group teaching were used as well (during a total of five lessons). Information-communication technologies were used for some lessons, searching information and supplementary teaching texts together with students and enhancing knowledge by analyzing available historical sources in electronic archives.

The chosen approach for the experimental groups while explaining new history materials (the Ancient World unit) was non-linear use of structured material. For this purpose, for each lesson and each new material of the given topical unit, a conceptual map was constructed, by which the material was explained to students. Further methods used included graphic/demonstrative methods (watching and analyzing documentary films). All supplementary chosen teaching material was processed through non-linear structuring. During group teaching (a total of five lessons), students worked on developing a group conceptual map, or added missing terms to the map prepared earlier, in order for the schema to make sense.

Students' mental representation of the chosen unit was analyzed through a *test of conceptual mapping* (the Ancient World); where the conceptual map is constructed by students this represents a graphic schema of their knowledge. The means by which the constructed conceptual maps were evaluated relied on theoretical knowledge of conceptual mapping, as well as on the actual construction of conceptual maps; specifically this was a *Relational method of evaluating conceptual maps*. The research team designated and analyzed the main parameter of operationalization: the meaningfulness of recorded assertions. By meaningfulness we understand a complexity of knowledge and systematic aspect of students' thinking manifested in mental representation. Above all else, precision in the information set down, inter-subject links, the material's connections with the entire unit, and the linking of the history material with other topical units were noted.

The research hypothesis was verified by using several quantitative statistical methods. We have applied the *Item Response Theory (IRT)* to assess whether the teaching process which uses non-linear structuring (in our case conceptual maps) in terms of meaningfulness – *(complexity of knowledge and systematic aspect of thinking in mental representation)* is more effective than the linear structuring presented in standard educational process of a teacher.

IRT theory was used for the evaluation of the quality of the conceptual maps, specifically the *latent correlations model* (Adams et al., 1997). IRT is an alternative to classical test theory (CTT) and allows you to identify the properties of items that classical test theory does not provide. IRT models with one latent variable use two assumptions: the assumption of unidimensionality – the probability of a respondent's answer to an item is affected by only one of his/her characteristics and any other influence is excluded; assumption of local independence – the influence to answer by other test items is not considered as influential apart from a person's character traits. Within the IRT we verified by the application of LRT test which of the compared candidate models is more suitable for the examined data. The quality of conceptual maps was assessed by the *structural method* and the *relational method*. It has been discovered that the learners in the experimental group achieved significantly higher average values in all four latent variables compared to the students in the control group, even though the distribution of any of the variables is not normal in either control or experimental group which we also verified by the Kolmogor – Smirnovov test. These were two selected files, threfore statistical significance was assessed by a non-parametric alternative of a multivariate analysis of variance which does not assume multivariate normality. From the result of the overall multidimensional test ($\Lambda\ (4; 91) = 17{,}89; p < 0{,}001$) it is evident that the four variables in the experimental and control file do not have the same distribution. Subsequently, in the *npmv* programme package at the significance level of 0.05 we searched for variables that cause a statistically significant result. Learners in experimental group achieved statistically significantly better results in all four monitored variables. Stated results are not the subject of the analysis of this study but are related to the evaluation of the statistical significance of the structural method results which are analyzed below.

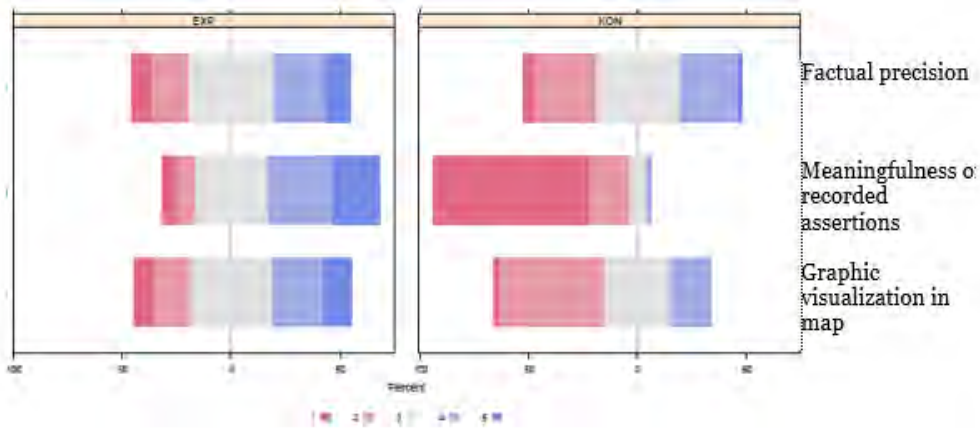
In the case of the structural method four areas: *concepts, relations, hierarchies and groupings* were evaluated using ten items coded on a three-level scale 0, 1 and 2. The data were also analyzed by application of the IRT theory specifically the *model of correlated latent features* (Adams et al., 1997).

In the matter of relational method three ordinal variables were assessed: meaningfulness, graphical readability and factual accuracy on a five-point scale (1 lowest, 5 highest). The consistency of the conceptual maps was evaluated by a relational evaluation method, using ordinal variables for *meaningfulness of recorded assertions* on a 1-to-5 scale.

Table 2. Meaningfulness of recorded assertions

Meaningfulness of recorded assertions	
5	Knowledge in the map is complex. Recorded assertions express integrated ideas and reflect the student's systematic thinking. Information is recorded precisely and in association with material from various topical units. The map features inter-subject links.
4	Knowledge recorded in the map is complex, but the ideas lack aspects of integration, and are not systematically arranged. The assertions include inter-subject links, but association with material is limited to the given topical unit. Association with other history material is slight.
3	The assertions recorded in the map are not integrated, and ideas not arranged systematically. Relatively few inter-subject links between different materials appear on the map. Materials within the topical unit are linked, but there is an absence of association between history material and that of other topical units.
2	Though the map features information, the assertions are incompatible with the terms, and so the individual ideas lose their function and meaning. Inter-subject links are not conveyed in the map, and there is an absence of association with other materials from other topical units. There is association conveyed within the topical unit, but with some imprecision.
1	The conceptual map has no relevant assertions, and knowledge is neither systematic nor integrated. Information is not precisely recorded, and there is absence of inter-subject links and of association with other materials either from this or other topical units.

The evaluation was followed by the comparison of the scores of constructs obtained, given students' group identity (in control and experimental groups), by the nonparametric alternative of one-factor multivariate analysis of variance (Bathke, Harrar, 2008). Test statistics were used to verify the assumption of local independence (Maydeu-Olivares, Joe, 2006) with chi-square partition.



Legend: 1 lowest quality level – 5 highest quality level

Fig. 1. Success of solutions in control and experimental groups

Analysis of research results

The ordinal variable meaningfulness is together with graphical readability and factual accuracy an indicator of the quality of the map. We were interested in whether the quality indicator of a map – *meaningfulness* is statistically significant and different among students of the experimental group in comparison to the students of the control group. As can be seen in Figure 1 and in Table 3, the learners of the experimental group achieve better evaluation in all three indicators.

Likewise the table (*Descriptive statistics of latent variables in control and experimental groups*) shows that experimental group students achieved higher-quality evaluations in all the indicators observed.

Table 3. Descriptive statistics of latent variables in control and experimental groups

Group		Factual precision	Meaningfulness of recorded assertions	Graphic visualization in map
EXP	N	47	47	47
	Average	3.15	3.51	3.11
	Median	3	4	3
	SD	1.12	1.12	1.09
	Minimum	1	1	1
	Maximum	5	5	5
CON	N	49	49	49
	Average	2.65	1.39	2.94
	Median	2	1	3
	SD	0.80	0.76	0.90
	Minimum	1	0	1
	Maximum	4	4	5

Since all three variables are ordinal and the assumption of multivariate normality cannot be met, we used a nonparametric alternative of multivariate analysis of variance to compare the results of control and experimental learners. The calculation of statistical significance at the significance level of 0.05 in the npvm software package was applied as well. Corresponding p – values are not stated cause the *ssnonpartest* function in the npmv package also does not specify them. It turned out that the results of the differences in the category: meaningfulness of recorded assertions between the control and experimental group are statistically significant. By application of nonlinear structuring methods within the curriculum learners achieved statistically significant better results in the category of meaningfulness than students in the control group. Based on the above can be stated that the nonlinear structuring of the curriculum realized through the application of mental maps in the teaching of history has a statistically significant effect on learners' mental representation in the complexity of knowledge and systematic thinking.

To verify the results of the evaluation of the quality of conceptual maps we also compared the results of the structural and relational methods through correlation in groups using Kendall's correlation coefficient. From the values of Kendall's correlation coefficient given in Table 4 which are all statistically significant at the significance level of 0.05 it clearly shows that the majority of correlations between individual pairs of variables according to de Vaus' classification (de Vaus, 2002) is *substantial even very strong* (0.50-0.69) and a foursome of correlation coefficients is *medium strong* (0.30-0.49). These facts show that the results obtained by the structural method are relatively strongly correlated with the results obtained by the relational method.

Table 3. Kendall's correlation coefficient between variables from the structural method and the relational method.

Relational Method	Structural Method			
	Concepts	Relations	Hierarchy	Groupings
Factual Accuracy	0,63	0,59	0,62	0,57
Meaningfulness	0,68	0,70	0,69	0,69
Graphic readability	0,47	0,47	0,47	0,44

In most cases, students learn history mechanically, in order to memorize all facts and information, but they do not learn meaningfully. Consequently the process result does not correspond to optimal expectations. If students' comprehension of the subject of history is to be improved, a variety of teaching strategies must be evaluated and compared. The scope of our analysis consists of comparing the application of non-linear and linear structured teaching material (of the chosen topical unit) to students' mental representation, as recorded in conceptual mapping. Our results show that non-linear structured teaching material is a more suitable strategy than the linear-structuring that is predominantly used in teaching history in academic secondary schools.

Our hypothesis anticipated that students to whom material was presented by non-linear structuring would achieve a statistically significantly higher level of meaningfulness of the recorded assertions compared to students to whom the material was presented by linear structuring. Within this hypothesis we analyzed how systematic students' thinking was, the complexity of their knowledge, the precision and associations in their information, and their use of inter-subject links. From the results it can be deduced that experimental group students achieved higher-quality evaluations on the parameter of operationalizing the meaningfulness of statements recorded. Comparing the results of successful solutions yielded an interesting finding. Control group students were unable to achieve the highest possible evaluation (5) on this parameter. Analysis of the conceptual maps showed to a significant degree that these students did not record relevant statements, and almost completely left out inter-subject links and indication of relationships among the given topical unit's materials. In many cases the students' thoughts lost their import, as they were not compatible with the terms used. It was here we see that control group students did not comprehend how they were meant to work with the material, or how to detect and analyze the relationships and associations within the information. Although they had taken in a good deal of knowledge, it was difficult for them to pace terms within a meaningful system. On the other hand, experimental group students recorded complex knowledge in their conceptual maps. Detailed analysis showed that the mental representations portrayed reflect how systematically they were thinking. The topical unit's material related one to another, and students comprehended the material and proved capable of creating a more heterogeneous knowledge structure (e.g., in their conceptual maps these students: showed that organs of executive power comprise the basic pillars of civil society on which today's societies stand; depicted the rise of Rome's power, and wars with the Celts as well as Carthage and Tarentum; described the unification of economic matters and the origin of the Delian League; compared Draco's Code and the Solonian Constitution; and analyzed the evolution of Athens' political system from aristocracy through tyranny to democracy). Information recorded in experimental group students' conceptual maps were quantifiably linked to other teaching subjects, including geography (natural conditions), civics (the Laws of the Twelve Tables, classes of citizenship, democracy), literature (Marcus Aurelius – Meditations) and art (sculptures). For us (as instructor and research initiator) it was especially interesting and decisive to find that, notwithstanding our working predominantly with one type of conceptual map with students in the lessons (although their instructions included all types and means of mapping), the experimental group students' output was diverse. We conclude that the students themselves chose ways of mapping that best suited them and that enabled them to record their mental representations in as much detail as possible. The hypothesis was thus supported.

3. Conclusion

The educational content of the subject of history is immensely interesting, and need not be the boring drill of many facts. Of primary importance however is for teachers to understand they are

teaching students rather than a subject. Therefore the strategies of conveying material should be modified so as to function optimally. The basic requirement is for students simply to learn, comprehend and remember material. Students must be presented with diverse strategies that can help them develop their thinking, and code and decode the information taken in. It is essential for educators to realize that in educational practice students should be taught within contexts, not drilled on isolated facts. It is here we see the benefit of this study. This research verified that changing the teaching process by introducing non-linear structured teaching material – by way of conceptual mapping in conveying information to students – has many benefits, leads to deeper comprehension, aids in systematizing educational content, and develops students' self-regulation of their thinking processes.

4. Acknowledgements

This study has been written under the project: APVV-15-0368 Practice in the centre of the subject field didactics, subject field didactics in the centre of preparation for practice. The paper was developed with support under project VEGA 1/0391/20 Transformative learning of the student teachers in the context of pupils' critical thinking development.

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