UNIVERSITY OF SZEGED, FACULTY OF ARTS
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ASSESSMENT OF KNOWLEDGE ORGANIZATION IN WRITTEN COMPOSITION AND GRAPHICAL PRESENTATION

Thesis booklet

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BACKGROUND AND GOALS OF THE RESEARCH

Cognitive psychological theories about knowledge organization and knowledge structure have spread widely in international and domestic reference works in recent decades. Apart from all that, educational research also offer a wide range of further opportunities for research focusing on knowledge. Hungarian empirical research projects have explored several layers of academic knowledge and academic literacy over the past decade. Students studying in the public education system acquire their academic knowledge over a course of several years and through various subjects and learning materials. Their academic knowledge includes such old and new knowledge items (i.e. students have such knowledge) that they learnt especially when they were 10-14 years old, and there are also some others that they learnt while going secondary school. The National Curriculum regulates all those requirements that academic knowledge must meet with respect to competence improvement, education transmission and knowledge scaffolding at the output level. This document contains the acquisition of those oral and written communication methods broken down by fields of literacy that provide a means for checking subject knowledge. Written composition is an especially important area of using written communication methods since it can be considered the highest level of written communication.

Requirements pertaining to the use of written communication methods are also included in the National Curriculum as related to specific fields of literacy (broken down by subject) but Hungarian teaching practice still focuses primarily on the humanities literacy field related to the development of this especially important skill. The practice of correcting and assessing students' compositions is closely related to this. The current assessment strategy developed for teachers is based on contentual, structural and literary criteria. Considering them, it is the contentual aspects where subject knowledge can be presented. However, the assessment of contentual aspects is still directed at keeping to the subject, convincing arguments and acumen in present-day teaching practice. Nonetheless, these rhetoric-related aspects ignore the representation of subject knowledge appearing in compositions (the building and organisation of knowledge), although these factors can indicate the presence of students' old and new knowledge at the highest level of communication skill, i.e. in compositions. So we can assume that specialists do not get a clear picture about the representation of students' accumulated knowledge in the public education system, though we should be aware of how knowledge is structured at this high level of written communication (composition) and what represents knowledge organisation in this respect. The representation of subject knowledge in compositions has not been researched so far even though its research could even provide a means for measuring knowledge transfer. International composition research projects conducted in recent decades made some assumptions about the location of the area-specific content knowledge related to written composition.

There are also analyses describing research projects exploring the efficiency of written composition used as a learning stimulant. It is also a wide-spread practise in Hungary to emphasize the process character of composition, but written composition is still viewed mostly as a communication skill and not as a mean of improving knowledge as it is perceived in analyses presenting international research findings.

Graphical presentation is another representation of academic knowledge. Though the literacy content of the National Curriculum contains the combined management of audio and visual information, the visual text lay-out in the context as well as the interpretation of the figures, diagrams and typographic elements appearing in textbooks, the application of graphical presentation still receives little attention in pedagogical practice. What is more, teachers do not provide or give only little feedback about the quality of the students' graphical presentation. That is so even as the building and organisation of academic knowledge could possible be determined based on these graphical presentations. One of the large areas of international studies about graphical presentations concentrates on the research of thinking maps used in learning. These studies mostly agree on the usability of such maps but knowledge representation in compositions and drawings has been scarcely researched. No Hungarian research has been made either about the quality of graphical presentations created by students or related to the knowledge representation therein, although academic knowledge appearing in graphical representations should be explored.

THEORETICAL BACKGROUND OF THE EMPIRICAL RESEARCH

The research focuses on the representation of knowledge in composition and graphical representation. Since it is difficult to examine the building and organisation of knowledge using empirical methods, we had to use multiple aspects to approach its theoretical background. First, we took into account the theoretical models of knowledge building and organisation, then overviewed those of these models that assume decade-long stability, e.g. *Medin* and *Smith*'s (1984) definitive properties model or the schema theory about complex organisations (*Schank,* 1972, *Rumelhart,* 1975). Of the theoretical works made in Hungary we took into account *Nagy*'s (1985) knowledge theory, which is based on a structuralist concept.

The other approach to knowledge building and structures is constructivism, which views knowledge as a concept forming part of an interpretation process. This theoretical concept is indispensable related to the subject of our research as it takes into account that the knowledge organisation process depends on a large number of factors, which can be influenced by the knowledge that the student acquired related to a specific topic or the way its cognitive structure is built (*Nahalka,* 1997). Knowledge is formed, i.e.

constructed through interaction with the environment. This created knowledge is a unique, personal construct, which can be determined by the student's preliminary knowledge. Considering constructivist knowledge theories, we took into account *Carey* and *Spalke*'s (1994) and *Osborn, Bell* and *Gilbert*'s (1983) information processing theories, which assume the existence of such a concept network in the psyche, whose elements link to each other based on their content. Related to this, we included *Nagy*'s (2000) parallel information processing theory (PDP model), which views knowledge organisation as the operation of shared parallel units (network). *Nagy*'s (2007) knowledge building model views words and sentences comprising the language as fixed and loose elements.

With respect to the research it is important what we have learnt about the organisation of knowledge in the course of making written compositions. By the 2000s Hungary also had process-centered cognitive psychological models for written composition, which were published by *Molnár* (1996). *Bereiter* and *Scardamalia* (1987) identified the location of area-specific content knowledge in the relation between written composition and knowledge, and their important theoretical foundations include, among other things, that knowledge presented in written composition is organised in a different structure and that written representation transforms knowledge. *Kellogg*'s (2008) theory says that the relation between high-level composition and knowledge lies in the fast accessibility of the long-term memory. The person writing the composition can only extend his text if the knowledge stored in his long-term memory can be accessed quickly.

Concerning the epistemic operation of written composition, *Klein* (1999) published his related assumptions in his meta-analysis, trying to prove the knowledge deepening effect of written compositions. *Schumacher* and *Nash* (1991) developed those cognitive mechanisms that result in knowledge changes in written compositions.

We used cognitive linguistic models as the basis for making knowledge explicit in written compositions. *Holliday*'s (1985) theory assumes a close unity between the language and concept knowledge, and perceives text as some kind of mental ability. The respective theories of *Lakoff* (1987; 2002), *Langacker* (1987) and *Tolcsvai* (2000) assume text as one cognitive unit from a linguistic perspective, which can be interpreted as the combined structure of two major components: the structure (static) and the operation (dynamic process). Text is a thinking net where the structural arrangement of knowledge and the linear leading of thinking come to the surface.

We approached the theoretic basis of graphical presentation methods from three directions: the cognitive psychological interpretation of graphical representation (*Clark* and *Paivio,* 1991, *Barsalou,* 1999; *Sowa,* 2000), then using models of systematization capability development (*Nagy,* 2003), and finally from a learning methodology aspect (*Bereiter* and *Scardamalia,* 1994*;*

Readence, Bean and *Baldvin,* 2004). The graphical writing component was specified by *Scardamalia* and *Zhang* (2007).

The research required us to highlight knowledge organisation appearing in written composition also in international and Hungarian composition assessment systems. Composition assessment systems have been used in Hungary for decades (*Kádárné,* 1990*, Horváth,* 1998). However, we took into account only those aspects in the assessment system which are directed at knowledge organisation, such as the assessment aspects relating to the contentual elements of the two-level secondary school graduation exam and the knowledge organisation aspects of A Writing Framework for the 2011 National Assessment of Educational Progress (NAEP 2011). We used *Biggs* and *Collis's* (1982) assessment taxonomy, Structure of Observed Learning (SOLO) for assessing knowledge organisation in written texts. This taxonomy targets the acquired levels of learning results, and we used it to identify the complexity level of information elements in written texts.

The linguistic properties of texts have been researched from several aspects for a long time. Not only theoretical reference works but text pragmatic research projects also show significant results in this area. The purpose of text linguistics research is to identify which grammatical and semantic means ensure connexity and cohesion, and what impact it has on text clarity if they are missing. No research has been made related to the comparative analysis of texts using such aspects. We did not find any reference concerning the relations between information classification, text interpretation and analytic-assessing reproduction of the text on the one hand and the use of text coherence means on the other hand, either. (This may be not surprising if we consider the fact that our research is the first Hungarian study to attempt to look into the building of knowledge.)

SAMPLES AND INSTRUMENTS

The subject of our research was divided into two phases due to its hardly discernible factors: in the first phase we compiled exercises for concepts that were predefined for assuming universal and stable knowledge structures. In the second phase we assumed individual and instable (not dependent on the situation) knowledge structures, therefore, the exercises which we compiled for it did not focus on predefined concepts. We used sampling more than once during the two phases. We used the exercises compiled for the predefined concepts in the first phase as follows.

In the first phase of the empirical research:

May 2009 – 31 second-year college students studying to become conductors wrote a composition and completed a knowledge test with exercises for 20 predefined concepts.

May 2010 – 49 11th-grade secondary grammar school students wrote a composition and completed a knowledge test with exercises for 3 topics each containing 10 predefined concepts.

May 2011 – 57 11th-grade secondary grammar school students wrote a composition and completed a knowledge test with exercises for 3 topics each containing 10 predefined concepts.

In the second phase of the empirical research:

From March to May 2012: 495 students wrote a composition and completed a drawing exercise complete with tasks compiled for non-predefined concepts.

QUESTIONS, HYPOTHESES AND MAIN FINDINGS

The questions used in the empirical research were classified into five groups (1 to 5). A total of 15 (H1 to H15) hypotheses were formulated based on the questions. All these will be presented before going on to discussing the relevant findings.

(1) *Methodology*: How suitable are the instruments compiled for the predefined concepts (test sheets, composition exercises) for measuring knowledge building? How suitable are the instruments compiled for the non-predefined concepts (composition exercise, drawing exercise) for measuring knowledge building? How do various knowledge structures appear when using different interfaces (test sheets, composition tasks and drawing exercises)? (H1 to H7)

(2) *Learning impact*: Do the knowledge structures of exercises done in reverse order differ related to a) test sheets, b) written texts, c) drawings? (H8)

(3) *Organisation level of knowledge structures*: Do the aspects showing the organisation level of knowledge structures justify the advanced level of knowledge structures in written texts? Do the aspects showing the organisation level of knowledge structures justify the advanced level of knowledge structures in drawings? Can the knowledge-telling and knowledge-transforming models of writing strategy and the knowledge crafting level of the writing skill development model be mapped onto SOLO taxonomy levels? Do the different level-based quantity and quality properties of knowledge elements expressed in contentual-logical nuances in the SOLO taxonomy also appear in linguistic differences? (H9 to H12) What are the characteristic aspects of basic and advanced level knowledge structures in a) written texts and b) drawings?

(4) *Effect of the training direction*: There is no difference between secondary grammar school students specializing in humanities and in sciences

concerning the changes in knowledge structures with respect to either written texts or drawings. (H13)

(5) *Factors that may affect learning at school*: Which factors have an effect on the changes in knowledge structures? Plenty of school- and learning-related factors have an impact on the development of students' knowledge structure. Concerning some subjects, the relation between students' literacy coming from reading books other than textbooks and from other sources and the level of knowledge structures is more direct than the relation between the grades they get in these subjects and the level of the knowledge structure. There is no relation between the frequent use of various knowledge frameworks used for subjects and the level of drawings. (H14 to H15)

Methodology: quality of the assesment tools

Three instruments were developed for this many-sided research examining a subject matter which is empirically difficult to investigate. Our goal was to test their quality (reliability and validity). Three tests and three composition exercises were developed for the uniform and stable measuring of knowledge structures. Where we assumed uniform and stable knowledge structures, the instruments were developed for predefined concepts. (H1 to H7)

Test results

The exercises in the first test focused on 20 predefined concepts. The reliability of the test is appropriate (Cronbach's α: 0.91). The test consisting of 74 items contained ten exercises all of which had ending. We used *Nagy*'s (2003) systematization capability development model to determine knowledge structure properties. We measured tasks aimed at classification using 25 items and 3 exercises, tasks aimed at definition with 15 items and 3 exercises, and tasks aimed at creating sets with 25 items and 4 exercises. Interrelated elements of knowledge structures were examined using cluster analysis. Concerning knowledge structure tasks, mostly the classification and set creation exercises formed groups, such as arranging concepts in tables and placing concepts in drawings, arranging concepts in sets and identifying relations between concepts. The second test was compiled using three topics and focusing on 10 predefined concepts. This test was aimed at considering concepts that students learned at school earlier (in primary school and more recently, in secondary school), and making some drawings with the use of these concepts. The reliability of the 42-item test was appropriate (Cronbach's α: 0.86) so the tasks reliably measured the familiarity of students with the concepts. We used 30 items for defining concepts, 8 items for classifying concepts and 4 items for the short composition. We performed a cluster analysis for the interrelation of the 30 concepts, which

showed that only those concepts formed groups which students learnt either a long time before or recently, i.e. which students learnt either in primary school or in secondary school. Old and new concepts did not form common groups. The reliability of the 62-item third test was also appropriate (Cronbach's α: 0.84). We used 15 items and 2 exercises for the tasks aimed at classification, 33 items and 3 exercises for those aimed at definition, 10 items and 1 exercise for those aimed at grouping and 4 items and 1 exercise for those aimed at set creation. The interrelated tasks of knowledge structures were also examined with cluster analysis and we found that classification and grouping tasks formed a group (e.g. arranging concepts in a table, matching drawings to sentences and identifying relations between concepts).

Composition task results

Assuming uniform and stable knowledge structures, we compiled the composition tasks also for predefined concepts. The first composition task was based on 20 concepts and its reliability was accepted on the basis of 2 evaluators' opinions. The reliability index was expressed using Cohen's kappa (Cohen's kappa: 0.90). The second and the third composition tasks used 10 predefined concepts in 3 topics (second composition – Cohen's kappa: 0.91; third composition – Cohen's kappa: 0.91). The knowledge structures appearing in the compositions were interpreted in the linguistic representation of the predefined concepts. This was implemented through the evaluators assessing the relations between the concepts. They assessed the compositions by assigning them to one of three categories based on the number of cognitive units contained (compositions with no cognitive unit representation, representing 4 cognitive units, representing at least 5 cognitive units). Following that, we collected the most frequent solution samples. We found that students could represent similar cognitive units related to the same concepts, from which we concluded that students could present the connections between specific concepts only in units that they already learnt or as their teachers had expected them to during classes, which is assumed to be almost uniform.

The second instrument group comprised of tasks developed for non-predefined concepts. Two instruments were devised for this purpose: e composition task and a drawing task. The reliability of these tasks was also determined by evaluators. We developed two types of tasks (tasks A and B) with the goal of achieving the same task quantity and quality. We compiled a system of aspects for the composition task, which allowed assessing the compositions. We assumed that these aspects would make it possible to detect knowledge building and organisation elements that appear in compositions. The components of these aspects were based on theoretical models. The reliability of composition tasks was specified in Cohen's kappa. All components of both tasks (task A and B) proved to be reliable regarding the composition tasks.

Drawing task results

The exercises of the drawing tasks measured knowledge representation through graphical presentation. With a view on achieving standard quality and quantity, we devised two tasks (tasks A and B) again. The drawing task was also assessed by two evaluators, and their reliability was calculated using Cohen's kappa. The knowledge building and organisation aspects appearing in the drawing task were specified based on theoretical approaches and research findings. The reliability of the drawing task proved to be appropriate with respect to each index.

Learning impacts

Students did the tasks in two orders: while one sub sample did the composition task first and then continued with the drawing task, the other sub sample did the drawing first and then went on to the composition task. The tasks also contained texts, which were the same for the composition task and the drawing task. We presumed that there would be a difference between the results achieved in the composition and the drawing tasks depending on the order in which the students did the tasks. We tested the differences using *t*-tests and found differences in every variable for the composition results of those who did the composition task first. They performed better in the composition task than those who did the drawing exercise first. We can assume that the transfer effect, which could have helped with or supported the solution of the task, did not work here. The other reason for their better achievements could be that the composition as a new, so far unknown task could have been motivating for the students while the composition task seemed to be familiar and not much interesting for those students who had already done the drawing task beforehand. (H8)

Organisation of knowledge structures

Characteristics of knowledge organisation presented in compositions

Concerning the compositions, the components indicating knowledge organisation were compiled based on theoretical approaches and research findings. In order to overview the results, we will list the aspects and the relevant results achieved according to the SOLO taxonomy.

The aspects of knowledge organisation (H 9 to H12):

Understanding the subject matter: relevant knowledge and information elements matching the task questions appear in the composition

Linguistic levels of structuring: linguistic linking elements of the text appearing in and between sentences

Compression of meaning content: linking abstract and concrete information elements Building of a knowledge network: new knowledge elements appearing in written texts Operations with information elements in written texts: SOLO taxonomy

Structure: the arrangement of the material: unity, completeness, logic of progress, compliance with the standards of the genre, the text at macro level General impression: placing the composition in the total sample

Structuring: clear overview, the proportion of margins and line spacing, outlook of decorative writing

Characteristics of knowledge organisation presented in drawing

Concerning the drawings, the components indicating knowledge organisation were compiled also based on theoretical approaches and research findings. In order to overview the results, we will list the various aspects and the relevant results achieved in terms of outlay arrangement.

Relevance: displaying relevant information elements matching the question related to the task

Number of information pieces: the appropriate number of information elements to create the knowledge structure

Arrangement of information: arranging the information elements taken from the text and complementing them with additional aspects

Generalisation and specification: aspects from specific to abstract information elements

Presenting central and secondary concepts: highlighting central and secondary concepts taken from the text

Indicating connections: also indicates the connections between information elements by linking them with a line or an arrow

Disambiguity of signs and markings: the signs between information elements are clear and each connection is marked with the very same sign or the student even adds comments to the markings

Performing operations: it creates a connection between multiple information elements: e.g. the student makes conclusions, juxtaposes, indicates an opposing relationship

Clear overview: as a structured graphical image, the knowledge structure can be a concept map, a flowchart or a hierarchic representation on the form of a table or a problem tree

General impression: image placement in the overall sample

Appearance: proportion of letters and exact marking of labels (entries, frames)

Effect of training orientation

We assumed that there was no difference between the knowledge structure of secondary grammar school students specializing in humanities and in sciences with respect to either text writing or drawing tasks (H13). We made *t*-tests to identify differences. Based on our findings, we cannot identify any significant difference between the performance of those specializing in humanities and those specializing in sciences related to the composition tasks but in a single variable, the appearance of new knowledge elements (knowledge network). There is not any significant difference with regard to the drawing task of our research except for a single variable, the disambiguity of signs and markings.

Factors influencing students' knowledge structures

According to our assumption, there are several school- and learning-related factors that have an impact on the development of students' knowledge structure. Concerning some subjects, the relation between students' literacy coming from reading books other than textbooks and from other sources and the level of knowledge structures is more direct than the relation between the grades they get in these subjects and the level of the knowledge structure. We also assumed that there is no relation between the frequent use of various knowledge frameworks used for subjects and the level of drawings. (H14 and H15) To prove these effects, we had a questionnaire completed and made correlation calculations. Based on the findings we could conclude that there is just a not too strong relation between the grades and the various variables related to composition writing and drawing. We did not detect any significant relation between the variables of literacy, composition and drawings. Grades still appear to be a better indication of intellectual development than any other school-related factor or being educated.

IMPORTANCE OF THE RESEARCH AND FURTHER RESEARCHOPPORTUNITIES

The primary goal of the empirical research was to explore the representation of academic knowledge acquired in public education on two planes: in written composition and in drawing. Since the highest level of written communication still has an important role primarily in the area of humanities, it should be extended also to the representation of academic knowledge. *Molnár* (2003) already reported on the situation of written composition in Hungary, underlying that composition is interpreted as a linguistic skill in Hungarian teaching practice despite that it should be a development goal and a means of thinking. While composition opportunities known to be used as learning means from

international research projects are available (*Tynjälä,* 2001), Hungarian composition teaching still emphasizes mainly its traditional rhetoric function.

Our empiric research attempts to explore those components of the contentual aspects of compositions, which can show signs of knowledge building and organisation. Previous composition researches focused on skill development and the representation of various linguistic means. Our empiric research is the first to attempt to explore knowledge representation in compositions.

Educational research projects have paid little attention to knowledge representation appearing in drawings based on students' systemising thinking and to identifying the building and organisation of knowledge that can be explored in them. There has not been any research aimed at exploring the standards of students' graphical representations even though they would also have an important role in academic education because graphical mapping of knowledge helps promote understanding a lot. This is also justified by research (*Shavelson,* 1997, *Zhang* and *Scardamalia,* 2007).

The assessment strategy of compositions offers additional research opportunities. The contentual aspects of traditional composition assessments focus on rhetoric properties but have not created any further assessment aspects related to knowledge representation. If an assessment aspect focusing on knowledge building and organisation was involved in the assessment, the mapping of the knowledge acquired by students could also be represented. Since various research projects have proven for decades that written composition has a knowledge construction role (*Flower* and *Hayes,* 1984, *Bereiter* and *Scardamalia*, 1987; *Kellogg,* 2008), it would be important to have this appear also in the everyday practice of schools and composition teaching.

The other important feature of the research is that it attempted to explore those components of students' graphical representation that show knowledge building and organisation. The National Curriculum includes but indicative proposals concerning the development of graphical representation as a skill, and even those proposals refer mostly to studying and interpreting images in textbooks and learning materials and are not aimed at focusing development toward the creation of graphical images by students. The next research step could be aimed at exploring the methods of assessing graphical representations and identifying the skills whose development could be enhanced by graphical representation: whether it has an effect on learning sciences or humanities.

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