IMPACT OF AN INTERVENTION METHOD MEDIATED BY THE CONSTRUCTION OF CONCEPT MAPS IN A NEWS PRODUCTION NETWORK ON STUDENTS' CONCEPTUALIZATION OF WRITTEN LANGUAGE

Patrícia B. Schäfer[1], Universidade Federal do Rio Grande do Sul, Brazil
Alberto J. Cañas, Institute for Human & Machine Cognition (IHMC), USA
Léa C. Fagundes, Alex F. T. Primo, Universidade Federal do Rio Grande do Sul, Brazil
Email: patricia@lec.ufrgs.br

Abstract. This paper presents the evaluation of a proposal for the creation and implementation of an intervention method on students' conceptualization of written language. It rests on the integration of concept maps and texts created by fourth grade Elementary School students in an online news production network. The analysis of the textual development is carried out based on the triangulation of data concerning levels of development of linear writing, as well as topological and semantic taxonomies for concept maps. The results indicate a reciprocal development with regard to the conceptualization of linear writing and the construction of concept maps, favoring consciousness-raising in the process of revising texts, in order to improve semantic and structural aspects of written language.

1 Introduction

Brazil has substantially increased its investment in education and has made progress concerning the purpose of universal access to school. Nowadays, almost all Brazilian children are enrolled in educational institutions. However, grade repetition rates and the proportion of adolescents who leave school before completion of basic education remain high (IDEB, 2009). These results are corroborated by low levels of proficiency achieved in national and international assessment examinations (PISA, 2009; SAEB, 2009, IBGE, 2010). The difficulty of reading comprehension, identified in the tests described, is one of the main problems in Brazilian education. At the same time, students show writing deficiencies which lead to meaningless productions, unable to meet their communication objectives, according to PCNs (National Curriculum Parameters – Brazil, 1997, p. 49).

There seems to be a mismatch between national curriculum objectives and the students' effective reality. Despite the quantitative parameters adopted by most examinations, which do not allow an evaluation of each child's specificities, nor a deep analysis of the context in which the limitations are manifested, there is an emerging need to review practices and guiding principles of students' learning. This study considers the background presented as well as the necessity of a real functioning of written language in schools. It presents the creation and implementation of an intervention method that aims to face students' difficulties concerning conceptualization of written language based on two main proposals: their participation in a news production network and the construction of concept maps about the texts originated from this initiative.

2 Context and objectives

Since 2007, LEC/UFRGS[i] (Laboratory of Cognitive Studies, Institute of Psychology, Federal University of Rio Grande do Sul, Brazil) has participated in the federal Brazilian program PROUCA (One Computer per Student Program). It has the aim of examining the possibilities of distributing laptops to students and teachers of public schools in the country, integrated to connection to the Internet, as a means of improving education. Among the various activities carried out in order to create a field of study and application of a new approach to written language in schools, LEC/UFRGS started, during the first stage of PROUCA program, planning the creation of an integrated media network in which children and adolescents could organize themselves as authors and moderators of information targeted at their communities, taking advantage of mobility, connectivity and resources of the laptops. In 2011, the use of concept maps (CM) and the application of systematic interviews with guidance of Piaget's Clinical Method[ii] (PIAGET, 2005) were incorporated to the proposal, constituting the thesis project of one of the authors of this paper.

Concept maps integrated to the initiative work as a powerful resource to explicit logical connections of thought, enabling to assess the conceptualization processes about different subjects, since the research questions for the news production network are freely chosen by the students, such as in Learning Projects (FAGUNDES et al., 1999). Moreover, because of the possibility of a non-hierarchical format, the concept maps generate

dynamic representations of knowledge, next to the operation of thought, always susceptible to changes and new connections.

This paper discusses possibilities of the intervention method described to contribute to develop students' conceptualization of written language. The main hypothesis of the work was that the method and the performance of clinical interventions on the constructions originated from it would encourage a conceptualization process regarding semantic and structural aspects of written language, favoring improvement of students' writing.

3   Method and theoretical framework

In order to examine possible impacts from the construction of concept maps and interventions related to them on students' conceptualization of written language, two stages were applied, shown in figure 1:
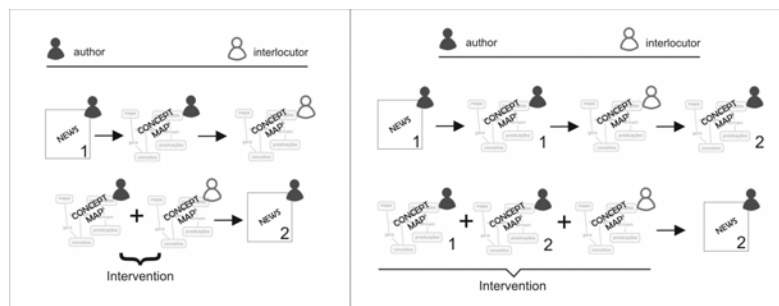

Figure 1: Stages of the intervention method

In the first stage of the implementation of the method, each student, after writing the first version of the news, created a concept map on his/her own text. After creating the map, without intervention, the student could review the text if considered it necessary. Another student was also asked to develop a concept map on his/her colleague's first version of the text. Finally, the intervention was performed in order to lead the student in writing a new version of the news to be published. This first stage of the method was applied with 16 fourth grade Elementary School students (9 to 11 years old), entitled, for the purposes of this paper, group 1. After carrying out the procedures described for group 1, the possibility of improvement of the method based on the inclusion of a second version of the concept map by the author himself/herself was observed. This second stage of implementation of the method was applied with six fourth grade Elementary School students (9 to 11 years old), entitled, in this paper, group 2.

Students' conceptualization of written language was assessed by considering both structural and semantic levels of the productions, focusing the construction of enunciations (BAKHTIN, 1997, 2003; KOCH, 2007; MARCUSCHI, 2008). Concerning the structural aspect, there was the aim of observing the development of cohesion and connections responsible for cotextuality, namely, the consistency of the relations that are internal to the text. Regarding the semantic analysis, the investigation had the aim of assessing the development oriented towards the enunciations meanings, focusing on the effort of children when operating with connections between meanings and communication context.

Based on the first findings of impacts of the production of concept maps on linear texts (as a previous step of the investigation – figure 4, section 4), it was possible to establish levels of written language development as well as a semantic and a topological taxonomy for concept maps in order to obtain a matrix of analysis that would allow both the investigation of data concerning each form of representation (linear texts and concept maps) and the triangulation of data originated from the comparison on them. The establishment of levels of changes related to structural and semantic aspects had its emphasis on textual continuity and on the implications on communicability and reading comprehension. They are shown in figure 2:

LEVELS OF STRUCTURAL AND/OR SEMANTIC MODIFICATION OF LINEAR TEXTS

- **Level 1** – Despite the existence of inconsistencies related to coherence or cohesion, the text is not revised or improved.

- **Level 2** – There are structural and/or semantic changes, in spite of remaining some gaps concerning coherence or cohesion (the revision would be necessary for a better communicability of the text).

- **Level 3** – There are structural and/or semantic changes with improvement of connections and meaning, in spite of remaining some gaps concerning coherence or cohesion (their maintenance doesn't have reflections on interpretability).

- **Level 4** – The revision of the text, concerning structural and/or semantic aspects, reveals new ways of referencing and textual organization, new argumentation operations (increasing cohesion), as well as improvement of connections among discursive topics (increasing coherence).

- **Level 5** – Adjustments of secondary importance concerning coherence and cohesion take place, what is justified by the high level of the alignment between semantic content and expressive element. Texts which dispense changes due to their high level of interpretability and communicability are also included in this category.

Figure 2: Levels of structural and/or semantic modification of linear texts

For the analysis focused on the structural construction of concept maps, the topological taxonomy developed by Cañas et al. (2006) and Miller (2008), widely used and validated by *Conéctate al Conocimiento Project* (Miller, 2008), was applied. The semantic taxonomy for concept maps was created with the support of Genetic Epistemology (Piaget, 1976). Beyond the understanding of the structure of concepts and propositions, the performance of interactions of type 1 (concerning exclusively the direct observables, accessible from the first experience of the subjects) and of interactions of type 2 (which also imply inferential coordinations) was considered. The levels of the topological and semantic taxonomies for concept maps are shown in figure 3:

TOPOLOGICAL TAXONOMY FOR CONCEPT MAPS
(CAÑAS et al., 2006; MILLER, 2008)

- **Level 0**: (a) texts predominate over concepts; (b) no linking phrases; (c) linear structure (0-1 ramification points).

- **Level 1**: (a) concepts predominate over texts; (b) half or more linking phrases are missing; (c) linear structure (0-1 ramification points).

- **Level 2**: (a) concepts predominate over texts; (b) fewer than half of linking phrases are missing; (c) low ramification (2 ramification points).

- **Level 3**: (a) no texts; (b) not missing linking phrases; (c) intermediate ramification (3-4 ramification points); (d) fewer than 3 hierarchy levels.

- **Level 4**: (a) no texts; (b) not missing linking phrases; (c) high ramification (5-6 ramification points); (d) 3 or more hierarchy levels.

- **Level 5**: (a) no texts; (b) not missing linking phrases; (c) high ramification (5-6 ramification points); (d) 3 or more hierarchy levels; (e) 1-2 cross links.

- **Level 6**: (a) no texts; (b) not missing linking phrases; (c) very high ramification (7 or more ramification points); (d) 3 or more hierarchy levels; (e) more than 2 cross links.

SEMANTIC TAXONOMY FOR CONCEPT MAPS

- **Level 1**: the concept map denotes lack of understanding of the structure of concepts and propositions, and its elements don't show unit of meaning.

- **Level 2**: the concept map denotes lack of understanding of the structure of concepts and propositions, but its elements show unit of meaning.

- **Level 3**: some propositions are produced, in spite of the reduced number when compared to connections that do not generate sentences. The unit of meaning is kept.

- **Level 4**: the concept map indicates recognition of the structure of concepts and propositions in most connections, but direct observables prevail in the connections made.

- **Level 5**: the concept map indicates recognition of the structure of concepts and propositions in most connections, as well as the production of inferential coordinations.

Figure 3: Topological and semantic taxonomies for concept maps

In the next section, the results obtained with the implementation of the method are presented.

4   Results

The first step of the work consisted in investigating the presence or absence of impacts of the production of concept maps on the linear texts, as well as, if and when existing, their results on the text composition in order to implicate effective review or, on the other hand, slight changes with few reflections on its initial structure. The impacts under consideration covered the transposition, the analysis or the referencing of elements contained by the concept maps that didn't appear on the first text and were shown on the second version, as well as the adjustments derived from the consciousness-raising situations triggered or facilitated by the production of concept maps and the performance of interventions. The results are presented in figure 4.
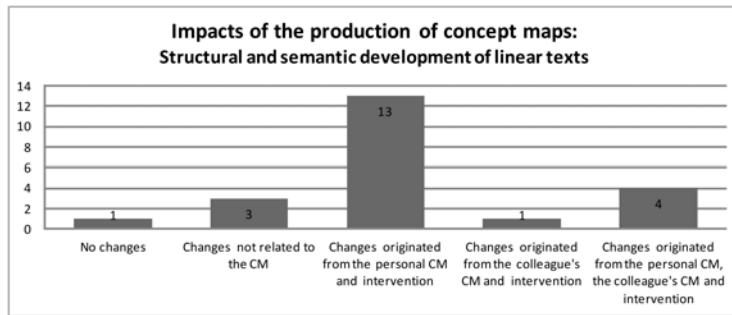
Figure 4: Impacts of the production of concept maps on linear texts

Of the total of 22 productions of students from groups 1 and 2, 18 have shown impacts from the construction of concept maps in the context of the news production network followed by the intervention. The largest portion of these productions – 13 of them – has presented impacts from the construction of concept maps on personal texts. Four of them have presented impacts derived both from the personal and the colleague's production. Only one production has shown exclusively impacts from the construction of the concept map by a colleague. The graph in figure 5 displays the frequency of levels of changes in linear texts, including both semantic and structural aspects.
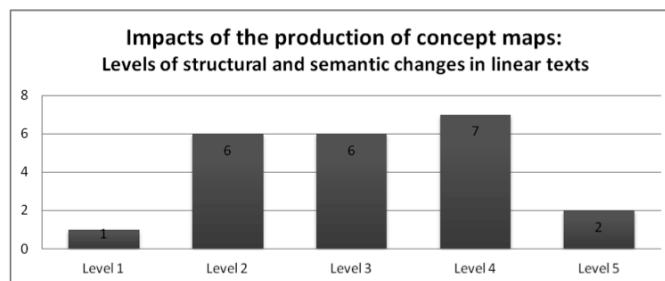
Figure 5: Levels of structural and semantic changes in linear texts

Only one student has shown, after the procedures and the interview, a production of level 1, in which we can observe the absence of review of inconsistencies related to coherence and cohesion, which would be necessary to obtain a higher text interpretability level. Six students have shown changes of level 2 and 3 in their productions, denoting concern about increasing quality of structure and semantic aspects through the procedure of review. Most of productions have shown changes of level 4: seven of the 22 students in groups 1 and 2. In these ones, there was a review procedure with improvement of interpretability based on adjustments in cotextual and contextual elements, such as the operation with new ways of referencing, textual organization and a better alignment of discursive topics. Also, two students have shown productions of level 5, although in these ones the maintenance of textual quality was observed (they have revealed a high level of coherence and cohesion since the first version of the text). In figures 6 and 7, an example of a production and the changes made by a student in group 2 is presented:

Figure 6: Example of a production and the changes made on linear texts – Student A
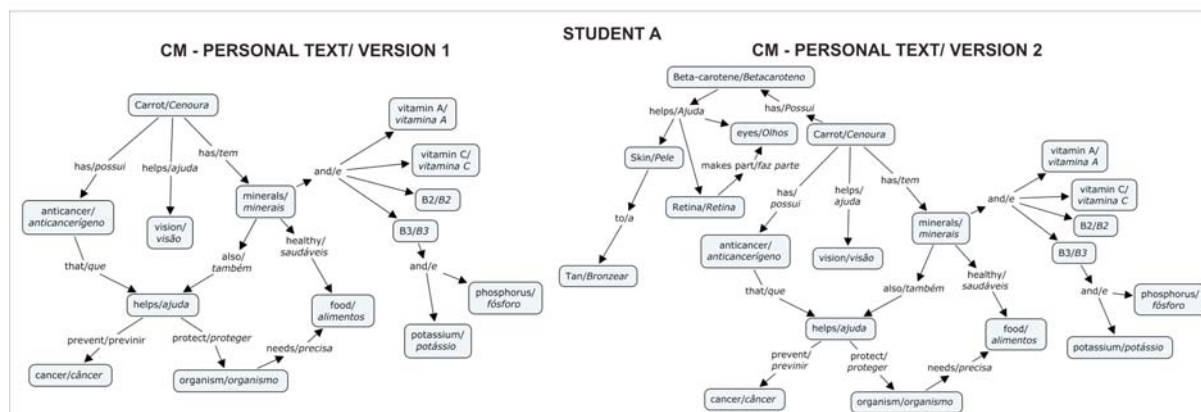
Figure 7: Example of a production and the changes made on concept maps – Student A

Student A has shown, both in the first and in the second version of the concept map, topological taxonomy of level 5. The second version was very close to level 6, not achieved only because of the number of ramifications (less than seven). Regarding the semantic level, there was an increase from 4 to 5 from the first to the second version. The concept map, since the first version, denoted unit of meaning and understanding of the structure of propositions. The student provided, in her productions, indicators of the extent of structural and semantic complexity, which impacted the textual production through the performance of inferential coordinations and the adding of new and important information, mainly in relation to Beta-carotene substance and its consequences for immunity and protection of the body, reflecting the achievement of level 4.

The graphs of figures 8 and 9 show the frequency of levels concerning topological and semantic taxonomies of concept maps on personal productions.
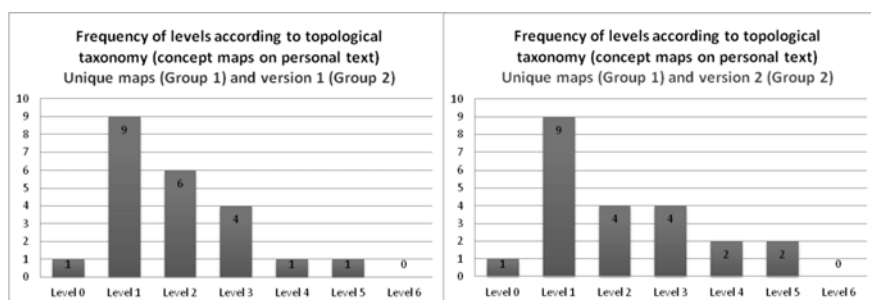

Figure 8: Frequency of levels according to topological taxonomy (concept maps on personal text)
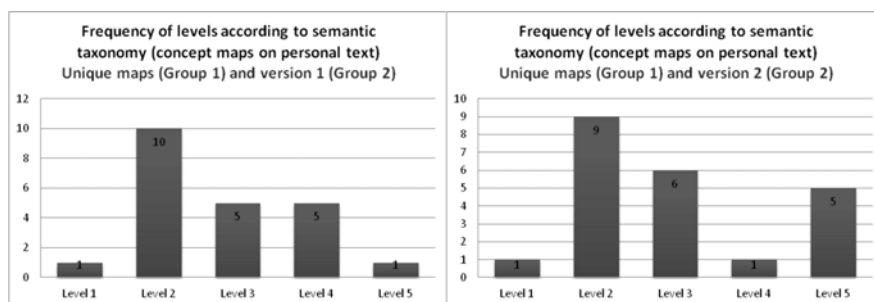

Figure 9: Frequency of levels according to semantic taxonomy (concept maps on personal text)

If the levels are considered individually, it is possible to observe the predominance of students – nine in all – in level 1 of topological taxonomy, which requires understanding, even if it is partial, of the structure of a concept map, since words or short expressions are used in the nodes instead of long texts, and linking phrases are also present. Only one of the students has shown misunderstanding of the basic topological structure of the concept map. The first concept maps (considering the first version of productions of group 2) have shown that more than half of the students – twelve of 22 – revealed in their productions level 2 or above, including linking phrases in more than half of the arcs and ramification points from concepts or linking phrases. Considering the second version of group 2, there was even a more homogeneous distribution of students among levels 2 and 5 – four students in levels 2 and 3 and two students in levels 4 and 5, respectively –, indicating a higher frequency of

ramifications and hierarchy levels, the possibility of the occurrence of cross-links, and, from level 3 on, the absence of blanks related to linking phrases. None of the students has shown a topological taxonomy of level 6.

Considering the semantic aspect of the productions, similar results were observed. A high concentration of level 2 productions was performed, and half of the productions, considering both version 1 and version 2 of productions of group 2, have shown semantic level 3 or higher, denoting the skill of building propositions in at least part of the connections established and keeping the unit of meaning. From version 1 to version 2 of the concept maps of group 2, there was also progress in relation to the construction of inferential coordinations, showed in the transition of four productions from level 4 to level 5. In these ones, it was possible to observe, besides the recognition of the structure of concepts and propositions in most connections, the replacement of part of the direct observables by the performance of deductions on implicit issues. Once more, only one of the students has shown, in addition to misunderstanding the structure of concepts and propositions, lack of unit of meaning in his production.

Important consciousness-raising situations have been observed during the implementation of the method, despite some of them have not had immediate reflections on the structure of the concept map. The example shown in figures 10 and 11, with regard to the production of Student B (group 2), illustrates it:
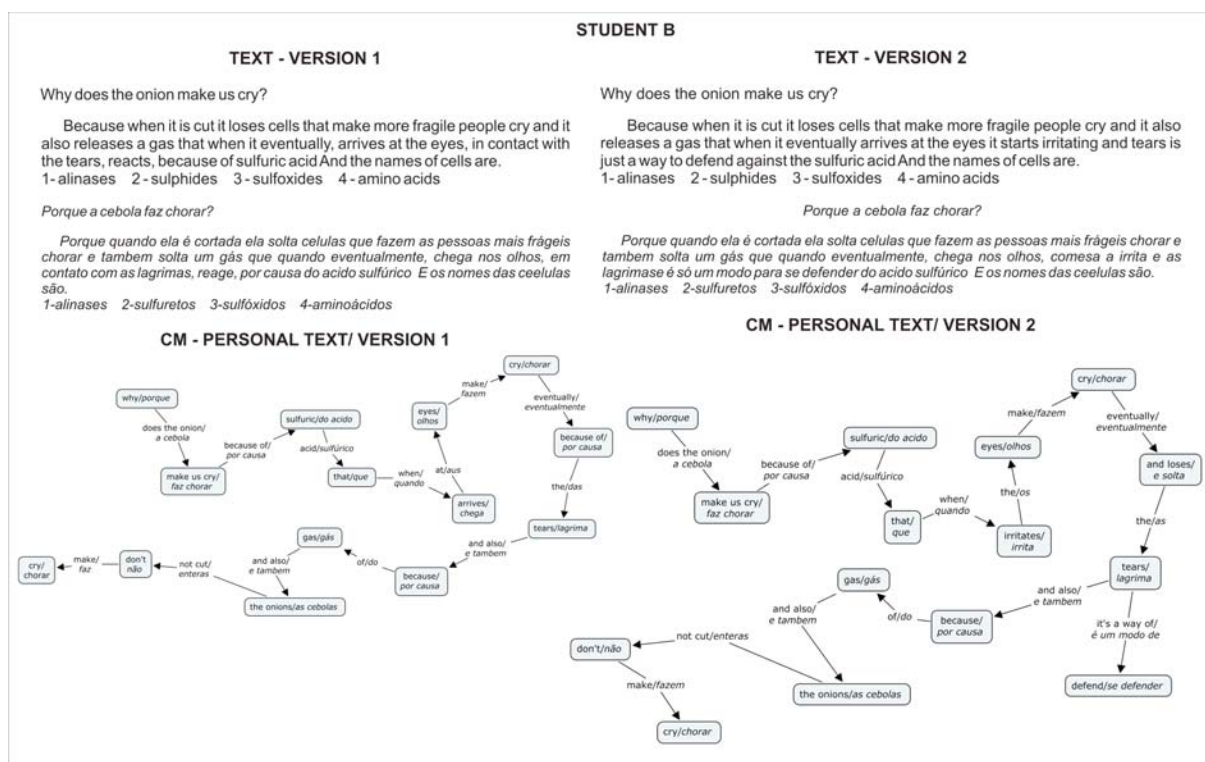

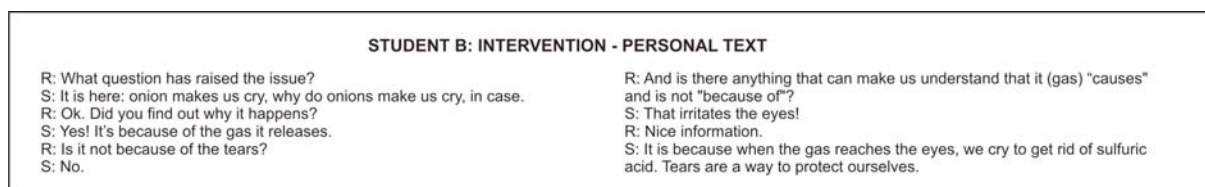**Figure 10:** Example of a production and the changes made – Student B

Figure 11: Intervention on personal text – Student B

Student B had the aim, in his research, of answering the question "Why do onions make us cry?". His production has denoted comprehension of the theme, although there was an inconsistency related to the information available: in the first version of the text, as well as in the first concept map, the student declared that the sulfuric acid, when in contact with tears, would cause cry. During the intervention, though, he demonstrated understanding that tears would be the reaction to the sulfuric acid, produced by the onion. After the intervention, the student became aware of the need to explicit the relation of cause and effect. Such conduct was also reflected on the topological structure of the second version of the concept map, which started showing

ramifications, becoming close to achieve level 2. In semantic taxonomy, the student has shown improvement from level 2 to 3. His text has also denoted level 3 of changes.

When analyzing the production of concept maps on the colleagues' texts, there was a predominance of slightly lower levels if compared to those resulting from the production on personal texts. In topological taxonomy, 12 of the 22 productions have shown level 1, and levels 4 and 5 were attributed to only one student each. Four students have had productions of level 2 and three students, productions of level 3. One student has denoted a production of level 0. Regarding semantic taxonomy, there were predominantly students at level 2 (11 students compared to 9 when considering productions on personal texts), one student else in level 1 and a more homogeneous distribution among levels 3 and 5 (two, four and three students, respectively). Despite the reduction of levels in the process of interlocution based on concept maps, it was possible to observe a construction effort that, at times, showed to be similar to the effort made to elaborate a second version of the concept map on the personal text. Such conduct is illustrated in figure 12.
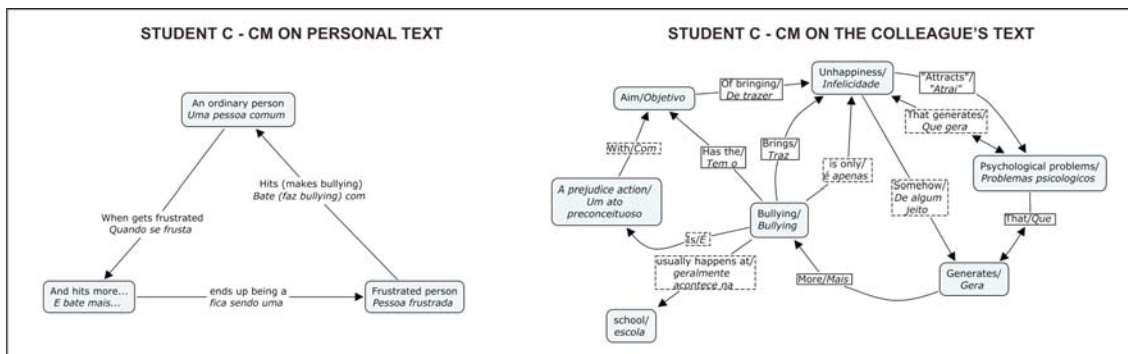

Figure 12: Example of productions of concept maps – Student C

The example refers to the production of Student C (group 1): concept maps on the personal text and on the colleague's text, respectively. The first production has shown topological level 1 and semantic level 3. The production on the colleague's text, in its turn, has denoted level 4 in topological taxonomy and level 5 in semantic taxonomy. One of the probable reasons for the development observed was the work on a common theme: both students – Student C and his colleague, author of the text he has represented as a concept map – have developed their researches based on the question "Why does Bullying happen?". The process of interlocution turned out being an opportunity to improve understanding related both to the topic studied and to the structure of the concept map.

Finally, in the analysis of levels of individual development, it was possible to observe the proximity of the results when comparing the different taxonomies implemented (for this analysis, levels 5 and 6 of topological taxonomy for concept maps were considered compatible with level 5 of semantic taxonomy for concept maps and textual taxonomy). Comparing the textual and the semantic taxonomy for concept maps, 19 of the 22 students from groups 1 and 2 have shown up to one level differences in their productions. Only three of the students have shown differences of two levels in the productions investigated. When comparing the textual taxonomy and the topological taxonomy for concept maps, 15 productions have shown up to one level differences, and five productions, two levels. One student has revealed a difference of three levels, and another student, four levels of difference. Lastly, in the comparison between the semantic and the topological taxonomy for concept maps, 16 students have shown differences up to one level in their productions, and six students, differences of two levels. As well as in the analysis related to the production of concept maps on the personal texts, similar results were observed when comparing the different taxonomies applied to the production of concept maps on the colleagues' texts.

5   Conclusions

The results point to a reciprocal development when considering levels related to the linear writing and the construction of concept maps, driven by the cycles of thought. When the conceptualization process is extended from the conventional written language to the connections in the concept map, new abstractions take place, which may be still empirical, if centered in direct observables, as well as reflective, with the construction of inferential coordinations. Both have shown the improvement of the unit of meaning in the productions investigated, which is reflected in the rewriting of the text.

The encouragement of the procedure of revision, carried out by the large majority of students in groups 1 and 2, shows the possibility of application of the method described for the age group considered. A systematic review effort was observed, mostly with reflections on cohesion and coherence elements, and consequent impacts on the semantic and structural aspects of the productions. Such reflections were mainly found in the productions about personal texts. Regarding the production of concept maps on the colleagues' texts, the method has not shown the same impacts. It was also observed the importance of the opportunity of constructing a second version of the concept map on the personal text: from the first to the second version of productions on personal texts of group 2, progress was identified in relation to the recognition of the structure of concepts and propositions in most connections, as well as the performance of inferential coordinations and improvement of linear writing.

Finally, it is pointed the relevance of performing an integrated approach, including interventions based on the students' productions and on a rich context for exploration. The news production network has allowed the raising of questions of learners' interest, as well as the socialization of discoveries with real audiences (instead of only with a teacher). So that, the construction of concept maps, the interlocution based on them and the interventions focused on semantic and structural aspects of texts have provided the background for assessing and encouraging conceptualization processes on written language.

5 References

Bakhtin, M. (2003). *Estética da criação verbal*. São Paulo: Martins Fontes.

_____. (1997). *Marxismo e filosofia da linguagem*. São Paulo: Hucitec.

Cañas, A. J. Novak, J. D., Miller, N. L., Collado, C., Rodríguez, M., Concepción, M., et al. (2006). *Confiabilidad de una taxonomía topológica para mapas conceptuales*. In A. J. Cañas & J. D. Novak (Eds.), *Concept Maps: Theory, Methodology, Technology. Proceedings of the Second International Conference on Concept Mapping*. San José, Costa Rica: Universidad de Costa Rica.

Fagundes, L. C., Maçada, D. & Sato, L. (1999). *Aprendizes do futuro*: as inovações começaram. Coleção Informática para a Mudança na Educação. Brasília: SEED, MEC, PROINFO.

IBGE. (2010). *Síntese de Indicadores Sociais*. Uma análise das condições de vida da população brasileira. Available in: <http://www.ibge.gov.br/home/default.php>.

INEP. Instituto Nacional de Estudos e Pesquisas Educacionais Anísio Teixeira. (2009). *SAEB – Sistema de Avaliação da Educação Básica*. Available in: <http://www.inep.gov.br/basica/saeb/default.asp>.

Koch, I. V. (2007). *A inter-ação pela linguagem*. São Paulo: Contexto.

Marcuschi, L. A. (2008). *Produção textual, análise de gêneros e compreensão*. São Paulo: Parábola Editorial.

Miller, N. L. (2008). *An exploration of computer-mediated skill acquisition in concept mapping by in-service Panamanian public elementary school teachers*. Doctoral Program on the Information and Knowledge Society, Universitat Oberta de Catalunya.

OECD. *PISA 2009 at a Glance*. (2010). OECD Publishing. Available in: <http://www.oecd.org/dataoecd/31/28/46660259.pdf>.

Parâmetros Curriculares Nacionais – PCNs. (1997). *Língua Portuguesa: Ensino de primeira a quarta série*. Brasília: Secretaria de Educação Fundamental.

Piaget, J. (1976). *A equilibração das estruturas cognitivas*: problema central do desenvolvimento. Rio de Janeiro: Zahar Editores.

_____. (2005). *A representação do mundo na criança*. São Paulo: Idéias e Letras.

Portal IDEB – *Índice de Desenvolvimento da Educação Básica*. (2009). Available in: <http://portalideb.inep.gov.br/>.

Programa UCA – *Um Computador por Aluno*. (2010). Available in: <http://www.uca.gov.br/institucional/projeto.jsp>.

[i] LEC/UFRGS was responsible for guiding the pre-pilot experience of PROUCA program in Rio Grande do Sul State and, in the second phase of the project trial, is one of the coordinating centers of formation of teachers.

[ii] The hypothetical-deductive method presented by the author aims the free expression of the subject so as to encourage him to communicate basic aspects of his thought, in order to investigate processes of reasoning underlying the responses, reactions caused by questions, perturbations and regulatory activities.