

CONCEPT MAPS: A TOOL TO IMPROVE READING COMPREHENSION SKILLS OF CHILDREN WITH HEARING IMPAIRMENTS

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Abstract. Children with hearing loss who are inserted into the regular Panamanian School System tend to have academic difficulties, often due to low reading comprehension levels. Concept maps may be able to support hearing-impaired children to achieve better reading comprehension skills, by providing a means to improve their reading vocabulary, as well as helping them follow sequences of ideas present in ordinary texts. The structure of concept maps may facilitate reading comprehension because sequences of ideas, and relationships among them, are presented in a graphic format more accessible to deaf students. Since concepts are not repeated in concept maps, children with hearing loss become less confused than with ordinary texts, in which anaphoric expressions are commonly used. In this first exploratory study, comprehension of an ordinary reading passage was compared with comprehension of its transcription to a concept map format, both with and without illustrations. Results suggest that the concept map format leads to a greater understanding of the reading passage, as evidenced by the answers to questions posed by the researchers, as well as the questions posed by the subjects themselves, and their comments about the topic. The concept map format also awakened and maintained the deaf students' interest more so than the ordinary text format.

1 Introduction

In Panama, issues concerning the disabled have become a priority for the Government. Proof of this are public policies being put into practice focused on the well-being of children with special needs, and aimed at helping them achieve their full potential in today's world. In 1999, Panama's National Assembly, the country's legislative body, approved Law 42, a law affording equal opportunities to persons with disabilities. This law was subsequently regulated through Executive Decree 88 of 2002. In 2004, the government created the National Bureau for the Integration of Persons with Disabilities,¹ and in 2007 the First Disabilities Survey was conducted, with the support of the Office of the First Lady. This survey revealed an 11.3% prevalence of disabilities in the Republic of Panama, equivalent to approximately 370,000 Panamanians.

One of the main aspects promoted by Law 42 is *inclusive education*, that is, the inclusion of children and adolescents with disabilities within the regular educational system. The principle of inclusive education received international recognition and support during the World Conference on Special Needs Education, held in Salamanca, Spain, in 1994, and sponsored by UNESCO and Spain's Ministry of Education and Science. The shift away from special education obeyed, on the one hand, to criticism regarding the effectiveness of this type of education, and on the other, to a worldwide trend towards the establishment of human rights and the adoption of equal opportunity policies.

At the beginning of the 2006 school year, of the 2910 public elementary schools in the country (Departamento de Estadística del Ministerio de Educación, 2005), 175 had joined the National Plan for Inclusive Education (Ministerio de la Presidencia, 2006), integrating a total of 10,692 students with disabilities. Clearly, much more needs to be done here in Panama in terms of bringing schools to integrate children with disabilities into the regular education system. However, the situation in Latin America is not much better. Reports indicate that children with disabilities tend to be excluded from most countries' regular educational systems. In Colombia, for instance, only 0.32% of students at regular schools are children with some disability; one finds similar statistics in Argentina (0.69%) and Mexico (0.52%), while Uruguay and Nicaragua appear to have slightly higher percentages, 2.76% and 3.5%, respectively.²

Presently in Panama, people speak about "inclusion" when in actuality they mean "insertion." Insertion differs from inclusion in that disabled children are immersed in a regular school, without previous adequate preparation of teachers, family, classmates, or the disabled children themselves.

This study is circumscribed to one specific type of disability, namely, hearing-impairment. Hearing impairment is characterized by a partial or total deficit in the ability to perceive sound, which affects the person's communication in a fundamental way. Hearing-impaired children may develop different communication styles depending, among other things, on 1) the moment at which the hearing loss occurred, and 2) the type of rehabilitation process used.

¹ Known by its Spanish acronym SENADIS, *Secretaría Nacional para la Integración de las Personas con Discapacidad*.

² Source: www.risolidaria.org.pe

Among the 10,692 student with disabilities included in the regular school system, there are 767 with hearing loss. One problem that often arises when hearing-impaired children are included in the regular educational system is that they are classified according to the degree or severity of hearing loss, not by the competencies these children can potentially develop. Children may be passed from one grade to another based on their age, not on the abilities they have developed. This leads to a situation of low academic performance for hearing-impaired, particularly with regard to reading, writing, and general communication skills.

Paul (1996) summarizes much of what is known about reading vocabulary knowledge and reading achievement level for deaf³ students. Research has shown that there exists a very strong connection between reading vocabulary knowledge and reading comprehension ability, though the exact nature of, or mechanism for, this relationship is still being debated. It is known, on the one hand, that good readers have large vocabularies. On the other hand, reading comprehension in children with hearing loss tends to be poor, owing among other language variables, to their limited vocabulary knowledge. Paul concludes that vocabulary instruction is necessary in order to help students with hearing loss to become independent word learners. However, he also points out that vocabulary instruction techniques such as the *definition-sentence approach*, which consists of looking up and/or writing down word definitions, along with using words in short sentences, are limited. This type of instruction leads to only partial word knowledge, which is often inadequate for discerning meanings, particularly in situations in which for alternative, figurative, or metaphorical meanings are involved. Thus, he recommends the *knowledge model* of instruction, a method that “promote[s] an in-depth knowledge of words” through “semantic maps... and other semantic elaboration techniques.”

The above gives reason to believe that concept maps (Novak & Cañas, 2008) can be helpful in improving reading comprehension among children with hearing impairments, as well as hearing poor readers. In addition to the problem of a diminished vocabulary base, hearing-impaired children have difficulty in keeping track of sequences of ideas as they appear in ordinary texts. The structure of concept maps facilitates their comprehension since sequences of ideas are made evident. The fact that in a concept maps concepts are not repeated (no two concept nodes are identically labeled), children with hearing loss become less confused than with ordinary texts, where anaphoric expressions (references to linguistic elements previously mentioned) are used. Furthermore, the ease to search for and include images in concept boxes offered by programs such as CmapTools (Cañas *et al.*, 2004) helps children with hearing disabilities to form mental images of concepts and visualize relationships. Sequences of ideas can thus be followed more easily and, we suspect, comprehension should improve.

To the best of our knowledge, no studies have been conducted in our country, Panama, that evaluate reading comprehension skills in deaf children or that explore the ways in which to improve these skills. The objective of this study is contribute to improve the quality of the education offered to children and adolescents with hearing loss, by improving these children’s reading skills and their ability to learn meaningfully through the use of computer-mediated concept mapping tools. In so doing, we will propose new pedagogical techniques for working with concept maps with hearing-impaired students and for acquiring skill in using the computer program CmapTools, version 4.15.

2 Methodology

In this study we began to explore the effectiveness of concept maps as a tool to foster better reading comprehension skills. Given its exploratory nature, the study involved only one deaf child, a 13-year-old girl with profound hearing loss,⁴ identified in what follows as S1. The subject at present uses no assistive hearing technology, though she did use a hearing aid up until 3 years ago.⁵ She has significant communication difficulties, probably due to a rehabilitation program that included a hodgepodge of different communication techniques. As a result, S1 knows some sign language and has some ability to read lips, but is not fluent in the former, nor completely proficient in the latter. Consequently, getting ideas across to her often poses a great challenge. S1 graduated last December from 6th grade.

³ “Deaf” students are those with *severe* to *profound* hearing disabilities (Paul, 1996)

⁴ Profound hearing loss corresponds to losses of 90 dB or greater. The person is unable to hear sounds such as the noise made by an airplane during takeoff.

⁵ We suspect the reason she is not using it at the moment is related to her having entered adolescence, and thus being more sensitive about her looks.

The study was conducted by three facilitators of Panama's Conéctate al Conocimiento Project (Tarté, 2006) one of whom is a special education teacher, specialized in hearing and language. She knows both sign language and lip reading.

In addition to S1, two other children (S2 and S3), both with normal hearing, participated in the study. S2 is an 11-year-old girl, presently in 5th grade; she is a very good student. S3 is a 12-year-old boy, enrolled in 6th grade; he is an average student. The purpose of including these two hearing children was to have a point of reference against which to compare and interpret our results with the deaf subject. All three children attended schools incorporated to Panama's Conéctate al Conocimiento Project and thus were somewhat familiar with concept maps.

The study was divided into two stages described below.

2.1 STAGE 1: *Approaching concept maps*

The first part involved the researchers working with S1, the hearing-impaired student, in order to ascertain her degree of familiarity with and understanding of concept maps. This initial phase required two work sessions with the subject. The subject was asked to construct a concept map responding to the focus question "Who am I?" During the construction process one of the researchers, using the chat window available in the synchronous collaboration mode, asked the subject amplification questions to help broaden and deepen her map.

2.2 STAGE 2: *Reading comprehension of text versus transcription to concept map*

This stage included the actual research problem, namely, the comparison of reading comprehension of texts presented in the traditional format versus their transcription to a concept map, for hearing-impaired. By "transcription" we mean any concept map whose information content, proposition by proposition, is equivalent to that of the original text.

The deaf subject's reading comprehension was derived from her reactions to and comments about the reading material. A combination of indifference to the material (e.g., expressionless face, looking away from the screen, fidgeting, playing with styles palette), with no comments to researchers were interpreted as "no comprehension." On the contrary, interest in the material (e.g., curious expression, attention focused on the screen, following the reading with the mouse pointer), along with questions or comments made to the researcher about the material, were interpreted as "comprehension."⁶

Due to the fact that hearing-impaired students generally require more explanation time in order to understand correctly a given instruction, and in order not to bias the study as a result, the researchers had an additional work session with S1 during which she was introduced to the study's methodology.

S1 was presented with a short reading passage on the topic of "Vacation time," given time to read it, and then asked questions about it to test her comprehension. This text was presented as a Word document on a computer. Subsequently, S1 was given a concept map rendition of this text, given time to read it, and asked questions about it.

For the actual study, all three children were first provided with a brief reading passage on the subject of "Adolescence." The text (appendix A), an adaptation of Wikipedia's definition for *adolescence*, was given in printed form. The text contained a total of 87 words, 179 syllables, 4 main ideas, 15 key concepts, and 1 illustration (not shown). Afterwards, the subjects were presented on a computer screen with two transcriptions of the reading to concept map format: the first one included no illustrations (appendix B), while the second one included 9 illustrated concepts (appendix C). Subjects were given as much time as they needed to complete the readings. They were asked to indicate unfamiliar concepts after each reading.

3 Results

The results of the first part of the study showed that S1 was indeed familiar with concept maps. With help, she was able to incorporate into her Cmap as propositions concepts that arose through questions posed by the

⁶ We realize these reactions need not indicate a full comprehension, for they could also indicate puzzlement or only a partial understanding; however, given the communication difficulties of this particular subject it was difficult to make this kind of distinction.

researchers, questions such as: Where do you live? Where do you study? What do you like to eat? Where have you traveled to? What do you want to be when you grow up? What is your family like?

Having ascertained that neither concept maps nor computers were an obstacle for S1, and having gained her trust and cooperation, we moved on to the second stage of our study.

3.1 Comparison between traditional text format and concept map format

As explained above, during the second phase, subjects were to read a passage on adolescence presented first in text format. However, a preliminary practice session was conducted with the hearing-impaired student in order to make sure she had a full understanding of the instructions and the procedures. During this session, we noticed that S1 often became distracted from the reading task, as evidenced by 1) spending time altering style options of the Word document, such as font size, and highlighting the text in various colors; and 2) frequently looking away from the screen to observe her roundabouts. When she was done, she asked no questions, and made no comments about the text to the researchers.

When the same topic was presented in a concept map with no images, S1 demonstrated a certain amount of interest in understanding the map's content by pointing at concept nodes. Later, when presented with the illustrated concept map, she not only showed interest, but actually began to add to the map based on her vacation own experience. Confident that she was clear about what was to take place, we proceeded to present the adolescence text to all three subjects.

S2 and S3 took approximately 10 minutes to read the passage in text format, while S1 required 20 minutes. Table 1 (below) shows the concepts understood by each of the subjects after reading the passage first in text format, then in non-illustrated Cmap format, and finally, in illustrated Cmap format.

As the table makes plain, S1's recognition of concepts in the reading passage was quite poor. She made no comments about the passage, and when asked whether she had any questions, she pointed to key concepts like "adolescent" and "mind" and indicated she was not familiar with those words. When asked specific questions about the passage⁷ (table 2), she was unable to provide concrete answers: she would reread the text, searching for the answers, or would look away into the distance.

S2 and S3, on the contrary, were familiar with most of the concepts in the passage, 12 and 9, respectively. Moreover, the hearing students understood 3 of the 4 main ideas contained in the text.

Turning to the transcription of the reading passage to the non-illustrated Cmap format of the, S1 required 10 minutes to read it. As before, she displayed little interest in the reading, asked no questions, and did not appear to relate the subject matter of the Cmap to that of the text previously read in the traditional format.

When the illustrated version was given to her, however, her attention was aroused. She focused intently on the screen, followed the connecting lines between concepts with the mouse pointer, and asked questions about the images she observed in the concept nodes. Interestingly, as she read from the map she focused more on the concepts than on the linking phrase, which she just passed over. She was particularly interested in the images associated to the concepts of "mind" and "changes in body weight and size," pointing out to the researchers that this has not yet happened to her or would not happen to her. She also pointed, with certain embarrassment, to the figure representing biological changes, questioning the researchers about it. In the end, S1 was able to understand 4 concepts through the illustrated concept map, for a total of 5.

As for the hearing students, after reading the non-illustrated Cmap S2 understood 2 of the 3 concepts she did not comprehend after reading the text; the illustrated map contributed no further understanding though. S3, for his part, was able to understand 4 additional concepts (of 6) after reading the non-illustrated Cmap; as with S2, the illustrated map made no further difference.

S3 noticed and commented that the Cmaps contained same information as the original printed text. Neither of the other two subjects gave any indication that they were aware of this connection.

⁷ The 4 questions posed by the researchers referred to the 4 main ideas contained in the passage.

Comprehension of concepts from the reading passage “Adolescence”	Comprehension after reading text (regular format)			Comprehension after reading Cmap without images			Comprehension after reading Cmap with images		
	S1	S2	S3	S1	S2	S3	S1	S2	S3
Adolescence		✓	✓		✓	✓		✓	✓
Development stage		✓			✓	✓		✓	✓
Childhood	✓	✓	✓	✓	✓	✓	✓	✓	✓
Adulthood		✓	✓		✓	✓	✓	✓	✓
Grow		✓	✓		✓	✓	✓	✓	✓
Biological change		✓			✓	✓		✓	✓
Mind		✓	✓		✓	✓	✓	✓	✓
Social life			✓		✓	✓		✓	✓
Intellectual maturity		✓			✓			✓	
Sexuality		✓			✓	✓		✓	✓
Weight increase		✓	✓		✓	✓	✓	✓	✓
Size increase		✓	✓		✓	✓		✓	✓
Hormonal secretions									
Environment		✓	✓		✓	✓		✓	✓
Latin					✓	✓		✓	✓
Total	1	12	9	1	14	13	5	14	13

Table 1. Comprehension of concepts after reading the passage in 1) traditional format, 2) non-illustrated concept map format, and 3) illustrated Cmap format. Shaded concepts are those represented by images in illustrated version of the Cmap.

QUESTIONS	Subjects’ answers after reading from text		
	S1	S2	S3
<i>What does “adolescence” mean to you?</i>	No concrete answer.	It’s a development stage, when one is growing and changing the way one is. One becomes an adult after a certain age. At 30 years, approximately. Biological changes cause changes in the way one acts and talks. These are changes in our weight and size, as the reading says. Mental maturity: one matures since one is a child.	It’s when a child becomes an adult.
<i>What changes do you think take place during adolescence?</i>	No concrete answer.	From adolescent to grown-up.	You grow and your size changes.
<i>When do you think adolescence ends?</i>	No concrete answer.	It ends when you finish your studies (school). More or less around 28 or 29 years of age.	It ends when you become 18 years old. ⁸
<i>Do you think your adolescence has begun? Why?</i>	No concrete answer.	No. Because I am still a child. I have not changed certain physical and mental things, and things about school.	I don’t know. I’ve never stopped to think about that.

Table 2. Answers provided by subjects after reading the passage in text format.

⁸ In Panama, a person is legally considered an adult at 18 years of age.

4 Discussion

The results presented in the previous section suggest that illustrated concept maps, unlike non-illustrated ones, may provide a means to foster reading comprehension among deaf students, even (or perhaps particularly) those with very limited vocabulary and serious reading comprehension limitations.

When presented with the reading passage in ordinary text format, S1 recognized only 1 of a total of 15 concepts. Reading a transcription of this text to a non-illustrated Cmap format made no difference for this student. However, after reading the illustrated version of the same Cmap, she was able to comprehend 4 additional concepts. It is important to point out that all of these were among the illustrated concepts in the map, and all had clear, unequivocal pictorial representations.

Nonetheless, this still leaves four more illustrated concepts that S1 did not comprehend. We believe that this may have been the result of an inadequate choice of images. For instance, the concept “biological change” was represented by the nude body of an adolescent girl and boy. However, this image is static and does not imply a transformation. Another problem arose with the concept of “size increase,” which mistakenly was represented by the same image as “weight increase.”

These problems may be overcome in part by a proper choice of illustrations. However, using CmapTools it is also possible to include other forms of visual resources, such as videos, applets, Web pages, etc. In some cases, these might help clarify those ideas which a single snapshot may not be able to.

These difficulties notwithstanding, we consider that illustrated concept maps can be a useful tool to facilitate reading comprehension and content retention for children with hearing disabilities. One reason is that children with hearing loss have trouble following sequences of ideas in ordinary texts. The structure of concept maps, in which relationships are made explicit, can help overcome this difficulty. Moreover, the fact that concepts are not repeated in concept maps, avoids the confusion resulting from anaphoric expressions commonly used in ordinary text.

Based on S1’s positive reaction and involvement with the illustrated concept map, it would also seem that this format is in some sense more “inviting” to deaf students. Perhaps by its flexible, non-linear structure of overt relationships, these students are motivated to draw from their previous knowledge, contributing from to the reading from their own personal experiences.

With regard to the two hearing subjects, these too benefited from the transcription of the text to concept map format: 2 out of 3 for S2, and 4 out of 6 for S3. It must be pointed out, though, that one of the concepts neither S2 nor S3 understood from in the original text was “Latin.” In the concept map, this was transcribed as “Latin language,” which probably accounts for their subsequent understanding of it.

For them, however, the illustrations made no difference in terms of their comprehension of individual concepts or the entire passage. In fact, one of the students (S2) indicated that it was actually easier to read the non-illustrated concept map than the illustrated one. This may be related to the fact that they are older students, and may not be true of younger ones.

5 Conclusions

In summary, this study attempted to find out whether concept maps can promote greater reading comprehension skills, and thus, can contribute to improve the academic performance, and the personal and social development of students with hearing disabilities. The results of this exploratory study are encouraging. It appears the structure of concept maps, along with the visual props provided by illustrated concepts, may ultimately provide a richer context for hearing-impaired students to acquire and derive meanings from. Illustrated concept maps also awakened and maintained the deaf students’ interest more so than the ordinary text format. This would constitute a valuable side benefit for these children, who due to their condition, may easily become disengaged from a learning situation.

We plan to continue working with S1, helping her to improve her knowledge construction skill and her academic achievement through the use of concept maps. We also hope to continue research into the possible benefits concept mapping might have for hearing-impaired students.

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Appendix A: Reading passage on the topic of *adolescence* in ordinary text format.

Adolescence is a development stage that comprises the passage from childhood to adulthood. (Idea #1)

The Word comes from the Latin *adolescere* which means “to grow.” (Idea #2)

The transition that takes place is not only a biological change that includes changes in weight, size, and hormonal secretions, but extends also to the mind, social life, intellectual maturity, and sexuality.

(Idea #3)

This development of body and mind is related also to the environment. A good development is important to become a healthy adult. (Idea #4)

Source: Adaptation of definition of adolescence found in Wikipedia (<http://es.wikipedia.org/wiki/Adolescencia>).

Appendix B: Transcription of the text “Adolescence” to concept map format - non-illustrated version.



Appendix C: Transcription of the text “Adolescence” to concept map format – illustrated version.

