



Understanding Scientific Texts: From Structure to Process and General Culture

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In this study, the historical development of experimental research on learning processes from scientific texts has been introduced. Then a detailed analysis of the main contributions of cognitive science has been provided and the theoretical developments that are considered to have had a major role in the comprehension and understanding of scientific texts have been dwelled on. Our premise is to determine how development in understanding the basics of the comprehension of scientific text has been achieved and indicate the best way to continue research in the fields in which there has been less development. For this reason, types of theoretical developments required in order to make progress within the framework of learning processes from scientific texts have been included in this analysis. Thus, a contribution will be made in terms of better interpretation of the scientific texts used in environmental and science education.

Keywords: Scientific text, expository text, comprehension, environmental education

INTRODUCTION

It is believed that if learning purposes of students are supported with actual scientific experiments and activities, not only their abilities of individual communication will improve but also they will be included within the context of the knowledge developed for the problems in collective living through common inferences obtained from experimental research (Atkinson, 1999; Kelly & Green, 1998; Keys, 1999). Hence Goodwin (1995) argues that the structuring of knowledge should be conceived as more than a personal function and regards this process more like a social bond established with the material world. In a similar way, Kelly & Bazerman (2003) examined the ways in which students become involved in cognitive reasoning practices through organizing written discussion. In their study, they evaluated how university students connected general theoretical claims to particular data when they are developing evidence through the textual analysis of scientific articles and discussed the fact that the role of evidence has gained a central importance through this social bond established with the material world. According to them, philosophical, scientific, and linguistic interest in the relations between the

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concrete details of the visible world and general ideas goes back as early as Plato and Aristotle. They also think that forms of expression, discovery, and knowledge explain the disputed aspects of professions and teachings:

In this study, we are focusing on how research in science education can be brought together with research in science studies (such as philosophy, sociology, anthropology, and rhetoric in science) as well as academic and scientific writing in order to discuss developing evidence in student writing. Theoretically, we are making use of scientific practice studies, discussion analysis, applied linguistics, and rhetoric while discussing the various ways in which language and writing can be used to provide the students with opportunities in order for them to develop a bond with scientific knowledge and practices from a doctrinal point of view. Then we shift to the analysis of two student theses. This analysis considered the rhetorical moves of the students, epistemic level of their claims, and lexical harmony as the ways of use of evidence for convincing purposes. Finally, we are focusing on some related topics of discussion and presenting educational inferences (p. 29-30).

Britton & Black (1985), who believe that the importance of written text in the psychosocial evolution of human race cannot be overlooked, state that written text has been shaped as an extension of spoken language. For this reason, they argue that written texts become clear through the transfer of knowledge throughout generations and cultures and also enable the clustering of mental events that occurred across generations and cultures at different times and places.

The topics above also correspond to a considerable case in terms of their inclusion in socio-cognitive practices based on language skills within the educational environments of students (Pearson & Fielding, 1991; Britton, Glynn, Meyer & Penland, 1982; Meyer & Rice, 1984; Weaver & Kintsch, 1991; Hahn, Dullweber, Unglaub, & Spies, 2014; Hasni, & Potvin, 2015). The approaches within this framework reflect different edges of the evaluation and interact with many different theoretical perspectives from literacy as a social practice to literacy as a cognitive skill. For example, Gates, Duke & Martineau (2007) emphasize the importance of experience and getting within the context directly rather than open education and gradual education. Moreover, they state that also the properties of the relation between the form of style and purpose and content are included in this evaluation and suggest that research within this context to should be conducted in a way that admits the fact that linguistic form and content are inseparably and absolutely connected to each other. Again, in a similar fashion, Berman & Nir-sagiv (2007: 79-81) argue that narrative and expository scientific discussion as two separate forms of discourse are different in terms of both linguistic expression and basic organizational principles (scheme-based in narratives and category-based in explanations). Besides, in their mentioned study, they also investigate how school children and youth write narratives and expository texts that are analyzed as different styles, or in other words, that are defined by different communicative aims and functions and analyzed as types of discourse (Grimshaw, 2003, Paltridge, 1997 and Steen, quoted from 1999 by Berman & Nir-sagiv 2007: 79-81). According to this, narratives are agent oriented. In other words, people focus on their acts and reasons and transmit the development of events within a timewise framework (Berman & Slobin, 1994; Hickmann, 2003; Longacre, quoted from 1996 by Berman & Nir-sagiv 2007: 79-81). On the contrary, Berman & Nir-sagiv (2007: 79-81) argue that expository texts are subject oriented. According to them, expository texts focus on scientific concepts and problems. For this reason, the development of ideas, claims, and discussions is presented in these texts.

Gates et al., (2007), who point out that a variety of suggestions have been made within the literature regarding how teachers can configure the inclusion of reading-writing activities within the education provided in science courses, state that the common points in these suggestions are the facts that actual scientific reading and writing purposes should stem from actual scientific purposes and these should

include scientific experiences and activities. For example, McNamara, Kintsch, Songer & Kintsch (1996) conducted a series of experiments in order to examine the conceptual changes in the reader's mind that emerge as a result of reading a text and to reiterate the previous findings regarding the fact that making the text more coherent makes the text easier to be remembered. Their study presented considerably informative results. In order to be able to determine the structure of knowledge a student has prior to and after the reading of a biology text, they were interested in the task of classification in particular. This way, they were able to indicate that reading a text changed the way students organize concepts in a foreseeable way. In this sense, they reported that students make classifications based on their general knowledge prior to reading the text and they made classifications based on not only their own knowledge but also on the grounds of the memory of sequential text. The following example in a text that was used in their experiment can clarify their own approach:

Suppose that the following sentence pair is the part of a coherent text: "Blood cannot get rid of a sufficient amount of carbon dioxide through lungs. For this reason, blood turns into a purplish colour." Even though a reader does not know why carbon dioxide causes the blood to turn into purple, he/she can easily understand these two sentences. The result can be a superficial understanding since the reader either does not have sufficient background information or does not make an effort to understand. All readers frequently choose to show less resistance. In order to produce a text with less coherence, "for this reason" can be eliminated. Without this conjunction, these two sentences simply become compound sentences. These sentences can naturally be considered as statements that are not connected except stating facts on the same subject. But more probably the reader will realize this gap and try to fill in. This cannot just be made on the basis of textual content; when we only have these two sentences, numerous potential sentence conjunctions such as for this reason, and, because, then, and but can be used and no linguistic clue is necessary in order for the reader to pick the right one. Therefore, artificial solutions for this dilemma are not possible. The only way to bridge this gap is to have the knowledge of some major facts such as the rate of oxygen in the blood from the heart to lungs is low whereas that of carbon dioxide is high and looks blue, yet the blood from lungs to the heart is rich in oxygen and poor in carbon dioxide and looks bright red. Knowing these facts enable the reader to be able to infer "for this reason" as the correct conjunction required to link the two sentences (p. 5).

On the other hand, aside from the research on text structure, Gates et al. (2007) argue that the ideas on actual literature activities in learning larger discourse units are mostly based on theoretical evidence rather than experimental evidence and for this reason underline that new configurations that include experimental data are required in order to acquire new information on teaching written discourse and on other subjects related to the learning of it at schools. In that sense, they selected texts that include scientific information and procedural texts in their own study. In a similar way, based on the general idea that the actual purpose of reading is to make sense of the text, Gajria, Jitendra, Sood & Sacks (2007: 210-211) argue that the main emphasis at primary education level is on "learning to read", however at subsequent levels such emphasis shifts on "reading to learn". They state that this emphasis is particularly related to content fields in which the intensity of knowledge provided increases "such as content that is not familiar, technical words, complex and different syntax structures, abstract concepts". Yet Gajria et al. (2007: 210-211) also suggest that "Most of the course books with content field are generally above the classroom level reading skills of students and written with an obvious lack of organization." Moreover, Seidenberg (1989) tried to analyze the reasons of the difficulty faced by different students in understanding what they read with regard to reading social and scientific texts. In this context, difficulties in understanding what is read varied from student to student in a scientific experiment or a mathematical word problem. According to this,

students encountered varying difficulties in terms of indicating the distinction between coherent and incoherent information, defining and recognizing the reciprocal relation between main ideas, and organizing and memorizing information (such as the events that caused a war as a result of England's economic exploitation of its colonies). Scruggs & Mastropieri (1993) explain that despite the fact that special teaching methods can increase students' academic success, the general educational success in classrooms depends largely on medium scale material and teaching approaches. Thus, literature suggests that various students are defined and come to the fore through their teaching-related, experimental, socioeconomic, linguistic, psychological or cognitive foreknowledge, which cause different needs of learning and curriculum.

However, different brochures and informative books students read as part of reading-writing activities in their courses also correspond to an important social function in terms of environmental literacy and awareness. Especially the determination of actual reading and writing activities and textbooks' representation of real life environmental situations are extremely important. In that sense, in most of the research with actual teaching configuration, it is underlined that teaching must have a clear and comprehensible ground in order to help the students to understand the complicated nature of environmental situations. For example, Seidenberg (1989) underlines the fact that school textbooks are frequently written in an insufficient fashion and the books are incoherent as well as unsuccessful in indicating the connection between various information. Such that the books used are indicated as the cause of hardships encountered by most students in comprehension-oriented skills. This is because books are problematic in terms of defining basic ideas, supporting important information, and clarifying the relations between the main topics of a text. In this sense, Linderholm et al. (2000) argue that the problem of understanding a text cannot be resolved completely without a careful analysis of the ways text structure and the cognitive processes of the reader interact. Moreover, they also suggest that the formation of mental presentations of texts is a process that can take place based on how the text has been structured and ideally readers create the mental presentations of texts as well. This is because this "level of comprehension helps long-term remembering" (Graesser, 1981; van Dijk & Kintsch, 1983, van Oostendorp & Goldman, quoted from 1999 by Linderholm et al., 2000: 525-530) and "enables the textual information to be accessible" (Singer & Ritchot, 1996; quoted from 1999 by Linderholm et al., 2000: 525-530).

So and so, Gates et al. (2007) presented teachers course examples in compliance with this teaching model and asked each teacher to create and share such form of example. Besides, they also distributed a path including actual scientific purposes that enable the reading and writing of informative and scientific texts and the strategies that determine actual scientific reading-writing purposes. Regarding this, their adoption of the language theory that considers language inseparable from social relations or practices has been influential.

As can be observed in the leading studies in which Bakhtinian language is considered as a **dialogic**, communicative, and socially constructed element, the theme of environment and science comes to the fore within the framework of the definition and development of an actual reading and writing activity for including scientific experiences and activities in the structuring of actual reading-writing purposes (Bakhtin, 1981, 1986; Vygotsky, 1962). Gates et al. (2007) explain this with the social perspective that is the theoretical perspective we use for linguistic development or learning, and underline that environmental subjects including scientific experiences and activities are in line with the **constructivist** perspective (paradigm) that has been developed and shaped in a way that it will replace **cognition** and learning within social realms. Moreover, they also state that students within language use social

context structure language in a way that will perform the required function within such contexts.

CONCLUSION

Students' awareness of structure, process, and general culture within the framework of scientific texts and environmental themes make their inclusion in socio-cognitive practices more qualified (Engert & Krey, 2013; Eren, Bulut, & Bulut, 2015; Kazempour, 2014 & Morgado, Otero, Vaz-Rebello, Sanjosé, & Caldeira, 2014;). Approaches in this context reflect different edges of the evaluations and interact with numerous different theoretical perspectives from literacy as a social practice to literacy as a cognitive skill and even to environmental literacy (Oliveira, 2015 & Sjøberg, 2015). Thus, the importance of experience and direct inclusion within the context rather than open education and gradual education in language learning is also being emphasized in the related literature regarding this subject (Alpaslan, Yalvac, & Loving, 2015)

REFERENCES

- Alpaslan, M. M., Yalvac, B., & Loving, C. C. (2015). Curriculum Reform Movements and Science Textbooks: A Retrospective Examination of 6th Grade Science Textbooks. *Eurasia Journal of Mathematics, Science & Technology Education*, 11(2), 207-216.
- Atkinson, D. (1999). *Scientific discourse in sociohistorical context: The philosophical transactions of the Royal Society of London, 1675-1975*. Mahwah, NJ: Erlbaum.
- Bakhtin, M. M. (1981). *The dialogic imagination*. (C. Emerson & M. Holquist, Trans.). Austin: University of Texas Press.
- Bakhtin, M. M. (1986). *Speech genres and other late essays*. (V.W. McGee, Trans.). Austin: University of Texas Press.
- Berman, Ruth A. & Nir-sagiv, B. (2007). Comparing narrative and expository text construction across adolescence: A developmental paradox. *Discourse Processes*, 43 (2), 79-120.
- Britton, B.K. & Black, J. B. (1985). Understanding expository text: From structure to process and world knowledge. In B.K. Britton & J.B. Black (Eds.). *Understanding expository text: A theoretical and practical handbook for analyzing explanatory text*. Hillsdale, NJ: Erlbaum.
- Britton, B. K., Glynn, S. M., Meyer, B. J. F. & Penland, M. J. (1982). Effects of text structure on use of cognitive capacity during reading. *Journal of Educational Psychology*, 74, 51-61.
- Engert, K., & Krey, B. (2013). Reading Writing/Writing Reading on Epistemic Work with Scientific Texts. *Zeitschrift Fur Soziologie*, 42(5), 366-384
- Eren, M., Bulut, M., & Bulut, N. (2015). A content analysis study about the usage of history of mathematics in textbooks in Turkey. *Eurasia Journal of Mathematics, Science & Technology Education*, 11(1), 53-62.
- Gajria, M., Jitendra, A. K., Sood, S. & Sacks, G. (2007). Improving Comprehension of Expository Text in Students With LD: A Research Synthesis. *Journal of Learning Disabilities*, 40, (3), 210-225.
- Gates, V. P., Duke N. K. & Martineau, J A. (2007). Learning to read and write genre-specific text: Roles of authentic experience and explicit teaching. *Reading Research Quarterly*, 42 (1), 8-45.
- Goodwin, C. (1995). Seeing in depth. *Social Studies of Science*, 25, 237-274
- Hahn, P., Dullweber, F., Unglaub, F., & Spies, C. K. (2014). Text mining, a method for computer-assisted analysis of scientific texts, demonstrated by an analysis of author networks. *Handchirurgie Mikrochirurgie Plastische Chirurgie*. 46(3), 186-191.
- Hasni, A., & Potvin, P. (2015). Student's Interest in Science and Technology and its Relationships with Teaching Methods, Family Context and Self-Efficacy. *International Journal of Environmental & Science Education*, 10(3), 337-366.
- Kazempour, M. (2014). I Can't Teach Science! A Case Study of an Elementary Pre-Service Teacher's Intersection of Science Experiences, Beliefs, Attitude, and Self-Efficacy. *International Journal of Environmental and Science Education*, 9(1), 77-96.

- Kelly, G. J. & Bazerman, C. (2003). How students argue scientific claims: A rhetorical semantic analysis. *Applied Linguistics*, 24 (1), 28-55.
- Kelly, G. J., & Green, J. (1998). The social nature of knowing: Toward a sociocultural perspective on conceptual change and knowledge construction. In B. Guzzetti, & C. Hynd (Eds.), *Perspectives on conceptual change: Multiple ways to understand knowing and learning in a complex world* (pp. 145-181). Mahwah, NJ: Erlbaum.
- Keys, C. W. (1999). Revitalizing instruction in scientific genres: Connecting knowledge production with writing to learn in science. *Science Education*, 83, 115-130
- Linderholm, T., Everson, M. G., van den Broek P., Mischinski, M., Crittenden, A., & Samuels, J. (2000). Effects of causal text revisions on more and less-skilled readers' comprehension of easy and difficult texts. *Cognition and Instruction*, 18(4), 525-556.
- McNamara, D. S. Kintsch, E., Songer, N. B. & Kintsch, W. (1996). Are good text always better? Interactions of text coherence, background knowledge, and levels of understanding in learning from text. *Cognition and Instruction*, 14.
- Meyer, B. J. F., & Rice, G. E. (1984). The structure of text. In P. D. Pearson, R. Barr, M. L. Kamil, & P. Mosenthal (Eds.), *Handbook of reading research* (Vol. 1, pp. 319-351). White Plains, NY: Longman.
- Morgado, J., Otero, J., Vaz-Rebello, P., Sanjosé, V., & Caldeira, H. (2014). Detection of explanation obstacles in scientific texts: the effect of an understanding task vs. an experiment task. *Educational Studies*, 40(2), 164-173.
- Oliveira, A. W. (2015). Reading Engagement in Science: Elementary Students' Read-Aloud Experiences. *International Journal of Environmental & Science Education*, 10(3), 429-451.
- Pearson, P. D., & Fielding, L. (1991). Comprehension instruction. In R. Barr, M. L. Kamil, P. Mosenthal, & P. D. Pearson (Eds.), *Handbook of reading research* (Vol. 2, pp. 815-860). White Plains, NY: Longman.
- Scruggs, T. E., & Mastropieri, M. A. (1990). Current approaches to science education: Implications for mainstream education of students with disabilities. *Remedial and Special Education*, 14, 15-24.
- Seidenberg, P. L. (1989). Relating text-processing research to reading and writing instruction for learning disabled students. *Learning Disabilities Focus*, 5 (1), 4-12.
- Sjøberg, S. (2015). PISA and Global Educational Governance—A Critique of the Project, its Uses and Implications. *Eurasia Journal of Mathematics, Science & Technology Education*, 11(1), 111-127.
- Vygotsky, L. S. (1962). *Thought and language*. (A. Kozalin, Trans.). Cambridge, MA: MIT Press. (Original work published in 1934).
- Weaver, C. A. & Kintsch, W. (1991). Expository text. In R. Barr, M. L. Kamil, P. Mosenthal, & P. D. Pearson (Eds.), *Handbook of reading research* (Vol. 2, pp. 230-244). White Plains, NY: Longman.