SESSION 5
Computer and Applied Linguistic

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WAYS OF IMPROVING COMPREHENSION THROUGH DISCOURSE PROCESSING FOR APPLIED LINGUISTICS STUDENTS

The field of discourse processing offers some solutions to the challenge of promoting deep comprehension during learning. The present article sketches the basic components of discourse processing mechanisms, such as constructing explanations, asking deep-reasoning questions, tutoring, and subsequently points out how such mechanisms can be recruited to improve deep comprehension of the study material. The practical mission is viewed as designing of software (both the programming and the linguistic parts), modeling the pointed out mechanisms, which is suggested to become a part of the student-teacher research work carried out in the field of Applied Linguistics.

Keywords – discourse, discourse processing mechanisms, comprehension, learning, educational software.

1. The Past: The Birth of Discourse Processes.

The multidisciplinary field of discourse processes does not have a long history. It was officially launched in 1978, with the publication of the first issue of the journal Discourse Processes. Researchers became interested in discourse when they became dissatisfied with the sentence or utterance as the unit of analysis in their investigations of language. It is quite correct that printed texts consist of a sequence of sentences, and that oral conversations consist, more or less, of a sequence of spoken utterances. However, discourse cannot be entirely reduced to sentences and utterances. Discourse has a context, cohesion, coherence, and rhetorical structure that weaves together and transcends the sentences/utterances. The further interest in discourse arose when researchers discovered some systematic discourse patterns, empirical findings, and processing mechanisms. These discoveries emerged rather quickly from several different fields in the 1970's, just before the field was launched in 1978 [1].

2. The Present: Current Trends and Approaches.

The field of discourse processes is currently fuelled by seven dominant approaches, which can be labelled as (1) discourse psychology, (2) corpus analysis, (3) computational discourse, (4) discourse technologies, (5) conversation analysis, (6) hybrid qualitative and quantitative approaches, and (7) cultural foundations. Most of these approaches are hybrids of two or more disciplines, but some are confined to a single discipline but there is hope that the field will become more interdisciplinary instead of being merely multidisciplinary. Interdisciplinary research is a serious attempt to integrate research from 2 or more fields, a form of intellectual crossbreeding. For example, computational linguistics is a field that combines computer science and linguistics. Multidisciplinary research is a collection of disciplines that focus on investigating a particular phenomenon; there may or may not be serious efforts for the disciplines to communicate. A.C.Graesser [2] argues that discourse processing research will become progressively more sophisticated to the extent that it shifts from being multidisciplinary to being interdisciplinary. This shift requires developing an appreciation for multiple methods of establishing rigorous scientific claims.

The aim of the presented article will be to focus on such approaches towards the study of discourse processing as discourse psychology alongside with the computational discourse since they are directly connected with obtaining results in improving comprehension of the material under study being the sample of a certain discourse.

Discourse Psychology. This is the most dominant approach to investigating discourse processing (Graesser, Hoffman, & Clark, 1980; Gernsbacher, 1997; Graesser, Millis, & Zwaan, 1997; Kintsch, 1998) [2], [3], [4], [5]. Discourse psychologists test theories by collecting data from humans either during or after discourse comprehension or production. The most recent research in discourse psychology has become progressively more interdisciplinary in several respects. One of trends has been to develop quantitative models that more precisely specify predictions of theories. These efforts coordinate discourse psychology with mathematical models developed in the cognitive

sciences. For example, Kintsch's (1998) [5] construction-integration model incorporates neural networks, production rules, and latent semantic analysis (i.e., high-dimensional semantic space) in his attempt to quantitatively pin down the mechanisms of particular processing modules. Another example of such research is a recently developed computer-based instrument for the detailed assessment of reading skills carried out by Richter & Naumann, working at University of Cologne, Department of Psychology (Richter & Naumann, 2000) [6]. The theory underlying its construction is van Dijk and Kintsch's (1983) strategy model of text comprehension [7]. The target group of the instrument are adults with a presumably high level of reading ability, for instance university students. Therefore, the instrument is not intended to assess difficulties in reading or achievement in learning to read. Apart from that, the subtests refer to basic cognitive processes of reading but not to metacognitive strategies or standards of comprehension. The instrument is designed for research purposes; authors are planning to use it for the measurement of covariates in experiments on text comprehension (see Christmann, Groeben, Flender, Naumann & Richter, 1999) [8].

Computational Discourse. Just as the field of computational linguistics combines computer science and linguistics, the computational discourse approach combines discourse processes and computer science. The researcher needs a sufficiently detailed understanding of a discourse processing module so that the researcher can program the computer to implement the mechanism. Some discourse modules are comparatively easy to implement. A lexicon is a list of words or morphemes, with each entry having a list of linguistic features (phonological, syntactic, semantic), semantic word senses, familiarity metrics, and so on. There is no available system that automatically tracks the goals, beliefs, and common ground of speech participants or that automatically constructs the rhetorical composition of a text. Nevertheless, there have been some notable successes in computational discourse. Most of these successes have used statistical models of discourse and world knowledge that induce discourse patterns from a large discourse corpus. The most successful statistical models are Bayesian Markov models, neural networks, and latent semantic analysis (Jurafsky & Martin, 2000) [9]. Biber developed a system that impressively classifies texts into different discourse genres and registers on the basis of approximately 50 different linguistic/discourse features (Biber, 1988) [10]. AutoTutor is a computerized tutoring system that holds conversations in natural language with students on the topics of computer literacy and conceptual physics (Graesser, Person, Harter, & the Tutoring Research Group, 1994-1999, in press) [11], [12], [13], [14], [15]. These success cases in computational discourse demonstrate that it is not too early to build automatic systems of discourse analysis. However, there is a large road ahead of us.

3. The Future: Three Directions for Growth and Survival.

Researhers in the field of discourse processing, such as A.C.Graesser, offer three directions that are either inevitable or are profoundly needed for the field to survive. These are the integration of neuroscience with discourse research, the use of more advanced computer technologies for analyzing discourse, and a more pronounced shift from multidisciplinary to interdisciplinary research [1].

4. The Use of Discourse Processing for Improving Learning Comprehension.

Students rarely acquire a deep understanding of the material they are supposed to learn in their courses. This painful fact is widely acknowledged in the field of education. Students normally settle for shallow knowledge, such as a list of concepts, a handful of facts about each concept, and simple definitions of key terms. What is missing are the deep coherent explanations that organize the shallow knowledge and that fortify the learner for generating inferences, solving problems, reasoning, and applying their knowledge to practical situations. The acquisition of shallow knowledge is unfortunately reinforced by the normal classroom activities and testing formats. Classroom lectures typically are information delivery systems for shallow knowledge. The teachers' questions in the classroom typically are shallow short-answer questions that require only single words or short phrases in the student response. The format of most examinations consists of multiple choice, true-false, or fill-in-the-blank questions that, once again, tap primarily the shallow knowledge. Given this unfortunate state of affairs, many researchers and teachers in education have been exploring learning environments and pedagogical strategies that promote deep comprehension.

The field of discourse processing offers some solutions to the challenge of promoting deep comprehension during learning and thus it is of necessity to take into account the salient components of discourse processing mechanisms and subsequently point out how such mechanisms can be recruited to improve deep comprehension.

5. Components of Discourse Processing.

Discourse psychologists have identified five levels of discourse representation that are constructed during comprehension (Graesser and others, 1997; Kintsch, 1998) [2], [5]. These include the surface code, textbase, situation model, pragmatic communication, and discourse genre. The surface code preserves the exact wording and

syntax of the sentences. The textbase contains explicit propositions in the text in a stripped-down form that preserves the meaning, but not the surface code. The situation model (or what is sometimes called the mental model) is the referential microworld of what the text is about; it contains the people, setting, states, actions, and events that are either explicitly mentioned or inferentially suggested by the text. The pragmatic communication level refers to the exchange between the speech participants, between the reader and writer, or between the narrator and audience. Discourse genre is the category of discourse, such as narration, exposition, persuasion, and so on. Discourse analysts have proposed several different discourse classification schemes that are organized in a multi-level hierarchical taxonomy or in a multidimensional space (Biber, 1988) [10]. Deep comprehenders construct rich representations at the levels of the situation model, pragmatic communication, and discourse genre. These three levels are preserved in memory for a long time if they are successfully constructed during comprehension. In contrast, the surface code and textbase have a secondary status. In fact, memory for the surface code is normally 30 seconds or less, whereas memory for the textbase normally decays after a few hours. Paradoxically, the examinations that students normally receive tap the surface code and textbase rather than the deeper levels.

6. Discourse Mechanisms that Promote Deep Comprehension and Learning.

The purpose of this section is to identify some methods of improving deep comprehension during learning. These methods are based on research in discourse processing, although aspects of these methods are also grounded in cognitive psychology more generally. This is hardly an exhaustive list of methods. Instead, we focus on methods that are believed to have a substantial impact on learning and that have a solid empirical research base.

Constructing explanations. Good comprehenders generate explanations as they read text or listen to lectures (Bransford and others, 1991; Chi and others, 1994; Graesser and others 1993; Pressley and others, 1992; Trabasso & Magliano, 1996) [16], [17], [18], [19], [20]. The explanations trace the causes and consequences of events, the plans and goals of agents (humans, animals or organizations), and the logical derivations of assertions. The questions that drive explanations are why, how, what-if, and what-if-not. Students learn much more when they construct the explanations on their own (which are called self-explanations) than when they merely read or listen to explanations.

Computer software can be designed to encourage the learner to construct explanations. One simple way to do this is to ask the learner to think aloud while studying the material and to probe them with explanation-based prompts (such as “why,” “please explain,” and “how does that occur”). More sophisticated software would present animations of the causal mechanisms and would allow the student to manipulate inputs and steps in the causal stream (Hegarty and others, in press; Mayer, 1997) [21], [22]. Simulation software allegedly provides an excellent learning environment for acquiring deep explanations of complex systems.

Asking deep-reasoning questions. Students should be encouraged to ask and answer deep-reasoning questions during comprehension because they help construct explanations. Unfortunately, students are not in the habit of asking many questions and most of their questions are shallow. A typical student asks only .17 question per hour in a classroom (Graesser & Person, 1994) [11] and less than 10% of student questions involve deep reasoning. When students are trained how to ask good questions while reading or listening to lectures, their comprehension scores increase on objective tests (King, 1992, 1994; Rosenshine and others, 1996) [23], [24], [25]; the median effect size is .36 when standardized texts are used and .86 when experimenter-developed comprehension tests are used. Teachers rarely ask deep-reasoning questions in classroom settings, so it would be prudent to train teachers to model good questioning skills.

Computer software has been developed to train students how to ask good questions while learning. For example, Graesser and others (1993) [26] developed a “Point & Query” hypermedia system in which students learn about woodwind instruments by asking questions and comprehending answers to the questions.

Tutoring. One-to-one human tutoring is superior to normal learning experiences in traditional classroom environments. Meta-analyzes on learning gains have revealed that the effect size of the advantage of tutoring over the classroom has ranged from .4 to 2 standard deviation units (Bloom, 1984; Cohen and others, 1982) [27], [28].

Psychologists and computer scientists have recently built intelligent tutoring systems that help the learner reason and solve difficult problems. The recent generation of intelligent tutoring systems are attempting to incorporate tutorial dialogue patterns that humans use during tutoring. For example, AutoTutor teaches students about computer literacy by holding a multi-turn conversation with the student and implementing the tutoring tactics of normal human tutors (Graesser, K.Wiemer-Hastings, P. Wiemer-Hastings, and Kreuz, 1999; Graesser, VanLehn, Rose, Jordan, and Harter, in press) [14], [13].

Closing Comments. There has been presented a few examples of how research in discourse processing can help solve some of the pressing challenges in our educational enterprise. Discourse plays an important role in helping the learner shift from the shallow waters to the deep, from being a fact collector to becoming an inquisitive explainer, from being a repository of inert knowledge to becoming a vital agent who puts the knowledge into action. The field of discourse processing has some excellent theories that are grounded in solid scientific research. This research has shown its currency in the practical arena of education.

7. Conclusion

The research trends in the field of discourse processing have pointed out towards the problem areas in the educational sphere connected with the lack of the deep comprehension of the study material. First of all, it concerns the students' training since their ability to have a solid knowledge base of the issue in question alongside with deep reasoning skills can guarantee students' becoming qualified professionals. At the same time the discourse processing research trends offer the ways of solution of the mentioned problems by designing the proper educational software. This is exactly the issue that can be taken as the research topic for both teachers and students working at the department of Applied Linguistics (the structural subdivision of the Institute of Computer Sciences and Information Technologies at Lviv Polytechnic National University).

Currently the students and the teaching stuff from the department of Applied Linguistics as well as other computer science oriented departments of the mentioned Institute have been working upon the following issues reflected in the students' diploma works:

- development of the linguistic part of the software in systems of artificial intelligence with its further application in automatic/automatized programs working with the language information processing;
- research of optimization ways in the sphere of machine translation;
- research in the lexicography sphere, in particular compiling of electronic dictionaries of the thesaurus and multilingual types;
- modeling of linguistic objects (in particular, in the sphere of syntax) with the further possibility of their application in automatic/automatized programs working with the language information processing;
- research of the ways of logical representation of information in Internet sources; optimization of ways of the information search in the Internet;
- developments in the sphere of CALL (Computer Assisted Language learning) with the further implementation of elaborated applied programs in the language learning classroom process [29], [30].

The field of discourse processing offers new challenging perspectives for the scientific research work for both teachers and students at the Applied Linguistics department. Thus employing methods based on research in discourse processing, such as constructing explanations, asking deep-reasoning questions and tutoring, there can be elaborated both the linguistic and the programming parts of the software directed towards the comprehension improvement of a subject under study with elements of the hypertext versus the linear text and the thesaurus-type databases, which will bring both theoretical and practical benefits.

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