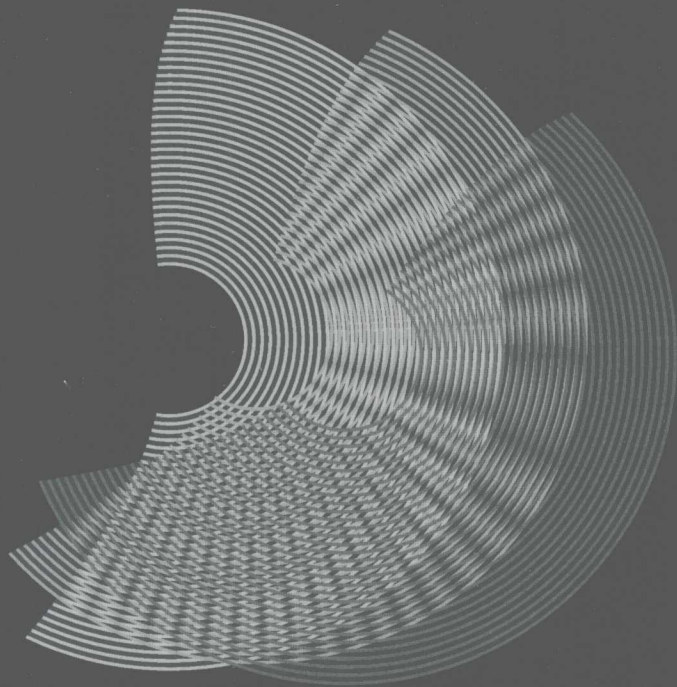


Theses of International Conference on Information
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2006

**2006年现代教育技术与
大学外语教学国际研讨会
论文集**

金启军 赵 雯 王勃然 主 编



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Message from Dr. Arthur McNeill

Chair of the Organizing Committee Hong Kong

The collaboration between the English Language Teaching Unit of the Chinese University of Hong Kong and the College English Teaching and Research Association extends over a number of years. TCELT 2006 will be our fourth joint conference. We are particularly delighted that the 2006 conference will be co-hosted by the Foreign Studies College of Northeastern University, whose expertise in the applications of information technology (IT) in language teaching is widely recognized. It is all the more fitting that the 2006 conference has adopted as its theme “IT in English Language Teaching.”

Widespread

The use of IT in language teaching is particularly widespread throughout southeast Asia, where both teachers and learners appear to have welcomed the new technology with open arms. In fact, during the past few years, English language teachers have grown accustomed to virtual learning environments (VLEs), e-mail, PowerPoint, and even computer and multimedia laboratories, and integrate them freely into their regular teaching. There can be no doubt that the quality of language teaching has been greatly enhanced through IT's ability to: bring “real” English into the classroom; allow learners easy access to useful language resources; connect learners and teachers to international networks; and provide access to corpora and other databases. Yet, advances in technology continue at an astonishing pace, providing greater and greater opportunities and challenges, for language teaching.

Valuable forum

Most of the papers, demonstrations and workshops in the Conference program are based on recent research and development in the use of IT in language teaching. I very much hope that the Conference will provide a valuable forum for the exchange of ideas on how language learning and teaching might continue to benefit from the potential of the new technology — and how our lives as teachers and learners will inevitably be affected.

Message from Professor Jin Qijun

Chair of the Organizing Committee Shenyang

I am pleased to welcome each of you to the International Conference on Information Technology in English Language Teaching 2006 in Shenyang. This year, we are honored to have the following well-known professors as the keynote speakers at this international conference: Prof. Yang Huizhong, Natural Language Processing Institute, School of Foreign Languages, Shanghai Jiao Tong University; Prof. Thomas Cobb, The University of Quebec; Dr. John Milton, Language Center, Hong Kong University of Science and Technology; and Prof. Zhao Wen, Language and Multimedia Center, Foreign Studies College, Northeastern University, Shenyang.

Motivational

There are two kinds of reasons for using IT in English instruction. Firstly, there are the benefits to teachers and students in any learning area. For students, technology can be very motivational; be the source of a significant amount of reading material; be fun — and when it's fun, you learn; and can help students to produce excellent published work. For teachers, technology can allow for the easy production, storage and retrieval of prepared materials; free up communication with other teachers; help teachers to find information easily; and assist good teaching, but not replace it.

Changing social practices

Secondly, there are the challenges and opportunities presented by IT that make it an increasingly important part of English teaching in particular. These include the emergence of new kinds of texts and the consequent need to teach students to create and use these texts effectively; changing social practices associated with communicating via IT and the consequent need to teach students how to make judgments about appropriate use of different avenues of communication; and the pervasiveness and power of texts created through IT and the consequent need to teach students to be critical readers and viewers of such texts.

Shenyang is the capital of Liaoning Province and the largest city in northeastern China. 2006 Shenyang International Horticultural Exposition begins on May 1, 2006, and will last 184 days. I hope you find the trip to the city rewarding and I hope you go back with fond memories, not only of the friendliness and the welcome of the people in Shenyang.

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Noun Construction Based on Object-Oriented Semantics—The Construction of College English Semantic Dictionary

ZHAO Wen, SUN Nan

(Northeastern University)

Abstract: The development of information technology results in a great amount of information and data. However, it is impossible for human beings to analyze and process them manually to gain useful knowledge. As a result, natural language understanding has become an important developing trend in computer science. The semantic processing naturally becomes the research focus in natural language understanding. The semantic technology in natural language processing is based on semantic dictionaries and semantic classifications. The task of semantic dictionaries is to establish semantic classifications and semantic relations of some language, which provides the semantic knowledge for natural language processing.

Key words: Object-Oriented Semantics; noun construction; college English; semantic dictionary

1 The significance of constructing CESD

The Ministry of Education (MOE) released the College English Curriculum Requirements (CECR) (For Trial Implementation) in 2004 (College English Curriculum Requirements 2004: 22). In CECR the recommended vocabulary is 6,674 words, which actually are word forms (including 2,354 active words) and 1,875 phrases. The recommended vocabulary is divided into three levels, that is, Basic Level, Intermediate Level and Higher Level.

As we know, the lexical learning plays an important role in language learning. Moreover, the dictionary is a necessary, helpful and important tool in lexical learning. It also plays an important part in the vocabulary expansion and language learning. Building semantic relation is very crucial in language learning. Therefore, building a good command of the semantic relations and the network structure between words is quite essential for language learning.

2 The general introduction of CESD

CESD contains 9,643 word forms which are oriented from CECR, 31,618 word senses and 1,875 phrases. The word forms are selected from *The Collins Bank of English Corpus*. As we know that CECR contains 6,647 word forms, however, the word forms in CESD are more than those in CECR because CECR only lists the word forms regardless of the grammatical reflections, while the number of word forms in CESD is counted according to the word forms in four grammatical forms.

Since resources in our repository are organized and constructed on the basis of Object-Oriented Semantics (OOS), we adopt the OOS methodology and apply it to construct CESD nouns in order to integrate the CESD with other resources. Thus, CESD is constructed from four dimensions according to OOS; they are class, relation, attribute and operation.

3 CESD noun construction

Nouns are the open class words, that is to say, nouns can be enlarged and increased at any time. Nouns also take a large proportion in the English lexicon. Thus, it is obvious that how to construct nouns is a big and important issue in CESD. Therefore, CESD noun construction is an important task. In CESD noun word forms are 4,692 and word senses are 15,067.

3.1 Word form

The noun word forms in CESD are oriented from CECR. However, the words in CECR are actually the word forms, which means there are no grammatical category denotations after each word form. As we know, in WordNet the organization of nouns is better than the organizations of the other three grammatical categories in the aspect of the classification or the relations. Thus, we decide to extract the noun word forms from the word form list on the basis of WordNet with reference to the synset (synonymous set) file.

The synset file includes the synonymous words, the grammatical category indicators (indicating noun, verb, adjective and adverb with cardinal number 1, 2, 3, 4 respectively), and the synset sequences referring to the synonymous word sequence in the synset and the semantic senses of the synsets. Hence, at the beginning we put 6,674 word forms oriented from CECR into WordNet synset file. Secondly, we mark 6,674 word forms in synset file and in this step some functional word forms are omitted because the synset file merely contains nouns, verbs, adjectives and adverbs. Thirdly, we extract the marked word forms whose grammatical category indicator number is 1 as number 1 indicates the grammatical category noun. At last all the marked word forms with the grammatical category indicator number 1 are the noun word forms in CESD. These extracted noun word forms are organized and filed into CESD Noun Word Form file (NWF file for short). Totally, there are 4,692 noun word forms in CESD.

3.2 Word sense

CESD is a machine-readable semantic dictionary, so the semantic analysis is the most important linguistic analysis in the compilation of CESD. Generally speaking, the semantic analysis is to analyze the linguistic units. The semantic analysis here refers to the essence of the semantic meaning, that is, the lexical semantic analysis. The word sense in CESD should be focused on the denotative meaning. The denotative meaning has the relation with the accuracy of the explanations of word meanings in the dictionary. Thus, in the compilation of the dictionary the lexicographers must have comparative study and analysis of the source language and target language.

3.2.1 Semantic field and word senses

According to Lyons (1977: 250), a semantic field contains words that belong to a defined area of meaning. Words in a semantic field share a common semantic feature, or semantic component. There are paradigmatic meaning relations and syntactic meaning relations in the semantic field. Words from different lexical field have the internal relations to some extent and they are combined together based on the co-occurrence. The semantic field can be large or small. A big semantic field has several sub-fields.

Since the standard dictionaries usually dissevers the semantic field as the word meaning, we decided to use the semantic relations to describe the word senses. We adopt the concept of WordNet to organize and construct CESD. We have WordNet database in our repository and we made full use of WordNet database to extract the noun word senses in CESD and also the synonymous sets of the noun word senses. First, we put

WordNet database, the CESD noun senses are also sequenced from high to low.

As for the foreign language learners in China, the frequently used word senses in communication are the central meanings and the high-ranking secondary meanings. There's no need for them to remember all the senses of a word. Taking these into consideration, we have to cut down some rarely used senses of the word. Since the words in CECR are oriented from *The Collins Bank of English* and the words in WordNet are oriented from *The Brown Corpus*, we have to make a critical comparison between the word senses from these two corpora to see whether the word senses are sequenced similarly or differently. CESD noun word senses are oriented from *The Brown Corpus*, too. So we must choose a dictionary, which is compiled on the basis of *The Collins Bank of English*, and we select the *Oxford Advanced Learner's English-Chinese Dictionary* (the sixth edition) (OALD^{6th}). Therefore, what we have to do is to make comparisons between the noun word senses both from CESD and from OALD^{6th} and to see whether the sequences of the word senses are the same or not. If most of the word sense sequences are the same, we can draw a conclusion that the word sense sequences in CESD are scientific and they are almost identical with the word sense sequences based on *The Collins Bank of English*. On this scientific condition, we can cut down the unnecessary word senses.

Therefore, we select 1000 words from BNC where the words are arranged according to the high frequency. With the technicians' help, we have put all the information in OALD^{6th} into our repository and have established OALD^{6th} database. As a result, we have both OALD^{6th} database and WordNet database in our repository. We put 1000 word forms into OALD^{6th} database and WordNet database, and then the word senses in each database are extracted respectively. We make comparisons between each sense extracted from two databases. Take *way* for example: there are 12 senses for the noun *way* in WordNet while in OALD^{6th} the noun *way* has 13 senses.

The noun *way* is selected from the high frequency word list. The second column is the senses extracted from WordNet database and the third column is the senses extracted from OALD^{6th} database. In the second column the number before each sense is the sense count and the sentences in the parenthesis are the glosses which explain the synsets clearly. And the number before each sense in the third column is the sense sequence number in OALD^{6th}. Note that as the senses given in WordNet are so subtle, some senses in WordNet cannot have an identical counterpart in OALD^{6th} and we have to pick out the similar expressions in OALD^{6th}. Because an entry in OALD^{6th} contain the semantic information that, in WordNet, would be distributed over several distinct synsets, one for each meaning, if there is not even an expression in OALD^{6th} which can match the senses in WordNet, we write the number zero in the counterpart place in the third column. Thus, from this comparative table, we can draw a conclusion that nearly most of the sense sequences in WordNet database are similar as those in OALD^{6th} database; the word sense whose sense count is above 3 is frequently used and its sense sequence ranks high in the sense item. With these scientific data, we can cut down the unnecessary senses whose sense counts are under 3 in CESD Noun Word Sense file.

In short, CESD noun word senses are organized into the synsets. The synsets are the basic conceptual building block in CESD. CESD noun word senses are extracted from WordNet database without sense selection at first. In comparison of WordNet with OALD^{6th}, we cut down the unnecessary senses whose sense counts are under 3. In other words, the senses whose sense counts are above 3 are in CESD Noun Word Sense file at last.

Table 2 The comparison of way senses between WordNet and OALD 6th

| Word form | Senses in WordNet | Senses in OALD 6 th |
|---------------|--|---|
| way <i>n.</i> | (1) (652) manner, mode, style, way, fashion—(how something is done or how it happens) | (1) a method, style, or manner of doing sth. |
| | (2) (367) means, agency, way—(how a result is obtained or an end is achieved) | (1) a method, style, or manner of doing sth. |
| | (3) (162) way—(a journey or passage) | (4) a route or road that you take in order to reach a place |
| | (4) (153) way—(the condition of things generally) | (1) a method, style, or manner of doing sth. |
| | (5) (106) way, path, way of life—(a course of conduct) | (6) a road, path or street for traveling along |
| | (6) (88) way—(any artifact consisting of a road or path affording passage from one place to another) | (6) a road, path, or street for traveling along |
| | (7) (85) direction, way—(a line leading to a place or point) | (7) a particular direction; in a particular direction |
| | (8) (49) way—(the property of distance in general) | (10) a distance or period of time between two points |
| | (9) (27) way—(doing as one pleases or chooses) | (12) a particular aspect of sth. |
| | (10) (22) way—(a general category of things; used in the expression “in the way of”) | 0 |
| | (11) (19) room, way, elbow room—(space for movement) | 0 |
| | (12) (1) way—(a portion of something divided into shares) | (12) a particular aspect of sth. |

3.3 OOS method to construct CESD nouns

The Object-Oriented Semantics is a semantic model of the natural language. The Object-Oriented Semantics is a kind of methodology to express concepts and knowledge by using the basic concepts such as object, class, attribute, operation and relation. The OOS model can not only be applied on computers but also cater for human being’s mental dictionary.

In our repository, we use the OOS method to construct and integrate all the resources. As CESD is a part of the repository, we have to adopt this scientific semantic model to construct CESD in order to have a good combination and integration with other resources.

CESD nouns are constructed in four dimensions according to OOS. However, in fact, nouns are only constructed from class, attribute, and relation. The operation is neglected as it is more important element to construct verbs than nouns. The attribute is the most important element to construct nouns. Since attributes denote simple qualities that are secondary characteristics of objects (e.g. red, solid, damp), in contrast to the essential properties represented by classes. Attributes are the distinguishing qualities from all the others in the class. Hence, the important step to construct CESD nouns is to classify the attributes scientifically.

3.3.1 Classes

The noun word senses in CESD are organized into synonymous sets. These synsets are organized according to the semantic fields. Thus, the classification of nouns should correspond to relatively distinct semantic fields, each with its own vocabulary.

Classes should provide a place for every English noun in CESD and they should cover distinct conceptual and lexical domains. In considerations of these criteria, we analyze WordNet 25 noun classifications. These 25 classifications are selected after considering the possible adjective-noun combinations that could be expected to occur. They cover the domains of tangible things, abstractions, psychological features, natural phenomenon, state, location and so on. After analyzing them, we also compare them with the classification in SUMO. We can conclude that the noun classification in WordNet is relatively scientific and general. Therefore, we decide to adopt these 25 noun classifications in WordNet as the noun classes in CESD.

There are totally 25 classes for nouns in CESD. They are {act, activity}, {animal, fauna}, {artifact}, {attribute}, {body}, {cognition, knowledge}, {communication}, {event, happening}, {feeling, emotion}, {food}, {group, grouping}, {location}, {motivation, motive}, {natural object}, {natural phenomenon}, {person, human being}, {plant, flora}, {possession}, {process}, {quantity, amount}, {relation}, {shape}, {state}, {substance} and {time}. Among them, 8 classes denote the tangible things, they are {animal, fauna}, {artifact}, {body}, {food}, {natural object}, {person, human being}, {plant, flora} and {substance}; 5 classes denote the abstraction, they are {attribute}, {communication}, {quantity, amount}, {relation} and {time} and 3 classes denote the psychological features, they are {cognition, knowledge}, {feeling, emotion} and {motivation, motive}.

3.3.2 Attributes

In OOS attributes are the most important element to classify and distinguish the objects from the others. In conventional dictionaries, nouns are usually defined with their superordinates with distinguishing features. These distinguishing features are the attributes, parts and the function of nouns. Thus, the analysis of the noun attributes is most important in the noun construction in CESD.

As we know, the attributes are numerous and the number of the basic attributes is more or less than 100. Most of the attributes are adjectives. How are the attributes of nouns extracted in CESD? One important feature of our method is to observe and analyze the selected 6,000 words in CESD and then to extract the basic limited attributes. Take *quality* for example, we observe and analyze the words that have the quality attributes among the selected 6,000 words and then confirm 138 sub-attributes at last. First, we integrate the words that have the quality attribute and then we analyze and classify them into 146 sub-attributes of the quality. When we find out that these 146 sub-attributes are not satisfactory or they don't meet the needs, we have to modify these sub-attributes rationally or expand them to some extent. In this way the final quality attribute is confirmed and established with 138 sub-attributes (See Appendix A).

In CESD Attributes are subdivided into two main categories, one is the relational attribute and the other is the internal attribute. These two main categories are hierarchical. They have their own trees. For example, the internal attribute is sub-divided into quality, property, trait, human-nature and state on the principle of the commonly-shared and distinctive attributes.

After we confirm the majority of the attributes, how can we examine whether they are basic or not? We find another 1,000 words to examine whether these confirmed sub-attributes are essential. One principle we must bear is that the confirmed sub-attributes are basic and essential and they can describe all the concepts of the attributes.

To sum up, the induction is the important feature of our method to observe, analyze and classify the attributes from the bottom to the top. Not only the attribute extraction but also the examination and confirmation of the attributes are important and significant in CESD noun construction.

3.3.3 Relations

According to Lyons (Lyons 1977), the senses of a word are actually the semantic relations with other words. For example, the senses of the word *horse* are determined by its semantic relations with other words in the semantic network.

According to OOS, the object doesn't exist solely and it is co-related with others in the semantic network. The object can be defined with its semantic relations with others. Hence, the semantic relations are very important when we construct CESD and nouns.

The semantic relations are paradigmatic and syntagmatic. The paradigmatic relations are about the choice between words, which can substitute for each other in a particular slot in a sentence. Synonymy, antonymy, hyponymy and meronymy are the paradigmatic relations. The syntagmatic relations are about the co-occurrence of the words. The collocations are the syntagmatic relations.

(1) Paradigmatic relations

Synonymy

Synonymy is used in modern semantics to refer to a relationship of "sameness of meaning" that may hold between two words. The synonymy is the semantic relation between word forms.

When talking about synonymy in CESD, we can vary degree of "loose" synonymy, where we identify not only a significant overlap in meaning between two words, but also some contexts at least where they cannot substitute for each other.

All the word senses are organized into synsets. That is to say, a lexicalized concept is represented in CESD by the set of synonyms that can be used in an appropriate context to express that concept. Synsets are the basic building block in CESD. Thus, when a word form is entered, the senses are represented by the synsets with glosses.

Antonymy

Antonymy, though often understood as the oppositeness in the meaning, is in fact a special kind of synonymy. The property they do not share is present in one word and absent or reversed in the other. Thus, to be opposite, two words must be semantically very similar.

Semantic opposition is not a fundamental organizing relation between nouns, but it does exist and so merits its own representation in CESD. Perhaps the most interesting observation about antonymous nouns is

• Attribute

○ Relational Attribute

- Time
- Space
- Social Role

○ Internal Attribute

- Quality
- Property
- Trait
- Human-nature
- State

Figure 1 The classification of attributes in CESD

that noun antonyms nearly always have the same hypernym, often the same immediate hypernym.

Hyponymy

Hyponymy / hypernymy deals with the relationship of semantic inclusion. That is, the meaning of a more specific word is included in that of another more general word (Lyons 1977, Jackson 1988). The specific words are known as hyponyms or lower terms, the general words are superordinate terms or upper terms. For instance, *tulip* and *rose* are hyponyms of *flower*, and *lion* and *elephant* are hyponyms of *animal*. Hyponymy is also the kind-of relation. Here *tulip* is a kind of flower, and *lion* is kind of animal. Also, here the words *tulip* and *rose* are co-hyponyms of *flower* and the words *lion* and *elephant* are co-hyponyms of *animal*. In CESD the co-hyponyms are called *coordinate terms*.

The hyponymy is the most important semantic relation in organizing nouns in CESD. It is asymmetric and (with reservations) transitive. It is this semantic relation that organizes nouns in CESD into a lexical hierarchy. For human users, a graphical presentation of hierarchy may be easier to grasp. One feature of hierarchies is that items that are lower in a hierarchy (that is, more specific) inherit characteristics from the items above them. Inheritance has two aspects. First, conceptually, the definition of a term lower in the hierarchy includes (or implies) the definitions of the terms directly above. The second aspect of inheritance is that objects belonging to a lower class have all the properties of the subsuming higher classes as well.

Hierarchies are widely used by computer scientists as a means of representing knowledge (Sowa 1991). They have the advantage in that information common to many items in the database need not be stored with every item.

Meronymy

Different from hyponymy, meronymy involves part-whole relation between words. Meronymy is the part-of relation. The part-of relation can similarly be represented by a hierarchy of superordinate and subordinate terms (meronyms).

The meronymic relation is transitive (with qualifications) and asymmetrical (Cruse, 1986). Meronymy is found primarily in three noun classifications, they are {body}, {artifact} and {quantity, amount}. There are three types of meronymy in CESD: component-object (branch/tree), member-collection (tree/forest) and stuff-object (aluminum/airplane). The component-object relation is the most frequent.

(2) Syntagmatic relations

In CESD the syntagmatic relations are represented by the lexical phrases. As we know, there are 1875 lexical phrases included in the vocabulary in CECR, and most of them are the verbal phrases. Nearly all the lexical phrases in CECR are the strings of specific lexical items. We only select the phrases which have the CESD noun word forms as the noun lexical phrases. For example, the noun word form result has the lexical phrase as a result in CESD, in which result has a syntagmatic relation with the words *as* and *a*.

4 Application

4.1 Natural language processing

Some computer scientists and linguists have always been researching on the semantics of the natural language, as the semantics is essential to understand the natural language. The classification or the taxonomy is the basic step to understand the natural language. As we know, things are usually described by their superordinates and their own attributes. So how to find out, classify and confirm the superordinates and the

attributes is very important and significant.

This paper has discussed the noun construction based on Object-Oriented Semantics. We have adopted OOS method to construct nouns in CESD as a case study. Nouns in CESD are constructed in four dimensions, they are, classifications, attributes, operations and relations. However, actually, nouns are constructed in three dimensions, classifications, attributes and relations. The operation is neglected on the consideration that it is not important to construct nouns compared with attributes. However, it is very important to construct verbs. In this paper, nouns in CESD are classified into 25 files. We've only found out the basic attributes of nouns because we just want to find out the basic and common attributes. These attributes don't have further subdivisions. They merely have one or two sub-levels. All the classifications and basic and common attributes of nouns in CESD are helpful and constructive for natural language processing.

4.2 Language learning and teaching

CESD is a machine-readable semantic dictionary. Nouns in CESD are represented by the synsets which are the basic building blocks to represent the conceptual meanings. The semantic relations of nouns in CESD are synonymy, antonymy, hypernymy, and meronymy. These four semantic relations are very important in the paradigmatic relations of nouns. All the four semantic relations are linked hierarchically.

The lexical learning is a very important part in language learning and teaching (L&T). A dictionary as the learning tool plays a very important role in lexical learning and vocabulary expansion. However, the standard dictionaries are compiled orthographically. Finding things on an alphabetical list can be tedious and time-consuming. These standard dictionaries only cater for looking up new words. However, they have some limitations for the vocabulary expansion, the semantic lexical learning and the associative lexical learning. However, many semantic relations in CESD can be a great help for language learners to build up their own lexical semantic network. These hierarchical semantic relations can help them learn words analogically.

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The Cognitive Load Theory and Computer-Aided Language Instruction Design Principles

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Abstract: The 21st century has witnessed the wide utilization of computer technology in language learning class and its considerable achievements. However, problems emerge when instructors and designers ignore the work load in learners' learning process. Based on information-processing process, Sweller posed a Cognitive Load Theory to keep the work load of learners below a minimum in the learning process. The article studies some unsuccessful examples in computer-aided instruction and advocates some principles by applying the different aspects of the cognitive load theory in computer-aided language instruction design.

Key words: cognitive load theory; computer-aided language instruction; instruction design

1 Introduction

Computer-aided Instruction has found a niche in modern education, especially in language learning classes. It integrates various media like pictures, automations, images, voices, music and texts to display a totally different world for the learners and diversify the language learning class by bringing concreteness, more interest and reality to the instructional setting. There are numerous research about how these changes affect the ways we learn and teach languages (Chapelle, 2003; Kern, Ware & Warschauer, 2004; Salaberry, 2001; Thorne & Payne, 2005; Zhao, 2003; Richard, 2006), and it is impossible to exhaust them.

There is no doubt that the computer-aided language instruction design explores a new and significant area for language learning and teaching, however, we should not only think of the advantages, but also bear in mind the problems of multimedia technology (Bai, 2003; Cao & Li, 2004; Liang, 2006). Many multimedia coursewares disappoint learners and teachers with their speciosity in design, lack of quality-instruction, and negligence of learners' affective factors. Clark (2001) argued that technology does not cause learning; rather, the instructional methods afforded by technology affect learning. Instructors or designers of computer-aided language instruction have to take into account the effectiveness of learning. Cognitive load theory, posed by Sweller and some other researchers, studies the process of learning and illustrates that instruction should aim to reduce the cognitive load to aid effective learning. Following his theory, there should be some principles to deal with the cognitive load control in computer-aided instruction design, in attempt to guide learners to efficient learning.

2 Theoretical background

Cognitive Load Theory, as defined by Sweller (1988), states that optimized learning occurs in human learning process when the load on working memory is kept to a minimum to best facilitate the changes in long term memory. The contents of long term memory are "sophisticated structures that permit us to perceive,