An Empirical Study of Schema Theory and Its Role in Reading Comprehension[*]

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Abstract—**Schema is the abstract and organized knowledge structure. Access to pertinent schema in reading would greatly facilitated meaning extraction and meaning retention. This paper quantitatively and qualitatively explored the effect of schema and how it works in reading process and finds out that readers with appropriate schema would perform significantly better than those without in both immediate and delayed recalls. That is they would recall more correct ideas and omit fewer ideas and in their expansion of the original text, more elaborations rather than distortions will be found. Besides, readers provided with schema tend to recall the text more coherently and logically.**

Index Terms—**schema theory, reading comprehension, meaning extraction, meaning retention**

I. INTRODUCTION

In his book *Critique of Pure Reason*, Immanuel Kant (1963) claimed that "new information, new concepts, new ideas can have meaning for an individual only when they can be related to something the individual already knows". Pearson & Johnson defined comprehension as "building bridges between the new and the known" (1978, p. 24). That means meaning does not have a separate, independent existence from the reader, and prior knowledge of the reader or schema counts a lot in the extraction of meaning from the graphic words in the print.

II. LITERATURE REVIEW

A. Schema Theory

Under the influence of Gestalt Psychology, Bartlett (1932) was the first person that explored the functioning of schema in the process of reading, but he was still hazy about how schema worked in the reading process at his time, neither did he form a sound theory of it to account for the nature of reading.

It was since the 1970s, with the development of cognitive psychology and people's deepened understanding on the process of reading, that schema once again became the focus of scholars' interest. Since then various names and definitions have been proposed for schema, with Minsky (1975) putting forward "frame" concept, dealing particularly with stereotypical situation, Rumelhart (1977) developing story grammar, analyzing narrative stories; Schank et al. (1977) suggesting script, describing event sequences and Sanford (1981) preferring the term "scenario", referring to typical situations. However various the name or wording for this concept, they share the same essence that readers' prior knowledge directly impacts upon new learning situations and thus can be seen as the variants of schema.

Generally speaking, schema can be defined as the abstract knowledge structure the reader brings to the text. A schema is abstract in the sense that it "summarizes what is known about a variety of cases that differ in many particulars" (Anderson & Pearson, 1988, p. 42) for the economy of our memory.

A schema is structured in the sense that it represents the relationships among its component parts. Far from being linear as the arrangement of words in the print is, what these words evoke in readers' mind is a highly complex and hierarchical structure of certain situation. When human beings experience the world, they mediate or conceptualize their experiences into concepts, relations, etc. through the brain and store them in the memory. These concepts and relations etc. are not stored randomly in the brain, but are combined into "networks composed of knowledge spaces centered on main topics" (Beaugrande & Dressler, 1981, p. 94). In this way, a schema might be representations not only of entities in a certain situation, but also the roles those entities play in the situation. It is the different roles of those entities that connect the entities in the schema into an organized structure.

To put it simply, a schema is a knowledge structure. According to Ausubel et al. (1978, p. 168), it can refer to "significant substantive and organizational properties of the learners' total knowledge in a given subject-matter field" and can also refer to "the substantive and organizational properties of just the immediately or proximately relevant concepts and propositions within cognitive structure" (ibid). In brief, a schema can be a concept or it can be a set of related concepts. It can be about objects, ideas or phenomena (Irwin, 1986, p. 103). For instance, readers probably have a schema for a chair that includes the characteristics of chairs and a mental image of a typical chair. Similarly, they also

probably have a schema for going to a restaurant that includes such things as looking at the menu, paying the bill and so on.

As it is almost impossible for human beings to remember all the specific people, events, objects, impressions etc. they encounter in real life, these abstract yet structured schemata representing the typical or prototypical situations of certain occasions become necessary in understanding their surroundings as well as discourses.

B.   Empirical Studies about Schema Theory

Schema theory was first examined in L1 reading comprehension (e.g. Bransford & Johnson, 1972, 1973 etc.) and was later acknowledged in EFL/ESL reading.   Numerous studies in this area varying in experimental designs and purposes have been carried out and led linguists as well as practitioners to the realization that apart from language problem in EFL/ESL reading, readers' prior knowledge is also a determinant factor for effective and efficient reading.

Numerous studies (e.g. Hudson, 1988; Floyd & Carrell, 1987; Carrell, 1983; Qi&Wang., 1988 etc.)examined the effect of language competence/complexity and prior knowledge on reading comprehension and find out that background information is more likely to determine the comprehension of a passage than linguistic factors. Other studies(e.g. Gatbonton and Jucker, 1971; Steffensen and Joag-Dev, 1984; Levine& Haus, 1985; Kintsch & Franzke, 1995 etc.) explored how content familiarity affected reading comprehension and revealed that subjects familiar with the reading passage recalled and inferred significantly more ideas while those unfamiliar forgot or misinterpreted significantly more ideas.

Still other experiments (e.g. Alderson & Urquhart, 1988 etc.) were carried out to investigate the role of EFL students' background discipline or the knowledge of a particular academic field in reading comprehension and the findings supported that students from a particular discipline would perform better on tests based on texts taken from their own academic discipline than students from other disciplines.

C.   Rational for This Study

The studies mentioned above revealed that schema does influence reader's comprehension of a text, but how it will exert its influence is not fully examined.   Some of the studies only adopted multiple choice questions (e.g. Qi&Wang, 1988) as instruments which increases the likelihood of guessing. Besides, most studies focused on whether schema facilitates meaning extraction in reading, few has explored the effect of schema on meaning retention, which while may be as well important for readers.

In view of these deficiencies in previous studies, this experiment is designed to examine the influence of schema on both EFL students' **reading comprehension** and their **meaning retention** by analyzing both the immediate and delayed **recall protocols** of the subjects.

This research aims to answer two questions.

Research Question One: Do students with pertinent schema **comprehend** better than those without?

Research Question Two: Do students with pertinent schema **retain** better than those without?

III.   METHODOLOGY

A.   Participants

This study took 110 sophomores of two parallel classes from Shandong Trade Union College as subjects, with each class 55 students. The subjects were regarded as the intermediate level in English and   the proficiency of the two groups showed no significant difference. To avoid "Hawthorne effect", the whole process was carried out by their regular English teacher in their normal class environment.

B.   Instruments

This study employed four data collection instruments: one passage for both groups, a questionnaire for the control group, relevant schema for the experimental group, an immediate recall after reading and a delayed recall after a week's interval by two groups.

The reading passage was the description of some activities children and adults would conduct on Halloween excerpted from *The U.S.A. Customs and Institutions*. (For detail, see Appendix A). The passage selected was considered as appropriate for subjects after examined by their teacher and read by other students of the same level with the subjects. And it was assumed that understanding the passages would involve some background knowledge.

To make sure the control group did not possess background knowledge about the passage, they would be assigned a questionnaire in Chinese about Halloween, its origin and activities etc. designed by modifying Levine & Haus' (1985), while the experimental group would be taught pertinent background knowledge before reading (see Appendix B).

Both groups would read the same passage within the same time, and do the same recall task almost immediately after reading. Both groups would be asked to recall the passage again after a week's interval. Both recalls should be done in English.

C.   Procedures

The experimental and control groups were tested respectively in their regular class periods. For the control group,

first a questionnaire was assigned to find out whether they had relevant background knowledge. The questionnaire is composed of 5 questions, 2 points for each. If a student scores above 6 points, he/she would be excluded from the control group. Students who failed to follow the requirements during the experiment were also excluded from both groups. In the final analysis, there left 47 subjects in the control group and 51 in the experimental group.

After the questionnaire completion, the passage was handed out and students in the control group were allowed 8 minutes to comprehend it, and the passage was taken back after that.

To avoid short-term memory effect on the passage, two tasks unrelated to the passage were conducted before the recall. Finally, subjects were allowed 15minutes to recall the text as well as possible in written form in English.

For the experimental group, their teacher first provided them with some pertinent schema on the topic (see Appendix B) and then asked them to read and recall the text following the same requirement for the control group.

A week later, both groups would recall the passage again, with the same requirements as in the first recall. During this interval, both groups were asked not to refer to any reference on Halloween.

D. Scoring

For ease of scoring, the passage containing 252 words was parsed into 82 idea units.

Examples of idea units:

Most American children/ have a wonderful, exciting day/ on Halloween.

(3 idea units)

Both the immediate and delayed recall protocols of two groups were scored according to how many idea units they contained. An idea unit was regarded to have been recalled if it was reproduced verbatim, or if the essential meaning of that particular idea unit was produced. Five types of ideas would be marked: correct recall, overt errors, elaborations (correct expansion of the passage), distortions (incorrect expansion) and omissions (the ideas not recalled). The inter-rater reliability for the scoring of the recall protocols was r=0.96.

IV. RESULTS

Idea units of correct recall, elaborations, distortions, overt errors and omissions were collected in both the immediate and delayed recalls and quantitatively analyzed by SPSS and qualitatively analyzed by the researchers.

A. Quantitative Analysis

To examine whether schema has a role to pay in meaning extraction, the immediate recall protocols of two groups were analyzed into the five categories and compared through Independent-sample T test.

TABLE 4.1
MEAN COMPARISON OF THE TWO GROUPS IN THE ALMOST IMMEDIATE RECALL

group	Correct recall	elaborations	distortions	overt errors	omissions
control group	23.98	0.21	2.28	3.76	58.02
experimental group	28.53	3.84	0.37	3.06	53.72

TABLE4.2
INDEPENDENT -SAMPLES T TEST OF THE TWO GROUPS IN THE ALMOST IMMEDIATE RECALL

	T	df	Sig. (2-tailed)	Mean Difference
Correct recall	-3.192	96	.002	-4.550
Elaborations	-8.109	53.298	.000	-3.630
Distortions	6.364	63.822	.000	1.904
Overt errors	3.511	96	.001	.707
Omissions	3.014	96	.003	4.295

Mean comparison and Independent-Samples T Test showed the experimental group performed significantly better than the control group in their recall of correct idea units and elaborations and at the same time, the control group made significantly more distortions, overt errors and omissions than the experimental group.

To test Research Question Two, similar mean comparison and Independent-Samples T Test for the delayed recall of

the control and experimental groups was carried out and resulted in the following data.

TABLE 4.3
MEAN COMPARISON OF THE TWO GROUPS IN THE DELAYED RECALL

group	correct recall	elaborations	distortions	overt errors	omissions
control group	18.58	0.66	2.64	3.85	63.15
experimental group	22.45	5.64	0.41	3.03	59.33

TABLE4.4
INDEPENDENT-SAMPLES T TEST OF THE TWO GROUPS IN THE DELAYED RECALL

	T	df	Sig. (2-tailed)	Mean Difference
Correct recall	-2.761	96	.007	-3.599
Elaborations	-7.256	56.041	.000	-4.987
Distortions	7.930	70.528	.000	2.226
Overt errors	3.350	96	.001	.811
Omissions	3.038	96	.003	3.815

Mean comparison and Independent- Samples T Test revealed that the experimental group significantly outdid the control group in their delayed recall of correct idea units and elaborations. Meanwhile, the control group produced significantly more distortions, overt errors and omissions than the experimental group in their delayed recall

B. Qualitative Analysis

Apart from quantitative results from SPSS, qualitative difference in recall protocols of both groups was also obtained and analyzed.

Qualitative analysis of the recall protocols by the experimental and control groups revealed that the experimental group not only recalled more correct idea units and made fewer omissions in their almost immediate recall, but also arranged the ideas of the text in a well-organized way with some specific information of the text. In contrast, the control group not only recalled fewer correct idea units and made many more omissions, but also poorly organized the recall.

For example, the control group had more tendencies to make some abstractions rather than recall the specific information in the text. And in the recall of "Some communities build bonfire reminiscent of the Celtic celebrations in the Middle Ages", and "Halloween, which began hundreds of years ago as an evening of terror", few subjects in the control group could fully understand, while the experimental group, provided with the Celtic origin of this festival, obviously outperformed the control group.

Apart from the generalizations and lack of ability to understand some part of the text, some rote memory with little understanding of the passage was also found:

For example: one student in the control group wrote:

American children bring their costumes to school and spend the last few hours of the school day with spooks instead of with book. Trick just so so. Celtic snacking camarel-covered apples, apple cider and pumpkin. Masqurae parties.(I can't understand what I am writing.)

As for the expansion of the ideas, the experimental group made more elaborations, and the control group made more distortions. For instance, one student of the experimental group recalled "They put up their costumes and (go to everyone home) said trick-or-treat"; another recalled "(they went to door to door to ask for something)…"; another wrote, "People can take the Jack-o-lantern to (keep away from ghosts)"; to list just a few. In contrast, a considerable number of subjects in the control group recalled "…they will take [beautiful] clothes to school", or "they dress [very beautifully]".

In the delayed recall, both groups suffered some forgetting during the interval and made more interpretations of the ideas in their recall instead of using the exact wording of the texts. However, except some lack of specific details, the experimental groups could still keep a well-organized text and remain the coherence of the whole text. Yet the control groups could only recall some general and even vague ideas and some part of their recall even could not keep coherent.

The following examples were from subjects of the experimental group.

If not, they (go out and knock at doors) and say "trick-or-treat"…

they wear (mask) and costumes…
(The children ask for gifts. If you don't give them, they will trick)…
They put up bonfires to (drive away the spirits)…
They dress up look like spooks (because they believe spooks look this will be afraid)…

Yet subjects in the control group fossilized some distortions they made in their almost immediate recall and made some rationalization (Bartlett, 1932) according to their general knowledge, or the wrong schemata they fell back upon. For example:

At party, (they dress up differently), and [the most beautiful] will get the prize…
They eat apples and so on. [some recall the past]…
Celtic would build a bonfire，[adults recall past around the fire]…

Another subject, possibly influenced by the spending of some Chinese festival twisted some ideas of the original text to fit the Spring Festival schema.

V.   DISCUSSION

A.   Research Question One

Both quantitative and qualitative analysis revealed that the students provided with relevant schema would comprehend the meaning of the passage significantly better than those without, revealing the facilitative role of schema in readers' extraction of meaning.

In the reading process, the perceived information should go through another two processing systems---working memory and permanent memory (Carroll, 2000, p. 47). Working memory, as many experiments have revealed, has the size limitation as consisting of only about 7 chunks maximally. This limited amount of information in working memory, if neither integrated with information in the permanent memory, nor actively and repeatedly rehearsed, can be lost in "20-30 seconds" (Reed, 1982, p. 89). Due to these limitations of working memory in capacity and duration, for information to be learned, it is necessary to be transferred, either through integrating information on the page with readers' prior knowledge or through actively and repeatedly rehearsing that information, to the permanent memory---which, on the contrary, is unlimited in capacity and duration.

As common sense tells people, the latter kind of transference is just like children's attempt to remember a poem by actively repeating it. It will consume rather long time but yield little meaning for readers. So this kind of transference, in Goodman's (1982) sense, cannot be defined as reading at all. In this case, reading can be fulfilled only through the integration of information on the page with readers' prior knowledge.

Yet how is new information integrated in the reading process? In Ausubel's assimilation theory (1978, p. 124), readers' preexisting knowledge structure or schema (if any) can be defined as "A", and the new information as "a". When a new idea "a" is meaningfully learned and linked to relevant established idea "A" in the reading process, both ideas are modified and "a" is assimilated into established idea "A", creating the new ideational product "A'a'" with new meaning through the integration.

The new ideational product as a unified pattern, establishes various connections among its components, thus "relating the symbolically expressed ideas in a non-arbitrary and substantive fashion" (Ausubel et al, 1978, p. 41) to what readers already know. In this way, the newly learned meaning becomes an integral part of the particular ideational system. Schema, in this assimilation process serves as a supportive background structure or "anchoring ideas" in Ausubel's term (1978, p. 170) to integrate new information.

Besides, in the reading process, having larger and better-connected patterns or schemata to integrate new information will facilitate the processing speed and thus free up more space in working memory. This available space in turn, can be used for reflecting on new information and for problem solving. In this manner, the relevant schema, in fact, helps to solve the problem of the limited capacity of working memory.

In the absence of the relevant schema, readers can only try to transfer this information from working memory to permanent memory through "rote learning" (Ausubel et al., 1978, p. 144) or verbatim and mechanical learning. When information is rotely learned, according to Ausubel et al. (1978, p. 146), it will be "incorporated into the cognitive structure in the form of arbitrary associations". These associations are discrete, self-contained entities, organizationally isolated from readers' established ideational systems.

Various experiments, including this one, however, have revealed that human mind has a rather frail capacity for processing arbitrary and verbatim associations as discrete and isolated entities in their own right. Thus it will take longer time and more effort for readers to process such information in working memory.

In summary, reading with the activation of the relevant schema can easily assimilate new information into the prior knowledge structure in a substantive and non-arbitrary way, thus consuming less time and effort in working memory. On the contrary, reading without the activation of relevant schema will result in long and laborious processing in working memory. Information that is rotely remembered turns out to be hard to be integrated with readers' prior knowledge structure; hence little comprehension resulted.

B.   Research Question Two

It is evident that both meaningfully and rotely learned information will suffer from another memorial

process---forgetting during the interval between reading and retrieval. But according to Ausubel et al. (1978, p. 138), there is an important difference between forgetting that occurs after meaningful learning and forgetting that occurs after rote learning. It is believed by Ausubel et al. (1978, p.143), during the second phase, the retention period itself, meaningfully learned meanings, with the support of relevant schema, tend to be integrated into the relevant ideas in the cognitive structure that assimilate them, thus suffering less forgetting. Rotely learned meanings, on the contrary, tend to be interfered by the incoming of another discrete process, hence more forgetting.

Apart from the superiority of forgetting after meaningful learning to that after rote learning, in retention process, retention resulting from meaningful learning is also superior to that resulting from rote learning. First, since meaningful learning has some advantages inherent in the substantive and non-arbitrary relatability of new ideas to relevant, established ideas in cognitive structure as discussed above, it "circumvents the drastic limitations imposed by the short item retention and time spans of rote memory on the processing and storing of information"(Ausubel et al., 1978, p. 64). New ideas thus processed are demonstrated as incorporated more easily and made more available after learning. Second, a new idea acquired by assimilation to a well-established relevant idea will tend to gain some of the inherent stability of the original idea and hence be retained longer.

In a word, the substantive and non-arbitrary integration of new ideas with established schema makes the acquisition of meaning much easier and faster. At the same time, the stability of the integrated organization or the dissociability of new information from the previous knowledge makes forgetting more restrained and retention more durable.

VI.   FINDINGS AND IMPLICATIONS

The main findings of this study can be summarized as follows:

Quantitative and qualitative analysis of the two groups' immediate recall protocols revealed that schema, serving as the readers' cognitive context and the supportive knowledge to assimilate new information, greatly facilitated the process of meaning acquisition.

Quantitative and qualitative analysis of the two groups' delayed recall revealed that information assimilated into readers' prior knowledge gained more stability and less dissocciability and thus could be retained longer and better than information that had nothing to cling or attach to.

This study provides some invaluable insights into the nature of reading. That is, schema theory, with both its theoretical and practical feasibility and effectiveness as is demonstrated in this thesis, breaks through some traditional views on the nature of reading and sheds new lights on the teaching and learning of EFL reading. Since meaning, as schema theory suggests, does not reside in the text itself, but should be reconstructed by readers through the interaction between the text and their prior knowledge, more attention should be paid to what is going on in the readers' mind and a learner-centered and process-oriented reading method should be highly recommended in hope to bring about great improvement in the effectiveness and efficiency of the teaching and learning of EFL reading.

NOTE

In the qualitative analysis, all examples are what subjects exactly wrote. In the analysis of subjects' recall protocols, information in () refers to elaborations, and information in [] refers to distortions.

APPENDIX A.   THE READING PASSAGE

Most American children have a wonderful, exciting day on Halloween. If Halloween falls on a school day, they bring their costumes to school and spend the last few hours of the school day with spooks instead of with books. After school and perhaps on into the evening, they go trick-or-treat. Often, here is a party at a friend's home or at the local community center. At most Halloween parties, prizes are given for the best costumes. Bobbing for apples, telling fortunes (predicting the future), playing scary games, and snacking on caramel-covered apples, candy, apple cider, and pumpkin pie are all part of the fun. Some communities build a bonfire, reminiscent of the Celtic celebrations in the Middle Ages. The children may sit around the bonfire telling scary stories while roasting hot dogs or toasting marsh-mallows. Halloween, which began hundreds of years ago as an evening of terror, is now an occasion of great fun. It is certainly one of the favorite holidays of American children.

Although Halloween is celebrated most enthusiastically by children, adults sometimes get into the act too. College students and other adults may attend masquerade parties or participate in Halloween parades. Places of business are often decorated with jack-o-lanterns, scary crows and witches. And sometimes a serous, hard-working adult employee will arrive at the office dressed as a tube of toothpaste or a garbage can. No one is too old to enjoy the fun of surprising friends by doing a little creative costuming.

APPENDIX B.   THE QUESTIONNAIRE FOR THE CONTROL GROUP

Please briefly answer the questions:
1. Do you know something about Halloween?
2. What activities would be carried out on this day?

3. Why do people have such activities?
4. What do people usually eat on that day?
5. Why are such a tradition?

APPENDIX C.   HALLOWEEN SCHEMA FOR THE EXPERIMENTAL GROUP

Halloween falls on October 31st.

There are two origins of Halloween, one is from Celtic worship of Death , the other is from the Roman's worship of the God of the orchard. There are two colors associated with the festival: black---linked with death and yellow---associated with harvest.

The legend of the Celtics: the Celtics were said to worship the God of nature, and were afraid of the arrival of winter. Because winter often associated with death or ghosts. October 31 is the last day of a year according to their calendar, and they think ghosts will come out from the grave on that day. Priests often lit a fire to scare ghosts and even threw the harvest grain on the fire as gift to the ghost. The Celtics often wore the same clothes as the ghost and believed that the ghost would not hurt them. Now people will enjoy the fancy masquerade where they would put on every kind of scary clothes.

The children were the happiest in the festival. They can go "treat or trick" to each house to ask for presents. If the owner does not give them, they often do some mischieves, for example painting color strokes in the house, blowing soap bubbles to glass and so on.

Jack-o'-lantern is also from the legend of the Celtics. It is said that they used to keep a candle inside the pumpkin to frighten away the ghost.

The legend of the Romans: The Legend of the Romans mainly is linked to the harvest. After the harvest, Romans show their gratitude to the God of the orchard and would have a feast to enjoy the harvest food.

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