Supporting Online Reading of Science Expository with iRuns annotation strategy

Sunny S. J. Lin*, H. Y. Chen, Yu-Tzu Chiang,
Institute of Education, National Chiao Tung University
1001 Ta-Hsueh Rd, Hsinchu 300, Taiwan R.O.C.
correspondence E-mail: sunnylin.nctu@gmail.com

Guo-Heng Luo, Shyan-Ming Yuan
Departmet of Computer Science, National Chiao Tung University
1001 Ta-Hsueh Rd, Hsinchu 300, Taiwan R.O.C.

The purposes of this study were two folds. First was to design three strategies to help elementary school children reading science expositories online with the supports of an annotation system. The "iRuns" strategies were proposed based on the SOI model of Reading expository text [1] to include (1)"underline" for selecting main ideas, (2)"annotation for connection" to organize important ideas and (3) "summary" for integrating multiple concepts. Then a field study was conducted to explore whether students efficiently adopted iRuns strategies and achieved comprehension on earth science materials. A total of 55 5th and 6th graders from an elementary school participated a 8-week reading club. A plug-in annotation system (COM2ANNO) developed by Huang et al. [2] was adopdeted. Students' underlying, annotation and summary efficiencies were rated more favorable if they hit more main ideas. The results showed that iRuns strategy efficiencies decreased slightly across multiple time points and the high reading ability students' three annotation efficiencies were always better than the low ones. The gaps of iRun strategy efficiencies between high and low reading ability groups was gradually getting closer through series of instruction. Low ability students' strategy efficiencies correlated with comprehension score significantly but the high ones didn't. It indicated that low reading ability students benefited greatly from the iRuns strategies instruction. The annotation efficiecy was affected by using different types of annotating method (type vs. copy-paste). Typing resulted in shorter annotations while copy-pasting produced better quality of annotation which demonstrated more highly relevant main ideas selected across texts.

Keywords—annotation system, online reading, reading strategy, science expository

I. INTRODUCTION

Reading is essential for k to 12 learning in almost all domains of knowledge acquisition. The importance of strategic reading is also postulated to be critical for scientists in pursuing breakthrough [3] [4]. Many science education results found that reading expository text is the initial step to understand science concepts and it has to be continued for the deepening of understanding while an individual involves in hands-on science activity or enquiry [5] [6] [7] [8]. In the Internet era, new type of strategic reading should be developed because of the rapid improvement in information technologies and multimedia/hypertext. However, little is known about efficient learning strategies with respect to these new technologies.

The purposes of this study were two folds. First was to design three strategies to help elementary school children reading science expository hypertexts with the supports of an online annotation system. We developed a package of reading strategies called "*iRuns*," based on the SOI model (Selection-Organization-Integration) of knowledge construction [1]. The *iRuns* strategies include four components:

(1) **I**nitial **R**eading expository hypertext: for scanning and skimming the text, pictures, figures, and animations,

(2) **U**nderline: for the selection of main ideas from hypertexts according to the specific learning goal,

(3) a**N**notation for connecting concepts across texts with hyperlink: for the organizing of important ideas dispersed on relevant hypertexts when the important ideas were selected in the previous stage of underlying and,

(4) "**S**ummary": for the integrating of multiple concepts across linked hypertexts to form a meaningful essay.

Secondly, a field study was conducted to explore whether elementary students could efficiently adopt *iRuns* strategies and gain comprehension on reading scientific expository hypertexts of earth science topics, i.e. earthquake, volcano and El Niño. In sum, the present study attempted to explore how well elementary students could perform the *iRuns* strategy while they read science-topic hypertexts using the plug-in annotation buttons on the browser (strategy efficiency which is explained in the METHOD). In addition, we are interested

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in the relations between reading strategy efficiency and text comprehension and finally we compared differences of reading strategies efficiencies and comprehension between high and low reading ability students.

II. METHOD

A. Participants and Grouping

A total of 55 5th and 6th graders, members of 2011 reading club at an elementary school in Hsinchu city of northern Taiwan, participated and were categorized as high and low reading abilities according to their performances in the pretest of "Reading Comprehension and Summary Test for 3rd to 6th graders" (RCST, [9]). Those RCST scores larger than the average of 55 individuals were grouped as high reading ability (n=24) and else low (n=31).

B. Materials

1) Reading Materials: The expository hypertexts on three earth scientific topics (earthquake, volcano and El Niño) were carefully selected and edited by the authors and displayed in an instructional blog (Fig. 1). Each topic contained a main article and three extended articles linked and displayed as hypertexts. All articles were examined by a readability analysis package to control word frequencies and difficulty level. Average length of all articles was 1270 words and 64% of the words in each article were in the frequent words list recommended for the elementary students (Ministry of Education, Taiwan, 2002).

2) Reading comprehension pre- and post-tests

a) Reading Comprehension and Summary Test for 3rd to 6th graders: We adopted RCST as the pretest to group students as high and low ability. This test is a valid and popular tool for the research and examinations on science reading among Taiwan elementary students.

b) Earth Science Comprehension Test: In 2nd to 7th weeks, after students accomplished the requirement (reading and applying one of the iRuns strategy), we evaluated students' text comprehension by the ESCT which is the posttests that we designed to evaluate conceptual understanding of each earth science topic. Each test is composed of 7 to 12 items.

C. Annotation System

The system adopted to support reading science hypertexts with iRuns strategy is called "The Community Communication Annotation (COM2ANNO, [2])." It was developed by the Distributed Computing System Laboratory (DCSLAB) in National Chiao-Tung University, Taiwan. The system client is a browser plug-in, which is easy to install and deploy on students' computer. For the present study, the annotation server was placed in the computer center of the participant school for faster response time. The system functions of COM2ANNO are described in the following.

1) Underline/Highlight for selecting main ideas: Students can choose partial text content (word, sentence or paragraph) on any web page to highlight main ideas. Underlining aims to select main ideas from a lengthy science expository text which is the basics of reading comprehension. The system will change text color to blue and add underlines for the selected text (see Fig. 1). This is to support the iRuns "underline" for the selection of main ideas from hypertexts according to a specific learning goal and teacher introduced this functions with various main idea selection principles and students were asked to practice. Teacher and peer feedbacks of main idea selection were given.

Fig.1 Underline function for selecting main ideas in a web page

2) Annotation for connecting/organizing main ideas across hypertexts: Students can choose partial text content to create a text annotation box and type in words (unlimited size). The annotated text will be highlighted with yellow color and a mouse event for showing the annotation (see fig. 2). The teacher introduced this annotation function as a support to connect the selected main ideas across texts that can help to integrate important ideas dispersed among relevant hypertexts. Teacher and peer feedbacks also were given.

Fig.2 Annotation function for connecting and organizing main ideas across relevant webpages

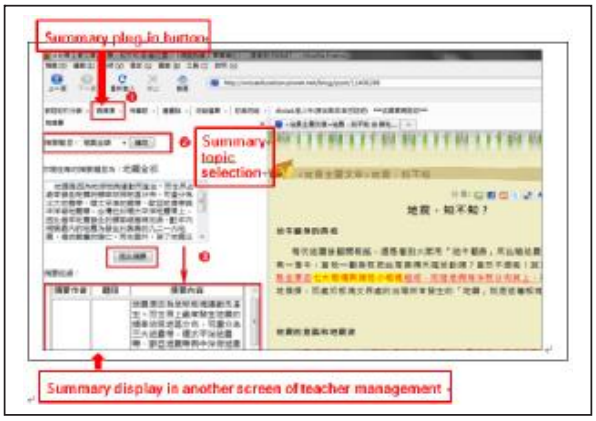

Fig.3 Summary function to form an integrated essay

3) Summary previous annotation message to form an integrated essay: Students can write summary after reading several pages of hypertexts as shown in Fig. 3. The teacher introduced this summary function as a support to integrate concepts (multiple relevant concepts across linked hypertexts) into a single piece of essay in which each paragraph is coherent to a topic. They were encouraged to paraphrase or rewrite the original texts as for knowledge construction. Students are guided for how to condense and structurally explain the main concepts of the relevant hypertexts.

III. Efficiency Ratings of iRuns Strategy

We rated students' efficiencies (quality) of annotations produced from three *iRuns* strategies.

A. Underline efficiency

The "underline efficiency" is to compare whether readers could select the main ideas (or key phrases) that two teachers selected. Teachers' selection served as the scoring rubric. For example, the sentence "Crust is the surface of earth which is composed of seven major tectonic plates and other minor plates" is a main idea in one of the texts of earthquake and "seven major tectonic plates" is the key phrase in this particular main idea. The evaluation formula is: The ratio of main ideas students selected compared with those expert selected

B. Annotation/organization efficiency

The ratio of organization (annotation) quality score to the number of the annotation words

C. Integration efficiency:

The ratio of integration (summary) quality score to the number of the summary words.

D. Procedure

In the first week, several pretests were applied to the students. For each topic of earthquake (four texts) and volcano (another four texts), a teacher conducted two to three week instruction of iRuns reading strategy with teacher demonstration and student practices. In the 2nd to 4th weeks, the teacher introduced the reasons, principles, and various examples of iRuns strategies then students were asked to apply newly acquired strategy to the hypertexts of the main article and extended articles of the first topics, "earthquake." Students were asked to practice, feedback were offered and peers feedback were exchanged.

The hypertexts of volcano and iRuns strategy were repeatedly introduced from the 5th to the 7th weeks following the same instructional procedure. In the 8th week, a posttest session, students need to read a new text "El Niño" and freely apply iRuns strategy to show how well they could use iRuns strategy. Then the "Earth Science Reading Competence test" was applied to measure students' reading competences after the six-week instruction. The underline, organization and integration efficiency of each student was rated by 2 raters.
In 2nd to 7th weeks, we evaluated students' text comprehension by the ESCT.

IV. Results

The major findings of this study are summarized as follows.

A. *The result showed that all three iRuns strategy efficiencies (underline, annotation, and summary) decreased slightly across multiple time points.*

Students' underlying, annotation and summary efficiencies were rated more favorable if their works hit more main ideas provided by the experts. This might indicate that students paid less effort along the instructional period. However, the high reading ability students' three efficiencies were always better than the low reading abilities. However, the gaps of reading strategy efficiencies between the two ability groups were gradually closer through the series of instruction. Those who initially were better in underline excelled than the initially poor ones all the way through the instructional process but the discrepancies were getting closer. If teachers expect to help low reading ability students to improve online reading science materials, students' low motivation over instructional time is an important issue needed to take care and then the instructional package may need to extend over 8 weeks.

B. *Although we instructed the participants to produce annotation for the connection and organization of the main ideas across linked hypertexts, most of our participants intuitively generate annotations to connect main ideas within one webpage*

An annotation to connect main ideas within one page is the most frequent notes took by school children and adults [10] [11]. We found that especially when the difficulty level of the reading materials increased, most annotations produced connected main ideas within a single webpage. The connection

type of annotation may be very difficult for elementary students.

C. The science text comprehension was influenced by the difficulty and familiarity of the reading materials but was not associated with the efficiencies of iRuns strategies.

D. Low reading ability students' three annotation efficiencies correlated with the reading comprehension score significantly but the high ones didn't, especially the organization and integration strategies were of the most obvious.

It indicated that low reading ability students greater benefited from iRuns strategies instruction.

E. The quality of annotating strategy was affected by using different types of annotating (type versus copy-paste).

Typing resulted in shorter annotations while copy-pasting produced better quality of annotation which demonstrated more highly relevant main ideas been selected across texts. This result is conflict with previous studies in which scholars [12] [13] found that copy-paste damaged annotation quality. We suggest that annotation with copy-paste function lessened students' efforts to type allowing more time to select, connect, and organize the relevant main ideas across linked hypertexts. To prevent students copy-pasting all words in a webpage (no selection at all), we suggest to limit the size of the annotation box.

According to the findings of this study, suggestions for teachers, parents and researchers in the future were proposed.

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