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The effect of online summary assessment and feedback system on the summary writing on 6th graders: The LSA-based technique

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ABSTRACT

Studies on teaching of reading strategies have found that summarizing is of tremendous help to reading comprehension. However grading students' summary writings is laborious, but given the importance of summarizing, an effective summarizing learning module is important. This study developed an automatic summary assessment and feedback system based on Latent Semantic Analysis (LSA) to provide score, concept and semantic feedback, and then investigated the effects of concept and semantic feedback on the writing of summaries by students in the sixth grade. The design involved two between-subject factors: semantic feedback (with, without) and concept feedback (with, without). 120 sixth-grade students from an elementary school were recruited for the study, and then were randomly assigned to each group. The overall results demonstrated the effectiveness of the proposed system in improving the summary writing skills of students. The effects of semantic feedback and concept feedback were also discussed.

1. Introduction

Using learning strategies to enhance students' literacy has been recognized as an important approach of teaching (Block & Pressley, 2002; Lan, 2015; Sung, Wu, Chen, & Chang, 2015), among the proposed strategies, summarization is one of the most recommended strategies for developing reading and writing skills (Chang, Sung, & Chen, 2002; Lenhard, Baier, Endlich, Schneider, & Hoffmann, 2013).

A summary is meant to express the important ideas in a text as succinctly as possible. Thus, summary writing tends to be more constrained than open-ended writing styles. The author must understand the text, identify and compile the important points, and finally restate the content in a more concise form in their own words (Kintsch, 1990; Kintsch & Van Dijk, 1978). A summary is the product of summary writing, and has been considered as the representation of a reader's understanding or

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knowledge about a text and has therefore been used as a measure of reading comprehension (Head, Readence, & Buss, 1989). In addition, researchers seeking to develop effective reading strategies (Bean, Singer, Sorter, & Frazee, 1986; Bean & Steenwyk, 1984; Franzke, Kintsch, Caccamise, Johnson, & Dooley, 2005; Malone & Mastropieri, 1992; Weisberg & Balajthy, 1990) have found that instruction or training in summary writing can be of tremendous help to learning performance outcomes, such as retention and comprehension.

Summary writing can be viewed as a helpful learning activity; however, grading students in their summary writing abilities and providing individual feedback is very difficult and time-consuming for teachers. Consequently, many teachers opt not to assign many assignments based on summarization in order to save time for other important tasks. As a result, most students are not provided sufficient opportunities to engage in this effective learning activity. Computer-assisted assessments could be used to assist teachers in the grading of summaries while automatically providing students tailor-made feedback immediately upon completion of their assignments. In this paper, we propose an ensemble approach for improving students' summary writing ability. This approach integrates traditional and newly developed methods: Two traditional summary assessment indices, the "Efficiency of Summarization" by Garner (1982), and "the proportion of important idea units (IMUPIU/IU)" by Head et al. (1989) were used along with two techniques developed recently, namely latent semantic analysis (LSA; Landauer, Foltz & Laham, 1998), an effective automatic summary evaluation method, and concept mapping (Brunt & Karpicke, 2014; Chang et al., 2002), a kind of spatial learning strategy.

The following literature review includes an overview of the proposed summary assessment methods, automatic summary assessment techniques based on LSA, and spatial learning strategies.

1.1. Summary assessment

Numerous methods have been devised for the evaluation of learner performance in regards to summarization, such as Garner's (1982) Efficiency of Summarization, Head et al. (1989) IMUPIU/IU, and LSA-based automatic assessment (Landauer et al., 1998).

Garner (1982) presented the Efficiency of Summarization, which refers the "proportion of number of judged-important ideas included to total number of words in each summary" (p. 275). In that study, 16 graduate students were invited to rate the importance of every sentence in the target text about Dutch elm disease. Then, three important ideas (causes, signs, and remedies) were taken from the target text according to the rated scores of sentences. Finally, Garner and her assistant then identified the three most important ideas in each summary. The number of important ideas and words used in each summary were then counted for use in calculating the summarization efficiency of the students.

Head et al. (1989) used the proportion of important idea units (IMUPIU/IU) as a summary score, which was tallied according to the ratio of the number of important idea units divided by the total number of idea units in the summary. The target passage in that study was parsed into 63 idea units, and assigned one of four scores according to importance, from 1 (least important) to 4 (most important). Summaries were compared with a template of idea units from the target passage for the calculation of IMPIU/IU.

Deerwester, Dumais, Furnas, Landauer, and Harshman (1990) first proposed a statistical method called LSA for indexing documents and retrieval information. The rationale behind LSA is the use of a 2-D term-to-document occurrence matrix for the presentation of relationships between words (terms) and texts (documents). Each element in the matrix refers to the frequency of a term appearing in a document. The matrix is then transformed using singular value decomposition (SVD) in order to construct a semantic structure with fewer dimensions. The semantic space preserves only essential semantic relationships between words and texts rather than surface syntactic features; therefore, Deerwester et al. (1990) named this approach latent semantic analysis.

Landauer and the LSA research group introduced the LSA method to the fields of language research (Landauer et al., 1998) and automatic summary assessment (Foltz, Kintsch, & Landauer, 1998). They built a 60,768 $\times$ 30,473 term-to-document occurrence matrix using the Grolier Encyclopedia as a textual input, and then transformed the occurrence matrix using SVD and dimension reduction methods into a semantic space with approximately three hundred dimensions. The semantic space made it possible to conduct analysis on the meaning of every word, sentence, passage, or text, which could be projected into the semantic space to obtain a vector. The proximity (cosine value) between two vectors is used as an indicator of the similarity between two words, sentences, or texts. The higher the cosine value, the greater the similarity. Because LSA can be used in this way, it can also be used to measure the similarity between source texts and summaries.

1.2. Summary assessment and feedback techniques

Automatic feedback and assessment systems might lessen the work load of teachers when they teach summary writing. Kintsch et al. (2000) employed LSA in the development of two automatic feedback systems for the writing of summaries. These systems were referred to as "State the Essence" and "Summary Street." In both, LSA is used to calculate the relationships between student summaries and source texts, whereupon feedback is immediately relayed to students. The general feedback information provided by these systems deal with (a) spelling, (b) length, (c) an overall score, and (d) the adequacy of section coverage and overall content coverage. In addition, the students could also request checks for (e) redundancy, and (f) relevance.