Development of Learning Support System for Critical Reading of Academic Papers

Aota NISHIDA[a], Kazuhisa SETA[b*] & Yuki HAYASHI[b]
[a]*Colledge of Sustainable System Sciences, Osaka Prefecture University, Japan*
[b]*Graduate School of Informatics, Osaka Metropolitan University, Japan*
*seta@omu.ac.jp

Abstract: Critical reading skills, which require learners to examine texts from multiple perspectives rather than relying solely on what is written, play an essential role in reading academic articles to acquire high-level literacy. Several systems have been developed to support the improvement of critical reading skills; however, there is no system that follows the learners' thinking and the process of reading articles at the content level and provides feedback that captures the semantic connections specific to the research domain. Therefore, we propose a support system for critical reading of academic papers, which has a function to help learners organize the contents of academic papers to promote awareness of essential viewpoints that encourages their critical reading based on semantic connections specific to the research domain.

Keywords: Critical reading of academic papers, research activity ontology, dynamic intervention based on ontology

1. Introduction

Reading and writing skills such as understanding advanced texts, critically examining them, and writing papers are called "high-level literacy," the need to develop such skills has been pointed out in recent years in secondary and higher education. In response to the expansion of the number of learners who enter universities and to social demands, many universities have begun offering various study and academic skills as part of first-year education or remedial education. Critical reading skills, which require learners to examine texts from multiple perspectives rather than relying solely on what is written, play an essential role in reading academic articles to acquire high-level literacy. To develop these skills, it is essential to understand the writer's thoughts in a way that allows the reader to follow their own thoughts and form their own ideas after thoroughly examining them (Norris, et al., 2013, Duke, N. K., & Carlisle, J. F., 2011, Pearson, P. D. et al., 1992)..

Okochi states that there are three aspects to critical reading activities (Okochi, 2012) (Figure 1). The first is the aspect of "examining one's own understanding" (comprehension monitoring) by examining whether one understands the author's argument correctly, the second is "examining the writer's logic" by examining the logical line of the writer, and the third is the productive aspect of "deepening one's thinking" by considering new problems and alternative solutions to the writer's logic that one has understood.

In general, we define "critical reading" as productive activities to deepen one's own thinking while understanding and examining the author's logic while reading academic articles, and this study aims to develop critical reading skills.

In this study, we encourage learner's self-dialogue in which the author's thoughts and one's own thoughts on the author's thoughts formed from the author's argumentation are interactied. Based on the idea, we propose a support system for critical reading of academic papers, which has a function to help learners organize the contents of academic papers by comparing their ideas with those of authors and a function to compare the organized contents of reading and to promote awareness of critical viewpoints.

Figure 1. Critical Paper Reading Support System

2. Critical Reading Support System

We developed a critical reading support system that encourages productive dialogue. The system interface is shown in Figure 1. The system has a function to support the organization of the contents of an article by comparing the author's and one's ideas and a function to compare the organized reading contents and promote awareness of critical perspectives.

The system is a server-client model that can be used anywhere and anytime. By uploading a PDF file of an article, learners can read it in the same format as they usually read it and comprehend the article with their dialogue. The learner reads the paper displayed in the paper display area (Fig. 1(ii)). In the question presentation area (Fig. 1(iii)), a question that encourages deepening and consideration of the content of the paper (e.g., "What are the difficulties that learners have that prevent them from achieving their learning goals?") is presented by the system. Using this question as a guide for reading comprehension, the Thought Organization Map (Fig. 1(i)) provides a thinking organization environment that allows the learner to separate the author's ideas from his or her own and to organize them relative to each other (Mori, N., et al., 2020). The learner reads the article while marking it and expresses his or her understanding of the author's arguments and ideas on the map using the question.
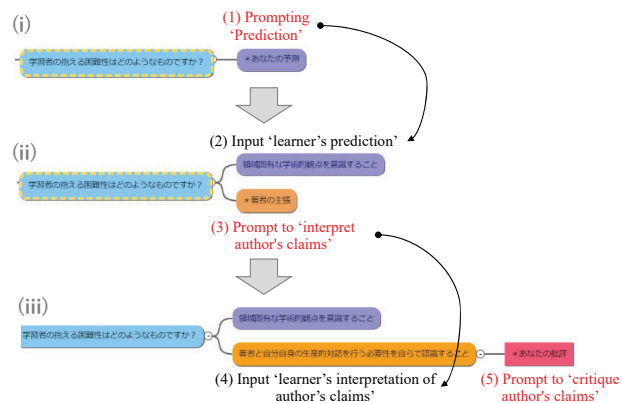

Figure 2. Example of presenting nodes that encourage self-dialogue between the author and his/her thought

2.1 Thinking Organization Support Map

When a learner adds a question that he/she thinks should be considered as a question node on the thought organization map, a purple "prediction node" labeled "your prediction" is automatically added as a child node to encourage the formation of his/her idea (Fig. 2(i)). When the learner responds to this prediction node, an orange "interpretation node" labeled

"author's claim" is automatically added (Fig. 2(ii)). As the learner continues to read, he or she is encouraged to dig deeper relative to his or her prediction, editing and positioning the node's contents when the author's claim appears later. A "critique node" that critiques the author's ideas, labeled "Your Critique," is also automatically added (Fig. 2(iii)). This "critique node" requires the assignment of semantic tags that express the critique viewpoints (value judgments, issues, opinions, etc.), which are hierarchically arranged in advance, so that learners can compare their predictions with the author's claims and deepen their thinking. In this way, the nodes are presented step by step in the order of "prediction," "interpretation," and "critique" for each question, and these cognitive activities are aimed at making the author's claims relative to their own. These are performed in a chain-like manner, systematically representing the process of internal self-dialogue during reading in a mind map format.

2.2 Cross-referencing Function

Cross-referencing function between a node and article texts is also provided. A node and the text it refers to are highlighted in the same color according to the node type. This is achieved by converting the article file read in pdf format to HTML format, enclosing each text of the article with tags and giving it a unique ID, and assigning the unique ID of each node to the text information selected by the learner. This mechanism allows the system to capture the thoughts of multiple learners who have read the same paper and what they read. Thus, the system enables learners to organize their thinking while examining the contents of the paper and the results of their thinking as appropriate during reading and to compare the reference structure of the paper with the maps of other learners who have read the same paper after reading it.

3. Concluding Remarks

This study focused on three aspects of developing critical reading skills. We defined *critical reading* as a productive activity that deepens one's thinking while understanding and examining the author's logic in reading academic articles. The functionality of the system could only be realized based on the ontology in which concept definitions specify semantic relationships specific to the intelligent tutoring system research domain (Chen, L., & de Oliveira, R., 2021, Mizoguchi, R., 2003).

We will verify whether the critical reading comprehension support system described in Section 2 can be used in actual practice. After confirming that the system works as intended, we will conduct a questionnaire survey to determine whether using the system to read papers has a potential leading to a change in learners' attitudes toward critical reading comprehension.

References

Chen, L., & de Oliveira, R. (2021). Enhancing critical reading skills with technology: A systematic review. Computers & Education, 174, 104271.

Duke, N. K., & Carlisle, J. F. (2011). The development of reading comprehension. The Oxford Handbook of Reading, 2, 277-297.

Norris, S. P., & Phillips, L. M. (2013). How literacy in its fundamental sense is central to scientific literacy. Science Education, 97(2), 224-240.

Okochi, Y. (2003). The Roles of Structural Aspects of Texts on Critical Reading. The Bulletin of the Graduate School of Education in the University of Tokyo, 43, 305-313.

Pearson, P. D., Roehler, L. R., Dole, J. A., & Duffy, G. G. (1992). Developing expertise in reading comprehension. What Research Has to Say About Reading Instruction, 2, 145-199.

Mizoguchi, R. (2003). Tutorial on ontological engineering. New Generation Computing, 21, 363-364. https://doi.org/10.1007/BF03037310

Mori, N., Hayashi, Y., & Seta, K. (2019). Ontology-based Thought Organization Support System to Prompt Readiness of Intention Sharing and Its Long-term Practice. The Journal of Information and Systems in Education, 18(1), 27-39.