Acquiring Knowledge from Scientific Texts through Graphic Organizers and Question Generation

Angela O'Donnell
Rutgers University
10 Seminary Place, New Brunswick, NJ 08901, USA
angela.odonnell@gse.rutgers.edu

Abstract. The purpose of the study was to compare the effectiveness of the collaborative use of a graphic organizer or a question generation strategy on students' learning about the circulatory system. 192 students from five 7th grade classes and four 8th grade classes within the same school participated. Students were taught to use either graphic organizers or to generate questions. They were asked to generate *fact* questions whose answers could be found in the texts. They were also asked to generate *connection* questions whose answers required the integration of information in the text. Students who used graphic organizers were more successful than those who generated fact and connection questions. However, the interaction of grade level with condition qualifies this finding. Seventh graders did better in the fact/connection question condition than in the graphic organizer condition whereas the eight graders did as well in either condition.

Keywords: collaboration; graphic organizers; questioning

Overview

The research reported here involves an examination of middle school students as they work in collaborative groups to come to an understanding of the circulatory system. Collaboration among peers is known to enhance reasoning and conceptual development under some circumstances. One clear finding from the literature is that the quality of outcomes is linked to the quality of interaction of the group members. An important issue for both teachers and researchers lies in understanding how to promote and sustain high quality discourse in groups. Students in the middle school are only beginning to develop self-regulatory skills necessary to maintain focus, direct strategic cognitive actions in the pursuit of goals (Zimmerman, Bandura, & Martinez-Pons, 1992). Left without support, students may flounder. The research described below examines the effects of two strategies for providing cognitive support to the collaborative group with the goal of promoting high levels of discourse. One strategy involves students planning how to go about making a complex comparison by listing ideas and organizing and grouping those ideas. A second strategy involves students in planning by generating sets of comprehension and elaboration questions that they then use in making the comparison

Promoting Effective Discourse

Learning of many different kinds of knowledge (declarative, procedural, conditional) can be facilitated by group interaction. The quality of that group interaction, however, is important in determining who benefits from group learning and what is learned. Effective discourse can be difficult to achieve, especially when students are young, lack the metacognitive skills to direct and regulate their own cognition, and are addressing complex and abstract concepts (Palinscar & Herrenkohl, 1999; Webb, 1989; 1992; Webb & Farivar, 1994, 1999). The skills required to monitor and regulate the level of cognitive activity of a group are not typically well developed in middle school children.

One strategy for distributing the scaffolding of effective discourse is the use of graphic organizers or knowledge maps (Hall & O'Donnell, 1996; O'Donnell & Dansereau, 2000). A second strategy for promoting good discourse is the use of questions. Providing questions can focus students' attention on salient features of the task but may limit their problem-posing and idea generation (King (1992, 1994; King, Staffieri, & Adelgais, 1998).

Method

192 students from five 7th grade classes and four 8th grade classes within the same school participated. The school was in a lower socioeconomic district and English was the first language of 56% of the students. Classes were assigned to either a Graphic Organizer group or a Questioning

group. On the first day, all students took a prettest. The students in the Graphic Organizer were then provided with a list of structures of the human circulatory system in the form of a graphic organizer and were asked to find out the functions of these. The students in the Questioning group were asked to generate Fact or Connection questions about the human circulatory system. A *fact* question required students to generate questions that asked for declarative knowledge (e.g How many chambers are there in the human heart?). Connection questions asked students to link information from different parts of the text (e.g., How is the circulatory system of the earthworm different from that of a grasshopper?). On successive days, the students worked on material related to the earthworm's and the grasshopper's circulatory systems. On the third day, students also worked together to compare the circulatory systems. On the final day of the study, the students took the posttest.

Results and Discussion

Both pre- and posttests included true/false items and a series of open-ended items. Students' responses to the open-ended questions were rated using a four-point scoring rubric. A 2 (Gender: Male or Female) x 2 (Condition: Questions vs. Graphic Organizer) was conducted on the percent change in correct answers on the judgments of true or false. Female students improved more than male student, $\underline{F}$ (1, 188) = 7.3, $p \leq .01$. Those using graphic organizers improved more than those generating and answering fact and connection questions, $\underline{F}$ (1, 188) = 15.2, $p \leq .01$. Students were successful in learning about the circulatory system. The true/false questions tapped into many common misconceptions held by students (Chi, Chiu, & De Leeuw, 1992) and the improved performance by students on the posttest indicated a reduction in misconceptions.

A 2 (Condition: Question or Graphic Organizer) x 2 (Gender: Male or Female) x 2 (Grade: 7^{th} or 8^{th}) analysis of variance with the total posttest score as the dependent measure was conducted (see Table 1). One eighth grade class was eliminated from the analysis to equalize the number of classes involved. A significant main effect of condition, $\underline{F}$ (1, 165) = 8.7, $p \leq .01$and a significant interaction between Condition and Grade level was also found $\underline{F}$ (1, 165) = 13.9, $p \leq .01$). Students who used graphic organizers were more successful than those who generated fact and connection questions. However, seventh graders did better in the fact/connection question condition than in the graphic organizer condition whereas the eight graders did as well in either condition.

The previous analysis included both honors classes and classes that had within-class support for students with special needs. Separate analyses were conducted for the advanced classes and for classes with in-class support. The analysis for the advanced classes showed a marginally significant main effect for Condition ($p = .054$) a significant effect for grade level, $\underline{F}$ (1, 114) = 15.7, $p \leq .05$).and a significant interaction between grade level and condition, $\underline{F}$ (1, 114) = 6.7, $p \leq .05$). Students in advanced classes in the eight grade performed better if they were in the Graphic Organizer group than if they were in the Questioning group. Seventh graders did equally well in both treatment conditions. There were no significant effects in the analysis of the classes with in-class support. The average performance of the classes with in-class support was lower than the other classes and although the strategies helped students' learn, there was little effect of the type of strategy. For advanced students, however, the picture was different. Eighth graders did better with the graphic organizer as it may have required less effort than the question generating strategy.

References

Chi, M. T. H., & Bassok, M. (1989). Learning from examples via self-explanations. In L. B. Resnick (Ed.), *Knowing, learning, and instruction: Essays in honor of Robert Glaser* (pp. 252-282). Hillsdale, NJ: Lawrence Erlbaum Associates.

Hall, R. H., & O'Donnell, A. M. (1996). Cognitive and affective outcomes of learning from knowledge maps. *Contemporary Educational Psychology, 21,* 94-101.

King, A. (1992). Facilitating elaborative learning through guided student-generated questioning. *Educational Psychologist, 27,* 111-126.

King, A. (1994). Guiding knowledge construction in the classroom: Effects of teaching children how to question and explain. *American Educational Research Journal, 31,* 338-368.

King, A., Staffieri, A., & Adelgais, A. (1998). Structuring tutorial interaction for mutual peer tutoring: Effects on knowledge construction and responsibility for learning. *Journal of Educational Psychology, 30,* 134-152.

O'Donnell, A. M., & Dansereau, D. F. (2000). Interactive effects of prior knowledge and material format on cooperative teaching. *Journal of Experimental Education, 68,* 101-118.

Webb, N. M. (1989). Peer interaction and learning in small groups. *International Journal of Educational Research, 13,* 21-40.

Webb, N. M. (1992). Testing a theoretical model of student interaction and learning in small groups. In R. Hertz-Lazarowitz & N. Miller (Eds.), *Interaction in cooperative groups: The theoretical anatomy of group learning* (pp. 102-119). New York: Cambridge University Press.

Webb, N. M., & Farivar, S. (1994). Promoting helping behavior in cooperative small groups in middle school mathematics. *American Educational Research Journal, 31,* 369-395.

Webb, N. M., & Farivar, S. (1999). Developing productive group interaction in middle school mathematics. In A.M.. O'Donnell & A. King (Eds.), *Cognitive perspectives on peer learning, 1*17-149.

Zimmerman, B. J., Bandura, A., & Martinez-Pons, M. (1992). Self-motivation for academic attainment: The role of self-efficacy beliefs and personal goal-setting. *American Educational Research Journal, 29,* 663-676.

Table 1: *Descriptive Statistics of the Posttest Score*

Experimental Condition	Gender	Grade level	Mean	Std. Deviation	N
Fact Connection Questions	Male	7.00	27.2500	7.8273	16
		8.00	25.0000	6.2576	20
	Female	7.00	27.1250	5.8407	24
		8.00	20.8750	7.2099	16
Graphic Organizers	Male	7.00	25.3448	7.6871	29
		8.00	30.1154	5.5952	26
	Female	7.00	27.3889	6.6433	18
		8.00	29.8333	7.1546	24

Table 2: Descriptive Statistics of Total Posttest Score for Advanced Classes

Experimental Condition	Gender	Grade Level	Mean	Std. Deviation	N
Fact Connection Questions	Male	7.00	31.6667	6.5574	9
		8.00	26.0000	5.5136	11
	Female	7.00	29.3333	4.5774	15
		8.00	23.0000	7.4981	10
Graphic Organizers	Male	7.00	29.2857	7.3215	14
		8.00	30.1154	5.5952	26
	Female	7.00	30.1538	5.2097	13
		8.00	29.8333	7.1546	24