Effects of The Representational Structures on Pupils' Image Reading Understanding

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Abstract. Based on visual grammar this study explored the effects of representational structures of image on pupils' understanding of nervous system. Three images of nervous system from a current textbook were selected as Target Images and examined in terms of conceptual and narrative representation, and then they were modified as Modified Images based upon the reading difficulties of TIs. Two image reading understanding diagnostic probes were developed that having exactly the same verbal description with TIs and MIs, respectively. 140 students were administered to these two probes randomly. Major findings include: Only a portion of students (20%~67%) read correctly both the conceptual and narrative domains from the TIs. Meanwhile, the MIs readers outperformed significantly on both domains. The implications for science textbook editing and science teaching and learning were discussed.

Keywords: Visual grammar; nervous system; image reading comprehension.

Introduction

Nervous system is one of the topics that troubles student learning biology (Bahar, Johnstone & Hansell, 1999). Content analysis indicates that there are two facets of foci of this topic in junior high science textbook: the conceptual aspect that depicts the part-of and kind-of relations between and/or within nervous system and subsystems; and the narrative aspect that states the dynamics of neural transmission. Each is complicated for beginners. To help readers understand human nervous system, varieties of image are designed and deployed in textbooks as well as verbal discourses. In contrast with image, verbal text reading comprehension has received much more attention both in psychology and science education. Though the importance of the role of image in science learning is recognized, the factors of image that affects readers' comprehension need to be explored theoretically and empirically if image is believed to be helpful in improving learners' understanding.

Systemic functional Linguistists claim that language serves three major functions: to represent experience, to set up and sustain interaction between people using language, and to create connected and coherent discourse (Unsworth, 2000, Halliday & Martin, 1993). Furthermore, the language features of science texts have been explored (Halliday, 2004) and applied in school science text construction (Unsworth, 2001) and school science text reading comprehension (Hsu & Yang, 2007).

As a mode of language, visual image also serves the functions to represent experiential world ("representational" function), to project the relations between the producer of a sign or complex sign, and the receiver of that sign ("interactive" function), and to allow the realization of different textual meaning with different compositional arrangement ("compositional" function) (Kress & van Leeuwen, 2006). It is possible to apply such visual grammar to explore the features of image of school science textbooks and its effects on students' science learning.

Representational structure is one of the most important elements of image and image reading understanding, since it encompasses the "conceptual" and the "narrative" domains of image. The former represents the classes, compositions, and meanings of the science objects of experiential world by visual image; the latter describes the unfolding actions, process of change, and transitory spatial arrangement among science objects.

Questions

The conceptual and narrative aspects are two main components of nervous system images. In this study three questions were investigated. (1) What conceptual difficulties will be encountered when students read nervous system images? And similarly, (2) what narrative difficulties will be encountered as student read them? As soon as the representational features of such images were explored empirically and examined on the perspective of visual grammar, these images could be modified. Then, (3) what were the effects of these two sets of images on students' conceptual reading comprehension of nervous system?

Design

A two stages study was designed to answer the three questions. The first stage was to answer the first two questions. Based upon the conceptual and narrative aspects of nervous system, three images were select as 'Target Images' (TIs) from a current textbook. A Diagnostic test of Image Reading Difficulty (DIRD) was developed to probe student image reading difficulty. Thirty students who had finished the school teaching of nervous system participated in the first stage study. Based on student performance on DIRD, the visual characteristics of these images were examined in terms of visual grammar, and modified into corresponding Modified Images (MIs).

MIs modify the following representations of TIs: (a) implicit classification into explicit classification. (b) Replacing exhaustive analytical process with inclusive analytical process. (c) Rearranging symbolic representation of the objects of images to be consistent with other conceptual elements. (d) Adjusting typological representation into topographical representation to help the readers make real sense of image. (e) Deploying unidirectional and bidirectional action processes separately. In addition, several modifications with respect to framing and modality were also being considered.

At the second stage, two instruments, 'Test of Image Reading Comprehension with TIs/MIs', were formed with TIs and MIs, respectively. These two tests have exactly the same item description but different images. 140 8^{th} and 9^{th} graders participated in this study to answer the third research question. Coefficient alpha of the measure is 0.77.

Findings

Conceptual and Narrative Understanding Difficulties of TIs

About three quarters students failed to differentiate cranial from spinal nerve reprented in the image. At best only two third students reported correctly about the classification of nervous system and the distribution of nerves inside of hands and legs, meanwhile only about one fifth students could identify the paths of reflex action and conscious control moves. These results suggest that the conceptual component of the TIs function improperly to help students retrieve what they have learnt of nervous system.

Students performed little better in reading actions, processes of change, and transitory spatial arrangement represented in the TIs, however, TIs failed to help the readers to recall the narrative nature of nervous system.

Comparisons of TIs and MIs

Table 1 summarizes students' understanding of reading TIs and MIs. For the sub-domains of conceptual representation, MIs readers gained significant higher level of comprehension than TIs

readers. Although no significant difference on the 'symbolism' sub-narrative domain, the MIs readers outperformed on the 'action' and 'conversion' parts of narrative representation.

Table 1: Performance on target and modified images

Domain	Sub-domain	# of Item	Average Performance		P
			MIs	TIs	
Conceptual	Classification	3	2.46	2.01	0.00
	Composition	4	3.17	2.53	0.00
	Symbolic	5	4.10	2.90	0.00
	Total	12	9.74	7.27	0.00
Narrative	Action	3	2.54	1.87	0.00
	Conversion	2	1.29	1.06	0.03
	Symbolism	3	2.30	2.23	0.55
	Total	8	6.13	5.15	0.00

Discussion

The present study shows the possibility to modify current version of images into a more effective version that improves readers to retrieve and recall what they have learned. The possibility is realized by the 'visual grammar'. In the same way, it might be also effective to construct images that are friendly for the beginning learners. It's could be a valuable attempt to improve the quality of overall science text editing in terms of the grammar of science language and visual grammar jointly. Moreover, science teaching should take image reading as well as verbal text reading into consideration.

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