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An Analysis of Collaborative Visualization Processing of Text Information for Developing e-Learning Contents

Eunmo SUNG*
Seoul National University
Korea

The purpose of this study was to explore procedures and modalities on collaborative visualization processing of text information for developing e-Learning contents. In order to investigate, two research questions were explored: 1) what are procedures on collaborative visualization processing of text information, 2) what kinds of patterns and modalities can be found in each procedure of collaborative visualization of text information. This research method was employed a qualitative research approaches by means of grounded theory.

As a result of this research, collaborative visualization processing of text information were emerged six steps: identifying text, analyzing text, exploring visual clues, creating visuals, discussing visuals, elaborating visuals, and creating visuals. Collaborative visualization processing of text information came out the characteristic of systemic and systematic system like spiral sequencing. Also, another result of this study, modalities in collaborative visualization processing of text information was divided two dimensions: individual processing by internal representation, social processing by external representation.

This case study suggested that collaborative visualization strategy has full possibility of providing ideal methods for sharing cognitive system or thinking system as using human visual intelligence.

Keywords : collaborative visualization, human visual intelligence, text representation

* Korea Human Resource Research Center, Seoul National University
eunmo04@snu.ac.kr

Introduction

In a knowledge-based society where the amount and the speed of knowledge growth in on a rapid increase, it is required the way to acquire knowledge in an effective and efficient manner rather than just to learn the knowledge. In this context, e-learning has been paid interest and attention in the area of educational technology. E-learning, in other words "computer-mediated learning" deals an issue of "in what way information represent" in an efficient manner to a very limited computer screen (Sung, 2009; Heo, 2006; Kim, 2006).

From this point of view, one of the possible representing ways which enables to display text information efficiently can be visualization of text information. Visualization of text information, which represents the conceptualized information by conveying text information in easier manner has been regarded as a critical factor in terms of storyboarding-which is named as the blueprint for the final contents, user interface design, and interaction design, particularly in the process of e-learning contents development. However, it is not simple task how to visualize the text information to each individual partly because semantic structure of represented text information may differ to individuals' characteristics. And thus it may cause less effectiveness and efficiency due to instructional designer's and developer's subjective, various and inconsistent visualization. To address the limits, collaborative visualization is to suggest. In the actual process of development, subject matter experts, educational technologist, and/or peer designers and developer tend to collaboratively visualize the text information and carry out with its revising and elaborating job.

Collaborative visualization may be useful strategy for developing better e-learning contents as well as an analysis tool for designers or developers to elaborate contents by realizing the activated construct of knowledge that they utilized in the process of visualizing text information. For better and more effective way of developing e-learning contents, collaborative visualization may be a working strategy to construct text information in more systematic manner as tools for visual

communication.

At this point, it is necessary to investigate i) in what process the text information transform into visual information, ii) in each procedure of visualization what features and characteristics appear.

In the present study, it aims to explore in what process collaborative visualization of text information involves, and to define detailed procedures involved and its features in terms of e-learning content development. The results expect i) to provide theoretical insights or grounds which explain strategies and methods of collaborative visualization that enables learners to acquire text information in effective manner, and ii) to provide theoretical foundation to develop learning tools that learners share by means of strategies of learning environment design and construction, and individual visualization or representation of his or her own knowledge.

Research Questions

The purpose of this study is to explore procedures and process on collaborative visualization of text information for developing e-Learning contents. In order to investigate collaborative visualization processing of text information explored the following questions:

1) What are procedures on collaborative visualization of text information?

2) What kinds of modalities can be found in each procedure of Collaborative visualization of text information?

Method

Participants

The participants in this research were a couple of graduate students, one male

and female who were master degree programs in educational technology at S university.

They have been previously experienced design for e-Learning contents, which is especially storyboard design. However, they have never been trained collaborative visualization for developing e-Learning contents.

Data collection

In order to data collection about collaborative visualization processing of text information, this research was applied think-aloud protocols. This method allows understanding the thought process during collaborative visualization processing of text information. This method means that the subject keeps on talking, speak out loud whatever thoughts come to mind, while performing the task at hand. Thus, think-aloud protocols is thought to be more objective in that participants merely report how they go about completing a task rather than interpreting or justifying their actions (Ericsson & Simon, 1993).

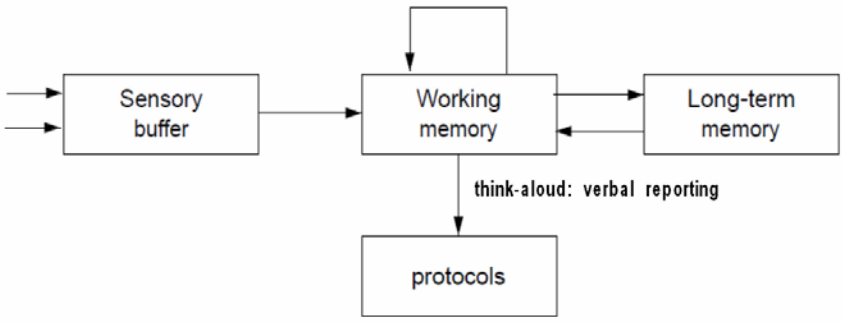

Figure 1. Model of think aloud protocols

Related this aspects, the subject was asked to talk aloud, while designing storyboard for developing e-Learning contents and this request was repeated if necessary during the collaborative visualization process thus encouraging the

subject to tell what he or she was thinking. This involves participants only describing their action but not giving explanations during collaborative visualization of text information.

The subject matter of given text to participants was 「solutions of the environment pollution」, which was consisted 526 words, 10 sentences, 6 paragraphs. The participants were conducted storyboard design through collaborative visualization.

Different sources of evidence were used to triangulated the data, including transcripts of recorded verbal reporting data by video-camcorder and MP3 player, participants observation note by researcher, and interview data of participants.

Data analysis

The collected qualitative data that came from videotape or MP3 player, observations, and interviews was analyzed qualitatively by means of protocol analysis. In analyzing data, method of grounded theory was employed. Grounded theory was three main phases; open coding, axial coding, and selective coding(Strauss, 1987).

Table 1. Three phases of Grounded theory

Phases	Stage	Purpose
Open Coding	Codes	Identifying anchors that allow the key points of the data to be gathered
Axial coding	Concepts	Collections of codes of similar content that allows the data to be grouped
Selective coding	Categories	Broad groups of similar concepts that are used to generate a theory

Open coding is identifying anchors that allow the key points of the data to be gathered through data reduction on the first level of abstraction. The key points are marked with a series of codes that written data from field notes or transcripts are conceptualized line by line. Axial coding entails conceptualizing from coded data. Concepts are grouped into similar action modality, in order to make them more workable. From this process was identified a frequently occurring patterns or theme on collaborative visualization processing. Selective coding is forming theoretical framework from these concepts categories, which are the basis for the creation of a theory. This phases is done after having found the core variable or what is thought to be the core, the tentative core. The core explains the behavior of the participants in resolving their main concern.

Regarding validity of coding, triangulation strategies was employed in this study including cross checking participants and using multiple data resources(Krefing, 1991; Coffey & Atkinson, 1996). Especially, for elaborating code and concepts on collaborative visualization processing, researcher frequently asked participants if researcher's understanding about what they said was correct.

For convenience of coding, NVivo version 2.0 was employed, computer-assisted qualitative data analysis software.

Findings

Procedures of collaborative visualization processing of text information

The result of data analysis emerged six stages on collaborative visualization processing of text information: identifying text, analyzing text, exploring visual clues, creating visuals, discussing visuals, elaborating visuals, and creating visuals.

Table 2. Procedures of collaborative visualization processing of text information

Dimension	Stages	Activities
Individual level	Identifying text	• Reading the problem • Underlining • Boxing, Circling • Numbering
	Analyzing text	• Re-reading the problem • Searching key words • Identify problem's structure • Propose a problem of problem situation
	Exploring visual clues	• Over and over thinking again • to search visual clues • Individual representation • Individual visualization like a scribbling
Collaborative level	Creating visuals	• Drawing lines, boxes, circles, arrows • Using graphic organizers • Painting colors
	Discussing visuals	• Explaining • Contrasting and comparing • Questioning and Answering • Insisting or Persuading • Opposing argument, Understanding, Requiring agreement • Making a decision
	Elaborating visuals	• Re-identifying • Revising, complementing, and Adjusting • Re-questioning and answering • Explaining • Decision making

Identifying text

In collaborative visualization of text information, participants primarily read and comprehended text information. They tried to comprehend meaning of text information and to identify theme of text information. Main features in this step; they read a text using strategies for understanding text such as underlining, boxing, circling and numbering focus on key words.

Analyzing text

After reading a text, participants tried to reread a text to figure out text structure and to search key words or key sentences. They went into details from a whole text structure. Reigeluth (1983) explained the nature this sequences using the analogy of a zoom lens. A pairs started with a wide angle view, which allows one to see the major part of the text structure and the major relationships among those parts, but without any detail. Zooming in at one level on a given part of the text structure allows participants to see the major subparts. After having studied those subparts and their interrelationships, they could then zoom back out to the wide-angle view to review the other parts of the whole text structure and to review the context of this part within the whole text structure.

Participants analyzed text information contrasting between key words. At the same time, they tried to externalize their cognitive structure what they understood relationships between key words. In that case, they found a difference of subjective understanding and tried out to collaboratively negotiate meanings.

Exploring visual clues

In making decision to negotiate meaning, they actually explored visual clues for visualizing a text and externalized their cognitive structure with using graphics. First of all, they visualized at individual level like a scribbling. It was a role that representational visuals carry the same information as the text, making the information more concrete at least individual dimension. They started making

visuals for collaboratively visual communication. This means that they ready for sharing a cognitive system.

The main features of this step were often appeared 'silence'. This means that Participants have much thinking time over and over again to search and to represent visual clues. Until this step, participants' activity mainly occurred visualization processing at individual level.

Creating visuals

In steps of creating visuals, interactions that rapidly took place between pairs could be more collaborative visualization of text information. They were making ideas visible, using both words and visuals. this means that they were visibly making shared cognitive system about their thinking process. Participants tried to link relationship between collected key words using visuals such as line, box, circle, arrow, metaphor, analogy, and visual organizer. They created a lot of visuals through brainstorming

Discussing visuals

This step was a very important process on collaborative visualization of text information at social interaction level. Participants tried to find out optimal visual representation about text information. In that case, created visuals helped participants develop, organize and communicate ideas because those could easily be shared important ideas and prior knowledge.

Main feature of collaborative visualization in this step was shown a three discussing process: Comparing and contrasting created visuals that took place early to exchange visual clues or verbal information, critical debating that happened circulated sequence such as questioning, explaining and persuading, negotiating that took place understanding, requiring agreement, and making a decision. If they couldn't negotiate or understand the shared visuals, the activities confused a circulated process from identifying text, initial step to discussing step until they

came to the same conclusion or understanding. This process visually represent as follow

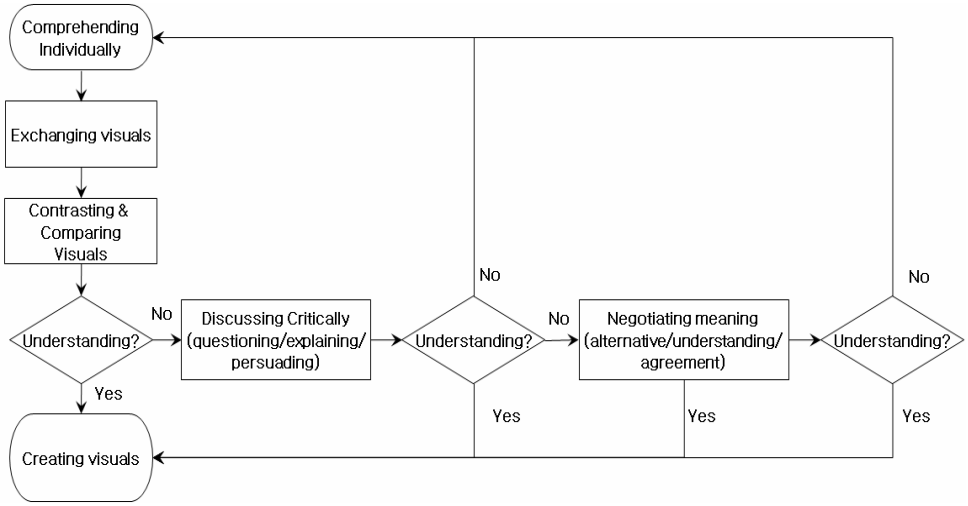

Figure 2. Visual mechanism of creating visuals for using collaborative visualization strategy

Elaborating visuals

Step of elaborating visuals was almost last step. In this step, participants were mainly doing like revising, complementing and adjusting about final output through discussed visuals. However, if elaborated visuals couldn't appeal for designer, they went back from identifying text to elaborating visuals. In addition to elaborating visuals to find out optimal visual representation of text information, collaborative visualization usually have the possibility to interaction between collaborative partners. Collaborative visualization processing must be similar to those triggered in individual visualization processing

As a result of this study, collaborative visualization processing may be shown up spiral sequencing. From the first step to final step, participants continued pattern of zooming in to see the major substructure of a text and zooming back out for context and review. Participants follow the same zoom in and out pattern for elaborating optimal visuals. These procedures revealed development's steps as

spiral or circulation system. Procedures of collaborative visualization processing revealed as a spiral or circulation system. It was representing visually as a follow.

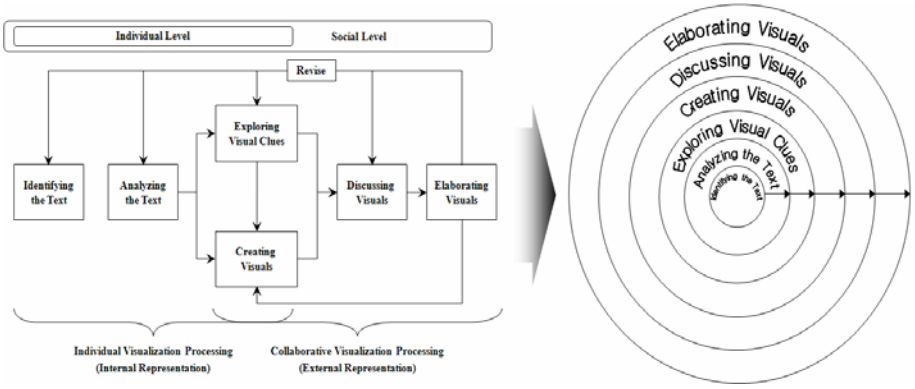

Figure 3. Procedures of collaborative visualization processing of text information.

Modalities in collaborative visualization processing of text information

According to result of this study, modalities in collaborative visualization processing of text information were divided two dimensions: individual processing by internal representation, social processing by external representation.

Characteristics of individual processing for collaborative visualization revealed five features; Analyzing the text, Structuring mental model, Visualizing of cognitive structure, Contrasting and comparing of visuals, Understanding visuals. These characteristics were shown initial steps of collaborative visualization, after that, collaborative visualization was slowly and strongly emerging on social levels: social interaction, social reflection, social understand, and social integration.

A distinguished result in this research, collaborative visualization processing were facilitated by creating visual clues as a thinking system visible. They were elaborating, supplementing, and revising based on visual clues by means of collaborate visualization through social interaction that were discussing, reflecting, negotiating, questioning and explaining, et al. These modalities of collaborative

visualization were more complex, practice, and multiple cognitive activities with utilizing visual knowledge. In other words, collaborative visualization was facilitating of designer's mental processing by sharing knowledge, thinking system, and cognitive structure among pairs. Modalities in collaborative visualization processing of text information were represented visually as follows.

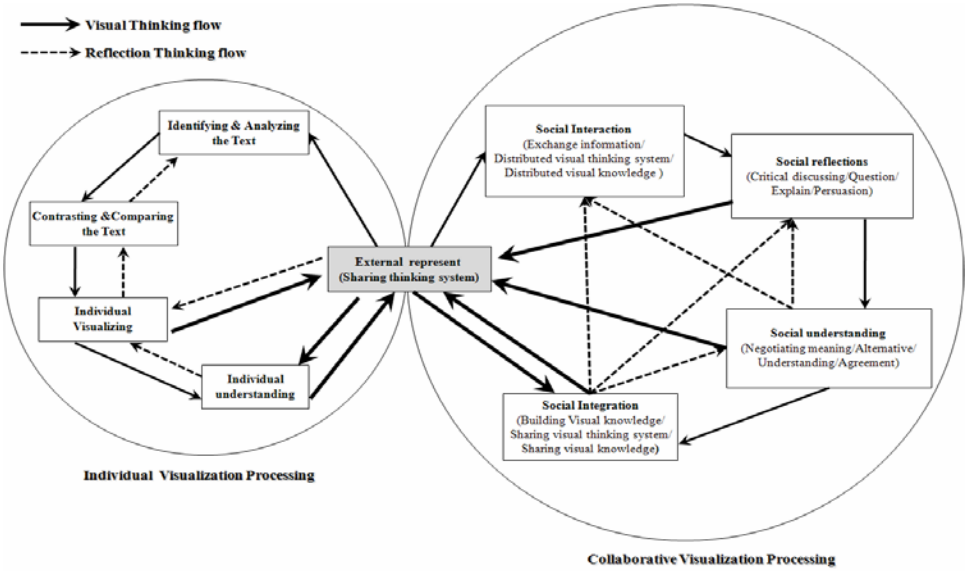

Figure 4. Modalities on collaborative visualization processing of text information

Conclusion

This study has taken notice of critical role of collaborative visualization of text information for developing e-Learning contents. It was focused on exploring procedures and modalities in collaborative visualization processing of text information. The findings of this research revealed that procedures of collaborative visualization processing of text information were six steps: identifying text, analyzing text, exploring visual clues, creating visuals, discussing visuals, and elaborating visuals. And modalities of collaborative visualization processing of text

information were shown two dimensions: individual processing mode, social processing mode.

According to this result, first, utilizing collaborative visualization was facilitating of designers ' cognitive interactions and activities by sharing theirs knowledge structure, mental model. Second, collaborative visualization of text information could helped clearly expression of student's opinions, ideas, and thinking by doing role of the cognitive tools and mind tools (Kommers, Jonassen, & Mayes, 1991;. Jonassen, Howland, Moore, & Marra, 2003). Visible thinking system was a role of visual scaffolding as a collaborative visualization that is a important facilitating interaction tool because it provides comprehensible input and makes complex ideas more accessible. This naturally led to collaboration between pairs. Third, process of collaborative visualization was the same problem solving processing that was structuring new knowledge by transformation and utilization of learner's acquired knowledge as a distributed cognition system (Salomon, 1993; Dillenbourg, 1999), or sharing cognition system. Finally, collaborative visualization is role of the feedback system about creating visuals. Collaborative visualization can be given immediately correct or not about their ideas, opinions because they identify others thinking system.

These results will be expected to influence on strategies of instructional design with using a collaborative visualization of text information for developing e-Learning contents. Also, it will be helpful suggestion strategies to collaborative problem solving situations, designers or learners who learn with assistance of visual scaffolding in socially constructed environments will have an advantage over designers or learners who do not.

Educational technologists are in the era of knowledge based society searching for effective and efficient methods of knowledge generation, organization, and dissemination. In this regards, I hope that result of this study has full possibility of providing ideal methods as using human visual intelligence.

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Eunmo SUNG

Senior Researcher, Korea Human Resource Center, Seoul Nat'l University. Interests: Instructional system design, e-Learning, Visual intelligence

E-mail: eunmo04@snu.ac.kr