

**A MULTI-DIMENSIONAL APPROACH TO THE STUDY OF  
ONLINE ANNOTATION**

by

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# ABSTRACT

Digital annotations share the purpose and nature of traditional paper annotations when reading online. Annotation *form* represents the behavior associated with completing an annotation. Annotation *function* reflects the users' cognitive states while annotating. The *role* indicates the intended audience (private, work group, and larger public) for the annotation, and provides an opportunity to investigate the functions of annotation in its social setting. *Perceived values* indicate the acceptance of annotation online. A broader understanding of what forms facilitate the creation of an individual's online annotation while reading, as well as the co-relation of the form, function, and role of annotation when reading online is needed. Furthermore, evaluations of the perceived values of online reading and writing that constitute the acceptance of annotation online are also critical.

This research employs a mixed-method approach for studying annotation online. Using an annotation prototype plugged into the Open Journal Systems, 15 participants conducted three reading tasks. The findings from the main study (user think-aloud protocol and interview transcripts) and supplementary information (post-session questionnaire and perceived value questionnaire) are analyzed according to the six research questions. Furthermore, a review of existing annotation tools and literature are used as an explanatory component for comparing and contrasting the findings of main study. The findings show that some online annotation forms take advantage of the change capability in visual styles of interface design and the network environment of the community, which have no counterpart in the print environment. Findings of online annotation functions are grounded in visual foraging of information and the theory of text signaling. In addition, annotation forms in combination with types of text annotated (e.g., headings) and text structures (e.g., topic sentence) result in the manifestation of different functions. Furthermore, role-attached social forms also function the same as "signals" for sharing or communication. It is also observed that annotation functions shift in different reading tasks. In general, people consider online annotation very useful, and improvements in performance, effectiveness, and utility of annotation while reading online, as well as the ease with which the skill is acquired, account for this acceptance.

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# 1 INTRODUCTION

## 1.1 Aim

This research aims to explore the behavior, cognition, and social dimensions of annotation online. Based on Marshall's (1997) studies of annotation in paper documents, this study investigates the *form*, *function*, and *role* of annotation in the digital environment. In addition, hyperlinks and linktype components are identified as part of the form to support the larger goal of understanding why users create links as annotations and how these links represent the relationships in connecting components of information. Marshall's mapping of annotation form into function (Marshall, 1997) is applied as a framework for studying annotation online in this study. With regard to Marshall's framework, this study poses six research questions in relation to annotation forms, functions, roles, and perceived values. With an annotation prototype system, a mixed-method approach is used to analyze the annotation practices, and to assess any implications for design.

## 1.2 What Is Annotation?

The *Oxford English Dictionary* (2nd Edition, 1989) defines “annotation” as a note added to anything written, by way of explanation or comment. As such, annotations represent a bridge between reading and writing, which facilitates the user's first approach when he/she begins dealing with an information resource. Thus, an annotation has meaning in relation to the base document, and is made manifest in some form. Annotation has a long and rich history – one that has been traced by a number of scholars (Howsam, 2006; Johns, 1988; and McKitterick, 2003; Siemens, Warwick, Cunningham, Dobson, Galey, Ruecker, & Schreibman (2009). In this thesis, the focus is on the more recent form of digital annotation.

Each digital annotation in a system can be composed of five items: some content (for example, a user's highlighted marking, or comment), an anchor (the information used to position an annotation in the base document), a visual mark (such as a symbol or an icon indicating the presence of annotations), a linktype (such as an explanation of the annotated content), and, if shared within a community, an authorization capability, e.g., an activation of an annotation to be shared with a work group or the larger public (Brush, 2002; Bottoni, Levialdi, & Rizzo, 2003). Thus, the term "annotation" in the digital environment bears a variety of meanings depending on the formats presented, its context of use (MacMullen, 2005), and its communicative acts, e.g., a user asks the author of a comment if he could further elaborate on it, and in turn, the author answers the request with a promise to provide the needed information (Agosti, Bonfiglio-Dosio, & Ferro, 2007). In this study, the initial form of an annotation is created by readers and not automatically generated from text extraction. Annotation is made on a text segment within a document and is different from bookmarking or tagging of a digital resource such as a Web page or a Web site. The full definition of annotation used in this study is presented in Section 2.5.1.

### **1.3 Context and Purpose of Research**

In the world of paper documents, annotations are usually found either as underlined or highlighted passages, or as textual comments or markings in the margin. Constantopoulos, Doerr, Theodoridou, and Tzobanakis (2004) pointed out that annotations can be unstructured and very personal, or they can be relatively structured, following certain rules with regard to aspects of annotation and format.

Past studies of annotations in paper documents examined annotations retrospectively, similar to examining historic artifacts, to identify the different forms and functions of

annotations, without examining the annotation process in which the creator reads and writes *in situ*, and shares with others. Thus, we have little understanding about the context of annotation creation as well as about the sharing of annotations in contrast to the final presentation of annotations.

Digital annotations not only share the purpose and nature of traditional paper annotations to interpret existing documents, but they also create new information resources and offer higher potential than paper annotations to support accessing, indexing, distributing, linking, and sharing (Agosti, Ferro, Frommholz, & Thiel, 2004; Arko, Ginger, Kastens, & Weatherley, 2006). Consequently, providing Web users with electronic annotation tools has received attention in both academia and industry (Wolfe, 2002; Rau, Chen, & Chin, 2004). Web annotation tools allow users to annotate on hypertexts, to organize and present annotations, to build up knowledge structures, to browse annotations previously made by others, to share annotations with other users, and to interact with other users. Without electronic annotation tools on the Web, users must use paper or word processing software if they want to take notes or make comments, which are inefficient and ineffective. Certain annotation functions, such as editing, indexing, distributing, or linking, are not yet fully supported by either paper or word processing methods.

Despite the developments in online annotation in the areas of metadata, features, and tool development, online annotation tools still face hurdles that have slowed their adoption in digital libraries (Agosti et al. 2004; Arko et al., 2006). Fu, Ciszek, Marchionini, and Solomon (2005) conducted a survey of published research on Web annotation which showed that papers presenting prototype applications by far outnumber those trying to study how and why Web users annotate. Thus, many annotation tools have been either in prototype form or with smaller

scale functions, and as a consequence, users have not become accustomed to seeing annotated information in digital libraries, and have not begun to think of new, creative uses for annotations. In electronic environments, there is little known research on the behavior of annotation creation, the cognitive aspects of annotations at the time they are created, as well as the effects of sharing when creating annotations online, the preference of the use of online annotations, and the perceived values regarding tool use as creating annotation online requires the use of a tool.

A broader understanding of what forms facilitate the creation of an individual's online annotation while reading, as well as the correlation of the function and role of annotation when reading online is needed. By creating a digital annotation environment, this study addresses the research questions related to investigating the relative value (combining frequency of use and user rating) of combinations of form, function, role, and perceived values.

## **1.4 Theoretical Background**

Considering annotation online as a critical engagement activity for hypertext readers, this study takes annotation as hypertext and its relationship with linktyping as critical for the understanding of the creation of annotation online. Marshall (1998) pointed out that the functions of annotations, in their many forms, frequently bridge reading and writing, and she regarded annotation as a multi-faceted event with various characteristics. The facets of annotation, including form, function, and role identified in the literature, are discussed in this section. Furthermore, this dissertation views annotation as an integration of reading and writing; more specifically, annotation is understood as a form of active reading. Perceived values of online reading and writing indicate the acceptance of online annotation. Usefulness and ease of use are the two determinants of the perceived values of annotation online. This study adopts the concept of Davis' (1989) technology-acceptance-model (TAM) for evaluating usefulness and

ease of use from the perspectives of annotation writers and annotation readers. The discussion is presented in Section 4.2.6.3. This study also considers annotation forms as “signals” in processing the text (e.g., to attract future attention), and treats the annotation form-function relationship as analogous to the theory of signaling proposed by Lemarie, Lorch, Eyrolle, and Virbel (2008) in Section 5.2.2. Together these discussions lay out the background of this study.

### **1.4.1 Annotation: Integration of Reading and Writing**

Reading and writing are “inextricably intertwined” (O’Hara, Smith, Newman, & Sellen, 1998). For example, annotating and highlighting while reading is a common activity in the printed environment (Olsen, 1994). Once a document has been located a user typically does some work with it. Blandford, Stelmaszewska, and Bryan-Kinns (2001) pointed out when users are working with documents, the most frequent activities are reading and annotating. Brush, Barger, Gupta, and Cadiz (2001) pointed out that the computer industry now realizes that the majority of people read and annotate daily, but do not create new documents. The most common activity is not writing new documents but reading, followed closely by annotating, then collaborating, and finally authoring.

Some research showed that annotation on paper is smoothly integrated with reading, since writers do not have to swap to a different tool to make statements about the content, whereas online annotation is distracting (O’Hara & Sellen, 1997); however, later research by Schraefel, Zhu, Modjeska, Wigdor, and Zhao (2002) demonstrated that annotating the document *in situ* does not interrupt the flow of reading, minimizing “forced divided attention.” Other research (Miles, 2004) indicated that annotations are always situated within or beside the text, and stand out visually in a document, allowing readers to easily scan for them. In addition,

annotations aid understanding, memorization, and later retrieval (Schilit, Golovchinsky, & Price, 1998a), and help readers make documents “their own” (Golovchinsky, Price, & Schilit, 1999).

Reading a scholarly journal article is highly directed (Adler & van Doren, 1972; Bishop, 1998; Marshall, Price, Golovchinsky, & Schilit, 1999; Wolfe, 2000; Marshall & Brush, 2004; Kaplan & Chisik, 2005b). Reading can engage readers in thinking, making mental connections, linking ideas together meaningfully, and expressing themselves clearly (Healy, 1999), as well as in carrying on an active mental dialogue with the author. The question of what constitutes “active reading” has been debated extensively. Some have suggested that active reading is the combination of reading with critical thinking and learning, and it may involve not only reading *per se*, but also underlining, highlighting and scribbling comments (Adler & van Doren, 1972; Olsen, 1994; Liu, 2005). Active reading, in this sense, may also involve finding related material and moving from one text to another. For example, an English Literature student studying the hypertext history in a scholarly journal may decide to look up in Wikipedia the name “Derrida,” or a psychology student reading up on an article about cognitive overload may decide to follow a reference to read a paper on hypertext.

Active reading also involves activities stemming from the readers’ engagements with texts, and possibly with each other, as demonstrated by research into the annotation habits of students and professionals in their use and form (Marshall & Shipman, 1997; Marshall, 1998; Ovsianikov, Arbib, & McNeill, 1999), their influence on readers (O’Hara et al., 1998), and their effect on scholarly communication (Furuta & Urbina, 2002). Research has shown that support for annotations in electronic documents promotes and facilitates active reading (Marshall, 1997; Schilit et al., 1998a; Wolfe, 2000; Golovchinsky & Marshall, 2000; Brush, Barger, Grudin, & Gupta, 2002; Obendorf, 2003; Kaplan & Chisik, 2005a). For example, Marshall, Price,

Golovchinsky, and Schilit (1999), in their work on a digital reading appliance, found that annotations serve many functions for readers and collaborators, including reacting to or in other ways engaging the readings.

Others propose that it is highly problematic to suggest that active reading can be measured by observable physical activity in the moment of reading, including, say, highlighting and annotating. Brock Haussamen (1995) summarized the debate in “The Passive-Reading Fallacy.” For some, he observed that

Active reading is analytic, and it takes a lot of energy. It is like a conversation in that one is constantly questioning and talking back to the other party, and through this process the reader becomes both a critic and a participant. The fundamental fallacy is the idea that passive and active reading processes are separate processes, that one can read passively without reading actively, and vice versa. (Haussamen, 1995, p.379)

Rosenblatt’s *The Reader, the Text, the Poem* (1978) provided a different view. She noted that active reading has nothing to do with marking a book with pencil or questioning the writer, but with the process of sorting and synthesizing responses each time a reader reads the material. (Rosenblatt (1986), cited in Haussamen, 1995, p.379)

In this thesis it is recognized that reading is a complex process and that readers may be fully engaged and intellectually “active” when they are not making physical notations as well as disengaged when they are making notations. For the purpose of this thesis, however, the use of the phrase “active reading” will refer to reading that is accompanied by observable activity in the form of annotation.



## 1.4.2 Facets and Dimensions of Annotation

Annotations can be described by several facets<sup>1</sup>. According to Constantopoulos et al. (2004) annotation types can be grouped into families representing distinct annotation aspects, or dimensions, called facets. As a consequence, creation of annotations is regarded as a multi-faceted event with various characteristics, including those related to annotation itself as well as to the user's perception of annotation.

### Content, Form, and Function

Annotations can be regarded as *content* in two ways: they can be content about content (as a stand-alone document, such as reviews and comments) and they can be considered as additional content (as content enrichment, e.g., interpretations or clarifications) (Agosti et al., 2004; Rau et al., 2004). Neither type excludes the other. Annotation content can be understandable to an occasional reader, or can be very personal in meaning (Agosti & Ferro, 2005a; Van Meter, Yokoi, & Pressley, 1994); that is, personal annotation may sometimes be understood only by the person writing it.

Annotation form represents the behavior associated with completing an annotation. Annotation forms can manifest themselves in various ways. Marshall (1997) examined used textbooks and noted the different marking characteristics of annotation forms. She categorized these into two groups: telegraphic and explicit forms. Telegraphic markings appearing within text include underlines, highlights, circles and boxes around words and phrases. Telegraphic markings appearing in the margins or other blank spaces include brackets, angle brackets, and braces, asterisks and stars, circles and boxes around whole pages, arrows and other deictic

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<sup>1</sup> In Rau et al. (2004) used the term “attributes,” while other researchers used “facets” to describe the same concept; “facets” is used in this study.

devices to connect within-text markings to other marginal markings. Explicit characteristics appear within text as brief notes written between lines, especially translations of words in foreign language texts. Explicit characteristics appearing in the marginal spaces include short phrases, extended notes, worked problems, for example, calculations, as well as extended notes on blank pages in the front of the book.

Marshall further elaborated the characteristics of form along two dimensions<sup>2</sup>: from Formal to Informal and from Explicit to Tacit. An example of annotation at the most formal end of the spectrum is metadata (Marshall, 1998; Agosti & Ferro, 2005a; Constantopoulos et al., 2004). The informal end of the spectrum is more personal in meaning and tends to include telegraphic, incomplete, and tacit annotations. Personal annotations are often not explicit. On the other hand, Marshall (1998) pointed out that annotations intended for others to read tend to be the more explicit and well-written.

Fu et al. (2005) identified three forms of annotations on documents in a Web environment which replicate those found on printed documents: text selection and emphasis, association building, and document re-segmentation. Text selection and emphasis means underlining, highlighting, coloring, and crossing out words. Building associations means making notes and drawing symbols (telegraphic marginal symbols such as asterisks) to build associations, links, or relations. The third form, less frequently observed from examining books, is a re-segmentation of the document, which often happens when the physical structure of the document does not suit the reader's purposes, such as tearing out pages, making copies, or cutting them up and reorganizing them, etc.

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<sup>2</sup> Marshall emphasizes that each dimension should be considered as a continuum, not a dichotomy.

Past studies have identified different annotation functions as well, including reading, editing, linking, and sharing (Furuta, Shipman, Marshall, Brenner, & Hsieh, 1997; Roscheisen & Winograd, 1995); planning, reference, and checking understanding (O'Hara & Sellen, 1997). Use of annotation form will provide the behavioral manifestation of annotation function. Marshall (1997) studied the form of the annotations in college textbooks, and the function of the annotations derived from their form, and concluded that annotations do not serve a single function, but a multitude of functions. Marshall mapped these forms onto corresponding functions (see Table 1.1) using exemplars of both telegraphic and explicit marking characteristics:

Table 1.1 Mapping annotation form into function (Marshall, 1997)

<b>Form</b>	<b>Function</b>
<ul style="list-style-type: none"> <li>▪ Underlining or highlighting higher level structure (like section headings)</li> <li>▪ Telegraphic marginal symbols like asterisks</li> <li>▪ Cross-outs</li> </ul>	1. Procedural signaling to attract attention in future readings
<ul style="list-style-type: none"> <li>▪ Short highlightings</li> <li>▪ Circled words or phrases</li> <li>▪ Other within-text markings</li> <li>▪ Marginal markings like asterisks</li> </ul>	2. Place marks to aid memory
<ul style="list-style-type: none"> <li>▪ Appropriate notation in margins or near figures or equations</li> </ul>	3. Work on problems
<ul style="list-style-type: none"> <li>▪ Short notes in the margins</li> <li>▪ Longer notes in other textual interstices</li> <li>▪ Words or phrases between lines of text</li> </ul>	4. Record interpretations
<ul style="list-style-type: none"> <li>▪ Extended highlighting or underlining</li> </ul>	5. Trace progress through difficult narrative
<ul style="list-style-type: none"> <li>▪ Notes, doodlings, drawings, and other such markings unrelated to the materials themselves</li> </ul>	6. Incidental reflection of the material circumstances of reading

Marshall (1997) further elaborated functions into three dimensions to describe the readers' cognitive states:

- (1) The degree to which the reader has become a writer, which involves the activities in which readers wander, collect, organize, interpret, mark in, and mark on what they gather while they read.
- (2) The kind of reading that the reader is engaged in, which involves a spectrum of functions from the link following, fragmentation, and repetitions we associate with hypertext; a broad reading of many documents at a time; and a deep engagement with a single text.
- (3) The permanence of the annotations, which represents the status of annotations that hold for the current traversal or bring value to future readers. Annotations may be a reflection of a reader's engagement with the text at the very moment of reading, so that the value of annotations holds only for the current traversal through the text, or they may bring value to future readers, and it depends upon the content whether readers see them as transient or permanent.

Thus, the functions, in their many forms, frequently bridge between reading and writing.

Furthermore, Marshall pointed out that understanding the functions of annotation should help us answer the other more far-reaching question --- what roles might annotation play in a digital library setting?

## **Role**

Personal annotations and shared annotations may have different characteristics that reflect their authors' various purposes for creating them. Marshall (1998) introduced the role facet of annotation in addition to form and function to describe the ownership of annotation. Marshall (1998) pointed out that most annotations are initially created as a personal form, and not as a comment for the larger public. In the paper world, the annotated document is shared

through changing ownership from one reader to another reader. The annotations often remain anonymous.

Marshall (1998) further elaborated the Role of annotation into a Private vs. Published dimension to represent the circumstances in which annotations are created for personal use and those in which information is intended for the public arena. More specifically, she characterized a spectrum of Role, ranging from Global to Institutional to Workgroup to Personal. She pointed out that from these annotation roles we see the various visions of hypertext and differing assessments of the value of annotations. For example, Nelson's vision of hypertext and hypertextual annotation was global; Engelbart's vision extended from workgroups or institutions to communities; and Bush's trails were intended for the benefit of an increasingly fragmented online scientific community (see Section 1.4.3 for more detail).

Marshall (1997), and Schilit, Marshall, and Price (1998b) pointed out that annotations made on paper documents are unintentionally shared when the annotated documents are passed from hand to hand. The annotations made may not be clear or useful to others, and their sharing status may not be distinctly identified as public or private. The reader can only assess the value of annotated documents by examining the annotations, which oftentimes are rendered anonymous. If the annotator is well-regarded to the reader, he/she may value even a simple underline or an exclamation point in the margin. On the other hand, most annotation systems demand the intentional act of publishing annotations. The ownership of annotations and their status for sharing can be clearly presented to the reader.

In the digital world, an authorization mechanism can provide explicit and pronounced boundaries between private and public forms. It is clear that whatever we conceive of doing

with the annotations (whether explicit as with marginalia, or telegraphic as with asterisks, or highlighting) in a digital world, they are a private form of writing. Anonymity is also made possible in cyberspace. Electronic notes posted in group discussions, the authors of which are sometimes anonymous, often pseudonymous, and almost always strangers, are made public only through the “publish” mechanism. Moreover, a researcher may prefer not to make his/her annotations public if they are not complete in terms of either meaning or expression. This means that users should be able to maintain a personal view of the content. Schilit, Marshall, and Price (1999) pointed out that an annotation system that works best for connecting people should have a reciprocal arrangement. The reader must publish his/her reading and annotation data before he/she can search other people’s reading and annotation data. Anonymity and reciprocity are issues that need to be addressed by designers of systems in which electronic annotations are shared.

The capability to have different views of the same content can be exploited, for example, for educational purposes. Agosti, Ferro, and Orio (2005) pointed out that students can benefit from having access to the same information with the different approaches taken by scholars from different fields. The existence of different or contrasting views reflects that there are different critical approaches to the research. Marshall (1998) emphasized the locations that all or many readers consider important to mark up. These indicate a consensus reached by readers. This way, readers may know what other readers also thought remarkable. She indicated that there could be some kind of consensus mechanism built into the digital annotation system to gather and aggregate this consensus, and the consensus may be used as a summary.

Annotations are an important way to share one’s results with others. Shared or public annotations are visible to more people than the author who created them. Sharing data triggers at

least weak collaboration -- users can view others' results, without necessarily directly reacting to them. Systems supporting data sharing through annotations are well represented in the research literature (Agosti, Befante, & Orio, 2003; Frommholz et al., 2003; Gertz, Sattler, Gorin, Hogarth, & Stone, 2002; Nichols, Pemberton, Dalhoumi, Larouk, Belisle, & Twindale, 2000). Wilensky (2000) saw annotations as an example of spontaneous collaboration. Interaction within a community can be supported by means of shared or public annotations. In COLLATE (Brocks, Stein, Thiel, Frommholz, & Dirsch-Weigand, 2002; Frommholz et al., 2003; Thiel, Brocks, Frommholz, Dirsch-Weigand, Keiper, Stein, & Neuhold, 2004), users can take an active part in evaluating historic film sources and adding annotations, and also can directly react to other users' annotations. The annotation threads are then used to model a scientific discourse between film scientists. Exploiting the interrelation between the annotations, e.g., providing additional information or focusing on certain expertise of the participants of a discussion, allows for relevant search and retrieval methods to support collaboration.

Considering annotation as an essential activity for hypertext readers, as Marshall (1998) indicated, annotation can be used in many ways. For example, link making, path building, note-making, marking, highlighting, and as a record of reading and interpretation. Hypertext readers can also become annotation writers, blurring the line between readers and writers. Within a network environment, annotations can be a place for aggregating community memory. She concluded that the wide range of evidence found suggested a set of seven dimensions (see Table 1.2) that reflect the forms annotation takes, the function of annotation from a reader's point of view, and the roles of annotations as they are used to communicate with others.

Table 1.2 Mapping annotation dimension into facet

Facet	Dimension (as a Continuum)
<b>Form</b>	(1) Formal vs. Informal Annotations
<b>Form</b>	(2) Explicit vs. Tacit Annotations
<b>Function</b>	(3) Annotation as Writing vs. Annotation as Reading
<b>Function</b>	(4) Hyperextensive vs. Extensive vs. Intensive Annotation
<b>Function</b>	(5) Permanent vs. Transient Annotation
<b>Role</b>	(6) Published vs. Private
<b>Role</b>	(7) Global vs. Institutional vs. Workgroup vs. Personal

In addition, different layers of annotations can coexist on the same document: a private layer of annotations accessible only by the annotation author him/herself, a collective layer of annotations shared by a team of people, and finally a public layer of annotations accessible to all the users of the digital library. In this way, user communities can benefit from different views (private, working group, and public) of the information resources, as well as encourage cooperative work practices, enabling the sharing of documents and annotations (Schilit et al., 1998b).

### Temporal Facet

Agosti et al. (2007) argued that annotation has a *temporal* facet in addition to form, function and role, which Marshall (1997, 1998) did not explicitly define; for example, there may be threads of annotations, i.e., annotations made in response to another annotation. For example, when someone comments on someone else's annotation as can be done in COLLATE, the temporal dimension is implied (Frommholz et al., 2003; 2004). This temporal relationship between the annotation and the base document does not mean that the annotation cannot be considered as a stand-alone intellectual work, but it imposes a temporal ordering between an annotated text and the annotation annotating it, and though the temporal dimension is implicit, it cannot be neglected. There is no known research showing the importance of time or discussing the distinction between time and order. This research is focused on the correlation of form,



function, and role of annotations; therefore, the temporal facet of annotation is not explored in this study.

### **1.4.3 Annotation in Hypertext**

Three noted writers on hypertext, Vannevar Bush, Ted Nelson, and Douglas Engelbart have elaborated on annotation in hypertext. Vannevar Bush (1945) proposed a Memex machine focused on annotation through “trail blazing.” He pointed out that

... the human mind ... operates by association. With one item in its grasp, it snaps instantly to the next that is suggested by the association of thoughts... The owner of the Memex, let us say, is interested in the origin and properties of the bow and arrow... He has dozens of possibly pertinent books and articles in his Memex. First he runs through an encyclopedia, finds an interesting but sketchy article, leaves it projected. Next, in a history, he finds another pertinent item, and ties the two together. Thus he goes, building a trail of many items. Occasionally he inserts a comment of his own... Thus he builds a trail of his interest through the maze of materials available to him. (Bush, 1945, p.107)

What Bush described were personal annotations. Personal annotations are digital and serve to connect documents through trails that are not part of the original documents themselves. Nelson (1984) envisioned a “Docuverse” that would contain all of the world’s literature, accessible and interlinked from any point in the global network, in which new hypertext seamlessly assimilates portions of older writings. Engelbart (1984), on the other hand, emphasized the cooperative work environments through shared electronic spaces. The Augmentation System supports a commentary capacity for a journal system, where groups of workers could manage and exchange concepts and ideas in the form of linked structures. Carlson (1989) pointed out that despite their differences, Bush, Engelbart, and Nelson all describe hypertext as a means for enhancing reading, annotating, collaborating, and learning.

## **Annotation and Hypertext Linking**

Annotation and hypertext can profitably be combined (Brown & Brown 2003b; Brown & Brown, 2004). Each digital annotation can be in the form of hypertext. That is, annotations allow the creation of new relationships among existing contents through the use of links that connect annotations together and with existing content (Agosti & Ferro, 2005a). They pointed out that different annotation configurations can be organized by means of hypertext. Annotations made in response to other annotations can be organized as threads of annotations, and bundles of annotations on the same passage of text can be organized as sets of annotation.

In the digital world, annotation is fundamental for the enrichment of hypertext structure and content by allowing readers to add information. Readers can respond to hypertexts with comments, make links, create new pathways, and collect and record interpretations (Marshall, 1998). These annotations crucially augment existing hypertexts, increasing their value for future readers.

Annotation and hyperlinking together create a context of annotation. Context of annotation allows the user to create a link to all or part of the base document being read, or perhaps to an annotated version of it (Agosti & Ferro, 2005b). Within a digital library, annotations can serve several purposes: they aid in realizing features of digital libraries, like creation and interpretation, access, and usage of digital resources. They are helpful in creating, reconstructing, and exploiting the different types of contexts (Neuhold, Niederee, Stewart, Frommholz, & Mehta, 2004).

Furthermore, content and annotations together constitute a hypertext that can be exploited not only by providing alternative navigation and browsing capabilities, but also by offering

advanced search functionalities (Agosti & Ferro, 2005b). For example, a search strategy can take into account the multiple sources of evidence derived from both base documents and annotations to retrieve more documents that are relevant and better ranked (Ferro, 2005).

### **Annotation and Typed Links**

An annotation has meaning and is a self-described document. Using a linktype allows the annotator to describe the relationship of an annotation to the base document being annotated (Agosti & Ferro, 2005a). Agosti et al. (2005) proposed a taxonomy for linking annotations to point out a relationship between two images based on historical, aesthetic, and technical considerations. Another study by Frommholz et al. (2003) employed annotations to support collaboration between researchers on European historical film documentation, such as historical film censorship records, press materials, photos, film posters, and digital film/video fragments. In order to classify the interrelations between the annotations and the annotated documents, they made use of typed links. What the linktype does is tell the readers how the content of the destination node (i.e., annotation) is intended to alter his/her understanding or interpretation of the source node (i.e., base document).

Typed links address the potential problem of disorientation and cognitive confusion arising from large, associatively linked hypertexts. The ability of the link to indicate or convey information about aspects of the relationship between the nodes in advance of the traversal of the link is a salutary outcome of link typing (Kopak, 1999). The use of link taxonomies to discipline the hypertext network has been described by researchers such as Trigg (1983), DeRose (1989), Baron, Tague-Sutcliffe, Kinnucan and Carey (1996), and Kopak (2000). Kopak (1999) emphasized the development of a taxonomy of linktypes that describe the functions (discursive

qualities) that characterize the formation of links. That is, a typed link is intended to categorize the content of the destination node in relation to the source node.

A link taxonomy can be empirically derived and used to represent the functional relationships employed in discursive text, particularly in scholarly publications. For example, Trigg (1983) studied linktypes in scientific publications, Baron et al. (1996) used a hypertext manual, and Kim (2000) used e-Journals. According to Neuhold et al. (2004), typed links between annotations can form an annotation thread and thus can create a context and new information resources, in which they capture the results to be found in the new information resource, the process of finding the results, the motivations, and decisions which finally lead to the new content. Agosti et al. (2005) reviewed previous research regarding typed links and automatic link construction, and pointed out that few have yet been applied to the field of annotation.

In this study, for linking annotations and linktyping the relationship between two nodes of information depending on functional considerations, a linking feature with a core set of twenty-six linktypes from Kopak's link taxonomy has been built into ANNOLINK (see Section 3.4.2 for further detail), the annotation prototype plug-in of the Open Journal Systems (OJS)<sup>3</sup> (Willinsky, 2005).

## **1.5 Research Questions**

Annotation is a common activity in the print environment; however, annotating online requires resources and additional skills. Hyperlink and linktype components are added as part of

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<sup>3</sup> The Open Journal Systems (OJS) is a Web-based, open access, scholarly journal publishing and management application developed as part of the Public Knowledge Project (<http://pkp.sfu.ca/about>).

the form to support the larger goal of understanding why users create annotations and how these links help users interpret the relationships in connecting components of information. Therefore, it is hypothesized that annotation tools that work best in a new reading environment are (a) those that do exactly what was done in the old environment, and (b) tools that utilize the network environment of the community. For example, people might wish to have features such as highlighting, underlining, and drawing brackets, etc., similar to those they have in the paper environment, and they might wish to share hyperlinks and linktypes with specific audiences.

The following research questions are addressed in this study:

- Do the same annotation functions in the print environment also exist in a digital environment?
- Are the functions manifested through similar forms? If not, how are they different?
- What is the function of linking as a form of annotation?
- What other forms and functions might online annotation support?
- Do form and function vary by role?
- What are the perceived values of the use of online annotation?

It is also hypothesized that the role (personal use, work group, and larger public) affects annotation functions. In Table 1.3, the intensity of color in each column reflects a set of conjectures about the likelihood that a particular audience is inclined to benefit from the corresponding function. These conjectures use hypothesized relative values (combining frequency of use and user rating) for different users when these activities (e.g., the need to evaluate a number of annotations made within a limited community of researchers) and resources (e.g., articles with added public links) are present. This is examined via a field study using a prototype annotation system -- ANNOLINK in the Open Journal Systems.

Table 1.3 Relative value of annotation by purpose and audience

Annotation Functions	Personal Use	Work Group	Larger Public
Incidental reflection of the material circumstances of reading			
Procedural signaling for future attention			
Problem-working			
Tracing progress through difficult narrative			
Placemarking and aiding memory			
Interpretation			
Linking ideas meaningfully			

Systems like Amazon's book recommendation system publish readers' views; as a result both writers and readers of these postings make use of and appreciate the information these writings afford. However, Kaplan and Chisik (2005a) pointed out that in the research and academic environment, researchers did not yet know enough about how to create applications that would promote the growth of genuine communities of interest and practice. Due to methodological limitations, this study does not attempt to build a true community of interest among the participants. It does, however, examine the sharing of annotations by creating a hypothetical sharing situation.

Annotation function reflects the users' cognitive states of annotating. Annotation functions have different values for a user depending on who the audience is. The sharing of annotations with others provides evidence of annotation functions in a social setting. Therefore, to study the sharing of annotations between different audiences, this study explores two types of activities: sharing annotations and viewing shared annotations. One group of participants is asked to comment on what they would do to each annotation they make when sharing with

others; and the other group is asked to comment on others' shared annotations. The users' comments are elicited to show the impact that role has on annotation function and form.

## **1.6 Significance and Limitations of the Study**

### **1.6.1 Significance of the Study**

This study revisits Marshall's past work on form, function, and role in the print world, and with the network capabilities of hyperlinks and linktypes, adds "Linking ideas meaningfully" as the seventh function of annotation to further explore annotations that are manifested from readers' reading online. It investigates how the forms and functions of online annotation differ from those in print, and how they affect the way the relationship between two pieces of information is described in a hypertext link, as well as the effects of role on annotating online.

In this study, a prototype annotation system, ANNOLINK, allowed readers not only to highlight texts and write notes, but also to add hypertext components (links and linktypes) during their use of documents within Open Journal Systems. This prototype is a proof-of-concept design. Readers can simply make highlights, or they can first make a highlight and then follow with note-making, linking, and linktyping. Note-making and linking are done in one of two ways: 1) a reader can indicate a meaningful relationship between a node (word, phrase, sentence, paragraph) in one Open Journal Systems document to a node within the same document, or to a node in another document within the Open Journal Systems collection, or alternatively, 2) a reader can annotate a particular node within a document by writing a comment about the information in a node as one would when writing notes or marginalia in a paper document.

The greatest utility of hypertext annotation tools may lie in the social construction of a navigable semantic space within the article domain(s) contained within Open Journal Systems. An individual reader may create a personal (private) hypertext that may only be used by that reader; however, the reader may also comment on his/her shared annotations or others' shared annotations to investigate the patterns of behavior and cognitive states across the experiences of various audiences, as well as how the readers' interpretations of the same text differ and how this might affect the way they describe the relationship between two pieces of information in a hypertext link.

This study provides insights into the behavioral, cognitive, social, and affective factors governing annotation, as well as the differences among audiences in the patterns of behavior and cognitive states when performing annotation online, and derives implications for designing a system that better facilitates online annotation.

### **1.6.2 Limitations of the Study**

This study is limited in scale and scope as the participants only read the articles selected for the tasks. The reading tasks are not naturalistic and are limited to a two-hour session. Participants' highlighting, notemaking, linking, and linktyping processes are limited by the functions of the prototype system. The linking function can only be used within the Open Journal Systems and not for articles outside that environment.

In addition, the lack of a public function for sharing annotations with others in the prototype system makes it difficult to study how participants would share annotations with one another. To compensate for the lack of a public function, in the third task, the Confirmatory Task, participants are organized into two groups: one group as annotation writers who comment



on how they would alter their annotations if sharing with others, the other group as annotation readers who comment on the actual annotations of others. To confront the limitation of reading materials and functions, the design of the Confirmatory Task together with a revised sense-making interview elicits the participants' comments on their thoughts and decisions of sharing annotation online, as well as their difficulties, help needed, and functionalities desired.

## **1.7 Outline of the Study**

Following this chapter, a review of existing literature is presented in Chapter 2. The review in Chapter 2 is used to frame the research problem discussed in the introduction to this study. The review indicates that much of the existing research on annotation is in tool development, specifically in system implementation. Three major authors and their colleagues have conducted a series of studies on annotation, and these studies are categorized as multi-dimensional approaches to digital annotation.

Chapter 3 discusses the research design and research methods. First, the rationale for a mixed-method approach for studying annotation online is discussed. Then, a theoretical framework is introduced for evaluating and understanding the design issues of an annotation tool for a web-based journal system to support the reader's online reading and writing needs. Next, the research design, including the subjects, reading materials, prototype, tasks, and procedures is discussed.

Chapter 4 reports the findings from the main study (user protocol and interview transcripts) and supplementary information (post-session questionnaire and perceived value questionnaire). The data have been analyzed and are presented according to the six research questions.

In Chapter 5, a discussion of the findings of the main study is presented according to the six research questions. In addition, the results of a review of annotation tools and another set of literature are used as explanatory components for comparing and contrasting the findings of the main study.

In Chapter 6, the major outcomes of the study are summarized. First, these outcomes in terms of the overall research goal are highlighted. Second, a short reflection on the research procedures and techniques used in this study is given, and their adequacy assessed. Third, in light of the outcomes, implications for online annotation design and functionality are presented. Last, a number of recommendations are made for future research.

## **2 LITERATURE REVIEW**

### **2.1 Introduction**

The purpose of this chapter is to provide context for multi-dimensional research in digital annotation. This study is exploratory, with an approach grounded in learning from participants and from existing tools. Creswell (2002) suggests three placement locations for incorporating the literature in a qualitative study. The literature can be used to frame the problem in the introduction to the study, presented in a separate section as a review of the literature, or presented at the end of the study as a basis for comparing and contrasting findings of the qualitative study. Creswell suggested that a literature review can be used in any or all of these locations. Adopting Creswell's literature placement models (2002), the use of literature in this study is presented in two locations. The literature review in Chapter 2 is used to frame the research problem identified in the introduction to this study. In addition, in Chapter 5 another set of literature is also used as an explanatory component for comparing and contrasting the findings of the main study. The literature reviewed in this chapter shows that previous research focused on: comparing paper vs. online reading while annotating, new technologies, system features, annotation as metadata in developing annotation tools, and user studies. Much of the extant research is in tool development, specifically in system implementation and the examination of digital annotation as metadata. Three major authors and their colleagues, who have conducted a series of studies on annotation, are identified as taking a multi-dimensional approach to the study of digital annotation albeit in different ways. From the evidence examined, the gaps are identified which this study addresses in order to move toward a better understanding of online annotation from a multi-dimensional point of view.

## **2.2 Research in Digital Annotation**

In this section, a selective review of research on digital annotation is discussed. The topics fall into the following categories: comparing paper and online reading while annotating; tool development including new technologies, system features, annotation as metadata; and user studies. This review shows that the extant research is more about tool development than empirical research on annotation as a process.

### **2.2.1 Comparing Paper vs. Online Reading While Annotating**

Research on comparing paper to online reading while annotating tends to be concerned with usability, such as identifying the need to support quicker, more effortless navigation techniques, more flexibility, and control in spatial layout (O'Hara & Sellen, 1997). Research on the support for active reading offered by traditional paper-and-pencil vs. two existing annotation tools for the World Wide Web found that simple annotation tools should be made available to facilitate personal annotation, and the participants expected the system to create additional value out of their notes (Obendorf, 2003). Marshall and Brush (2002; 2004) investigated the relationship between the personal annotations people make while they are reading and the annotations they share with each other when they are discussing the same material in print and online. Their findings showed that students made far more personal annotations on paper than they did for collaborative annotations online, and a substantial editing effort was made to the personal annotations to be clearer and more accurately reflect the content when sharing. Marshall has done substantial research observing people creating annotation on paper, and she provides valuable insights into human activities. Her insights have, in turn, informed design (Marshall, 2010). Marshall's studies are discussed in more detail in Section 2.3.1.

## **2.2.2 Tool Development**

### **New Technologies**

The new developments in annotation technologies tend to vary in input device, interface, base text, anchors, storage, and searching and filtering mechanisms (Agosti & Melucci, 2000; Wolfe, 2002; Agosti & Ferro, 2005a; Reeve & Han, 2005). Fu et al. (2005) identified four major types of annotation system: (1) the annotation functionality built into Web browsers; (2) annotation systems consisting of personalized Web information organization systems provided by a few commercial Web portals for the public, such as My Yahoo!; (3) interactive Web publication forums such as blogs and wikis; and (4) annotation engines, implemented through either proxy-based intermediaries or client-based intermediaries, which help people mark-up documents on the World-Wide Web. Fu et al. (2005) pointed out that the existing literature showed an overwhelming bias toward annotation engines, while there are few studies addressing the other three types of annotation facilities.

Semi-automatic and automatic creation of annotations is another new technology that researchers are starting to develop (Reeve & Han, 2005). Agosti and Ferro (2006) presented a system called Flexible Annotation Service Tool, which was capable of employing topic detection techniques; a document can be segmented into topics of desired granularity and automatic annotations created to provide a summary of these topics to support users and their annotative practices.

### **System Features**

What system features do people expect from good annotation software? Ovsianikov et al. (1999) conducted a survey in the form of a questionnaire in which graduate and undergraduate students, professors, and a few professionals in neuroscience and computer

science were asked what annotation software features they considered to be desirable. The survey found the essential features include insensitivity to document format, keyword search, ability to write on margins, ability to export annotations, multilinks/non local referencing, and instant document access, etc.

Some research discusses the development of specific annotation functionalities. For example, the study of the relationship between annotation marks on a passage and the passage's ultimate utility in a task led to the design of a mark parser for e-book software that could analyze freeform digital ink to identify high-value annotations (Shipman, Price, Marshall, & Golovchinsky, 2003). Typed links were utilized by Agosti and her colleagues (Agosti & Ferro, 2005b; Agosti et al., 2005; Agosti et al., 2004) to define a hypertext link between annotations and annotated documents, which was exploited later to provide users with advanced search functionalities based on annotations. For accessing annotations, Price, Golovchinsky, and Schilit (1998a) implemented a hypertext structure that allowed the classification and organization of annotations, as well as searching for related information. Price, Schilit, and Golovchinsky (1998b) indicated the importance of a workspace component in annotation, as well as investigated semantic annotations for documents on the Web.

Asynchronous collaborative writing through annotations to mimic the functionality of physical annotations was also investigated in several studies (Cadiz, Gupta, & Grudin, 2000; Brush, 2002; Weng & Gennari, 2004). Systems such as Annotator (Ovsiannikov et al., 1999), CritLink (Yee, 1999), and DEBORA (Nichols et al., 2000) allow users to define a publicity level for their annotations: private, public, and restricted to members of a particular group.

## **Annotation as Metadata**

Annotation as metadata is another topic in the area of tool development. Marshall (1998) characterized metadata as the most formal end of the spectrum of the Formal/Informal dimension of the content facet. Neuhold et al. (2004) argued that all types of context are captured by some type of metadata, and annotations (pieces of free text) are a special kind of metadata. Agosti and Ferro (2005a) also defined annotations as metadata, because they clarify in some way the properties and the semantics of the annotated content. This level of formality helps ensure interoperability, and enables interpretation by different query mechanisms. Research in this area includes a study of a metadata infrastructure that uses library catalog records of different types to describe educational resources, collections, and annotations (Arko et al., 2006), and the definition of a semantic model of annotation, which provides the scheme for information organization supported by the annotation server (Constantopoulos et al., 2004).

### **2.2.3 User Studies**

In addition to new technologies, system features, and annotation as metadata, some annotation research has reported user studies. Van Oostendorp (1996, cited in Rau et al., 2004, p.166) conducted three experiments on the effectiveness and accuracy of electronic annotating, and reported that learning from a screen and taking notes on the screen produce the same or similar learning results and accuracy of annotating (detection and correction of errors) as the traditional pencil-and-paper method. User studies on the effects of the layout of windows were also found in the literature. For example, van Oostendorp (1996) found that the vertical layout of windows allowed users to make annotations more effectively than the horizontal layout; and Instone, Teasley, and Leventhal (1993) reported that simultaneous windows were easier to use.

There is some research, as well, on the effects of the level of public access to the annotations. Cadiz et al. (2000) found that systems that automatically make all comments public by default negatively affected use of these systems. Marshall and Brush (2002; 2004) investigated the relationship between the personal annotations people make while they are reading, and the annotations they share with each other when they are discussing the same material online. Their findings showed marginal notes were apt to be shared and few annotations were directly made for sharing; and those personal annotations underwent dramatic changes when they were shared.

## **2.3 Existing Multi-Dimensional Research in Digital Annotation**

In this section, studies by three major research groups that have adopted a multi-dimensional approach in studying the annotation process are discussed. Marshall's studies (1997, 1998) set a landscape for studying annotation by highlighting the relationship between form, function, and role. Agosti and her colleagues (2004) used metadata and typed links to define multi-dimensional relationships between content and annotation, and took a robust system design approach. Finally, Fu (2005), MacMullen (2005), and Ruvane (2005) established a framework of multi-faceted concept describing "annotation" as process, thing, and knowledge. At the end of this section, the gaps in previous studies are identified, and the research questions that guide this study are stated.

### **2.3.1 Marshall and the Nature of Annotation**

Catherine Marshall was one of the first researchers (Marshall, 1997) to conduct field studies and observations on people's annotation behavior. She categorized annotation into a set



of facets and dimensions to help situate a long-term study of a community of annotators, with the intended result of plotting an ecology of hypertext annotation.

Marshall (1997) took two different perspectives in her investigation of annotation. First, she suggested looking at the mechanics of annotation. Second, she argued that annotation is a highly developed activity, one that represents an important part of reading, writing, and scholarship. She studied the markings people make on the printed page, and the relationship between the commentary, the reader, and future readers. Her analysis began with form, since it was the readily observable aspect of the markings the students made in their books. The findings were classified in two ways: first, by the form the annotations took in the textbooks, and then by a reconstruction of the function of these markings derived from their forms (see Section 1.4.2.).

Sharing annotations is not uncommon. Marshall et al. (1999) pointed out that in the print world readers frequently inherit other people's markings. For example, students may buy used textbooks that other students have marked up. On occasion, they may find these marks to be valuable, and may even seek them out. While the students in Marshall's (1997) study annotated paper textbooks, support for annotating digital documents is becoming more common.

Annotations on digital documents are often easily shared. Thus, Marshall introduced an additional facet: the roles of annotation as they were used to indicate the degree of communication with others. Marshall and Brush (2004) looked specifically at easing the transition between personal and public annotations, including the manipulation and recognition of digital ink. They performed a study to track and compare the personal annotations students made while they were reading assigned papers and the corresponding annotations they contributed to online discussions of the same set of documents. They collected three sources of

data: semi-structured interviews with the study participants, a collection of their annotated readings on paper, and their corresponding contributions to online discussions and summaries. The interviews helped them to understand the students' reading practices and gave a general picture of how they annotated, both as they read and as they participated in online discussions. The collected annotations were used to analyze the relationship between personal and shared annotations in further detail.

To analyze the students' annotations in the online discussion, Marshall and Brush (2004) looked at three form elements of an annotation: anchor-only, content-only, and compound. Compound annotations consist of more than one constituent type, for example, an underline and a note. They found that shared annotations in the WebAnn system were always coded as the compound subtype of anchor+content (anchor is combined in use with content) since they consisted of a highlight and associated note. Their findings showed (1) only a small fraction of annotations made while reading are directly related to those shared in discussion; (2) some types of annotations – those that consist of anchors in the text coupled with margin notes – are more apt to be the basis of public commentary than other types of annotations; and (3) personal annotations undergo dramatic changes when they are shared in discussion, both in content and in how they are anchored to the source document.

Additionally, Marshall and Bly (2004) observed that people share information for purposes that have little to do with the content of the shared resources, but serve a variety of social functions. Sending and receiving these snippets of content often served to create, strengthen, or renew social bonds, rather than to inform or to instruct the recipient.

### **2.3.2 Agosti et al. and the Different View Points of Annotations for Retrieval**

Agosti et al. (2004) proposed a conceptual model for annotations to represent the different view points of annotations and enable the design and development of advanced retrieval functions. They claimed that annotations comprise different viewpoints: they may be considered as metadata, content, hypertext, context, or dialog acts. Moreover, the boundaries between these viewpoints were not sharp and these viewpoints may coexist.

Agosti and Ferro (2005a) believed annotations allowed the creation of new relationships among existing content, by providing a linking facility that can connect annotations together as well as with existing content. Agosti and Ferro (2005b) concluded that annotations introduced a new content layer that makes the meaning of underlying documents clear and comprehensible to the readers. They proposed the term *annotative context* for the special kind of context annotations provide for the documents of a Digital Library Management System. This viewpoint on annotations covers a wide range of annotations, ranging from personal jottings in the margin of a page to scholarly comments made by an expert in order to explain a passage of a text, which is similar to the dimensions of form identified by Marshall (1998). Agosti and Ferro (2005b) further identified a number of *annotative contexts*. First, annotations that are idiosyncratic to the annotation writer involve a *private annotative context*. Second, scholarly annotations aimed at people who are not necessarily related to the authors involve a *public annotative context*. Finally, annotations exchanged between a team of people working together on a shared topic involve a *collaborative annotative context*. This schema of *annotative contexts* is similar to the combination of Marshall's form and role definitions.

Typed links were utilized by Agosti and her colleagues (Agosti & Ferro, 2005b; Agosti et al., 2005; Agosti et al., 2004) to define a hypertext between annotations and annotated documents. To capture the complex semantics of the annotation identified, they distinguished the meaning and sign of annotations. For example, an annotation was expressed by one or more SIGNS of annotation (a piece of textual, graphic, or reference information) that in turn were characterized by one or more MEANINGS of annotation (e.g., comprehension and study, revision and cooperation). The relationship between annotations and annotated digital objects was represented by the ANNOTATE relationship, and the RELATETO relationship associated a SIGN of annotation with the digital object it referred to. The ANNOTATE relationship specified the origin of the link and the RELATETO relationship identified the destination of the link. In their design, not only could links be typed by using the MEANING entity, but they could also have a content by using the SIGN entity.

Agosti et al. (2004) used the Entity-Relationship model to describe the conceptual model of annotation. The model was also devised to be mapped to different schema models, such as a relational schema, an RDF schema or an XML schema, and it was suitable for developing an annotation service that could be seamlessly plugged into different digital libraries and repositories. Based on the conceptual model (Agosti et al., 2004), Agosti and her colleagues reported research on system architecture (Agosti & Ferro, 2005a), information service architecture (Agosti & Ferro, 2004), a prototype tool for annotating illuminated manuscripts (Agosti et al., 2005; Agosti, Ferro, Panizzi, & Trinchese, 2006), annotation as context for searching documents (Agosti & Ferro, 2005b), search strategies (Agosti & Ferro, 2006), as well as the interface design and interaction of a generic annotation service (Digital Library Annotation Service, DiLAS) that could be used in different Digital Library Management Systems (Agosti et al., 2006).

### 2.3.3 Fu et al. and the Multi-Faceted Concept of Annotation

A third research group, Fu, MacMullen, Ruvane, and others at the University of North Carolina, characterized the multi-faceted concept of “annotation” as process, thing, and knowledge (MacMullen, 2005; Ruvane, 2005). The typology (annotation-as-process, annotation-as-thing, and annotation-as-knowledge) provided a framework which was then used to enumerate general research questions for the exploration of annotation in arbitrary domains, including cataloging, music, historical geographers, Web usability for annotation, social networking, government statistics, and biomedical research.

MacMullen (2005) reported the aggregated empirical findings of a series of investigations, which was grounded in the multi-faceted concept of annotation as process, thing, and knowledge. A set of research questions were devised by taking the user’s perspective as *use context*, *instantiation context*, and *user context* to investigate various domains. A variety of research methods were employed, including structured and semi-structured interviews, surveys, task analysis, the critical incident technique, and content analysis in a series of investigations. MacMullen (2005) concluded that formal and informal mechanisms for annotation existed in multiple contexts, and that adding communication facilities to the standard tools promoted collaboration as a formal mechanism.

Fu et al. (2005) investigated the reasons for the lack of popularity of the existing annotation services, along with users’ expectations for future tool development. Their study relied on semi-structured interviews as the primary method of data collection. They focused on Web users’ explicit needs for personal annotation tools. They interviewed participants concerning their experiences of and preferences for making personal annotations on the Web.

Their study showed that text selection and association building through notes or symbols remain the dominant forms of annotation on the Web, while structural annotation (resegmentation) and layout annotation (change of font, color, etc.) are also prevalent. In addition, Fu et al.'s (2005) findings suggested that usability should be the most important design issue when developing Web annotation tools. Users welcome “lightweight” annotation features, easy to operate by simple inputs, and easy to integrate into standard Web browsers.

## **2.4 The Gap**

Marshall (1997; 1998) conducted a series of field studies and observations to examine the mechanics of annotation in the print world. In addition to field notes and interview data, she collected people's annotations from used objects like textbooks, journal articles, and printouts. Based on her findings, she categorized the form, function, and role of annotation. The forms and functions were identified in paper documents, but have not been verified in the digital environment. She explored the relationship between personal and public annotations by comparing students' personal annotations on assigned papers with those they shared with each other using an online system (Marshall & Brush, 2004) to explore the transition from personal to public annotations. The findings showed that few personal annotations translated into collaborative use, and the shared annotations were apt to be clarified and extended. They did not discuss these findings in the context of the forms and functions they earlier identified, nor discuss how forms and functions may be affected by the role when sharing annotations with others.

Agosti and her colleagues took a system-oriented design perspective. They conducted a user requirements study among art historians and other researchers. They defined annotation as

metadata and as context from a document perspective, and also defined annotations as dialogue acts from a communication workflow perspective in the system to create a conceptual model for designing a rigorous database management and workflow control (Agosti & Ferro, 2004). They aimed to design and develop an annotation service that could be plugged into different digital libraries (Agosti & Ferro, 2005a, 2004, 2006a; Agosti et al, 2006).

Fu et al.'s (2005) research focused on people's experience of and preferences for Web annotation tools and services for personal use. In addition, a framework of annotation context was developed (Ruvane, 2005; MacMullen, 2005), and was applied to investigate annotation in various domains (cataloging, music, historical geographic research, etc.). MacMullen (2005) reported that the formal vs. informal dimension of form defined by Marshall did exist in multiple contexts, but no further research reported on other dimensions of form, function, or role.

This review summarizes the empirical research on annotation, which is limited compared to the volume of work which focuses on tool development. Unfortunately, few theoretical studies and user studies have been found in the literature. Marshall's findings introduced an understanding of annotation in the paper environment. There was research on the preference and experience of Web annotation tools and services for personal use (e.g., Fu et al.), and investigation of formal vs. informal dimension of form exists in multiple context (MacMullen, 2005); and ways to support the transition from personal to public annotations have been explored (Marshall, 2004); but how much do we know about the forms and functions of online annotation? How does the role affect function, because of the ease of sharing annotations with others in the network environment? A theoretical approach is needed, in order to better understand the creation, presentation and sharing of annotations.

## **2.5 Statement of Research Goals**

The goal of this study is to explore the behavior, cognition, and social dimensions of annotation online. The definition of online annotation used in this study identifies components that are likely to be included in the research design. An information model is devised to describe the approach to understanding annotation in digital environments. Using a prototype annotation module of the Open Journal Systems as a digital annotation environment, the present research seeks to empirically investigate the relative value (combining frequency of use and user rating) of online annotation according to combinations of form, function, and role (private, work group, and larger public).

The forms of online annotation represent the behavioral states of the construction of annotation, which include forms that are conventionally seen in print as identified by Marshall, and also forms displayed by means of hyperlinks and linktypes in online hypertext environments. The functions for the intended investigation include those derived from print documents, as Marshall identified, and those generated from an online hypertext environment given the network capabilities within the community. Furthermore, the social dimension of annotation reflected through the role facet and personal expertise affects annotation functions. The sharing of annotations provides an opportunity to investigate online annotation functions in a social setting, more specifically in an online journal system where the readers not only tend to revise their annotations, but also to link ideas more meaningfully to their annotation audiences. This study further examines the relationship between the annotation forms, functions, and their role in an online environment.



### **2.5.1 Definition of Annotation Used in This Study**

Annotation is defined as a result of the active reading process (Adler & van Doren, 1972; Olsen, 1994; Liu, 2005). For this study, highlighting, notemaking, hyperlinking, and linktyping are defined as the behavioral manifestations of annotation that either singly, or in combination with one another constitute the forms of online annotation. The functions of online annotation reflect an individual's reading and writing strategies and plans of action to construct an annotation. When people are reading, their annotation process is affected by individual differences in terms of their background and familiarity with the topic and document structure, as well as activities stemming from their engagement with texts.

System features enable the user to write in the margin of an electronic text and highlight a document at a particular place, etc. Notes can vary in thoroughness and complexity, from simple marginal notations of words that one reader finds difficult or unclear to entire interpretations written between lines of the original text. In addition, annotations allow the creation of new relationships among existing contents, by means of links that connect annotations together and with content in the base document (Agosti et al., 2005b). With a linktype it is possible to describe the relationship of an annotation to the base document being annotated. Online annotation may have forms and functions similar to those identified by Marshall (1997, 1998) for annotations in print, as well as forms and functions found from utilizing computer network capabilities in the creation process.

Furthermore, in the digital environment the role of annotation may easily be assigned via system features to affect the annotation process. Annotations may start primarily as personal records of reading and interpretation, and later become a means of transmitting and sharing ideas

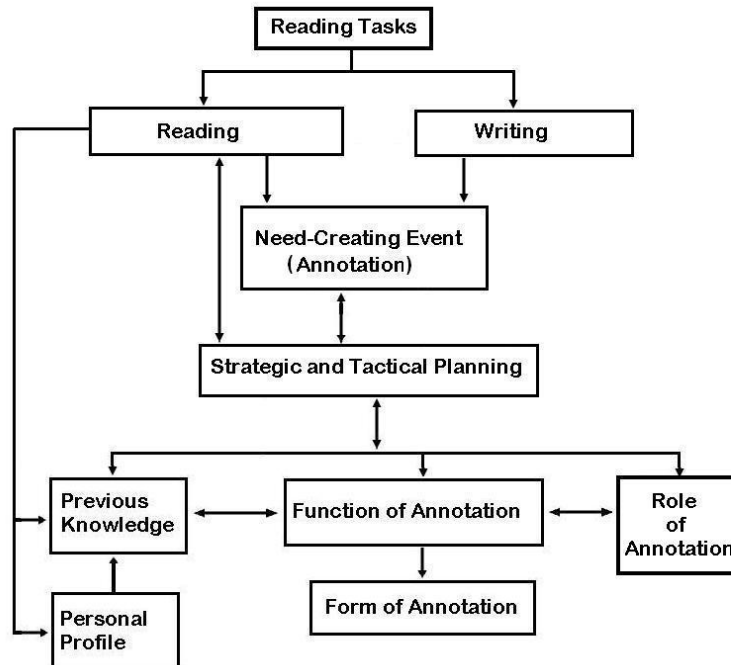
in order to improve collaborative work practices so that they serve as shared records of work and opinion within specific communities or the larger public (Constantopoulos et al., 2004; Agosti & Ferro, 2005a).

### **2.5.2 Information Model for Studying Annotation Online**

This study explores the behavioral, cognitive, and social dimensions of annotation online by applying multiple methods to investigate the relative value of online annotation according to combinations of factors. An information model (Figure 2.1) is developed for annotations which addresses the previous definition and describes the process (along with major constituents) in order to inform our basic understanding of annotation behaviors associated with the individual's cognitive state and the effects of role.

To understand annotation as an active reading process, in this information model for studying annotation online, annotation is defined as a need-creation event of certain reading tasks that involve writing when reading. While reading, people develop a plan of action to make annotations. Annotation form represents the behavior associated with completing an annotation. Use of annotation form provides the behavioral manifestation of annotation function. Annotation function reflects the users' cognitive states of annotating, and the user's personal profile and previous knowledge have an effect on the function of annotation. Furthermore, the sharing of annotations provides an opportunity to investigate annotation functions in a social setting.

Figure 2.1 A general model of studying annotation relationships



### Description of the Model

Every annotation is associated with a reading task. That is, individuals interact with information purposively through various levels of task complexity and goal development. In this study three different reading tasks are designed for investigating whether reading task has any effect on the function and form of the annotation. A person becomes aware of a reading task and attempts to react to or in other ways engage with the text. The person reads and creates annotations as a specific event. The person develops some strategies and plans of action to make annotations, and may perceive some functions of annotation with some consideration of the audience in mind to share the annotations with (role). Naturally, when reading, the person's previous knowledge and his personal profile influence the function of annotation. The function of annotation is presented by various forms of annotation.

For example, when a student reads an article for his term paper, the first reading task may be quickly skimming through this article, and making some highlights on the headings or first sentences as a signal to return to read more intensively. For a particular phrase he highlights chunks of text that attract his attention as a reminder to quote them later, and make connections to other related articles. In the second reading he gives a more in-depth reading on a specific theme related to his interests, defined as a directed reading task. He may make more highlights on phrases or keywords as he comprehends the text better. He may reflect from his background knowledge about this topic, and write some notes that may be used to build up the main theme of his paper or pose questions that may later be used for discussion with his group for the term project.

### **Defining Model Component Information:**

This section gives the definitions of the model components.

- Reading tasks

A person interacts with information purposively by conducting different levels of reading tasks. In this study, three tasks are administered: a General Reading Task, a Directed Reading Task, and a Confirmatory Task. For each task, users must decide what they have to elicit from the articles and determine how they tackle the information space (e.g., scan or read from start to finish, follow a link, highlight a passage, or write an annotation, etc.). Furthermore, for the Confirmatory Task they must review their annotations, and if necessary, revise them to share them with others.

- Reading

In this study this means active reading. Active reading is the combination of reading with critical thinking and learning, involving not only reading per se, but also underlining, highlighting and scribbling comments.

- Writing

Writing includes authoring, writing reviews, and annotating, etc. Research showed that “the majority of people read and annotate daily, but do not create new documents” (Brush et al., 2001, p. 28); therefore, only a small part of writing would produce annotation as a specific event, which is the focus of this study.

- Need-creating events

In this study this means an event that triggers a need to annotate. People may annotate when they read, which involves finding related material and moving from one text to another, as well as activities stemming from the readers’ engagements with texts.

- Strategic and tactical planning

A person develops plans and actions for making annotations.

- Function of annotation

Annotations serve a multitude of functions, including the six functions defined by Marshall (1997): (1) annotations are procedural signals; (2) annotations are place-markings; (3) they are an *in situ* way of working out problems; (4) annotations record interpretive activity; (5) and most elusively, these markings act as a visible trace of a reader’s attention; and, (6) the markings may just be incidental, reflecting the material circumstance of reading. In addition, with the hypertext capabilities of creating or following hyperlinks and linktypes, “Linking ideas meaningfully” is added as the seventh function of annotation to further explore the form and function of annotation that are inferred from readers’ online reading.

- Form of annotation

Annotation forms appear in various formats. In this study forms of online annotation include highlighting, noting with telegraphic characteristic or explicit text, creating a link between two pieces of information, and selecting a linktype to describe the link relationship.

- Previous knowledge

Previous knowledge means the user's previous knowledge about the topic, i.e., his/her familiarity with the topic and the document format.

- Personal profile

Personal profile means the user's gender, academic status and degree(s), reading preferences (online vs. print), etc. As Dillon pointed out, experts more easily recognize the semantic structure of a document, while novices rely more on the spatial structure of a document (Dillon, 2000).

This study investigates the annotation process in articles in the context of an online scholarly journal, which is specifically created for this study to enable the participants to make annotations resulting from their reading and writing. A public version of an annotated article is made from aggregating a number of participants' annotations in order to elicit the role effects of sharing annotations. This information model provides a conceptual model allowing us to enumerate general research questions for the exploration of annotation online.

## **3 RESEARCH DESIGN AND METHODS**

### **3.1 Introduction**

Chapter 3 discusses the research design and research methods. First, the mixed-method approach for studying annotation online is discussed. Then, a theoretical framework for evaluating and understanding the design issues of an annotation tool for a web-based journal system to support readers' online reading and writing needs is introduced. The remaining sections address the research design, including the subjects, reading materials, prototype, tasks, and procedures. Data collection methods include questionnaires, screen capture of annotation processes, and verbal protocols of participants. A revised sense-making interview was conducted, asking participants to recall the situation, difficulty, and help required when reading and annotating online during the course of the study.

### **3.2 Mixed Method Approach**

Studying annotation online is complex because of the multiple influences affecting annotation construction during reading and writing: task, form, function, role, and personal profile. In addition to form as readily observable evidence, other factors need to be explored in the context of annotation creation and the annotation writers' *in situ* reading and writing, as well as the sharing of annotation.

Marshall's studies (1997; 1998) indicated that annotation is a practice carried out over time and that annotation forms and functions reflect different levels of reading. For example, highlighting section headings reflects the procedural signaling function, which, it is conjectured, may more typically appear during a general reading situation where the reader would mark a

position or a segment of text for future attention. As another example, long highlighting (e.g., marking of whole sentences, paragraphs, and sections) may be more characteristic of intensive reading situations when tracing difficult narratives. Thus, every annotation is associated with a reading task. That is, individuals interact with information purposively through various levels of task complexity and goal development. In this study three different reading tasks are designed to see if reading task has any effect on the function (and form) of the annotation. Two different reading tasks, a General Reading Task and a Directed Reading Task, are designed to see whether the annotation function is affected by the difference in reading task. The third task, the Confirmatory Task, is designed to explore the role of annotation with different audiences.

Multiple methods were applied to gather the observable data (e.g., the text the participants read or the annotations they make) and questionnaire data to assess the participants' profiles and preferences. Observational data was gathered by means of screen capture of user interactions with the system during the process of reading and annotating. Data on cognitive processes was gathered via verbal protocols from users' thinking aloud when interacting with the system in the three reading tasks. After the think-aloud sessions, users were interviewed and asked to talk about the situation, difficulties encountered, and help required when reading and annotating online. The interview data is used to explore further aspects of the users' experience that may be revealed through retrospective recall and interpretation of their experiences. Furthermore, three questionnaires were administered in this study. A demographic questionnaire provides background information on user domain knowledge and annotation tool usage experience. A post-session questionnaire assesses the participants' preferences for annotation forms and functions. Lastly, a Perceived Values of Online Annotation Questionnaire (see Appendix 8) asks the participants' perceived values of annotation online.



## Research Methodology and Methods

This study uses the convergence model of a mixed methods triangulation design (Creswell, 2007, p.64)<sup>4</sup>. In this study, the triangulation design involves studying an issue using several different methods (questionnaires, screen captures, think-aloud protocols, and interviews), which provide different results, where the results are expected to converge on the “reality” of that which this study is investigating (Smith & Glass, 1987; Kidder & Fine, 1987; Greene, Caracelli, & Graham, 1989). The core premise of triangulation as a design strategy is that all methods have inherent biases and limitations, so using only one method to assess a given phenomenon would inevitably yield biased and limited results. Through the provision of counteracting biases, the triangulation design uses multiple methods in investigations of the same phenomenon in order to strengthen the validity of inquiry results.

### (1) Questionnaires:

The pre-test questionnaire (Appendix 4) gives a brief understanding of the participants’ demographic information, their familiarity with annotation tools, and the topic of the readings. The post-session questionnaires (Appendix 7) gather information via user ratings about the functions of annotation for each task and user preferences about the features, as well as the perceived values of annotation online. The post-session questionnaires use closed format questions.

### (2) Think-Aloud Protocol Method:

The think-aloud protocol methodology elicits verbalizations from the contents of an individual’s working memory by providing an individual with a specific task and instructing him

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<sup>4</sup> Each type of data are collected and analyzed separately on the same phenomenon and then the different results are converged (by comparing and contrasting the different results) during the interpretation.

or her to speak aloud while performing that task (Van Someren, Barnard, & Sandberg, 1994). Hayes and Flower (1980, p.153) pointed out that it is “a description of the activities, ordered in time, which a subject engages in while performing a task.” The individual is instructed to say anything and everything that crosses his or her mind, speaking constantly, without consciously filtering what is being said, so that the verbalization can be utilized as data. Protocols are collected, recorded, transcribed, and parsed to derive coding schemes that provide a good fit with the protocol data. Protocol analysis seeks to reveal the mental processes, which take place as individuals work on problem-solving tasks. Think-aloud sessions are conducted until saturation is achieved, and no new factors that affect annotating decisions are discovered. In this manner, the respondent would articulate his or her cognitive processes involved in performing the given task.

Think-aloud protocols are widely used and have been applied in various fields, including reading and writing research (Schellings et al., 2006; Wong, 2005). Afflerbach (2000) pointed out that a concurrent think-aloud protocol yields detailed descriptions of task-induced reader behaviors and complexity in reader’s thoughts and that they also permit the study of the effect of affective states on reader-text interaction. Concurrent think-aloud protocols (CTA) are used in this study. The basic principle of this method is that users are asked to complete a set of tasks with the artifact tested, and to constantly verbalize their thoughts while working on the tasks. The method has high face validity, since the data obtained reflects the actual use of an artifact, and not the participants’ judgments about its usability. The method is used in research focusing on people’s cognitive processes during the execution of a wide range of tasks -- e.g., writing texts, reading, playing chess, and choosing between alternative options (Van den Haak, De Jong, & Schellens, 2003a)

There is a debate over whether concurrent or retrospective think-aloud methods (Van den Haak et al., 2003a) are more efficacious. The studies reported by Van den Haak et al. (2003a, 2003b) indicate that concurrent and retrospective think-aloud protocols reveal comparable sets of problems, but that these problems come to light in different ways. The retrospective think-aloud methods are a variant of the CTA protocols, involving participants who silently work with a particular test object and then verbalized their thoughts afterwards. Van den Haak et al. concluded that, although the two methods have distinct differences, these two methods do seem to produce a similar outcome. This study chooses the CTA method, even though the CTA participants might experience difficulty in verbalizing when asked to perform tasks and think aloud at the same time, and affect the working of the concurrent think-aloud method (Schneider & Reichl, 2006). For the purpose of this study, the CTA method allowed capturing participants' immediate thoughts while they were being simultaneously involved in reading and annotating. Moreover, the CTA method saves the participants' time and the effort of having to remember and recount the thoughts they had during the reading tasks.

More generally, Rouet and Passerault (1999) pointed out that the validity and limits of verbal protocols have been subject to some debate. For example, verbal protocols can only reflect subjects' attentional control processes, but cannot be used to capture purely automatic processes; verbal protocols may interfere with the subject's main activity relevant to the production or comprehension of language; and subjects may comment on the verbal protocols rather than the activity they are asked to perform. Among other things, subjects may be influenced by their perception of the facilitator's expectations. In this study, it was ensured that the protocol is immediate and continuous to avoid this type of bias.

Despite the potential difficulty in verbalizing, this study uses the concurrent think-aloud method (Appendix 5). In this study, the participants were users of the OJS annotation module -- ANNOLINK. The participants were asked to constantly verbalize what they were reading and what they took into consideration when annotating. This approach makes the participants more attentive to the material they are reading, and their verbalization of the situations and problems. The think-aloud protocol data obtained reflects the actual use of the system, the subjects' thoughts, ideas, previous memories, or even their feelings. The procedure for this study is described in more detail in Section 3.5.

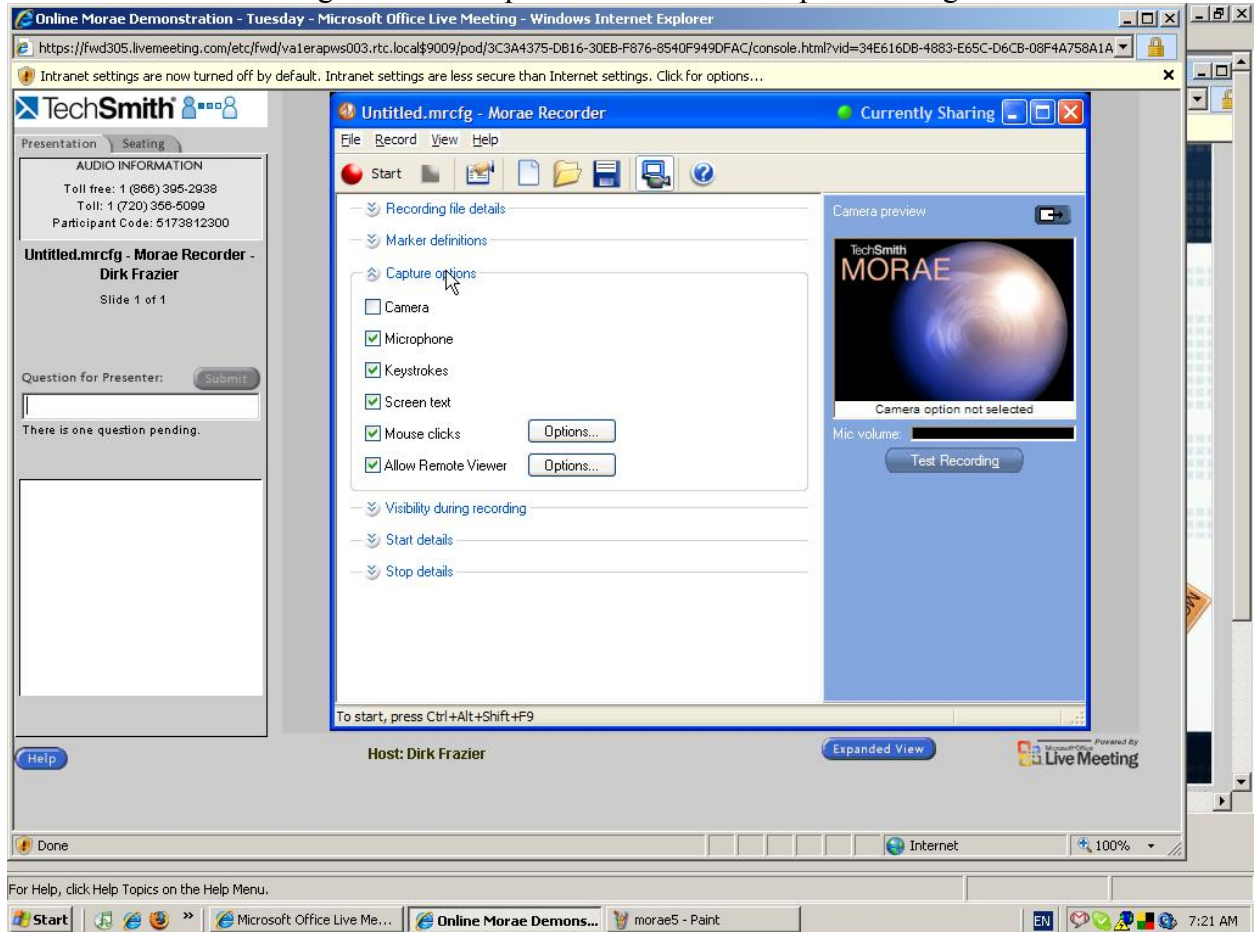
### (3) Behavioral Observation:

While participants think aloud, the recording software, Morae<sup>5</sup>, captures the screen (Figure 3.1) and the mouse movements, and also the tool use patterns (i.e., annotation forms including highlighting, notemaking, linking, and linktyping), time spent on task, and click path, etc. These data are mainly used to determine the “forms” of online annotation.

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<sup>5</sup> Morae software (<http://www.techsmith.com/morae.asp>)

Figure 3.1 Example of Morae screen-capture settings



#### (4) Sense-Making Interview:

Sense-making interviews (Appendix 6) were conducted immediately after the think-aloud process to further understand the problems encountered during the think-aloud process in addition to observation. The core elements of the Sense-Making theory are situations, gaps, and uses (Dervin, 1983). Situation consists of the time-space contexts in which sense is made. Gaps are where the individual senses something is missing. Uses are the ways in which the individual puts the newly created sense to work in guiding his or her behavior. In Sense-Making, the individual moves cognitively through time-space using whatever sense of the situation or information etc. he or she has already constructed based on both personal and indirect experiences (Kim, 2005).

The interview questions, based on Dervin's Sense-Making theory (Dervin, 1983; 1989; 1992; 1999; Dervin, & Dewdney, 1986), encourage participants to reflect upon their own perceptions and behavior with regard to the annotation process. In this study, the interview questions focus on the reading and annotating process of the three tasks a participant has experienced. The sense-making interviews administered immediately after the think-aloud protocol encouraged the participants to focus on a real situation, relevant to the research question, by recall or by using the annotations remaining on the screen for attention. All interviews were conducted individually with each participant. Each interview lasted for approximately twenty minutes. The interview sought to clarify the person's situation, the gap preventing reading and annotating progress, and the help looked for. The questions focused specifically on the annotation functions in relation to reading strategies, sharing decisions, difficulties, and specific help required in annotation online.

Using multiple methods allows us to compare observable data to the cognitive states reflected in verbal protocols. The multiple methods allow the investigator to compare what participants are thinking with what they are doing, to see if they are consistent or if they differ in some way. For example, mouse highlighting was only captured through observation and screen capture, and its related function (tracing through difficult narratives) was confirmed through think-aloud protocols. As another example, whereas the overall perceived values of online annotation were assessed through the Perceived Values of Online Annotation Questionnaire (Appendix 8), the verbal data provide an elaboration upon the results from the Perceived Values questionnaire. The multiple methods were applied with the intent of triangulation, seeking an additional example or further elaboration on the same conceptual phenomenon when annotating online.

### 3.3 Participants

After getting approval for the study from UBC's Behavioral Research Ethics Board (Appendix 1), the investigator recruited 15 participants. Recruitment was done through e-mail (Appendix 2) posted on the SLAIS<sup>6</sup> listserv and the CPSC<sup>7</sup> listserv on the UBC campus. When the participants confirmed their willingness to participate in this study, they were probed on a number of demographic factors (Appendix 4). The participants of this study were adult (at least 19 years old). All the participants were recruited from the SLAIS listserv, 12 were females and 3 were males. All participants were paid \$20 for participating in this study of approximately 2 hours.

The participants' academic backgrounds were varied, with individuals holding degrees in English Literature (3), Linguistics (2), as well as Psychology, Law, Political Science, Engineering, Mathematics, Archeology, Drama, Art History, and Music prior to entering their current degree program. All of the participants were students and faculty in the School of Library, Archival and Information Studies: three of the participants were doctoral students, two were faculty, with the remainder being Masters' students. Half of the participants had some familiarity with the concept of hypertext.

While all were experienced Web users, only one participant had previous experience with some form of online annotation (Zotero) and two participants had commenting experience in Microsoft Word and Adobe Acrobat. When asked whether they preferred to read paper or online documents, only four participants stated that they would prefer reading documents online

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<sup>6</sup> School of Library, Archival and Information Studies at the University of British Columbia

<sup>7</sup> Department of Computer Science at the University of British Columbia

### **3.4 Reading Materials, Prototype, and Task**

#### **3.4.1 The Reading Materials**

Before arriving at the laboratory and performing the tasks, all the participants were required to read an excerpted version of a review article on the topic of hypertext (Vora & Helander, 1997). This paper provides a brief history of hypertext, and discusses the advantages and disadvantages of hypertext, and issues related to navigation, typed links, comprehension, and usability. This paper was designed to give the participants a general understanding of the reading domain, and enable them to make annotations and make connections of ideas via linking when performing the tasks. Three other online articles for participants to read, annotate, and link during the laboratory session were selected from classic hypertext articles -- Landow (2003), Conklin (1987), and Burbules (1997) -- which were formatted in HTML for the purpose of this study, and then uploaded to a test site called the Journal of Hypertext<sup>8</sup> by using the Open Journal Systems.

In selecting the articles, two important themes crucial to the topic of this study were taken into consideration. First, the arguments for and against hypertext are introduced in the review article used for preliminary reading, and the arguments are further discussed in Landow, Conklin, and Burbules' articles, as well as Nielson's (1997) usability perspective, and thus might engage the participants more fully in making annotations and links. Second, all of these articles also discuss typed links, and therefore were chosen to familiarize the participants with the linktyping function implemented in the Open Journal Systems for this study.

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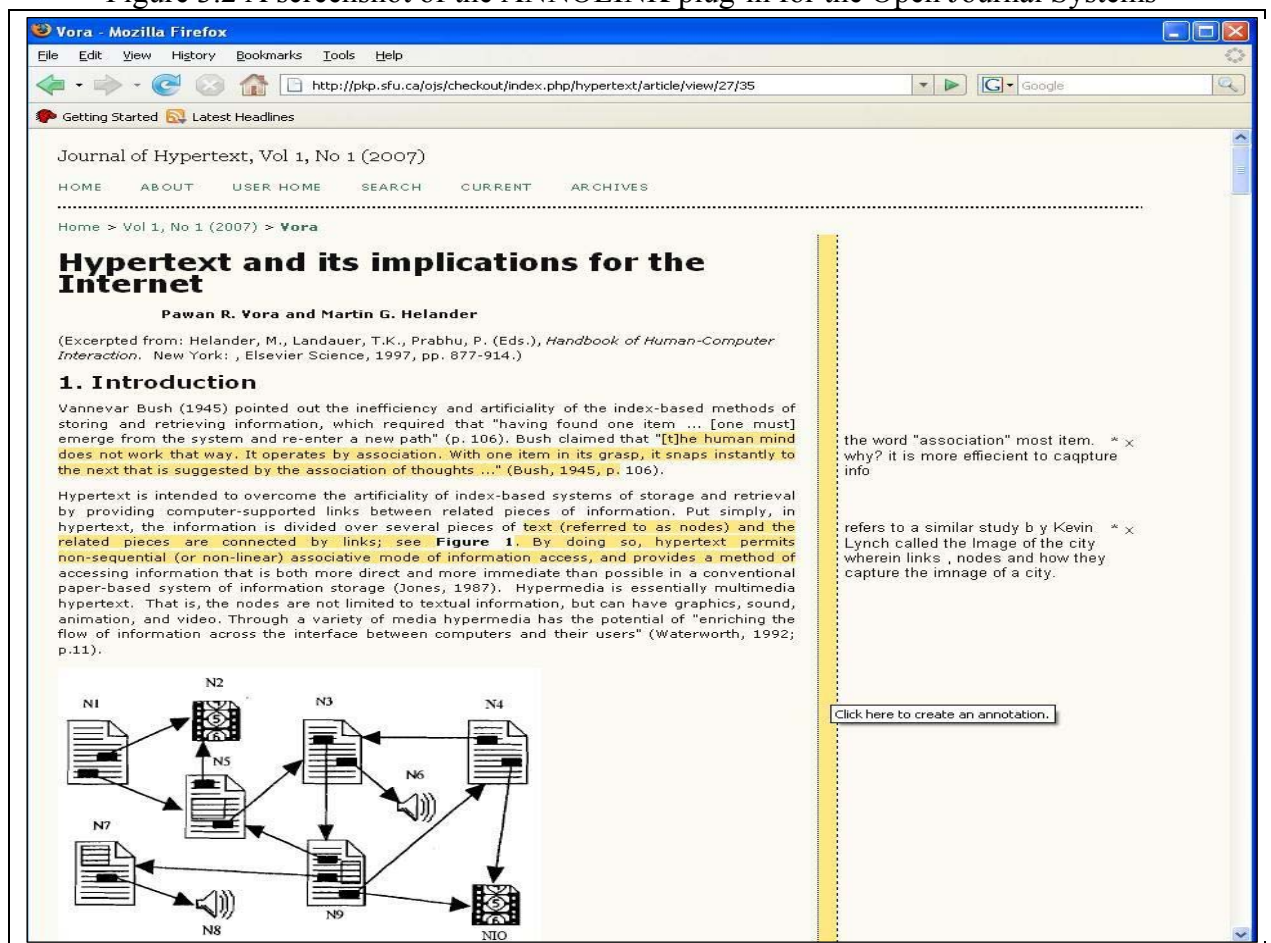
<sup>8</sup> The Journal of Hypertext Website was set up at <http://pkp.sfu.ca/ojs/checkout/index.php/hypertext/login>



### 3.4.2 The Prototype

This study employed ANNOLINK (see Figure 3.2), a plug-in developed for a Web-based journal publishing system (Open Journal Systems). The goal is to enable readers to become authors, creating annotation and linking while reading. The prototype is posted on a university Web server with password protection to ensure the privacy of participants. The access to “The Journal of Hypertext” was confined to the registered users and the investigator. To work with the prototype, the participant was registered within the system. Each registered user had his/her private annotation space.

Figure 3.2 A screenshot of the ANNOLINK plug-in for the Open Journal Systems



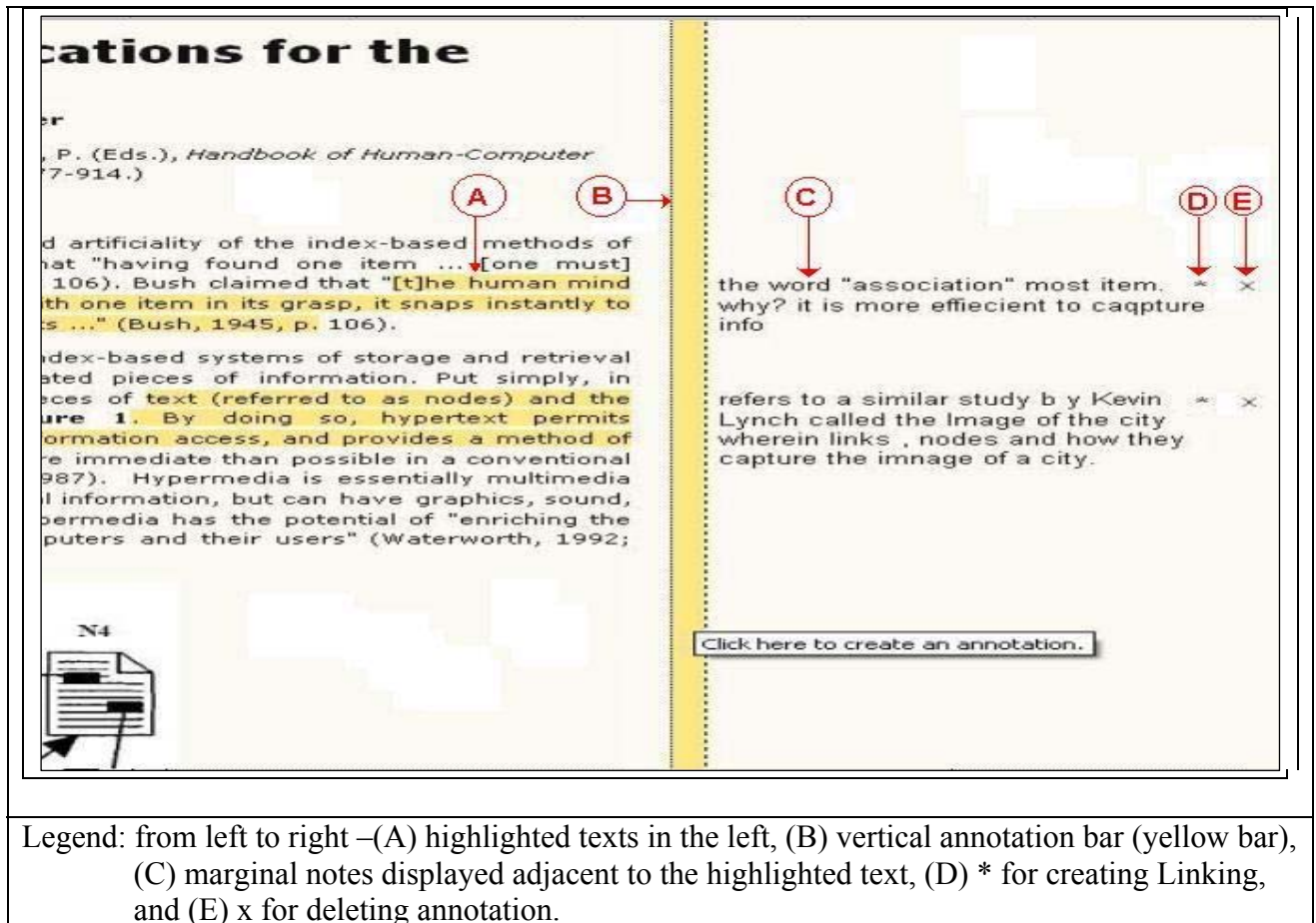
The ANNOLINK prototype consists of four components: highlighting, note-making, linking, and linktyping (Kopak & Chiang, 2007). The application thus enables participants to highlight texts, make marginal notes, make links, and select a linktype. Using ANNOLINK to highlight is straightforward and is similar to marker highlighting of a document in the print world. While viewing a journal article in the OJS, an annotation space is added to the right margin of the article text. Any note or linktype is displayed in the margin, similar to scribbling notes in the margin of a book. Links are presented in the text of the document by an asterisk (\*). Clicking on the asterisk takes the reader to the text segment in another journal article connected by the link. Each annotation is associated with a post (i.e., a particular location of the document); this text is highlighted. The annotation can be edited and deleted by the creator.

To highlight, the user uses the mouse to select a range of text, then clicks the vertical yellow bar (see (B) in Figure 3.3) in the annotation space to initiate the annotation feature, and then clicks elsewhere to save the highlight. To create a note (see (C) Figure 3.3), the user must use the mouse to select a range of text, and then click the vertical yellow bar in the annotation space to initiate the annotation feature. A text box appears in the annotation space for entering the note. The user must then click elsewhere in the annotation margin to save the note.

To create (or edit) a hyperlink, the user clicks on the asterisk icon in the margin next to the margin note (see (D) in Figure 3.3). The margin note is then replaced by a text edit control into which the user can type or paste the URL for the link, or simply move the mouse over and click on the target paragraph, and ANNOLINK would capture the URL of the target paragraph. Clicking elsewhere in the annotation margin saves the link. The link icon (a green asterisk) appears next to the highlighted passage in the article text. Annotation links can link to other journal articles on the same OJS web site. Unlike links leading elsewhere on the web, these

links specify exactly to which paragraph the link is made within a document, so that when the link icon is clicked, the browser would go to that paragraph in the linked document.

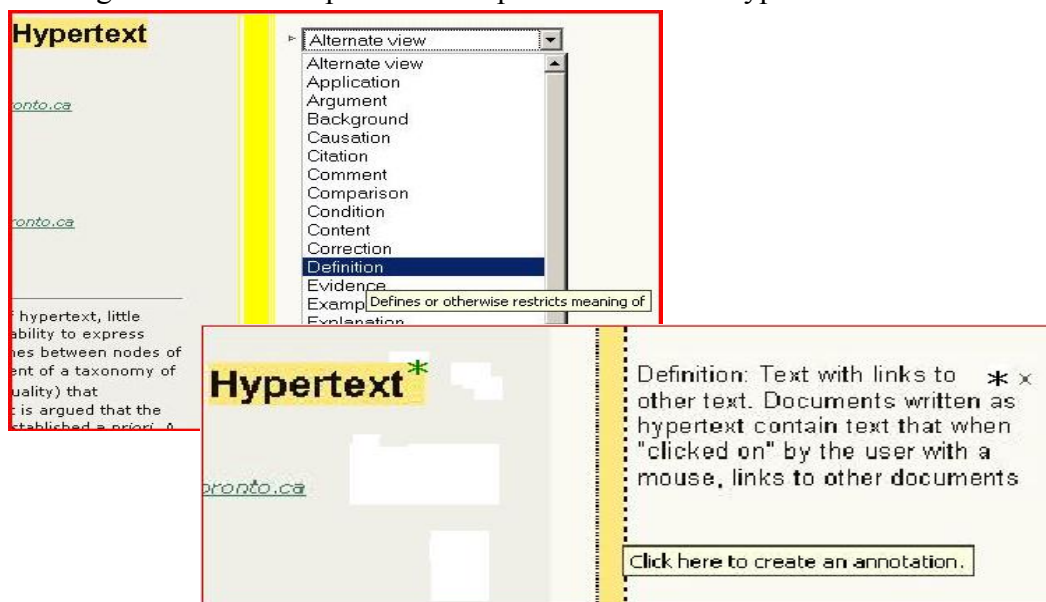
Figure 3.3 A screenshot of the ANNOLINK annotation example



After creating a linking component, users can select a linktype to describe the link relationship. To create a linktype, the user must use the mouse to select a range of text, click the yellow bar, and then in the annotation space click on the “-“ button to get the drop-down list of linktypes to select one (see Figure 3.4). A taxonomy of linktypes that describe the function (discursive quality) that characterize the formation of links was empirically developed by Kopak (2000). Twenty-six linktypes recommended in the results of Kopak’s study (2000) were chosen for the list for this study.

Using the linktype “Definition” as an example, ANNOLINK enables the reader to apply “Definition” as a descriptive label to a link that leads to information that provides a definition of the highlighted text fragment. So, when a reader sees “Definition” in the annotation and moves the mouse over the linking icon (asterisk) to find out what has been linked, he/she would find that the target information provides definitional information for the highlighted text fragment (see Figure 3.4).

Figure 3.4 An example of the drop-down list of linktypes for selection in ANNOLINK



### 3.4.3 The Task

Each participant was tested individually. At the beginning of each session, the participant was given a brief tutorial on how to use the ANNOLINK. Subsequently, each session proceeded through three major task sections: a general reading, a directed reading, and a confirmatory reading section. The investigator presented the tasks procedure to the participants orally using the User Session Procedure Sheet (Appendix 9). Three tasks that involved reading and annotating were designed for participants and are described in this section.

## **General Reading Task**

This was a task with a 15-minute limit in which participants used their reading strategies to grasp the general ideas of the articles and make annotations as they saw fit. The participants skimmed two articles for no more than 15 minutes in total. The condition of annotation was for personal use. It was intended that given the time limit to skim through an article, the participants would read only such things as the section headings and the first sentence of each paragraph. The forms they chose, whether highlighting or markings, would match two functions: (1) “Incidental Reflection” of the material circumstances of reading and (2) “Procedural Signaling” for future attention (See Table 1.3 Relative Value of Annotation by Purpose and Audience in Chapter 1).

## **Directed Reading Task**

For this task, participants were encouraged to adopt a reading strategy that was more intensive and focused on absorbing the ideas contained in the article. Each participant was given 30 minutes to choose one article (Landow, Conklin, or Burbules) and read intensively. He/she was asked to make highlights, notes, linktypes, or links as they saw fit.

The purpose of this task was to explore whether more intensive reading manifested specific annotation functions. For example, annotation functions such as “Placemarking” for aiding memory and “Recording Interpretation” might be more likely for creating annotations as results of more intensive reading.

## **Confirmatory Task**

This task had a 15-minute duration in which participants revisited their own annotations and commented on any changes they would make if they were to share their annotations with

others. They were further instructed to think of the audience, either a work group or the larger public, with which they might share their own annotations. Then, they were asked to comment on whether they would share their annotations with this audience, and how they would make changes to the annotations if they were to share them. All participants were asked to comment on how they would change if sharing with others. Half of them (the first group) were told that their annotations would be viewed, and the other half (the second group) were told that they were going to be viewers.

The first group (annotation writer group) commented on how they would alter their annotations if sharing with others. In addition to commenting on how they would alter their annotation if sharing with others, the second group (annotation reader group) also commented on actual annotations of others. Since the annotation writer group was told in advance that others would view their annotations, they may intentionally make the annotation clearer, which may cause it to be biased to reflect the “Recording Interpretation” function. Therefore, the revision would provide evidence on whether public annotation is more clearly interpreted than private annotation, that is, whether people tend to revise private annotations when sharing them with others.

It was expected that the shared annotations by the annotation writer group would be amended to be clearer than the first notes, flagged to solicit others’ attention or help, or flagged to link ideas meaningfully. Consequently, the annotation reader group who viewed those shared annotations later was asked to indicate whether they benefited from reading those annotations. The intention was to use the Confirmatory Task to help verify the value of shared annotations.

### 3.5 Procedures

When a participant confirmed his/her willingness to participate in this study, he/she was provided with a paper copy of Vora and Helander's article in advance of the scheduled session, and asked to become familiarize with the contents of this article prior to the day of the session in order to begin the session with a sufficient level of topical awareness. A copy of the consent form (Appendix 3) was also given to the participants after signing the form.

A number of systems and tools were used for this study. A procedure sheet (Appendix 9) was used for managing the flow of processes. It was administered to check that the systems and procedures worked properly to ensure that the participants would have a successful session. For example, the procedures include registering the participants in the OJS, logging into the OJS, demonstrating the features of ANNOLINK, launching Morae Recording, and using a tape recorder for recording the think-aloud sessions and interviewing the participants.

Each participant completed a pre-test questionnaire (Appendix 4) that collected basic demographic information, including their previous experience with online annotation tools, and their familiarity with the topic of the readings to give an overall understanding about the participant's background. Participants were then given a brief training session (see Appendix 9) on how to use ANNOLINK to make highlights, notes, linktypes, and links in the Open Journal Systems. Participants were then given 10 minutes to practice with ANNOLINK before they started the tasks. The main study was composed of three tasks and an interview, i.e., the general reading task, directed reading task, and confirmatory task. All participants were instructed to think-aloud while they completed each task (Appendix 5). After the task sections, each participant was asked to reflect on the task completion via the modified sense-making interview (Appendix 6). Participants were then asked to fill out a post-session questionnaire (Appendix 7)

about their preferences for annotation forms and functions. Lastly, to evaluate the perceived values of online reading and writing that constitute the acceptance of annotation online, a Perceived Values questionnaire (Appendix 8) was administered to assess perceived values about annotation online.

## **3.6 Data Collection**

### **3.6.1 Quantitative Data Collection and Analysis**

The quantitative component of the study collected data through questionnaires, annotations created by the participants that remained on screen, Morae recordings of the user sessions, the preferences for annotation forms and functions reflected from the post-task questionnaires, and the ratings of perceived values of annotation online.

The pre-test questionnaire asked the users' current academic status, gender, field of study, experience in annotation tools, and knowledge of hypertext (Appendix 4). The pre-test questionnaire was intended to provide a brief understanding about the diversity of participants such as their disciplinary background, e.g., history, political science, engineering. This study required participants who had no previous experience with annotation tools before coming to the sessions, although having some previous knowledge about the topic of the readings was preferred.

From the annotations remaining on screen and screen captures, the frequency of the mouse tracing, highlighting only, short and long notemaking, linking, and linktyping were documented and entered into a Microsoft EXCEL sheet (Figure 3.6). Each form was then



mapped with the verbal transcripts to identify related functions. Thus, data about the frequency of functions were reconstructed and entered into the same EXCEL sheet.

Participants' ratings of the forms and functions in terms of role (private, work group, and public), and their feelings about annotation online were collected through the post-session questionnaire (Appendix 7). Participants' ratings of perceived values of annotation online were collected through the Perceived Values questionnaire (Appendix 8).

### **3.6.2 Qualitative Data Collection**

The qualitative data included the transcriptions of participants' verbal protocols and interviews, the investigator's observation notes made during the think-aloud sessions and interviews with the participants, and the investigator's notes made while replaying the screen captures. The observation notes recorded participants' reactions, particular comments, or any conversations related to their personal profiles or previous knowledge that could not be captured by the think-aloud protocols and interview questions. Specifically, the relationships between form and function and between form and role were noted.

The sense-making interview questions were instrumented in determining the participants' difficulties, and any help or features they would like to have had. Participants were asked the following questions: What are your reading strategies in different reading tasks? What annotation functions do you think would match the situation in each reading task? What thoughts, ideas, memories, or frustrations do you have in each reading task? Would you share your annotations at the stage of the Directed Reading Task? With whom would you want to share (workgroup or public), would you revise your annotations if shared with others, and why would you make the changes? What help do you perceive as necessary in online annotation, and

what other features do you think would be helpful? The interviews were recorded and transcribed, and were used to make sense of how participants read and create annotations online (situation), as well as the difficulty (gap) they encounter and the kind of help they need (help) in the annotation processes.

### **3.7 Data Analysis**

Since this research is an exploratory study, a major emphasis is placed on the finding of any evidence that conveys the direction of effects, without regard to whether the difference is statistically significant. Descriptive statistics are used to describe the frequencies of a collection of data in quantitative terms, and are presented with qualitative analyses.

#### **Quantitative Measures**

Data collection on each of the tasks consisted of screen capture (via Morae) of the annotation and linking process (see the table in the red circle in Figure 3.5). Morae provides the capability to create markers to identify the observable annotation forms in the recordings, which can be exported in EXCEL format. The Morae tables and measurable data were then merged in EXCEL format for analysis (see Figure 3.6).

Figure 3.5 An example of Morae screenshot -- Markings on annotation forms (red triangular pointer) are flagged and created in Morae's table (shown in the red circle)

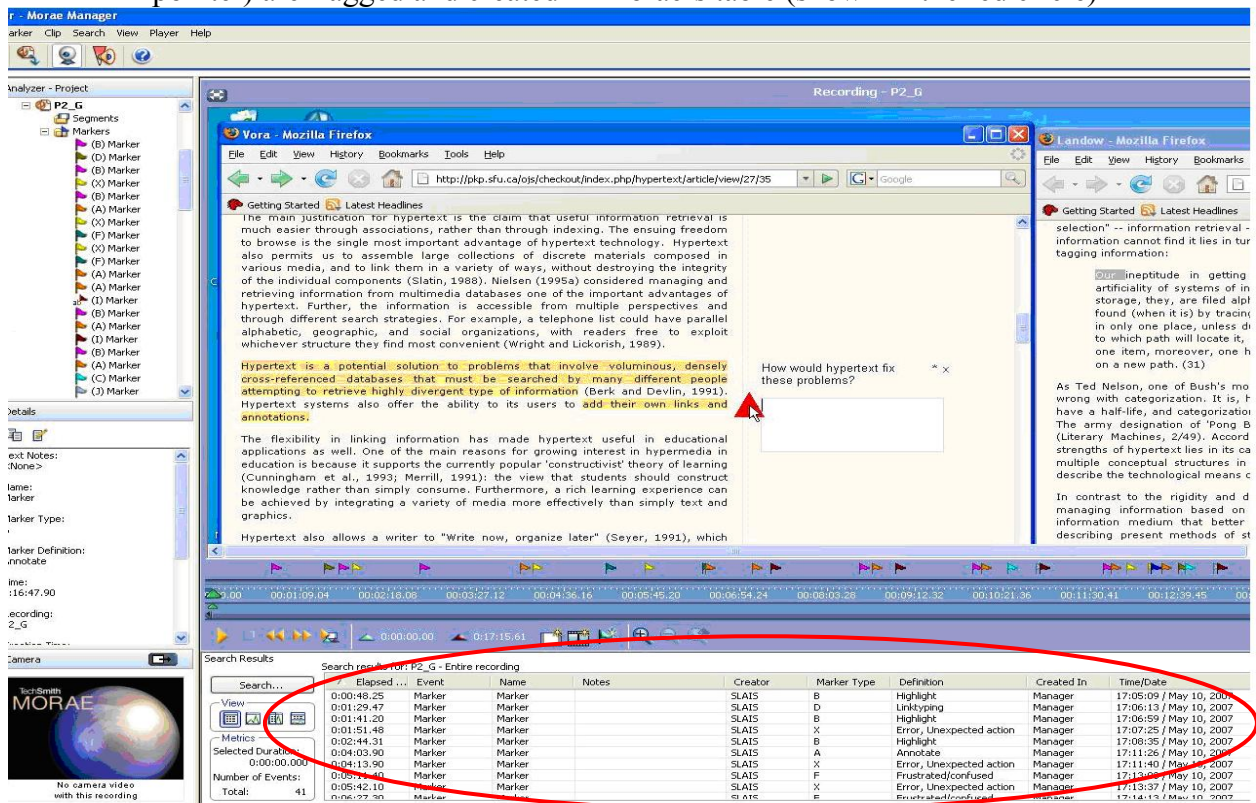


Figure 3.6 An example of measurable data of form, function and role converted from Morae's tables (the red circled table in the bottom of Figure 3.5)

Microsoft Excel - Analysis0709																			
File Edit View Insert Format Tools Data Window Help																			
H24 fx																			
	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S
	Time Stamp	Abort/ Delete	Task	participant	ID	text type	location	text	highlighting	noting	Note count	linking	link target	linktyping	function	observer comment	share	Group/ Public	reason to share
1																			
2			D	p02	8	sentence	in	In fact, there are several	14 words	what are the	18 words				Pose a question	Pose a question	No	public	Just a question
3			D	p02	9	heading	in	Disorientation	1 word	this seems to be a	15 words				Pose a question	Pose a question	No	public	
4			D	p02	10	phrase	1st	provide preauthored	4 words	if you have a linear	17 words				Pose a question	Pose a question	No	public	
Data Analysis / Tables / p1 / p2 / p3 / p4 / p5 / p6 / p7 / p8 / p9 / p10 / p11 / p12 / p13 / p14 / p99 /																			

## Qualitative Analysis

Verbalization data were recorded, transcribed, and parsed to derive coding schemes that provided a good fit with the protocol data. Data analysis in verbal protocols typically consists of

three steps: (1) transcribing, (2) segmenting, and (3) encoding. For the purpose of ensuring coding reliability (Carmines & Zeller, 1979), there were two independent coders who evaluated the transcription data, discussed, and reached the same conclusion. There is a loop involved in the process of coding the protocols, developing the coding schemes and developing a descriptive model, which suggest that the process can be subject to several cycles of interpreting, defining, and refining.

Strauss and Corbin (1990) pointed out that open coding is the analytic process through which concepts are identified and their properties and dimensions are discovered in the data. This process is equivalent to steps in the case study method of “analysis of themes<sup>9</sup>,” (Creswell, 1998, p.249) “development of issues” (Stake, 1995, p.123), and “categorical aggregation<sup>10</sup>,” (Creswell, 1998). Open coding in grounded theory (Glaser & Strauss, 1967; Strauss & Corbin, 1990) was used to reduce the data. Coding started with a provisional list of codes created prior to the fieldwork based on the literature review (Marshall, 1997; Ovsiannikov et al., 1999; Wolfe, 2002; Bringay, Barry, & Charlet, 2007; Ames & Naaman, 2007). These codes are labels attached to chunks of transcribed data from the think-aloud protocols, which serve to assign units of meaning to the information compiled during the study (Miles & Huberman, 1994).

A test run of code assignments in a transcript was conducted using Qualrus<sup>11</sup> (see Figure 3.7). A system of codes was defined (See Appendix 12), which are categories or variables describing the phenomenon. The codes and coding scheme were continually developed during

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<sup>9</sup> Analysis of themes: After collecting the data, the researcher will proceed to reiteratively read through the data in order to identify recurring specific ideas or themes. These themes will be identified as important and supported with details such as quotations, passages, and field notes taken from interviews, documents, and observations (Creswell, 1998, p. 249).

<sup>10</sup> Categorical aggregation: Categorical aggregation is the collection of instances or occurrences within the data that represent a specific category, theme, or idea that the researcher determines to be important as a result of it emerging from the analysis of the data (Creswell, 1998).

<sup>11</sup> Qualrus is a qualitative data analysis tool to analyze unstructured data. <http://www.ideaworks.com/qualrus/>

the course of this study. From the assigned codes Qualrus has a number of tools that can generate coincident patterns of codes, which form the basis for the theoretical framework used to interpret and explain the findings (see Figure 3.8).

Figure 3.7 An example of code assignments (color coded in Qualrus)

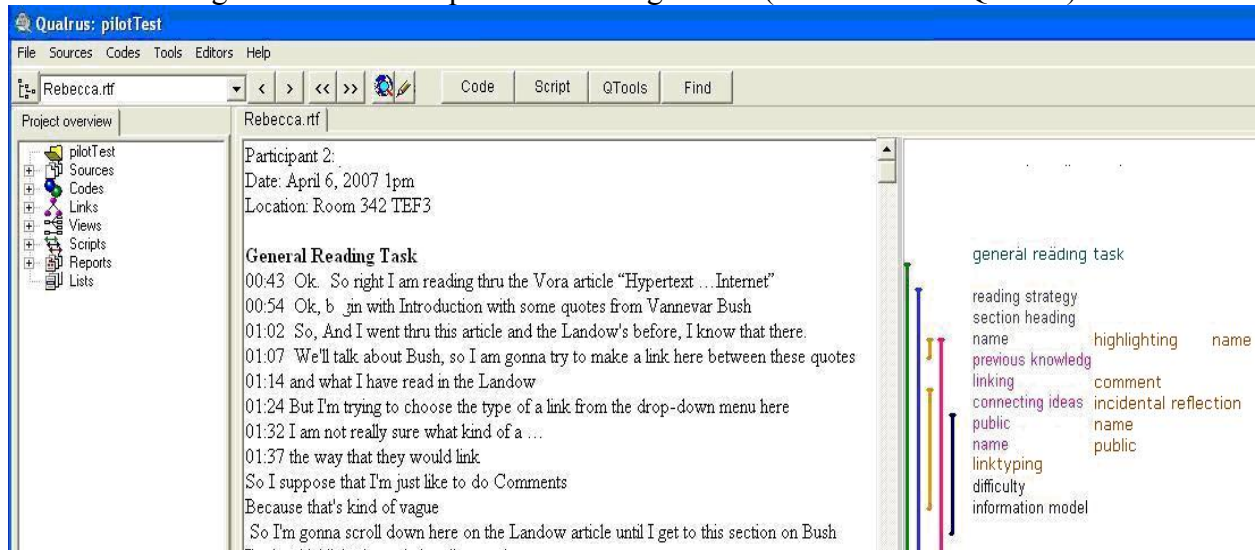
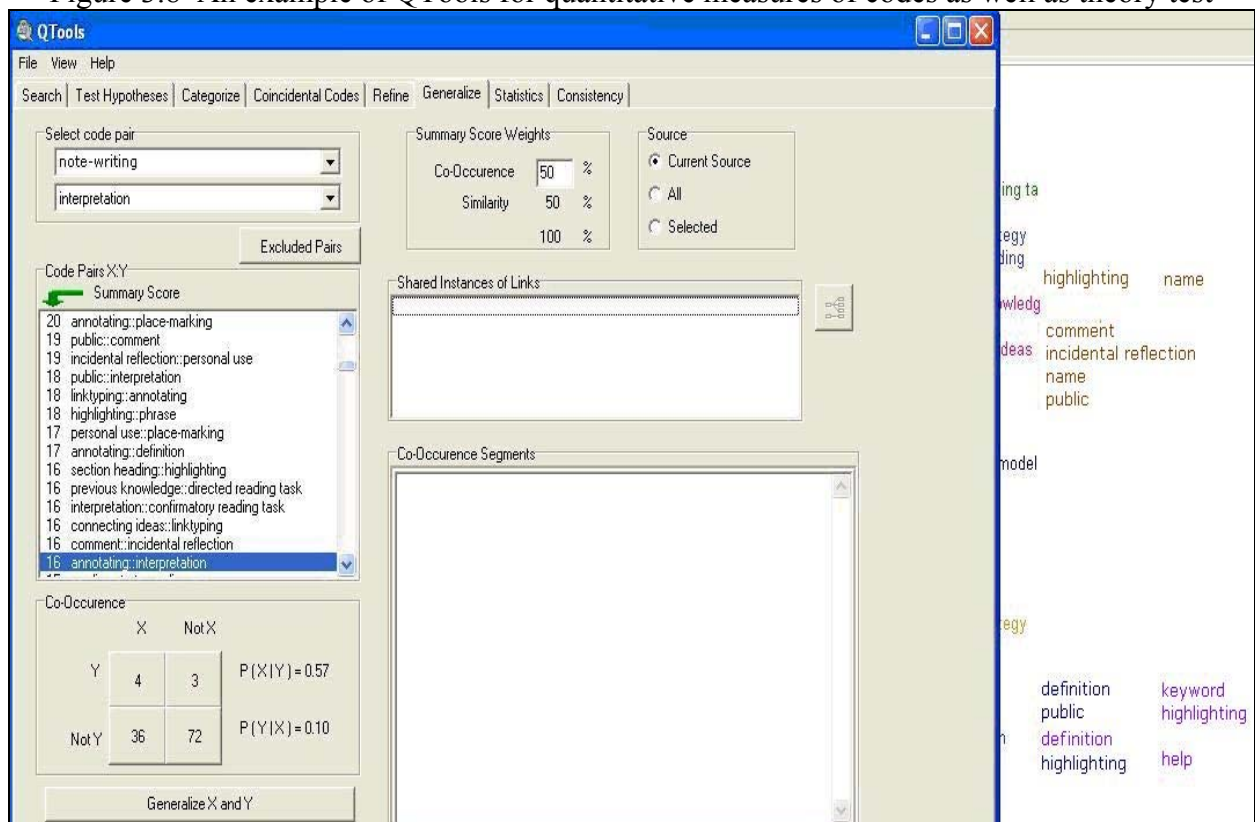


Figure 3.8 An example of QTools for quantitative measures of codes as well as theory test



A coding guideline was devised, specifying coding principles, coding sequence, and coding rules (Silverman, 2001). Using Qualrus a coding scheme consisting of all codes was created. As a crucial first step, two doctoral students who were recruited for the process applied the codes to a single participant's transcript according to the guidelines, and their results were compared in order to test the inter-coder reliability. Some variations among coders were due to different wording, but the ideas were similar. After repeated discussions and revisions, the two coders reached a consensus. The coding validity, as Silverman (2001) suggested, was investigated through the quantitative measure to demonstrate that the qualitative analysis was a reasonable representation of the data as a whole. When encountering disparities with the coding, the other doctoral student was consulted to resolve the differences and made revisions, if necessary, in the Qualrus code list. Qualrus provides the capability of assigning the revised codes to the text segments for ensuring the reliability of the coding. Using this quality control feature of Qualrus, the investigator completed all the coding according to the coding guidelines. After all the qualitative data (transcripts) had been coded, the total number of codes became saturated, i.e., no new codes emerged from the coding process. The final coding scheme was recorded as shown in Appendix 12.

### **3.8 Summary of Chapter 3**

This chapter reports the research design and research methods of this study. The mixed-method approach for studying annotation online is discussed. Then, the application of an annotation tool, ANNOLINK, for a web-based journal system to support readers' online reading and writing needs is discussed. The remaining sections introduce the research design, including the subjects, reading materials, prototype, tasks, and procedures. Data collection utilized a range of instruments: questionnaires, screen captures of annotation processes, verbal protocols, and interviews. Data analysis involved both quantitative measures and qualitative measures.

Quantitative measures included frequencies of annotation forms, functions, roles, as well as ratings of preferences and perceived values. Qualitative measures included the coding analyses of verbalization data of think-aloud protocols and interviews. These methods are applied to understand the behavioral, cognitive, affective, and social factors in online annotation in order to enrich the understanding of online annotations from the reader's perspective.

## **4 RESULTS**

### **4.1 Introduction**

This chapter presents the results of several analyses performed on data collected through the application of the methods and procedures outlined in Chapter 3. The data sources used include those from: (1) the main study (annotation instances, user protocols, and interview transcripts), and (2) supplementary information (post-session questionnaire and perceived value questionnaire).

The purpose of these analyses is two-fold. First, they attempt to categorize the annotation forms (i.e., annotation instances) and their active reading intentions (i.e., verbalization data) in an online environment, in order to compare and contrast them with Marshall's initial forms and functions. Second, they attempt to interpret the overall assessment of the questionnaire findings with richer interpretations found in the verbalization data.

### **4.2 Results from the Main Study and Supplementary Information -- by Research Questions**

Outcomes from the analyses of qualitative and quantitative data collected from the fifteen participants (main study and supplementary information) are reported according to the six research questions that guide this study. The quantitative component of the study is focused on collecting data through questionnaires, annotation forms remaining on-screen and from screen captures, the preferences of annotation forms and functions reflected from the post-task questionnaires, and the ratings of perceived values of annotation online. The qualitative data include the participants' verbal protocols and the protocol transcriptions, the investigator's



observation notes during the think-aloud sessions and interviews with the participants, the investigator's notes from replaying the screen captures, and the interview transcriptions.

For Research Question 1, Marshall's form-function mapping is applied as a framework to set up the context for analyzing the data and presenting the results. The online annotations created in the main study are categorized and mapped to Marshall's form-function mapping. The adapted framework is then applied to verify whether the same forms and functions exist in a digital environment. For Research Question 2, the verbalization transcripts and Morae recordings are examined to verify the findings in Research Question 1. The results show that the same function may be manifested through different forms, and different functions are manifested through the same form. For Research Question 3, functions manifested from "Linking Only," are explored with the expectation that "Linking Only" and "Linktyping Only" should have individual sub-functions. "Linking Only" signals the departure to a target segment, where the reader must determine the text relationship from the text types of the two segments (e.g., heading to paragraph). Then, the "Linking Ideas Meaningfully" function is explored with respect to the combination of linking and linktyping from annotation instances and verbalization data. Lastly, combinations of linking components such as "Linking with Note-making," "Linking with Linktyping and Note-making," and "Linktyping Only" are explored. For Research Question 4, other forms that online annotation might support are explored in the main study, which show that people want to use free-draw markings, typographic symbols, and multiple-color highlighting. Tags and/or labels are expressed as headings to identify patterns in the texts. These "wished-for forms" closely resemble their counterparts in print. Findings in Research Question 4 show that those social forms identified through the verbalization data manifest additional functions. For Research Question 5, the users' preferences for the usefulness of the forms and functions in terms of varying roles are assessed through the post-session questionnaire. Different

characteristics in sharing are also explored from the verbalization data. For Research Question 6, the overall preference and perceived values of the use of online annotations are discussed. The questionnaires and transcribed protocols are analyzed to explore the underlying reasons for usefulness and ease of use of online annotation. The findings from the main study (user protocol and interview transcripts) and supplementary information (post-session questionnaire and perceived value questionnaire) are analyzed and presented according to the six research questions in the following sections.

#### **4.2.1 Research Question 1**

**Do the same annotation functions in the print environment also exist in a digital environment?**

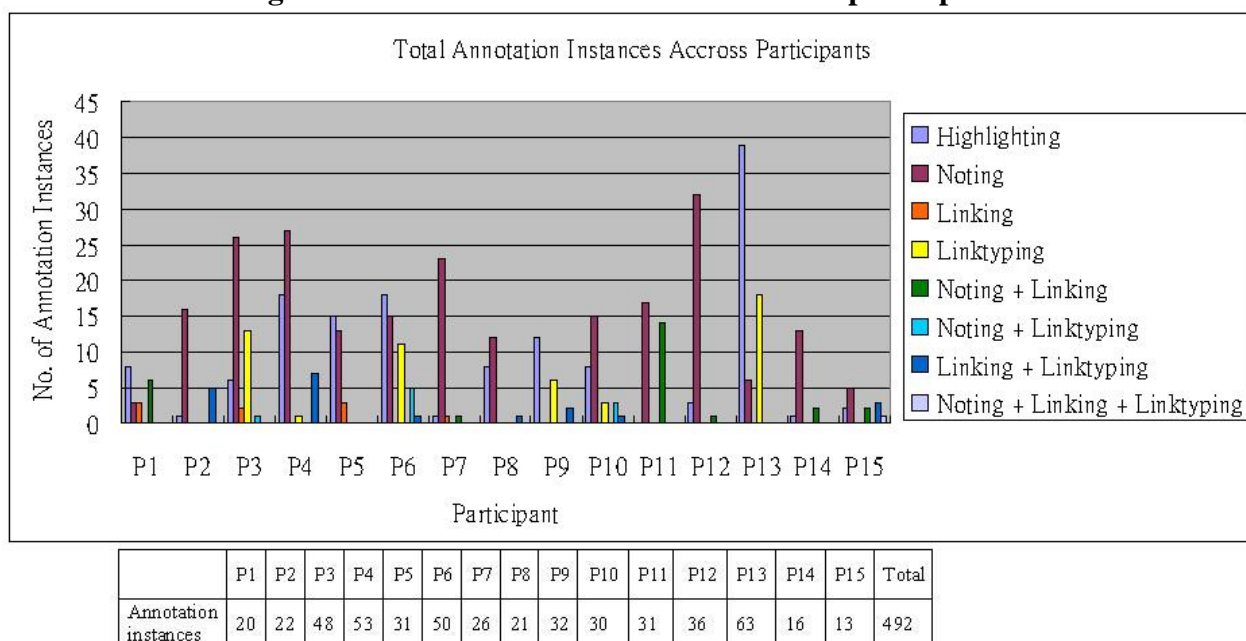
Marshall (1997) used annotations found in college textbooks and categorized them into different annotation forms, and then reconstructed the functions, and conjectured about the annotation form-function mapping. In simulating Marshall's study of annotation on paper, this study takes Marshall's mapping as a framework to approach the categorization and reconstruction of online annotation forms and functions. The first approach is to identify "similar forms" and "different forms" in the online annotations supported in ANNOLINK from Marshall's forms. As such, annotations are viewed as a specific kind of material evidence, the artifact that remains after the participant completes a session without consulting verbal protocols and screen recordings. "Similar forms" are those categorized in the typology Marshall identified. "Different forms" (e.g., linking and linktyping) are categorized with broader interpretation in the forms that closely resemble Marshall's original forms in the form-function mapping. Consequently, the categorized online forms are then mapped into Marshall's annotation forms. This "Online forms to Marshall's functions mapping" provides a framework to observe whether the same annotation functions in the print environment exist in a digital environment.

The data analysis processes include: (1) Mapping Marshall's forms to online annotation forms and identifying the differences; (2) Applying Marshall's form/function mapping to code the annotations as pieces of "evidence on the screen," and (3) Re-constructing annotation functions from the online annotation results. It is conjectured that there will be differences in functions or additional functions may exist in the online annotations.

#### **4.2.1.1 The Mapping of Online Annotation Forms to Marshall's Form**

Marshall examined annotations in textbooks and derived six functions from categorizing forms found in those textbooks (see Table 1.1, p.10). The ANNOLINK prototype is used in this study to verify whether these same annotation forms occur in a digital environment. Based upon the annotation instances (492 instances) collected from the main study (see Figure 4.1), the online annotation forms enabled by ANNOLINK were compared with Marshall's via "naked-eye" examination and these forms were interpreted in terms of the forms closest to Marshall's definition. There are some differences observed when mapping the online annotation forms in ANNOLINK to Marshall's forms. In comparison to Marshall's mappings, it is noted that some of Marshall's annotation forms are not supported in the ANNOLINK prototype, e.g., there is no underlining and crossing-out of the text; no circling of the text; no doodling or drawings and other such markings; and words or phrases or markings cannot be written between lines of text. The forms of Highlighting and Note-making (e.g., short notes or long notes) are supported, but with limitations on the length of characters or words to be highlighted or entered into a note.

**Figure 4.1 Total annotation instances across participants**



In addition, there are forms present in ANNOLINK not available in Marshall's list of forms. For example, there is no linking or linktyping form in Marshall's study. The form of Links is represented in the text of the document by an asterisk in ANNOLINK for the purpose of attracting users' attention to navigate to supporting or otherwise related information. The form of Linktyping is represented as an appropriate notation in the margin, as a Linktype can be applied from a drop-down list of twenty-six linktypes (e.g., Definition, Example, Illustration, etc.).

The results of mapping online annotation forms to Marshall's forms show some differences. Table 4.1 shows the results of mapping the ANNOLINK forms (Column B) to Marshall's forms (Column A), and then to their related functions (Column C). In Column B of Table 4.1, some examples from the annotation instances collected from the main study are presented to interpret the observed differences. Some functions may be manifested through different online annotation forms; for example, the form of Note-making (e.g., short notes or long notes) manifesting the "Recording Interpretation" function is mainly identified by their

physical form without further elaboration on the content. Notes unrelated to the materials themselves, judging by the content, are categorized as “Incidental reflection of the material circumstances of reading.” However, treating the Linking and Linktyping forms as an artifact poses a challenge in the mapping work. By the way they are displayed on the screen, the Linking and Linktyping components supported in ANNOLINK can only be categorized as telegraphic marginal symbols and appropriate notations.

Table 4.1 Mapping Marshall’s annotation forms to online forms onto functions

A	B	C
Form (Marshall, 1997)	Online Form (ANNOLINK examples)	Function
<ul style="list-style-type: none"> <li>▪ Underlining or highlighting higher level structure (like section headings)</li> <li>▪ Telegraphic marginal symbols like asterisks</li> <li>▪ Cross-outs</li> </ul>	<ul style="list-style-type: none"> <li>▪ Highlighting higher level structure (like section headings)</li> <li>▪ Telegraphic marginal symbols like asterisks (the Linking icon *)</li> <li>▪ Features not available</li> </ul>	Procedural signaling to attract attention in future readings
<ul style="list-style-type: none"> <li>▪ Short highlightings</li> <li>▪ Circled words or phrases</li> <li>▪ Other within-text markings</li> <li>▪ Marginal markings like asterisks</li> </ul>	<ul style="list-style-type: none"> <li>▪ Short highlightings</li> <li>▪ Features not available</li> <li>▪ Features not available</li> <li>▪ Marginal markings like asterisks (**), exclamations (!!!), and question marks (???)</li> </ul>	Place marks to aid memory
<ul style="list-style-type: none"> <li>▪ Extended highlighting or underlining</li> </ul>	<ul style="list-style-type: none"> <li>▪ Extended highlighting</li> </ul>	Tracing progress through difficult narrative
<ul style="list-style-type: none"> <li>▪ Appropriate notation in the margin or near figures or equations</li> </ul>	<ul style="list-style-type: none"> <li>▪ Appropriate notation in the margin (e.g., Linktype used as labeling the highlighted texts) or near links</li> <li>▪ Word definitions, pronunciation, and URL created from TinyURL site</li> </ul>	Work on problems
<ul style="list-style-type: none"> <li>▪ Short notes in the margins</li> <li>▪ Longer notes in other textual interstices</li> <li>▪ Words or phrases between lines of text</li> </ul>	<ul style="list-style-type: none"> <li>▪ Short notes in the margins</li> <li>▪ Longer notes in other textual interstices</li> <li>▪ Features not available</li> </ul>	Interpretation
<ul style="list-style-type: none"> <li>▪ Notes, doodlings, drawings, and other such markings unrelated to the materials themselves</li> </ul>	<ul style="list-style-type: none"> <li>▪ Notes unrelated to the materials themselves</li> </ul>	Incidental reflection of the material circumstances of reading

However, in a hypertext environment, linking imposes a certain syntax on the text structure, and linktyping is a semantic reference that contributes to determining the relationship between two text segments connected by a hyperlink that is made explicit to the readers. Hence,

online annotation forms such as Linking and Linktyping and their functions reflecting the capability of hyperlinking are further explored in Research Question 3.

#### 4.2.1.2 Applying the Online Forms-Functions Mapping to Online Annotation Instances Created in This Study

The previous section describes the analysis of mapping the online annotation forms supported in ANNOLINK to Marshall's mapping and derives an adapted mapping (Table 4.1). This section describes the results of applying the derived online forms-functions mapping to analyze those annotation instances created in this study to see whether the same annotation functions are manifested through the online annotation forms. Table 4.2 shows the results from applying the adapted mapping with some annotation examples found in this examination work. In total, 492 annotation instances are identified from the 15 participants in the main study, and are grouped by the mapping framework.

Table 4.2 Results from applying the online annotation forms to functions mapping (\* frequency of occurrence across all 15 participants)

Online Form (ANNOLINK examples)	Function	Total *	%
<ul style="list-style-type: none"> <li>▪ Highlighting higher level structure (like section headings)</li> <li>▪ Telegraphic marginal symbols like asterisks (the Linking icon *)</li> </ul>	Procedural signaling to attract attention in future readings (Procedural Signaling)	38	8%
<ul style="list-style-type: none"> <li>▪ Short highlightings</li> <li>▪ Highlighted words or phrases</li> <li>▪ Marginal markings like asterisks (***), exclamations (!!!), and question marks (???)</li> </ul>	Place marks to aid memory (Place-marking)	64	12%
<ul style="list-style-type: none"> <li>▪ Extended highlighting (more than 10 words highlighted)</li> </ul>	Tracing progress through difficult narrative	53	11%
<ul style="list-style-type: none"> <li>▪ Appropriate notation in the margin (e.g., Linktype used as labeling the highlighted texts) or near links</li> <li>▪ Word definitions, pronunciation, and URL created from TinyURL site</li> </ul>	Work on problems (Problem-working)	73	15%
<ul style="list-style-type: none"> <li>▪ Short notes in the margins (&gt; 10 words)</li> <li>▪ Longer notes in other textual interstices (&lt;10 words)</li> </ul>	Interpretation (Interpretation)	250	51%
<ul style="list-style-type: none"> <li>▪ Notes unrelated to the materials themselves</li> </ul>	Incidental reflection of the material circumstances of reading (Incidental Reflection)	14	2%
Total		492	100%

Examining those 492 annotation instances, some differences are observed from the adapted mapping. Among the total annotation instances, “Recording Interpretation” (51%) is the most frequently occurring function. An examination of the content of these notes indicates that, in addition to “Incidental Reflection,” some short notes (less than 10 words) could be identified as “Procedural Signaling” and “Place-marking.” For example, short notes like “need to return,” “review in more detail,” “not clear, needs further understanding,” and “explore” explicitly express the intention of the “Procedural Signaling” function. Short notes such as “Read this one” indicates the importance of the texts, and hence the “Place-marking and aiding memory” function. In one instance “Lisa” is a word that was used that is unrelated to the article; hence, it manifests the “Incidental reflection of the material circumstances of the reading” function. “Lisa” is also a person’s name and may suggest a sharing relationship of the text to “Lisa.” These examples found in the annotation instances suggest that the identification of functions from notes requires looking into the annotation content in addition to forms.

Another difference is noted in those annotation forms reflecting “Tracing Progress through Difficult Narrative.” Some extended highlighting (more than 10 words highlighted) includes whole paragraphs or citations, indicating that these are not really representative of the “Tracing Progress through Difficult Narrative” function, but may be “Procedural Signaling” or “Place-marking” instead.

In the results for the “Problem-working” and “Procedural Signaling” functions, some differences are also found in Linking and Linktyping forms. Linking may present other functions because of the capability for hyperlinking, which is not manifested in the same way as telegraphic marginal symbols. Linktyping, requiring the selection of an appropriate linktype to

describe the linking relationship, reflects the “Problem-working” function. However, it is noted that some linktypes have been used alone to label the highlighted texts instead of describing the linking components. The differences indicate that Linking and Linktyping components may represent other functions. Hence, the functions of linking and linktyping are further investigated in Research Question 3 regarding their hyperlinking capabilities and semantic relationships.

#### **4.2.1.3 Findings of Functions Reflected from Online Annotation Forms**

Table 4.2 (p.75) shows the results from applying the adapted mapping with some annotation examples found in the examination work. The findings presented in 4.2.1.1 show that there are “similar forms” and “different forms” found in online annotation instances. According to the mapping framework, those “similar forms” reflect the same functions as Marshall defined; and those “different forms” may reflect different functions. The findings presented in 4.2.1.2 show some mapping differences in functions manifested from Marshall’s mapping framework as described in the following.

- Similar annotation forms may manifest different functions. An examination of the notes shows the slightly different outcomes resulting from different interpretation of the function. In addition to the “Recording Interpretation” function the notes unrelated to the materials themselves may manifest as “Incidental Reflection.” The content of notes affects the identification of the “Recording Interpretation” and “Incidental Reflection” functions, e.g., “Lisa” is a reflection of relating text to a sister called Lisa. Also, notes recording word definitions copied from Wikipedia, word pronunciations, and URLs created from TinyURL indicate some work on a problem in context. The definitions are for resolving unfamiliar terms through searching online Wikipedia and dictionaries. TinyURL is an online service for converting long URLs entered by users into shortened URLs, which users commonly



use for resolving long URL problems. These “recording” notes show the participant’s work in resolving the problems through using online tools, and thus manifest the “Problem-working” function.

- The same function may be manifested through different forms; for example, “Procedural Signaling” can be manifested through short notes for returning in addition to highlighting at the higher-level structure and telegraphic marginal symbols.
- Other functions may exist. For example, Links and Linktypes should not be categorized as static telegraphic marginal symbols and appropriate notations the in margin as in the paper world, which do not reflect the capability of hyperlinking.

#### **4.2.1.4 Summary of Research Question 1**

This section presents the results of an “online form-function mapping,” which is adapted from Marshall’s form-function mapping. The mapping of online forms to Marshall’s form shows that there are “similar forms” and “different forms” in the results. There are three advantages of seeking replication of Marshall’s mapping process. First, it provides a framework to observe whether the annotation forms and functions are the same. Secondly, the resultant new mapping is then applied to examine the annotation instances remaining on the screen to verify whether the functions are the same as Marshall defined. Thirdly, the mapping framework can later be used as a baseline with which other functions found in Research Question 4 can be compared and added.

The mapping results show that it is not sufficient to simply reconstruct functions from forms in the digital environment provided. Some forms may not accurately manifest the functions they were mapped onto, due to the system features available. The findings show that

(1) the same forms used for the same functions do exist in a digital environment; (2) Similar annotation forms may manifest different functions; (3) The same function may be manifested through different forms; and (4) Other functions may exist.

#### **4.2.2 Research Question 2**

**Are the functions manifested through “similar forms<sup>12</sup>”? If not, how were “different forms<sup>13</sup>” used to implement functions?**

The findings of Research Question 1 indicate that the same function may be manifested through different forms, and different functions may be manifested through the same form. It is noticed that there are small differences, and some elaboration on the “Recording Interpretation” function is needed.

The approach used to answer this research question is to further investigate the relationships between forms and functions of online annotations. The data analysis processes include a content analysis of: (1) the manifest content of annotations: to examine the forms (e.g., notes) and content of annotations to identify the functions (e.g., “Recording Interpretation” vs. “Incidental Reflection”), and (2) the latent meaning underlying the manifest content: to examine the verbalization data for exploring the participants’ intention in creating such annotations.

##### **4.2.2.1 Findings of Content Analyses in the ANNOLINK Forms-to-Functions-Mapping**

In this study, content analysis is used to analyze the manifest contents of annotations. Furthermore, the latent meaning from the protocol transcriptions is used when the manifest

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<sup>12</sup> As defined in 4.2.1.1 “Similar forms” are those online annotation forms in this study that are categorized in the same category that Marshall identified.

<sup>13</sup> As defined in 4.2.1.1 “Different forms” are those online annotation forms in this study that are categorized with a broader interpretation of the forms that closely resemble Marshall’s original forms in the form-function mapping.

content does not provide adequate evidence. According to Krippendorff (2004), manifest content means literal content describing what the participants wrote or created that remains on the screen. Latent content means interpreted content; protocol analysis of latent meaning reveals what the participants intended in creating annotations based on an in-context interpretation of their utterances.

The analysis process includes (1) examining the manifest content of annotations in addition to annotation forms and (2) identifying the contents that manifest the annotation functions defined by Marshall. The latent content with the use of the verbal protocols is also used to supplement the findings of the manifest content when necessary. The transcript data provide a fine-grained observation. Furthermore, this analysis attempts to compare the results with the findings of Research Question 1, and to identify the similar forms implementing different functions as well as how different forms are used to implement similar functions.

### **Incidental Reflection**

According to Marshall's definition of "Incidental Reflection," people's writing may be re-purposed for different circumstances than they initially intended. The incidental reflection of the material circumstances of reading may not be related to the reading topic. To identify notes unrelated to the materials themselves as "Incidental Reflection," it is necessary to examine the annotation content among those identified as "Recording Interpretation." Appendix 10 demonstrates that some notes manifesting the "Incidental Reflection" function include long notes and short notes. Some notes are the readers' personal reflections inspired by the texts. For example, one long note made by Participant 7 shows him remembering having read a book about an image of a city and writing down his personal reflections about hypertext.

[02:14] This idea of links and notes harks back to a book that I read years ago, by Kevin Lynch, talking about cities and the links and notes using the same terminology to describe the image of a city. Just wanna make a note of that. Refers to a similar... and in this book he talks about the same terms: links, nodes, and how they capture the image of a city. (Participant 7)

Other findings from the manifest content include notes reminding a participant of applying the material to his/her class project or inviting input from others, and notes signaling to share the text. The content may be explicit enough for any reader, but it can also be very personal so that only the author knows what it means. For example, for a short note, “Lisa,” without reference to the verbal protocols, it is impossible to know that the annotated material is intended to be shared with the participant’s sister Lisa. Hence, “Incidental Reflection” is definitely one function that cannot be manifested simply from form.

### **Place-Marking**

According to Marshall’s definition, students may place markings to signal texts that must be memorized for a specific purpose, i.e., something that is important to remember or memorize. Appendix 10 shows that the “Place-marking” function is reconstructed from forms of (1) short highlightings on names, years, diagram captions, keywords, and phrases; (2) markings for important impressions; and (3) numberings of main points found in the reading. The majority of forms manifesting the “Place-marking” function is highlighted words or phrases, and 29 instances out of 52 (56%) appear in the first sentence of a paragraph, i.e., the topic sentence.

The short highlightings include highlighting on names, years, and keywords in the first sentence of a paragraph, which indicate that the highlighted words are important to remember. Names such as Barthes, Foss, etc., years such as 1997, and keywords such as association, flexibility, navigation, browsing, metaphors, surfing, etc. denote the key terms related to an

important author (or research), a specific year, or a particular topic. Highlighting helps people to focus on what they want to read, so that when they come back, they know that this is what they wanted to concentrate on, as one participant expressed:

[65:00] If I have a long article to read, first of all I must have in mind the purpose of the reading. So by highlighting those points, it helps me to focus on what I want to read. So then when I come back, I know that this is what I want to concentrate on. (Participant 10)

Markings manifesting “Place-marking” are also used in online annotation. For this study, the ANNOLINK prototype only allows entries from the keyboard, and no free-drawing tools are provided. Nevertheless, the participants used multiple punctuations or special characters such as asterisks, exclamations, and question marks to signal an important expression about the texts. For example, Participant 4 considered exclamation points to be her way of “saying wow!”, which is an expression of importance and which could be shared with others. Appendix 10 shows some examples of the comments made for those markings.

Examining the manifest content of short notes, it was also found that numbering (1, 2, 3, etc.) is used to represent distinct parts of the text. Numbering suggests aiding memory for signaled content both by indicating the relevance of the associated content and by providing an explicit statement of the organization of the content. Numbering can be idiosyncratic. Participant 4, for example, believed numbering was not suitable to share with others:

[1:14:20] Here I started numerically numbering things. I might not share that with other people just cause I think its an idiosyncratic thing that I do and people looking at that and seeing the number 1 (one) might not get it, and I wouldn't want to confuse them so I might not (...) number 1, 2, 3 here. (Participant 4)

In all, the results indicate that highlighted parts or markings manifesting the “Place-marking” function, implying that the importance of those highlightings or markings may be

indicating the main points that can be shared. Numbering is idiosyncratic and mostly for personal use. Therefore, the forms implementing the “Place-marking” function demonstrated some level of importance for use.

### **Procedural Signaling**

According to Marshall’s definition, the “Procedural Signaling” function is reflected by annotations that people use to remind themselves or readers about certain key points or to attract attention in the second or future reading. Table 4.3 (see also Appendix 10) shows the findings of the manifest content of annotations by applying the ANNOLINK Form-to-Function Mapping. In accordance with Marshall’s mappings, highlighting at a higher level is a form manifesting the “Procedural Signaling” function, as Participant 13’s comment best exemplifies:

[1:10:50] because I do like to highlight headings and things, and then after that, things that tend to be the longer highlights for me, like if I highlight a whole sentence or two sentences, that tends to be a “Procedural Signaling” for future attention. That’s ... things that I want to go back to because they’re important. (Participant 13)

According to Marshall’s research, “Procedural Signaling” may be manifested through “highlighting higher level structure” such as highlighting section headings. From this perspective, it is conjectured that text pattern (e.g., heading) and location (i.e., text structure) are related to the functions manifested. A further examination of protocol transcripts indicated the relationship of highlighted text pattern and location in the passage. First, highlighted text passages are coded by the text entities (heading, keyword, name, phrase, citation, sentence, paragraph) and locations (appeared in the first sentence, within, or at the last sentence of a paragraph), and then the related comments in the transcripts are coded by the functions according to the participants’ intention of creating highlights.

Table 4.3 The “manifest” content of annotations implementing the “Procedural Signaling” function

Function	Form (ANNOLINK)	Examples	Total
Procedural signaling to attract attention in future readings (Procedural Signaling)	▪ Highlighting higher level structure (like section headings)	▪ Highlightings on headings	29
	▪ Telegraphic marginal symbols like asterisks (the Linking icon *)	Links (where the signals are located) and their target text patterns include: ▪ * on a heading (linked to a heading) ▪ * on a heading (linked to a paragraph)  ▪ * on a name (linked to a heading) ▪ * on a name (linked to a name) ▪ * on a name (linked to a sentence)  ▪ * on a phrase (linked to a paragraph) ▪ * on a sentence (linked to a sentence)	9
Procedural signaling to attract attention in future readings (Procedural Signaling)	<b>Other Forms not in Marshall’s (From this row below)</b>	<b>Examples</b>	<b>Total</b>
	▪ Short Notes (less than 10 words)	Short notes signaling future revisit: ▪ Check it later ▪ I would like to read this article ▪ Look up and link for theory ▪ Need to return ▪ Need to revisit ▪ Not clear, needs further understanding ▪ Read more about this ▪ Reminder: read Bush’s paper later	28
	▪ Longer Notes (greater than or equal to 10 words)	Long notes signaling future revisit: ▪ Update? Look for newer editions or works by the same editor/author ▪ See Conklin, See below re: Nelson - inventor of hypertext; see also Vora and Helander for comparison ▪ I wish I could link to a definition in another article to that I could refer to it later	3
	▪ Short notes similar to Marshall’s Cross-outs	Short notes denote disagree or similar to cross-outs: ▪ Disagree with this ideas ▪ Not a current term ▪ I don’t buy this - weak point	3

Table 4.4 shows the coded results. In the General Reading task the “Procedural Signaling” function manifested more frequently from highlighting on headings, and particularly at the beginning of a heading. This may indicate the participants were scanning through the content in general reading and highlighting the headings for second readings. In the Directed Reading task, the “Place-marking” function manifested from highlighted phrases at the beginning of a paragraph, as well as from phrases and sentences within a paragraph. This may

indicate the participants were reading more in-depth within a paragraph and identified more important information to remember or to recall. The findings indicate that highlighting found in different text entities and locations manifest different functions, and the manifest functions vary by different reading tasks.



Table 4.4 Functions manifested from highlighted text pattern and the location in passage

Task	Text Pattern	Total	Location	Frequency	Function	Frequency
<b>General Reading Task</b>	Heading	23	1st	<b>16</b>	Procedural Signaling	<b>16</b>
			whole	7	Procedural Signaling	7
	Keyword	8	1st	5	Place-marking	5
			end	1	Place-marking	1
			in paragraph	2	Problem-working	1
	Name	2	1st	1	Place-marking	1
			end	1	Place-marking	1
	Phrase	12	1st	7	Place-marking	7
			end	1	Place-marking	1
			in paragraph	4	Place-marking	4
	Paragraph h	4	whole		Tracing Progress through Difficult Narrative	4
	Sentence	13	1st	5	Place-marking	5
			end	2	Place-marking	2
			in paragraph	6	Place-marking	7
	Citation	1	Whole	1	Tracing Progress through Difficult Narrative	1
	Year	1	1st	1	Place-marking	1
	Diagram	1		1	Place-marking	1
<b>Directed Reading Task</b>	Heading	6	1st	3	Procedural Signaling	3
			in paragraph	1	Procedural Signaling	1
			Whole	2	Procedural Signaling	2
	Keyword	10	1st	5	Place-marking	5
			in paragraph	5	Place-marking	3
					Problem working	2
	Name	2	1st	2	Place-marking	2
	Phrase	29	1st	<b>16</b>	Place-marking	<b>15</b>
					Interpretation	1
			end	2	Place-marking	2
			in paragraph	<b>11</b>	Place-marking	<b>11</b>
	Paragraph h	1	whole	1	Tracing Progress through Difficult Narrative	1
	Sentence	25	1st	7	Place-marking	7
			end	2	Place-marking	2
			in paragraph	<b>16</b>	Place-marking	<b>15</b>
					Interpretation	1
	Citation	2	Whole	2	Procedural signaling	2
	Year	-	-	-	-	-
	Diagram	-	-	-	-	-
Legend: 1st - highlighted text in the first sentence (topic sentence) of a paragraph end - highlighted text in the last sentence (concluding sentence) of a paragraph in paragraph - highlighted text somewhere inside a paragraph, not in 1st or end whole - highlighted text includes the whole paragraph						

Telegraphic marginal symbols like an asterisk (the Linking icon) are forms manifesting “Procedural Signaling.” However, this study also shows that other forms can be identified through an examination of the content of short and long notes that explicitly provide a signal for future reading (e.g., “Need to return”). In addition, short notes such as “I don’t buy this -- weak point” may express the implied meaning of cross-outs. These forms were not identified in Marshall’s study (1997), but the note’s content manifests the “Procedural Signaling” function signaling future revisit and denoting opinions similar to cross-outs.

The Linking component in the ANNOLINK prototype is marked by an asterisk and represents the connection between the highlighted anchor point and the target text. The asterisk serves as a visual cue and is intended not just to guide the readers’ cognitive processing but also to provide new information. One participant mentioned:

[0:14:12] Okay... so use the asterisk here... If I was reading this a week from now, and I was reading the Vora article... It might be useful if it could say "Comment: Gives additional information about...", and then maybe some short reference to which article the source was. Some idea would be to kind of... maybe like a citation if I wanted to show.... (Participant 15)

The results show that links (where the signals are located) are used to connect different text patterns that reflect specific kinds of relationship including the following:

- Name to heading: connects an important name with a concept
- Name to name: connects two names associated with a concept
- Name to sentence: connects an important name with a definition, example, etc.
- Heading to heading: connects two associated concepts
- Heading to paragraph: connects a concept with a statement
- Phrase to paragraph: connects a subject with a statement
- Sentence to sentence: connects two associate definitions, examples, etc.

Overall, in addition to Marshall's forms reflecting "Procedural Signaling" in the form-function mapping, the findings in this study show that short notes and long notes explicitly signaling attraction for future reading (e.g., Need to return) and short notes denoting the meaning of cross-outs are also found in this study.

### Recording Interpretation

According to Marshall's definition, "Recording Interpretation" means to add an explanation or express one's new ideas, critical remarks, or questions in annotations. Table 4.5 (see also Appendix 10) shows the findings of short notes and long notes in the margins manifesting the "Recording Interpretation" function.

Table 4.5 The "manifest" content of annotations describes "Recording Interpretation"

Function	Form (ANNOLINK)	Forms Used (Examples)	Total
Record interpretation (Interpretation)	<ul style="list-style-type: none"> <li>Short notes in the margins (less than 10 words)</li> </ul>	<ul style="list-style-type: none"> <li>A further elaboration of linking</li> <li>I'm still not sure that people really get this.</li> </ul>	109
	<ul style="list-style-type: none"> <li>Longer notes in other textual interstices (greater than 10 words)</li> </ul>	<ul style="list-style-type: none"> <li>Technique for organizing computer databases or documents to facilitate the non-sequential retrieval of information.</li> <li>It is interesting that Barthes refers to this specifically as "computer hypertext" which implies that there is a non-computer form of hypertext. This indicates somehow that the idea of hypertext is not limited to the technology used.</li> </ul>	65

Table 4.6 indicates that, when note-making in the General Reading task, participants were mainly creating notes for the "Recording Interpretation" function (38%), followed by the "Place-marking" (24%) and "Procedural Signaling" (20%) functions. In the Directed Reading task participants' note-makings demonstrated similar functions, yet when they read more in-depth they were focusing more on "Recording Interpretation" (64%). This result indicates that when

people read more in-depth and gain more understanding of the text, they tend to write more notes to record their thoughts -- i.e., the “Recording Interpretation” function.

Table 4.6 Functions manifested through note-making

Form	Total Frequency	Function				Subtotal	
		General Reading Task	No.	Directed Reading Task	No.	No.	%
Note-making	235	Incidental reflection	10 (14%)	Incidental reflection	14 (9%)	24	5%
		Interpretation	27 (38%)	Interpretation	106 (64%)	133	27%
		Place-marking	17 (24%)	Procedural signaling	18 (11%)	35	7%
		Procedural signaling	14 (20%)	Place-marking	21 (13%)	35	7%
		Problem working	3 (4%)	Problem-working	5 (3%)	8	2%
Subtotal of Note-making			71		164		

It is also observed that there is little to distinguish between the number and length of the notes in the two reading tasks. In the General Reading task, the average length of notes was 8 words. The length of notes was found to range from 1 word to 44 words. The average length of notes was 8 words in the Directed Reading task and the length ranged from 1 word to 32 words. Would the length and number of instances of note-making manifest different functions? A further exploration of functions manifested from note-making was conducted, and the results did not reveal any patterns. Overall, the length and number of instances of note-making had no effects on the function of note-makings in different reading tasks.

Through a further examination of the notes where the signal is located with respect to the relative location of text passages they cue, some interesting observations are found. Table 4.7 shows the findings of notes manifesting the “Recording Interpretation” function with respect to their length and the relative location of the cued content. The first column is Note-making type, the second column is the relative location of the cued content, and the third column is a further coding of sub-categories of the “Recording Interpretation.” It is based on Marshall’s definition

indicating the content may be an explanation or one's new ideas, critical remarks, or questions. In addition, the findings in the "Incidental Reflection" section show that annotation content affects the function manifested. Hence, this study uses more fine-grained sub-categories (e.g., "challenge an idea," "recapitulate," and "comment," etc. see Appendix 12) to explore the "Recording Interpretation" function.

Table 4.7 Notes manifesting the "Recording Interpretation" function with respect to their length and the relative location of the cued content

Note-making Type	Relative location of the cue content	Elaborated categories of Record Interpretation Function
Short notes	Topic sentences	Challenge an idea (6 notes), Comment (10 notes), Explain (3 notes), Recapitulate (12 notes) Label segment (3 notes)
Long notes	Topic sentences	Challenge an idea (2 notes), Comment (5 notes), Explain (5 notes), Recapitulate (8 notes)
Short notes	Concluding sentences	Challenge an idea (3 notes), Comment (4 notes), Explain (2 notes) Recapitulate (3 notes)
Long notes	Concluding sentences	Challenge an idea (2 notes), Comment (3 notes), Explain (1 notes), Recapitulate (1 notes),
Short notes	Text within a paragraph	Challenge an idea (14 notes), Comment (14 notes), Label segment (3 notes), Recapitulate (9 notes)
Long notes	Text within a paragraph	Ask question (1 note) Challenge an idea (6 notes), Check reference (1 note) Comment (8 notes), Explain (7 notes) Recapitulate (3 notes)

It is observed that notes made to recapitulate the text are mainly found in the topic sentence in a paragraph. The sub-category "recapitulate" describes notes that restate thematic

ideas or to recite briefly the major points in a narrative (Simpson & Nist, 1990; Abiodun & Amos, 2006). Notes made to comment on the text are mainly found within a paragraph. The sub-category “to comment” describes notes that state a fact or give an opinion of remark or critical observation (Abiodun, 2007). However, no significant findings are found for notes with respect to the concluding sentence.

### **Tracing Progress through Difficult Narrative**

Appendix 10 demonstrates the findings of extended highlights manifesting the “Tracing Progress through Difficult Narrative” function. In this study, a further examination is conducted to identify the location of highlighted words or phrases (at the beginning of a paragraph, within a paragraph, or in the last sentence of a paragraph) to see if there is a difference in function.

It is observed that not all extended highlightings can be categorized as implementing the “Tracing Progress through Difficult Narrative” function. Most extended highlightings (12 out of 38) are found in the topic sentence at the beginning of a paragraph. A topic sentence states the essential idea of its paragraph or larger section. The same as extended highlighting on a whole citation or a whole paragraph is evidently for placing marks of the importance of this citation or paragraph for future reading or reading closely. Hence extended highlightings on the topic sentence, a whole citation, or a whole paragraph should be manifesting the “Place-marking” function instead of “Tracing Progress through Difficult Narratives”.

Extended highlightings may also be represented in a reduced form. From the verbal protocols, it is observed that some participants highlighted the first word of a paragraph. It may be the realization of a shorthand way of highlighting the whole paragraph. For example,

[6:23] Ok and we've got a bulleted list here and I'm just going to ... highlight the first word in each of the list cause it represents they seem to represent main concepts ... just to draw my attention to those concepts. (Participant 4)

In general, the “Tracing Progress through Difficult Narrative” function may not be easily identified from extended highlightings in online annotation. The system features of annotation tools and readers’ highlighting habits may restrict the length of extended highlighting. It is observed that the participants used mouse highlighting during the protocol sessions. Hence, the “manifest” content may not truly represent the forms manifesting this function in online annotation.

### **Work on Problems**

Marshall’s definition of the “To work on a problem in context” function is adapted in this study to mean to resolve unfamiliar terms and/or to find information to answer the questions the annotation writers have when reading online. Appendix 10 demonstrates the findings of the “Work on Problems” function, which is manifested not only through making appropriate notations in the margin or near the Linking component (108 instances), but also through working on word definitions, pronunciation, URLs created from the TinyURL site, or any information found by searching on the Internet (8 instances).

Among those 108 instances, this study has found that participants not only select linktypes to describe the linking relationship as it should be used, but also select certain linktypes (e.g., Definition, Example) and apply them to label the highlighted texts as they see fit. The selection process of appropriate linktypes to describe the relationship forced the annotation writers to pay attention to different ways that a text affected them. Readers could reconstruct the purpose of the passages from the selected linktypes describing the links. Thus, linktypes

describing actual links manifest the “Work on Problems” function. However, when used to label highlighted passages, those linktypes (e.g., Definition, Example) manifest the “Place-Marking” function.

#### **4.2.2.2 Summary of Research Question 2**

This research question explores whether similar forms implement different functions as well as how different forms are used to implement similar functions. The approach is to examine the manifest content on the screen with respect to its form, content, and location. The transcript data is also examined to provide further interpretation.

The results show that similar forms implementing different functions are found. Notes, based on an examination of their content, may manifest different functions, such as “Incidental Reflection,” “Procedural Signaling,” “Record Interpretation,” or “Problem-working.” Linktypes not only describe the relationship of the linking, which should manifest the “Work on Problems” function; instead, some linktypes are used alone to label the highlighted text passages and thus manifest the “Place-Marking” function.

The results also show how different forms are used to implement similar functions. Some different forms are found to implement the “Place-marking” function. For example, short highlightings on names, years, keywords, diagram captions, and phrases, as well as various other markings, express importance. There are some different forms found to implement the “Procedural Signaling” function as well, for example, notes explicitly expressing future reading or cross-out intentions. The findings show not all extended highlightings implement the “Tracing Progress through Difficult Narrative” function when only the “manifest” content is



used. During the protocol sessions, the participants used mouse highlighting for tracing through a difficult narrative. Hence, mouse highlighting, as a transient form, may manifest “Tracing Progress through Difficult Narrative” in annotation online. In addition, this study also finds that those forms manifesting “Place-marking,” “Procedural Signaling,” and “Recording Interpretation” are associated with where the forms are located in relation to the types of text passages they cue. For example, Linking serves as a visual cue not just to guide the readers’ cognitive processing but also to provide new information. The results show that links, where the asterisks (signals) are located, are used to connect different text patterns that reflect specific kinds of relationships.

### **4.2.3 Research Question 3**

#### **What is the function of linking as a form of annotation?**

From Research Question 2, it is observed that linking cannot simply be treated as telegraphic marking; the functions of Linking and Linktyping, associated with hypertextuality, need to be explored. It is also obvious that the “Tracing Progress through Difficult Narrative” function does not apply to the functions that the linking component was mapped onto. However, Marshall’s other five functions may also be manifested through linking components. It is possible that other functions may be applied to explain the function of linking in relation to hypertextual capabilities; that is, linking components may manifest multiple functions.

The approach of this section is, first, to use the verbal protocols to explore the proposed “Linking Ideas Meaningfully” function. Incorporated with the linking components found in the screen recordings, combinations with Linking for describing the inter-text are examined. Marshall’s five functions and the proposed “Linking Ideas Meaningfully” are applied to re-

evaluate the functions of linking components relations. Secondly, the same data are investigated to explore the intended functions of creating linking components in relation to the reading tasks. Lastly, “Linking” as a marking of text structure allow certain types of text entities (headings, keywords, phrases, sentences, and paragraphs) to be linked, and the intended functions are investigated.

#### **4.2.3.1 Linking as a Marking of Text Structure**

In the ANNOLINK prototype, Linking as a form of annotation connects a content segment to a related piece of information. Users can accomplish this by linking directly to an existing piece of information and typing the link (attributing the functional nature of the relationship) between the content segment and the linked item. In addition, the attribution of the relationship is also realized by Linking with Note-making. The reading tasks had little effect on creating links. Linking can be considered as a marking of text structure allowing certain text entities (headings, keywords, phrases, sentences, and paragraphs) to be linked. The findings show that participants find that the linking of different text patterns (like heading and paragraph conventions) signal different textual content and aid to access. For example, Participant 1’s comment exemplifies Linking at the heading level as resulting in the connection of main ideas:

[74:11] I think I want to see the previous section to see how it connects with this section that I'm reading. I'm looking at the heading ...and going back to the last section that I just read. Okay, I think this is really connected to Vora's article. ... I'm linking it to Vora's article, again on the heading. (Participant 1)

Another participant considered linking a heading with a paragraph, to which the target paragraph is the supporting information.

[19:23] I remember it was Conklin that defined cognitive overhead and disorientation in his paper. Okay so this cognitive and disorientation. Disorientation yes, I need to make a link. So. Uh, in Conklin's paper he proposed two fundamental problems in hypertext. One is Cognitive Overhead another is Disorientation. And he even

provides two definitions concerning Disorientation and Cognitive Overhead. And it's yes, so I need to make a link: cognitive and disorientation. Link. Okay. So it should be linked. (Participant 5)

This participant's comment supports the finding in a previous section (4.2.2.1) that links (where the signals are located) are used to connect different text patterns that reflect specific kinds of relationship.

#### **4.2.3.2 Functions Manifested from Linking Components**

In the previous section, it is found that Linking not only has been used alone, but also used with other forms. Linking and Linktyping together manifest the proposed function “Linking Ideas Meaningfully.” Furthermore, Linking combined with Note-making may manifest “Recording Interpretation” and/or “Linking Ideas Meaningfully” depending on the content of notes. The function manifested is determined by the explicit meaning of the notes. Similar reflection applies to Linking with Note-making and Linktyping. Without notes or linktypes describing the link relationship, the function manifested by “Linking Only” relies on the textual signals. This section describes the exploration of function(s) manifest from the Linking component as well as combined linking components.

Table 4.8 shows the frequencies of using the Linking and other components in both the General and the Directed Reading tasks. The use of both Linking and Linktyping together was greater in the General Reading condition, perhaps due to the participants' eagerness to try out the linking features. “Linktyping Only” is highly used for labeling in both reading tasks, because the linktypes can be easily applied to label the highlighted text passages. The use of “Linking Only” is low by participants in both reading tasks.

Table 4.8 Frequency of linking and link typing created in general and directed tasks

Forms	Total	Task Type	
		General Reading Task	Directed Reading Task
Linktyping Only	51 (44%)	26	25
Linking + Linktyping	17 (15%)	12	5
Note-making + Linking	26 (22%)	11	15
Note-making + Linktyping	10 (9%)	10	0
Linking Only	9 (7%)	<b>3</b>	<b>6</b>
Note-making + Linking + Linktyping	4 (3%)	1	3
Total	117 (100%)	63	54

Although linking requires participants to engage more in thinking, making mental connections, and meaningfully linking ideas, Linking with Note-making is ranked the second (22%) most highly used component in both reading tasks. In addition, the use of Linking and Note-making is found more often in the Directed Reading Task. It might be conjectured that this outcome is an artifact of the methodology, where participants were keen to try out the linking capability in the early stages, but increasingly expressed their thoughts through text notes as the session progressed. In the Directed Reading task, participants read the same text a second time and more in-depth, and “Linking Only” is found more frequently to connect phrase-to-paragraph and sentence-to-paragraph instances. Perhaps the comments by Participant 14 best exemplify the use of linking and linktyping in relation to the reading task:

[1:18:26] the linking, that's nice, but I wouldn't be doing it as much. And the link typing, I don't know. I don't know if I would do that, to be honest. I really am intrigued by the concept, but I don't know if I would actually do it on a regular basis. But it's worth a whirl, just as something that's there to... I would find that intriguing as a user to see that that was there, and may eventually, once I gained comfort with the environment, and got the annotating that was part of my regular practice, then eventually I might add on the link typing. But I wouldn't be doing it the first day. (Participant 14)

The results show that participants more often use Linking with Linktyping and Note-making to describe the linking relationship than Linking Only in the Directed Reading task. It

would appear that Linking requires some consideration of the nature of the relationship between text items before attributing a linktype or a note.

#### **4.2.3.3 Exploration of the Proposed “Linking Ideas Meaningfully” Function**

Linking demands that users remember the reading and writing transition between the annotated texts and target passages. Points of transition require at least four mental operations on the part of the reader. First, the realization that a passage has been annotated may trigger an attempt to “link” the information into a target passage. The reader must establish a comprehension that two passages are related. Second, the readers must remember how to create the “Linking.” Third, introduction of a next text requires identification of a “Linktype,” opening a new memory slot for that topic (Gernsbacher, 1990). Last, the reader must remember the location of the source document he/she is reading after creating a link. It is a relatively demanding cognitive operation that involves accessing a representation of the topic structure and inferring the relationship of a new topic to previously established topics. Thus, Linking and Linktyping together are employed to indicate the “Linking Ideas Meaningfully” function.

The transcript data was coded to explore the proposed “Linking Ideas Meaningfully” function as well as Marshall’s functions with relation to the use of linking components. The coded episodes were then matched with the components used from the screen recordings. The functions identified through the “Linking” component alone and with combinations of other components were entered in an Excel sheet. In total, 117 instances were found. “Linking Only” instances include highlighted passages with links created as the starting point of a link relationship. Linktyping means only linktypes were chosen to describe the highlighted text without any notes or links associated. Notemaking+Linking means notes were created together

with linking relationship to another piece of information. Linking+Linktyping means that links have associated linktypes to describe the linking relationship. Notemaking+Linking+Linktyping means that notes were created on the margin in addition to the linking and linktyping components.

The protocol analysis shows that linking used alone (Linking-Only) is found in the “Recording Interpretation” and “Linking Ideas Meaningfully” functions (see Table 4.8). Some “Linking-Only” instances connect heading-to-sentence, heading-to-paragraph, keyword-to-paragraph, and name-to-sentence/paragraph. These instances show that the participants consider that the longer texts serve as some kind of interpretation to the source (like headings, names, keywords). These forms manifest a function similar to the “Recording Interpretation.” Other “Linking Only” instances, e.g., connecting heading-to-heading, name-to-name, and sentence-to-sentence, are interpreted as representing participants’ attempts to create a relation between the two text passages. Hence, online annotations using the “Linking Only” without any descriptions rely on the text patterns to signal different textual content and thus aid access to additional information provided by the readers.

Table 4.9 shows the examination of functions manifested through Linking and Linktyping components. The attributes of linktyping are used to describe the target information relationship as providing background information (Background) or examples (Example), or explaining (Explanation) or illustrating (Illustration) the source segments. The participants considered the linktype “Comparison” as not only expressing the “Linking Ideas Meaningfully” function, but also as distinguishing or differentiating between ideas. However, some linktypes were found to be confusing in meaning to participants. “Alternate View,” for example, was seen by several participants to initially indicate “coming from a different discipline” or “different

views,” but later in the Confirmatory Task participants expressed their doubts about using “Alternate View” as an appropriate label, and felt the need to write notes instead of using the linktype for better interpretation.

Table 4.9 Functions manifested through linking and linktyping components (G-general reading task; D-directed reading task)

Task	Participant	Text pattern	Location	Highlighted text	Linking	Linked target segment	Linktype	Function
G	P02	name	1st	2 words	linking	heading (Ladow) (5 words)	Comment	Linking ideas meaningfully
G	p02	name	1st	2 words	linking	heading (Ladow) (5 words)	Comment	Linking ideas meaningfully
G	p02	heading	whole	3 words	linking	heading (Ladow) (10 words)	Alternate view	Interpretation
G	p02	name	in	1 word	linking	paragraph (Ladow) (94 words)	Example	Interpretation
G	p02	name	in	1 word	linking	paragraph (Ladow) (94 words)	Example	Interpretation
G	p04	phrase	in	6 words	linking	keyword (Vora) (1 word)	Alternate view	linking ideas meaningfully
G	p04	paragraph	whole	142 words	linking	phrase (Vora) (4 word)	Illustration	Interpretation
G	p09	heading	1st	2 words	linking	paragraph (Vora) (79 words)	Alternate view	Interpretation
G	p09	heading	whole	7 words	linking	heading (Vora) (3 words)	Alternate view	Linking ideas meaningfully
G	p10	heading	whole	18 words	linking	diagram (Conklin)	Alternate view	Interpretation
G	p15	name	1st	3 words	linking	paragraph (Ladow) (177 words)	Comment	Interpretation
G	p15	phrase	1st	5 words	linking	paragraph (Conklin) (119 words)	Alternate view	Interpretation
D	p04	paragraph	whole	142 words	linking	keyword (Vora) (2 word)	Explanation	Interpretation
D	p04	sentence	end	19 words	linking	sentence (Burbules) (15 words)	Comment	linking ideas meaningfully
D	p06	heading	whole	5 words	linking	paragraph (Burbules) (124 words)	Comparison	Linking ideas meaningfully
D	p08	heading	whole	5 words	linking	paragraph (Vora) (138 words)	Background	Interpretation
D	p15	name	1st	2 words	linking	paragraph (Ladow) (286 words)	Background	Interpretation

As discussed in Research Question 2, the largest percentage (44%) of the linktypes did not reference an actual link but were used instead as subject headings (labels). Participants used the annotation as a collocation device, essentially applying a form of subject heading to the content to be used to identify and gather similar themes within the article. Interestingly, participants continued this strategy by using the linktypes to describe text content as labels rather than using them to describe a link relationship. For example, identification of unfamiliar words and terms within the content was an important aspect of the participants' interaction with the text content in both the General and Directed Reading conditions. Those Linktypes used as labels mainly manifested the "Place-marking" function rather than "Problem-working" discussed in the Form-to-Function mapping in Research Question 1.

Note-making used together with the linking components leads to an interesting observation. Table 4.8 shows that Note-making with Linking components used together function more for "Recording Interpretation" than for "Linking Ideas Meaningfully" regardless of reading tasks. In four of those Linking with Note-making instances, linking occurs at a higher level (like head-to-heading). It may be conjectured that these combinations implement the "Procedural Signaling" function. However, further examination in the content of 26 notes describing the relation of linking, 20 instances are for comparison between two texts regardless the text patterns the links cued. The other 4 instances are comments about the highlighted texts. In addition, there are 2 instances describing the linking relation with a comparison word entered in the notes. This finding shows that when Note-making is used together with the linking components it gives a clear description of the linking relationship. Note-making as an explicit form of annotation makes the linking component manifest more of "Recording Interpretation" in addition to the "Linking Ideas Meaningfully" function. Similar findings are also found in the combination of Linking with Linktyping and Note-making components. Hence, Linking components combined



with any notes are likely manifesting both the “Recording Interpretation” and “Linking Ideas Meaningfully” functions.

Table 4.10 shows that Linking with Note-making and Linking with Linktyping components are found to be the least used. Perhaps the combined forms were more complicated for participants to use; only four instances were found in the user study. As previously discussed, notes explicitly describe the “Recording Interpretation” function, and when these combined forms are used, the “Recording Interpretation” function is stronger than the “Linking Ideas Meaningfully” function manifested through Linking and Linktyping components.

Table 4.10 Functions manifested through linking and combinations of linking component

Functions	Linking	Linking + Linktyping	Note-making + Linking	Linktyping	Note-making + Linktyping	Note-making + Linking + Linktyping	Total Frequency
<b>Interpretation</b>	4	11	12	3	2	3	30
<b>Linking ideas Meaningfully</b>	5	6	3	0	0	1	25
<b>Place-marking</b>	0	0	0	44	6	0	52
<b>Procedural signaling</b>	0	0	11	4	2	0	10
Total	9	17	26	51	10	4	117

#### 4.2.3.4 Summary of Research Question 3

The findings show that “Linking Only” has less effect in the reading tasks. “Linking” as a marking of text structure allows certain types of text entities (headings, keywords, phrases, sentences, and paragraphs) to be linked, and the intended functions are investigated. To further explore “Linking Only” in relation to text structure and text patterns, a review of heading and paragraph conventions discussed in the existing literature was conducted and is discussed in Chapter 5.

It is also found that Linking has been used not only alone, but also in combination with other forms. Linking and Linktyping together manifest the proposed “Linking Ideas Meaningfully” function. Without notes or linktypes describing the link relationship, the function manifested from “Linking Only” relies on textual signals. It would appear that Linking requires some consideration of the nature of the relationship between text items before assigning a linktype or making a note. Linking combined with Note-making may manifest “Recording Interpretation” and/or “Linking Ideas Meaningfully” depending on the content of the note. The function manifested, i.e., “Recording Interpretation,” is determined by the explicit meaning of notes. Similar reflection applies to Linking with Note-making and Linktyping, where the content of the note mostly determines the function manifested.

#### **4.2.4 Research Question 4**

##### **What other forms and functions might online annotation support?**

In Research Question 1 and 2, it is noted that online annotation forms are limited by the system features supported by ANNOLINK; therefore, participants expressed some “forms” they wish to have in order to facilitate their active reading online. In Research Question 3, the findings show the linking components manifest multiple functions in relation to hypertextuality. The findings also show that there are more fine-grained sub-functions existing in the “Recording Interpretation” function, and the “Incidental Reflection” function that may manifest other functions associated with collaboration tasks. It was also noted that there are other forms and functions online annotation might support.

The purpose of Research Question 4 is two-fold: (1) to identify a list of “wished-for forms”; and (2) to identify a list of annotation functions that might facilitate more active reading

online. Data analysis includes, first, creating a “wish list” of forms mentioned by participants in the main study, and second, identifying the functions from participants’ expressed intentions in creating annotations including those that are “wished” for. The main outcome of the analysis of functions is the development of a coding scheme. The open coding was used to code function categories and a coding scheme emerged from the data. The resulting other functions that online annotation might support will be discussed in Chapter 5.

#### **4.2.4.1 The “Wished-for Forms” in the Main Study**

In the main study, participants mentioned additional forms they wished to use for annotating online that were not included in ANNOLINK. In this section, those “wished-for forms” from the protocol transcripts are identified. When forms are intended to support personal use and social or shared use, the personal use is discussed first and then followed by social or shared use.

##### **4.2.4.1.1 Markings and Typographical Signals**

Protocol evidence found in the “wished-for forms” is that participants want to be able to draw markings such as underlining, circle, check, bubble diagram, bracket, and so on. Markings enable them to manipulate the page from a graphic point of view, and are helpful for returning to the text and reading it quickly. Perhaps Participant 7’s comment best exemplifies the variations of these forms:

[1:32:08] What else would I want... underlining features, italicizing features, I guess that's already available, is it? Graphics, if I can circle, if I can go like this.. how do you say that? Instead of highlight, put a circle and a check. More like a... it's more like a pencil that I have in my hand, 'cause this is very two-dimensional at the moment, it's limited in that sense. But eventually, a purely graphic ability to even draw on the page, that might be helpful. Because if I can, yeah that's another thing, if I can draw bubbles diagram on the page, which I do, actually, in the printed text, I

can... you know that marking... just to manipulate, to be able to manipulate the page from a graphical point of view. That would be helpful. (Participant 7)

#### **4.2.4.1.2.a Multiple-Color Highlighting for Personal Use**

Multiple-color highlighting is found in the “wished-for forms” of using color highlighters for certain themes. For example, some participants (Participant 2, 8, and 13) mentioned that it is their habit to use three color-highlighters for certain themes that could allow looking purposefully for certain things. Participant 7 also mentioned the use of color to capture concepts for comparison. Participant 5 mentioned that different colors signal main points in each reading, yellow highlights main points in the first reading, green the second reading, and red the third, etc.

#### **4.2.4.1.2.b Multiple-Color Highlighting for Sharing Annotations**

Participants 11 and 15 mentioned that they wanted to separate their annotations from others, when in public view. For example, one of them suggested that highlightings created by the reader could be pink, and highlightings created by other annotation writers could be orange. This means some annotation creators have a strong sense about differentiating private and public view.

#### **4.2.4.1.3 Tag/Label Segments Consistently**

The purpose of tagging/labeling segments consistently is to find patterns through the examination of concepts. The findings show that participants wished those linktypes were subject headings for tagging a piece of information. Participant 8’s comment exemplifies how entering notes or choosing linktypes such as Definition, or Example help in tagging segments consistently as a strategy of placing marks for remembering:

[06:40] Oh, actually I could almost, no I don't do linktypes here, what I was going to say was this would be... if it were a linktype and I was connecting it to something, it would be context. (...) I think what's very handy about this is as I'm going through it now is being able to... the collocation function you can perform afterwards in terms

of all the times you put context, context, context, to a background, right? So it's now... It's like subject headings and it's not because you're using vocabulary similar to what you would be using in link typing, but you're not linking it outside the document yet, you're just, it's within the document you're trying to find patterns. (Participant 8)

#### **4.2.4.2 The Suggested Functions the “Wished-for Forms” Might Implement**

The intentions behind using these “wished-for forms” (see 4.2.4.1) are identified as the “suggested functions” in this section. The “suggested functions” for individual use are discussed first and then followed by those for social or shared use.

##### **4.2.4.2.1 The “Wished-for Markings” Signaling for Returning to the Text Are Intended for the “Procedural Signal” Function**

The findings show that Markings enable a reader to manipulate the page from a graphic perspective, and help him/her return to the text and read it quickly, which suggests the “Procedural Signaling” function Marshall (1997) identified.

##### **4.2.4.2.a Multiple-Color Highlighting for Different Themes for Personal Use Capture the Concept “To Differentiate” Themes**

The findings show that, for personal use, highlighting in color is often used to differentiate textual passages. Color highlighting is a kind of marking system useful to distinguish topics, subtopics, and common categories, which captures the concept “to differentiate”.

#### **4.2.4.2.b Multiple-Color Highlighting for Different Roles in Sharing Annotations Captures the Concept “To Differentiate” Roles**

The findings in “wished-for forms” show that difference in color might be useful for people to keep track of their own versus other people's annotations. As Participant 11 pointed out, if she were working on a group project, having a color contrast that way might be useful, because she can then figure out the thread, so that she might say, "I want to keep all the pink ones and get rid of everything else, because this person has actually done something useful for me.” Thus, highlighting in colors when sharing annotations captures the concept of “To Differentiate” roles.

#### **4.2.4.3 Tags and Labels Written in the Margin as Headings for Personal Use Capture the Concept of “To Tag/Label Segments Consistently” and Serve the Function of “Place-Marking”**

The purpose of tagging segments consistently is to find patterns through the examination of concepts. The use of vocabulary helps the collocation function readers can perform afterwards. As Participant 8 commented, to tag segments consistently is a strategy of placing marks for structuring the text and helps remembering.

#### **4.2.4.4 Summary of Research Question 4**

Other forms that online annotation might support are presented, and show that people want to create a variety of annotation marks including free-drawn markings, typographic symbols, and multiple-color highlighting. Tags and/or labels are expressed as headings to identify patterns in the texts.

These “wished-for forms” manifest functions including:

- (1) Markings that signal a graphic point of view for returning to the text quickly capture the “Procedural Signal” function
- (2) Multiple-color highlighting for different themes for personal use captures the concept “To Differentiate” themes
- (3) Multiple-color highlighting for different roles for sharing annotations captures the concept “To Differentiate” roles
- (4) Tag/Label in the margin as heading for personal use captures the concept “to tag/label segments consistently” serving the function of “Place-marking”

These “wished-for forms” closely resemble their counterparts in print. It is possible that online annotation may take more innovative forms by taking advantage of computer and network capabilities. To further explore other online annotation forms requires data other than that which the main study can provide. A review of twenty-two existing annotation tools and innovative online annotation forms discussed in the existing literature was conducted and is discussed in Chapter 5.

#### **4.2.5 Research Question 5**

##### **Do function and form vary by role?**

In discussing Research Question 4, it was noted that there are roles attached to some annotation forms. For example, some annotations are created for an intended audience, while others are created for discussion purposes. Research Question 5 explores the users’ preferences based on the usefulness of the forms provided in terms of varying roles, as well the functions manifesting these forms. Second, it explores whether annotation functions and forms not only

vary by role, but also have different characteristics for sharing purposes. Third, it is intended to explore whether these social forms manifest additional functions.

Based on their experience in the protocol sessions, the participants were asked for their opinions about sharing annotations with others. To compensate for the lack of a public view feature, in the Confirmatory Task participants were organized into two groups. One group responded as annotation writers who commented on how they would alter their annotations if sharing with others. The other group responded as annotation readers who commented on actual annotations of others. The design of the Confirmatory Task elicited the participants' comments on their decision on whether to share their online annotation. The post-session questionnaire gathered information via user ratings about the forms and functions of annotation for sharing with a workgroup and the public.

The approach of this section is, first, to analyze the post-session questionnaire to investigate the user's preferences about the usefulness of annotation forms by role and functions by role. Secondly, the questionnaire results are used in conjunction with the analysis of the transcript data to investigate participants' reasons for sharing.

#### **4.2.5.1 Post-Session Questionnaire Findings**

Overall, the participants considered all the functions more useful for personal use and for sharing with a workgroup, but less useful when sharing with the public. Table 4.11 shows that most of the participants rate the annotation functions as more useful for personal and workgroup than for public use. It shows the evaluation of the functions by role indicating that "Procedural Signaling" and "Recording Interpretation" are considered more useful for personal use. For



sharing with a group, those annotations manifesting “Recording Interpretation,” “Problem-working” and “Linking Ideas Meaningfully” are considered useful; but “Tracing Progress through Difficult Narrative” and “Incidental Reflection” are not considered useful for groups. Overall, annotations functions are not considered as useful when sharing with the public. Looking at individual functions, “Recording Interpretation” and “Linking Ideas Meaningfully” are also considered as useful for sharing with the public as with a group; however, “Tracing Progress through Difficult Narrative” and “Place-marking” are not considered useful for sharing with the public.

Table 4.11 Preference for annotation function by role – (1 indicates “Very Useful,” 5 indicates “Not Useful At All” (\*one participant did not respond for these roles)

	Personal					Workgroup*					Public				
	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5
Procedural signaling	(6	7)	2	(0	0)	(5	2)	2	(4	1)	(3	3)	3	(2	4)
Place-marking	(7	2)	5	(1	0)	(3	4)	2	(4	1)	(0	1)	5	(4	5)
Problem-working	(2	2)	7	(1	2)	(3	8)	2	(0	0)	(2	1)	6	(4	2)
Interpretation	(5	5)	3	(2	0)	(9	3)	2	(0	0)	(7	3)	3	(1	1)
Tracing progress through difficult narrative	(1	5)	5	(3	1)	(0	2)	3	(4	4)	(1	0)	2	(7	5)
Incidental reflection	(3	4)	4	(2	1)	(0	3)	3	(6	1)	(0	3)	5	(2	3)
Linking ideas meaningfully	(5	3)	5	(2	0)	(6	5)	1	(2	0)	(7	2)	4	(2	0)
Grand Total	(29	28)	31	(11	4)	(26	27)	15	(20	7)	(20	13)	28	(22	20)
Useful vs. Not Useful	57		vs.	15		53		vs.	27		33		vs.	42	

Overall, all forms are considered useful, regardless of role (see Table 4.12). The results from the post-session questionnaire show Highlighting is viewed as more personal due largely to its idiosyncratic nature and the lack of cues it provides to establish motivation and meaning outside the user’s specific task contact. In general, users think highlighting is more useful for sharing with a workgroup or for personal use, but less so when sharing with the public. Note-making is viewed as appropriate across all levels with 93 percent of notes viewed as useful or very useful in the personal role, 77 percent in the workgroup, and 77 percent for the general

public. Linking is judged appropriate across all groups with linktyping seen as useful across all groups, although viewed as slightly more applicable for workgroups and the public.

Table 4.12 User preference for annotation feature by role - 1 indicates “Very Useful,”  
5 indicates “Not Useful At All” (\*one participant did not respond for these roles)

	<u>Personal</u>					<u>Workgroup*</u>					<u>Public*</u>				
	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5
Highlighting	(11	1)	3	(0	0)	(2	6)	5	(1	0)	(1	3)	6	(2	2)
Note-writing	(8	6)	1	(0	0)	(9	2)	2	(0	1)	(6	5)	2	(0	1)
Linking	(7	1)	3	(2	2)	(10	3)	1	(0	0)	(8	5)	1	(0	0)
Linktyping	(4	3)	3	(3	2)	(6	5)	0	(3	0)	(7	3)	1	(3	0)
Grand Total	(30	11)	10	(5	4)	(27	16)	8	(4	1)	(22	16)	10	(5	3)
Useful vs. Not Useful	41		vs.	9		43		vs.	5		38		vs.	8	

In the Confirmatory Reading Task, the participants were asked to go through their annotations created in the general reading and directed reading tasks, answer whether they would share their annotations with others, and if they would, whether they would choose to share with a workgroup or the larger public, or both. Table 4.13 shows that the overall frequencies for sharing annotations are slightly higher than for not sharing annotations with others. If sharing with others, more annotations are identified as appropriate for sharing with a work group than with the public.

Table 4.13 Frequency of sharing all forms with group or public mentioned by participants in the confirmatory task

Participant	Frequency of sharing			Total	Share with		Total
	Share	Not Share	Not Sure		Group	public	
P1	9	2	9	20	9	0	9
P2	5	16	1	22	0	4	4
P3	18	30	0	48	18	0	18
P4	36	16	1	53	0	36	36
P5	3	28	0	31	3	0	3
P6	23	25	2	50	20	3	23
P7	26	0	0	26	26	0	26
P8	20	1	0	21	0	20	20
P9	32	0	0	32	32	0	32
P10	28	2	0	30	28	0	28
P11	18	13	0	31	0	18	18
P12	11	25	0	36	0	11	11
P13	20	42	1	63	20	0	20
P14	12	3	1	16	0	12	12
P15	11	2	0	13	0	11	11
Total	271	203	15	492	156	115	271

#### 4.2.5.2 Verbal Protocol Analysis Findings

##### Investigation on Functions Varying by Role

To understand the reasons for sharing or not sharing annotations in relation to annotation function, a further examination in the verbal protocols was conducted to find the rationale for sharing. The findings indicate the reasons for “sharing” annotations with others fall within three categories. Shared annotation can: (1) provide a clear, helpful, useful, or interesting means to share a personal insight on associated text; (2) ask questions, ask for comments, or spark discussion with others; and (3), indicate related resources to other readers.

Appendix 13 shows protocol evidence of annotation functions varying by role found in the verbal protocols. For example, annotation functions such as “Incidental Reflection,” “Recording Interpretation,” “Place-marking,” and “Procedural Signaling” fall within the category of shared annotations which may be clear, helpful, useful, or interesting to others. The

“Incidental Reflection,” “Recording Interpretation,” and “Place-marking” functions also fall within the second category: to ask for help or to spark discussion with others. The “Incidental Reflection,” “Problem-working,” and “Linking Ideas Meaningfully” functions may manifest in the third category: to give additional information to others. That is, the same annotation function may vary by different reasons to share.

On the other hand, the rationale for “not sharing” annotations is two-fold. First, the annotations may be created based on personal interests or for personal use and are not relevant to others. Second, the annotations are considered not clear (confuse people, typo, others’ won’t understand), not helpful (distract or impose something), or not useful to others (see Appendix 14).

Some participants held strong opinions about sharing or not sharing their annotations in a more general sense, including:

- Annotation notes should be revised before sharing, according to Participant 5.
- “I would share all my annotations. I’m open for discussion,” said Participant 7.
- I would “share [all my annotations] with anonymity,” said Participant 8.

#### **4.2.5.3 Morae Recordings Findings**

##### **Investigation on Forms Varying by Role**

If the functions vary by role, then do forms also vary by role? To understand the reasons for sharing or not sharing annotations in relation to annotation form, a further examination in the Morae recordings was conducted, and the findings are discussed below.

Further examination of the relationship of Highlighting and its functions with role (Table 4.14) shows the highlighting form mainly manifests three functions: “Place-marking,” “Procedural Signaling,” and “Tracing Progress through Difficult Narrative.” Highlights manifesting the “Place-marking” function are found to have different characteristics when they are intended for sharing with a group or with the public, i.e., highlighting main points to share with a group, keywords to share with the public. Highlights manifesting the “Procedural Signaling” function can be shared with a group or the public, but shared with anonymity. Highlights manifesting the “Tracing Progress through Difficult Narrative” are shared with conditions; if shared with a group the highlightings may be some main points, otherwise, they need to be revised before sharing; if they are shared with the public, shared with anonymity. In all, the characteristics in sharing with a group or the public indicate that highlighting and its functions vary by role.

Table 4.14 Highlighting and its functions varied by role and reasons

Form	Function	Share	Audience	Reasons
Highlighting (140)	Place-marking (58)	25 (42%)	Group (16)	Highlighted texts are main points (16)
			Public (9)	Highlighted texts are keywords (9)
	Procedural signaling (29)	9 (31%)	Group (4) Public (5)	Share, but with anonymity (9)
	Tracing progress through difficult narratives (53)	25 (47%)	Group (18)	<ul style="list-style-type: none"> <li>Highlighted texts may be main points (6)</li> <li>Need revision before sharing (9)</li> </ul>
			Public (7)	Share with anonymity (7)
Total=140		59 (42%)		

Users’ preferences for annotation function show “Procedural Signaling” and “Place-marking” are more useful for personal use (Table 4.12). “Tracing Progress through Difficult Narrative” is viewed not useful when sharing with the public (see Table 4.11), unless highlightings show main points and are shared with anonymity (see Table 4.14).

Table 4.15 shows the relationship of Note-making and its functions with role. The Note-making form manifests four functions: “Incidental Reflection,” “Recording Interpretation,” “Place-marking,” and “Problem-working.” Of those people commenting on Notes manifesting the “Incidental Reflection” function the large majority view them as not useful for sharing with the group (see Table 4.12), and only one participant commented that whether this type of function should be shared with the group is open to discussion. Table 4.12 also shows Note-making is viewed as appropriate across all levels with 93 percent of participants viewing it as useful in the personal role, 77 percent in the workgroup, and 77 percent for the general public. Table 4.15 also shows that participants perceived that notes manifesting the “Recording Interpretation” function have a greater need for revision in sharing with the public (52%) than with a group (26%). Helpful and useful notes are favored for sharing with both a group and the public. Users’ preferences also show that “Open to Discussion” is again expressed for notes manifesting “Recording Interpretation” within a group -- but shared anonymously with the public. Notes manifesting the “Place-marking” function are identified for sharing with a group to ask for help, and need to be revised if shared with the public. Notes manifesting the “Problem-working” function are expressed for personal use, and this finding is in accordance with the users’ opinion that “Problem-working” is more useful for personal use (see Table 4.12).

Table 4.15 Note-making and its functions by role and reasons

Form	Function	Share	Audience	Reasons
Note-making (235)	Incidental reflection (15)	7	Group (6)	Open to discussion(5); Revise before sharing (1)
			Public (1)	Express some inspiration (1)
	Interpretation (213)	120 (51%)	Group (57)	Revise before sharing (15= 26%); Helpful or useful to others (11=19%); Indicate exploration (4); Open to discussion (18)
			Public (63)	Revise before sharing (33=52%); Helpful or useful to others (13=21%); Not sure they are useful, but let people comment (6); Share with anonymity (11)
	Place-marking (5)	3	Group (2)	Ask for help (2)
			Public (1)	Revise before sharing (1)
	Problem-working (2)	0	private (2)	N/A
Total=235		130 (55%)		

The number of links created is not significant compared to other forms; perhaps the steps required to create a link increase cognitive load of the participants. Nevertheless, further examination of the relationship of Linking and its functions with role (Table 4.16) shows that links manifesting “Procedural Signaling” are said to create more links to give related information to, and open up discussion with, a group. Linking is judged appropriate across all groups, although viewed as slightly more applicable for workgroups and the public (Table 4.12). In Table 4.11, evidence from the user preferences survey indicates that “Linking Ideas Meaningfully,” i.e., the proposed function of the linking component, is considered useful across all groups.

Table 4.16 Linking and its functions by role and reasons

Form	Function	Share	Audience	Reasons
Linking (9)	Procedural signaling (9)	4	Group (2)	<ul style="list-style-type: none"> <li>• Create more links to share [related findings]</li> <li>• They are open to discussion</li> </ul>
			Public (2)	<ul style="list-style-type: none"> <li>• Add linktype or write more notes explaining the linking relationship</li> </ul>
Total=9		2 (44%)		

Table 4.17 shows Linktyping manifests the “Problem-working” function, and it is noted by participants that most of these linktypes may be shared with a group. In other words, linktyping is the result of a selection after thinking, and would be shared when its meaning is clear and helpful to others. For example, reasons for sharing expressed by the participants include statements that the linktype doesn’t impose anything on others, is helpful for others, and flags main ideas. It is interesting to note that some participants have said that they would delete the “Alternate View” linktype before sharing. When revisiting this linktype they are not sure about the meaning of “Alternate View,” and they do not want to share something they are not clear about.

Table 4.17 Linktyping and its functions by role and reasons

Form	Function	Share	Audience	Reasons
Linktyping (50)	Problem-working (50)	39	Group (39)	<ul style="list-style-type: none"> <li>• Doesn’t impose anything on others (6)</li> <li>• Delete “Alternate View” linktype (8)</li> <li>• Seems helpful or useful (5)</li> <li>• Indicate main ideas (1)</li> </ul>
			Public (0)	<ul style="list-style-type: none"> <li>• N/A</li> </ul>
Total=50		39 (78%)		20

Usefulness is the main reasons for sharing linktypes with others. It is observed that if a user is not sure about the meaning of a linktype, or is not sure it is helpful to others, or considers the linktype to be more a reflection of his/her own noting system, the linktype (for example, Alternate View) would be kept for personal use or would be deleted when sharing with others.

#### 4.2.5.4 Summary of Research Question 5

This section reports the findings from the survey of the users’ preferences concerning the usefulness of annotation forms by role and functions by role. The results are used in conjunction



with the observations from verbal protocols to identify the different characteristics of annotation forms and functions in terms of sharing or not sharing.

Secondly, this study reports the findings concerning the users' opinions on sharing annotations with others by asking users, in the confirmatory task, to go through their annotations and comment on sharing or not sharing their annotation with others. Specifically, they were asked whether they would like to share their annotations with a workgroup or the public and why, as well as why they would keep certain annotations for private use. In addition, the second group of participants is also asked to comment on the usefulness of some annotations shared by the first group.

The content analysis of the verbal protocol shows that some annotations are created for an intended audience and some are created for the purpose of asking questions, and hence there is a communication dimension of online annotation functions. The findings from the analysis of the post-session questionnaire indicate that functions vary by role; and the reasons for sharing annotations created under the same function may vary when sharing with others in the protocol analysis. The analysis of the Morae recordings reveals that forms and their functions vary when sharing with different audiences.

#### **4.2.6 Research Question 6**

**What are the perceived values of the use of online annotation?**

The purpose of this research question is to investigate the overall preference and perceived values of the use of online annotations. The questionnaires and transcribed protocols

are analyzed to investigate and explore the underlying reasons for the usefulness and the ease of use of online annotation.

The approach of this section is, first, to investigate the perceived values of the use of online annotation through the post-session questionnaire. Then, it attempts to use the Perceived Values of Online Annotation Questionnaire to investigate the overall attitude toward online annotation. Lastly, the perceived value factors from the Perceived Values questionnaire are used as the baseline criteria in analyzing the transcript data to assess the perceived values that account for the acceptance of annotating online.

#### **4.2.6.1 Values of the Use of Online Annotation**

In this study, almost all participants reflect positively on their experience using the ANNOLINK prototype. Laitenberger and Dreyer (1998, p.123) pointed out that users tend to use or not use a tool according to the extent to which they believe it will help them to perform their job better. In this study's context, this means the use of an annotation tool will help them to perform their active reading tasks.

It is intended in this research question to further investigate the ease of use, the usefulness of annotation online, and self-predicted future usage, which can be considered determinants of the values of the use of online annotation. More specifically, the “value” and “difficulty” episodes are also examined for evidence of the acceptance of annotating online.

#### **4.2.6.2 Post-Session Questionnaire Findings**

In the post-session questionnaire, the overall judgments of the participants about annotation online indicate that they think online annotation is very useful. The survey results show that 10 participants rate 1-Very Useful, 3 participants for 2-Useful, 1 participant for 3-Don't Know, 1 participant for 4-Little Useful, and no participant for 5-Not Useful at all. In the protocol sessions and post-session interviews of this study, the participants expressed their opinions and expectations about the usefulness and ease of use of online annotation in terms of annotation content, feature, impact on reading, sharing/shared annotations, as well as their difficulties in annotating online.

#### **4.2.6.3 The Perceived Values of the Use of Online Annotation**

Usefulness and ease of use are two determinants of the perceived value of online annotation. The perceived usefulness of a tool is defined as the potential for improving active reading online by using a tool, and software tools can only be effective if users accept them. However, even if users believe that a given tool is useful, they may at the same time believe that the tool is too difficult to use and that the performance benefits are outweighed by the effort of using it. This is best captured by the ease of use determinant.

Investigating user acceptance requires a model explaining people's attitudes and behavior as well as reliable and valid measurement instruments (Laitenberger & Dreyer, 1998). This study adopts Davis' (1989) technology-acceptance-model (TAM) questionnaire-based measurement instrument for evaluating the prototype ANNOLINK from the user's perspective in the following ways:

- Davis (1989) pointed out that a tool high in perceived usefulness is one for which a user

believes in the existence of a positive use-performance relationship. This study defines that the perceived usefulness is “the degree to which a person believes that using a particular system would enhance his or her active reading performance.”

- Davis (1989) indicated that a tool that is easy to use is more likely to be accepted by users. This study defines the perceived ease of use as “the degree to which a person believes that using a particular system would be free of effort.”

#### **4.2.6.4 Perceived Values Questionnaire Data Analysis**

A follow-up online questionnaire was sent to the 15 participants after completing the protocol sessions. This questionnaire was administered to assess the perceived values of the use of online annotation. Thirteen participants answered the 12 questions on the perceived values of using online annotation tools in the questionnaire (See Appendix 8). A seven-point Likert scale was used to measure the participants’ responses to each perceived value question with “1” indicating extremely likely and “7” indicating strongly unlikely to, for example, complete tasks more quickly.

Table 4.18 Average point for each question selected by perceived values. (The scale goes from 1, “Extremely Likely” to 7, “Extremely Unlikely,” the neutral score being 4, “Neither”.)

Perceived Values	p01	p02	p03	p04	p05	p06	p07	p08	p09	p10	p11	p12	p13	Avg.
Complete task more quickly	2	2	2	5	2	2	2	5	2	2	2	2	2	2.46
Improve performance in reading	1	3	4	3	3	2	2	3	2	1	2	2	2	2.31
Increase productivity	3	3	3	4	2	2	2	4	2	1	3	2	2	2.54
Enhance reading effectiveness	2	2	2	2	2	2	2	2	2	1	2	2	2	1.92
Make reading online easier	2	2	4	3	3	2	2	3	2	3	2	3	2	2.54
Useful for reading online	2	2	2	3	1	2	2	2	2	1	2	3	2	2.00
Easy to learn operating online annotation	3	2	3	2	2	1	2	2	2	2	3	5	2	2.38
Do what I want to do	3	2	5	2	2	2	3	4	3	2	5	2	3	<b>2.92</b>
Flexible to interact	3	3	4	2	3	2	2	4	2	5	2	3	2	<b>2.85</b>
Easy to become skillful in use	3	2	3	2	3	1	2	2	2	2	1	4	1	2.15
Easy to use the tool	2	2	5	2	3	1	2	3	2	3	2	4	1	2.46
Perceived use in future	2	2	2	5	2	2	2	1	1	2	1	3	1	2.00
<b>Std. Dev.</b>	0.65	0.45	1.1	1.16	0.7	0.45	0.29	1.16	0.4	1.16	1.1	1	0.58	

Table 4.18 shows the average point for each question selected by perceived usefulness and ease of use.<sup>14</sup> The scores reflect the likeliness for a user to accept any of the twelve perceived values of the use of online annotation. A score less than 4 indicates positive acceptance. Taking the mean of the scores given by thirteen participants, each of the twelve perceived values shows positive acceptance. Positive acceptance levels across all of the perceived value indicate that the participants are generally satisfied with using annotation online.

Nevertheless, each participant has given varying scores to the twelve perceived values, indicating which aspects of the online annotation tool he/she better or less favors. The perceived values which received lower average acceptance levels (larger number scores) from the thirteen participants indicate that improvements may be needed in those aspects of the online annotation tool. Two of the average scores stand out: one with 2.92, and one with 2.85; this shows that the tool may require some improvements in order to attain those corresponding perceived values. The other ten scores distribute quite uniformly between 1.92 and 2.54. The close spacing in

<sup>14</sup> The standard deviation of each participant is calculated for a later part of the analysis, but is also recorded here.

those ten scores makes it difficult to determine which of the perceived values have significantly higher or lower acceptance levels than the others.

Upon close examination of the participants' responses, some participants appear more critical than the others. The less critical ones have given uniform scores to all twelve perceived values. Their responses don't accentuate the likelihood (or unlikelihood) of acceptance for any of the perceived values, and they dilute the overall data. To eliminate this dilution, a smaller, selected group is chosen among the participants. For each participant, the standard deviation of the twelve number scores he or she has attributed is calculated. A larger standard deviation indicates that he or she has more varying, instead of uniform, levels of acceptance for the perceived values of the use of online annotation. Figure 4.2 shows the standard deviation scores of each participant.

Figure 4.2 Participants' acceptance of perceived values

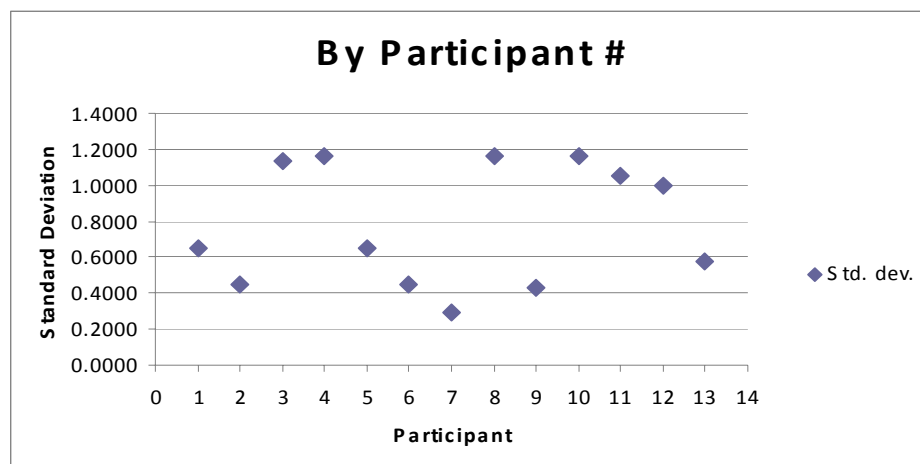
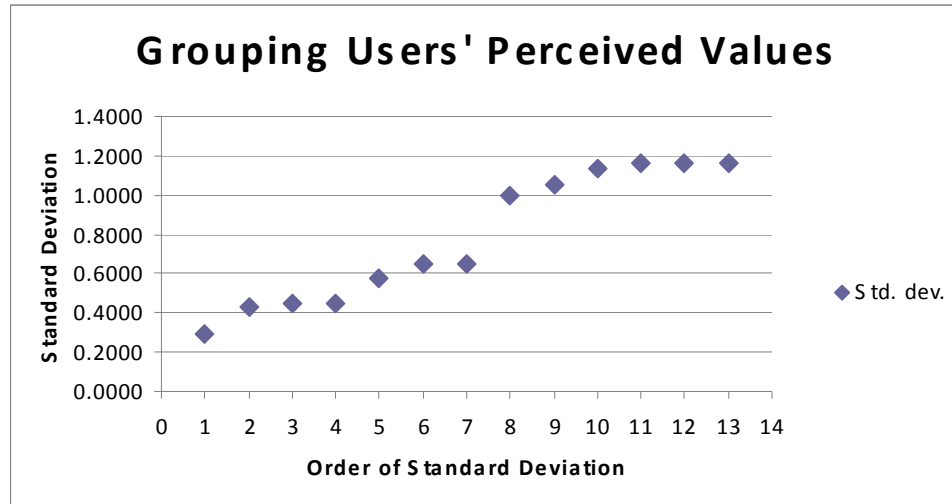


Figure 4.3 shows that by order of increasing standard deviation, there are two distinct groups: one group of standard deviation values below 0.65, and one group around 1 to 1.2. The latter group, with higher standard deviation values, represents the more critical participants, and

is more informative and indicative for this analysis. Therefore this group, consisting of participants 3, 4, 8, 10, 11, and 12, is chosen as the selected group.

Figure 4.3 Acceptance of perceived values showed two distinct groups



From the average scores of the full group, it is hard to tell the difference between the questions. Using the smaller group it gives much dispersed results than the averages calculated for all the participants. Recalculating the average scores using only the selected group, Table 4.19 shows that perceived values – Questions 2, 4, 6, and 10 receive more favorable scores, which indicates the participants favor the usefulness of online annotation in their reading online and with practice it would become easier for them to use online annotation.

Table 4.19 Recalculating the average scores using only the selected participants

PARTICI PANT	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10	Q11	Q12	Std. Dev.
p03	2	4	3	2	4	2	3	5	4	3	5	2	1.1382
p04	5	3	4	2	3	3	2	2	2	2	2	5	1.1645
p08	5	3	4	2	3	2	2	4	4	2	3	1	1.1645
p10	2	1	1	1	3	1	2	2	5	2	3	2	1.1645
p11	2	2	3	2	2	2	3	5	2	1	2	1	1.0553
p12	2	2	2	2	3	3	5	2	3	4	4	3	0.9962
Avg.	<b>3.00</b>	2.50	<b>2.83</b>	1.83	<b>3.00</b>	2.17	<b>2.83</b>	<b>3.33</b>	<b>3.33</b>	2.33	<b>3.17</b>	2.33	

Table 4.19 also shows that perceived values – Questions 1, 3, 5, 7, 8, 9, and 11 (see Appendix 8) are less highly favored and suggests the reason might have to do with the ease of use of online annotation. Perceived values – Questions 8 and 9 receive the lowest acceptance, which suggests the ease of use is an important factor for readers to use an online annotation tool. Examining those columns, it is evident that while the perceived values of Questions 3, 5, 8, 9, and 11 receive less favorable scores in general, perceived values – Questions 1 and 7 actually receive favorable scores from most participants, but their averages are compromised because they have been given less favorable scores by only one or two participants.

Perceived values – Questions 3, 5, 8, 9, and 11 remain (Increase annotation productivity, Make reading online easier, Easy to do what I want, Easy to learn operating online annotation, and Easy to use). These are the aspects of the online annotation that show lower likelihood of being accepted by users, and may require further improvement to increase its technology acceptance.

Consequently, when participants are asked about the self-predicted future usage if an online annotation tool were available as they read online, Table 4.19 shows Question 12 receives a favorable score. This favorable score from the full group indicates the participants are likely to use online annotations in the future, even though the critical subgroup considers that there are improvements needed in perceived values – Questions 3, 5, 7, 8, 9, and 11.

#### **4.2.6.5 Protocol Episodes Analysis**

Whereas the previous section discussed the Perceived Values questionnaire results, this section will use the verbal data to elaborate on findings from Perceived Values questionnaire data.



Eleven<sup>15</sup> perceived values identified from the Perceived Values questionnaires are used as the baseline criteria for identifying episodes of reasons in the transcribed protocols. In the transcribed protocol data, those episodes containing keywords such as “useful,” “helpful,” “it would be nice to have,” “it would be great to have,” and “it would be easy for me to,” etc. mentioned by the participants are categorized as “value episodes.” Those episodes containing keywords such as “having difficulty in,” “distract,” “not useful,” “not helpful,” “hard for me,” and “cannot do” are categorized as “difficulty episodes.” The episode analysis is used as another lens to explore the perceived values in the participants’ experience. Each of the “value” and “difficulty” episodes are grouped into sub-categories according to the original Perceived Values of Online Annotation questions. The following section is broken down by each of the questions.

1. “Using online annotation in my online reading would enable me to **accomplish tasks more quickly**”.

Table 4.20 “Value” reasons enabling faster completion of online reading

Value Reasons	Total Value Episodes	Difficulty Reasons	Total Difficulty Episodes
Ability to annotate <i>in situ</i>	3	-	0
Ability to search annotations	4	-	0
Ability of <i>in situ</i> online discussions	8	-	0

Participants commented that an online annotation tool for *in situ* annotating without having to look for other utilities would enable them to accomplish the reading and annotating task more quickly. Similarly, the ability to search annotations would enable them to locate related information quickly. These reasons apply in both personal use and a shared environment. Protocol evidence is found in the “value” episodes; for example, Participant 2 expressed the opinion that just to be able to comment on the screen as opposed to having it in a notepad file or having it on a piece of paper would be really useful. Another example is from Participant 7 who

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<sup>15</sup> Excluding the twelfth perceived value question asking about perceived future use.

thought online annotation facilitated a faster capture of information, so he wouldn't have to manually write anything down in his notebook.

Think-aloud Protocol evidence indicates that the ability to search annotations may also help to accomplish the reading and annotating tasks more quickly. For example, Participant 1 noted that the capability of searching her annotations, something impossible to do in print, would be a plus for her in an online annotation environment. Participant 7 commented that it was very easy to come back to a particular annotation using the browser search function, yet another function that would be impossible in a printed text.

In a shared environment, participants find that the ability of *in situ* online discussions and sharing annotations selectively with different audiences would facilitate interaction between annotation writers and annotation readers more effectively. For example, Participant 8 pointed out that *in situ* discussion is like a “workgroup function.” In a classroom discussion task, if a reader is working with somebody else on a paper, they can have a conversation through the *in situ* annotations. Participant 10, who used to be a teacher, suggested that the *in situ* discussions in classroom use would allow her students to respond to the annotations immediately online, and save time by not having to bring them together for classroom discussion. Students could look at online annotations immediately and give her feedback right away, whether they understood it or not. These findings indicate that participants perceive that *in situ* online annotations would allow them to accomplish their tasks more quickly, and the search function would speed up finding related information.

## 2. “Using online annotation would **improve my performance in reading online**”

Table 4.21 “Value” and “Difficulty” reasons related to improve the performance in reading online

Value Reasons	Total Value Episodes	Difficulty Reasons	Total Difficulty Episodes
Helpful to focus the attention in future reading	7	Annotated texts distracting the reader	10
Ability to turn annotations selectively on/off and share with different audiences	2	-	0
Marginal notes provides the context	1	-	0

Using online annotation would improve the reader’s performance in the second or succeeding readings online as the findings suggest in the “value” episodes and the “difficulty” episodes. For example, Participant 1 stated that having annotation in the margin to focus the attention in a future reading is useful because it resembles the way she would do it in print. She would usually use the margin of the print paper to write down her annotations, and it was useful that the online version retained the advantages of its print counterpart. She felt that the marginal annotations somehow provided context that may improve her reading.

If a reader has a long article to read, the reading task as well as the purpose of the reading would affect the reader’s performance in reading and annotating online. In the first reading, without a clear sense of the concept, the reader is likely to highlight a lot more than on the second or third reading. For example, Participant 8 pointed out that she usually read naively and looked at key concepts on a first read. Highlighting those key points would help her to focus on what she may want to read in succeeding readings. When she comes back to the article, she would know what she wanted to concentrate on.

However, participants also commented that different reading purposes might have a negative effect on using annotations to focus one's attention, and would not improve the reader’s

performance in their succeeding readings online. For example, Participant 11 expressed the view that sometimes she would read the same article for a different purpose, and the highlightings made previously would be distracting. The ability to turn online annotations on and off, maybe even by section, would be useful for her. When she wants to see the annotations as she reads through the article again, she might choose to see them all or selectively. The reading purpose is also considered useful in a shared environment. Participant 5 pointed out that the ability to color-code and categorize the annotations for sharing with different audiences and the ability to share annotations selectively for different purposes would be useful. When she comes back to read the article again, she can focus specifically on those annotations that have answered her questions or provided additional sources from someone she knows, or otherwise from someone unknown.

Previous research by Schraefel et al. (2002, p.175) indicated that annotating the document *in situ* does not interrupt the flow of reading, minimizing “forced divided attention.” However, in this research, protocol evidence found in the “difficulty” episodes shows that participants feel that the *in situ* online annotations may distract their performance in reading online. For example, Participant 9 usually doesn’t write anything or take notes when reading, because she finds that writing annotations distracts her reading. For some participants, *in situ* annotations added too much additional text, distracting their reading of narrative flow. Participant 14 said that it made it harder for him to understand the article by reading it fully, because he felt compelled to try to understand those side notes. Especially early on, when he was getting into the main ideas of the article, he was reading the annotations and the text at the same time. He had to piece together too many bits of information, which was strenuous to the reading, before he became familiar with the article. The responses were mixed; some

participants felt annotations may improve their reading performance, while others felt annotations may distract them.

### 3. “Using online annotations in my reading online would **increase my productivity**”

Table 4.22 “Value” and “Difficulty” reasons related to increase my productivity in reading online

Value Reasons	Total Value Episodes	Difficulty Reasons	Total Difficulty Episodes
Consistent labeling to connect topics	10	Having difficulty to choose linktype	13
A workspace for editing notes and linking articles	10	-	0
Layering annotations vary by purposes	9	-	0
Make later writing faster	2	-	0

Productivity is the rate at which annotations are produced when reading. Increase in productivity is observed in the following categories: “consistent labeling to connect topics,” “a workspace for editing notes and linking articles,” “layering annotations vary by purposes,” and “make later writing faster” in the value episodes. These categories fit the “write now, organize later” activity (Seyer, 1991). First, when reading along the text, participants find that consistently labeling text is useful to accelerate connecting related topics. Secondly, online annotation enables the reader to write thoughts inspired by what they are reading instantly without leaving the current space. Each time the reader’s understanding progresses, and so the annotations may present the layered understanding of every reading. Thirdly, it is a separate workspace that will further bind the reading and writing processes. Lastly, in this regard the workspace is viewed as facilitating the compositional purpose of scholarly work, which will make later writing faster.

In this study, it is observed that participants often use linktypes to tag items within the article they are reading rather than to describe hypertext link relationships. One thing

participants look for is quotable quotes, i.e., things that they can imagine putting into a paper. For example, Participant 8 pointed out that the ability to collocate those annotations using consistent labels was very handy. Readers could then perform the collocation function and group multiple instances where they put labels, such as “Context,” to certain passages. Similar to using subject headings within a document to find patterns, readers may, in succeeding readings, think about how they will structure and use these ideas.

Online annotations could then be pushed to a separate workspace for editing a paper as several participants thought useful. In some ways, the labels mark the structure of the paper using the annotations as the headings and subheading of the paper. Participant 7 also pointed out that the idea of “write now, organize later” has been a very successful strategy for organizing his thoughts into an essay. Participant 8 commented that using the collocation function, she could call up everything she identified as related to a particular section to a separate workspace. This separate workspace would allow her to collect and organize all the quotes and articles for an essay or a paper through the annotation system and through the linking system, and translate it into a word processor document at a much later time. She would be inclined to spend more time going through the workspace, and actually doing the writing through the annotations. In these perspectives, using online annotation is thought to increase their productivity because it would make later writing work faster. For example, Participant 10 pointed out that it would be a useful tool if one could read and write annotations at first, come back to the workspace with online annotations with the intent to write a paper, and know that “these are the things I want from the article”.

However, choosing the right label isn’t always an easy task, as shown by the evidence found in the coding results from “difficulty” episodes. Sometimes the relationship the reader

wants is vague, and the default ones seem too specific. The difficulty in choosing the right label is demonstrated by several participants. Participant 1 felt that examining the long list (26 linktypes) consumed too much of her time, so she opted to use her own annotation rather than to choose an appropriate linktype. Participant 8 pointed out the purpose of the labeling: that it indicated the function of the paragraph as opposed to its content. For example, the word “Background” or “Summary” classifies what type of argument it is, not what it is summarizing. The fact that online annotation increases productivity conforms to the “write now, organize later” activity (Seyer, 1991), but the difficulty lies in choosing the right label.

#### 4. “Using online annotations would **enhance my effectiveness on reading** online“

Table 4.23 “Value” and “Difficulty” reasons related to enhance the effectiveness on reading online

Value Reasons	Total Value Episodes	Difficulty Reasons	Total Difficulty Episodes
Insightful comments helps the readers understanding the text	10	Annotation contents are not evident to the readers	19
Useful passages to other readers	7	Credibility or trustworthiness of Annotations to the readers	9
Annotation support online reading engagement	3	-	0
Multi-colors for different topical schemes	5	-	0

This question addresses the capability of using online annotations to produce the intended results of having a striking effect on reading online. Some participants thought that annotations such as insightful comments and useful passages would engage the readers in reading and help the readers better understand the text. Others suggested highlighting different topical themes in multiple colors would help draw attention to the themes. Participants pointed out that after they had a fairly good understanding of the article, they would look for those insightful comments indicating what the article lacks, nuances others have picked up, or other reactions to the text.

Some participants said that they would only want to see insightful comments made by others, which would have a positive effect on their reading and understanding of the text. For the same reason, they would also want to share with others only useful annotations. For example, as Participant 7 pointed out, an online annotation system actually helps one's own growth of understanding. One can learn a lot from the ways others approach one's writing, one's thinking, and even one's readings.

Protocol evidence found in the value episodes shows that annotations support online reading engagement. For example, Participant 14 pointed out that he would absolutely use highlighting and note-making when reading online. He saw that there was an addictive quality to it, and it helped on-screen reading because it provided interactive engagement that helped to draw him into the text. Having different colors of highlighting is also useful for effective reading online. Participant 7 indicated the use of multi-color highlighting captures concepts for comparison, and Participant 5 suggested that yellow highlighting can be used on a first reading, and a different color on the second reading for some of the more important sentences or phrases, so that they can be easily identified later.

However, protocol evidence found in the "difficulty" episodes shows that annotations whose meanings are not clear to annotation readers would have a negative effect on reading engagement. Participants commented that a lot of the annotations seemed to be made for the annotation writers' own understanding. While it is clear to the annotation reader that the annotations mean something to the annotation writers themselves, the annotations do not stand out or mean anything to the annotation reader. It also may not make as much sense to the annotation writer him/herself if the annotation writer looks at the annotations a week later.



Participants responded that this kind of annotation was not really meant to be helpful to other people, and may just confuse them.

In addition, the credibility or trustworthiness of annotations is always of great concern to the readers and has an effect on reading engagement. Participants pointed out that it was very easy to misconstrue information when reading something on the screen, in which there were no verbal cues and the authors were unknown. Annotation writers may come from very different backgrounds, and much trust is involved in using others' online annotations. For example, Participant 15 commented that if Ted Nelson had written an annotation on one of these articles, he might find it very useful, or at least interesting; whereas if some unknown person wrote an annotation, it may still be interesting, but it may not be as useful to him because he did not know the background of the individual writing the annotation.

Participant 8 also commented that if it were an environment in which the annotation was seen as part of an intellectual exercise of sharing the document on the web, she wouldn't want to share annotations with her name attached to them, when they were simply place markers. If she were going to be known as the author of those annotations, the only kinds of annotation she would share would be those in which she made a counter-argument or an example or an elaboration that she thought would deepen the author's argument and would be beneficial to other readers of the text.

If the annotation writer's name is not revealed, how might the use of online annotations affect the engagement of reading online? Some participants suggested that an annotation should achieve some threshold before being shown in a public space. In addition, in terms of any value being indicated by the volume of the annotations, heavily annotation of articles might mean that

they are more important. An approach like that of Google, in which the importance of a page is ranked by counting the number of links to it, could be utilized for sharing in a calculated way. Instead of inspecting the quality of each individual annotation, the system could keep track of the heaviest link or annotation traffic. The evidence found in the “value” episodes indicates that whether in a personal or shared environment, aggregation of annotation attracts annotation readers’ focus when reading online.

##### 5. “Using online annotations would **make it easier to do my reading online**”

Table 4.24 “Value” and “Difficulty” reasons related to make reading online easier

Value Reasons	Total Value Episodes	Difficulty Reasons	Total Difficulty Episodes
Toggle off annotations	4	Annotated texts distracting the reader	10
Recapitulation to signal text processing	4	Cognitive load for creating linking	12
-	0	Disorientation caused by linking	11
-	0	Too much information make it hard to read from screen	2

The usefulness of annotations, i.e., insightful comments or useful passages, may enhance the reader’s effectiveness when reading online. On the other hand, would the personal or public annotations existing on-screen make it easier to read online? The findings show that more episodes are found in the difficulty episodes than the value episodes.

Protocol evidence found in the value episodes suggests that the ability to toggle annotations on/off is perceived as important for making reading online easier. Participants commented that it was absolutely critical that the readers could turn the annotations off very quickly and easily, perhaps in one single-click. It would also be important to have the annotations turned off by default. Participant 4 suggested being shown a clean copy first,

something which print readers could not do once the paper had been written on. “That is the value of online annotation,” she said. She would prefer to come to an article with fresh eyes, without being influenced by the annotations. In succeeding readings, she would make better sense of those annotations. Participant 14 also pointed out that it would be useful if he were able to turn individual annotations off, as well as to turn them all off globally, and to turn them back on at some point.

In addition, some participants are accustomed to extracting key points when reading, and write a note repeating a segment of text verbatim. This act of recapitulation serves as an index signaling a return to what the reader has previously been reading. It is also a method of reinforcing the idea that helps the readers to summarize the article and allows the reader to make a stronger connection to the text. The participants reflected that recapitulation would make reading online easier because it would reduce the amount of text from the original text.

However, much evidence found in the “difficulty” episodes shows that using annotations does not make reading online easier. The participants responded that reading others’ annotations may cause cognitive overload, and one may want to read an article without seeing anyone else’s annotations. For some participants, annotations on the screen were distracting because they added additional text, and it would become even more overwhelming and messy if the system automatically added others’ annotations to their own. They also commented that personal annotations made previously did not necessarily reflect the annotation writers’ current thinking, just what they did think at one point. The participants also noted that there may be some annotations that the annotation reader would neither want to delete nor wish to see.

In addition, for some people, reading from the screen is just not a habit. For example, Participant 14 said that he was less likely to be able to stick with reading full paragraphs for a long time, and he would tend to jump more quickly after reading a part of a line. Participant 9 commented that she normally wouldn't read articles from the screen because it was hard for her to concentrate.

Furthermore, protocol evidence indicates that the use of the linking component creates cognitive overhead and disorientation and does not make reading online easier. Some participants had some difficulty, largely due to the lack of an appropriate mental model of the linking function. Even though participants had an understanding of the idea of hypertext, and had actually been reading about it during the course of the session, they still had no clear idea of how linking works in the larger context of use. For example, Participant 2 reflected that in order to create a link it would take her a while to fully bring the two ideas together in her mind, and then she would need to remember the location of the target paragraph, as well as the steps in applying a link. Several participants expressed difficulty in remembering to click the asterisk first in order to make a link. Linking was not something that they were able to do very often.

A more specific design issue of the linking component is the manner in which the linked node is presented to the reader. When a link is engaged, the current prototype returns the target node to the same browser window, displacing the anchor node. Both observation and verbal protocols indicate disorientation on the part of participants when the target node replaces the anchor node. Typically, participants expect the target node to appear in a separate window so that the original text remains on the screen with the anchor text. This sense of physical relationship (the side-by-sidenedness) appears important in sustaining the context created by the link itself. The points of departure and arrival (Landow, 1989) are important rhetorically and

semantically, and having each point proximally represented appears efficacious in this context of use. Concerning context, it is also noted that the signaling of arrival carries additional responsibility in orienting the reader to what they are seeing once it arrives. The findings show that it is obvious that distraction is the major reason that people think online annotations is not making reading online easier.

#### 6. “I would find online annotations **useful for reading online**”

Table 4.25 “Value” and “Difficulty” reasons related to annotations are useful for reading online

Value Reasons	Total Value Episodes	Difficulty Reasons	Total Difficulty Episodes
Ability to link related external resources	21	-	0
Ability to link within a paper	1	Inability to direct the linking target at the highlighted passage	2
Ability of two-way links	1	-	0
Ability to preview the target’s citation information	3	Tool-tip window blocks reading flow	1

Although the linking component creates cognitive overhead and disorientation and hence does not make reading online easier, protocol evidence still indicates advantages of linking related external resources. The ability to link related external resources is perceived to be relatively useful for reading online, because linking provides additional information that the reader may want to know. For example, Participant 10 suggested that when readers return to read an article later, they would notice the link and navigate to the next article to get all the information they need for that particular point.

Participants favored the linking feature because they could not do that in print. For example, Participant 1 pointed out that usually, when she read many printed articles and wished to draw connections between them, she would use color stickers to signal the connections of

certain points or themes. However, in this manual linking method, she would have to refer to material by page number, in the hope that she will return to read it again. Participant 7 commented that if he were writing an essay and wanted to tie two points together, it would be difficult for him to remember which articles they came from, and the connection would easily be lost in the pile of papers on his desk. On the other hand, in an online environment, the advantage of linking annotation directly onto text would allow him to capture the connection between articles right from the very start. In a later reading, he would at least have a starting point.

Linking not only signals the connection between two passages, but may also pinpoint the relationship between the two with a linktype, notes, or highlighted passages in the linked texts. It allows the linking of very specific information so that the readers don't have to go hunting for things, and this is perceived as extremely useful to the participants. Some participants expressed the desire to be able to link to all the articles available on the Web, so they could navigate from one article to another, since it would be very useful for them to find related sentences or related ideas. The characteristic of showing connections between two pieces of information is also perceived to be useful in a shared environment as previously discussed in Research Question 3.

Creating a link demands, at least conceptually, a certain understanding of the content items at both ends of the link. Although link creation is accomplished through a relatively straightforward procedure, the overall ease of use is likely compounded by relative unfamiliarity. Some "wish to have" improvements are found both in the "value" and "difficulty" episodes. For example, an enhanced feature, such as the ability to link within the document as opposed to jumping between documents, is thought to be helpful, and so is the ability to make two-way links by selecting a primary and a secondary article.

However, the linking component must undergo some improvements in order to reduce the readers' cognitive load and disorientation in creating and using links. To overcome the cognitive overhead and disorientation problems of linking, Participant 15 anticipated having some kind of descriptive information on the target end such as what that article is, who is talking, or some general identifying information. Participant 12 raised the same issue, and brought up an example from the popular technology-related social media website, Slashdot:

[1:36:45] Like on Slashdot, if someone puts a Web address into a Slashdot, next to the link it tells you the domain that link goes to. I realized that it was actually really useful, because it gives you a little preview of where you are going. (Participant 12)

Nonetheless, an important design issue, in relation to reading online, would have to be addressed.

Participant 12 further elaborated on this issue:

[1:38:00] When you roll over a link it brings up a little preview in a pop-up window of the actual Webpage, it is miniaturized, but you sort of get a preview of what it's like if you go there, which creates a more coherent browsing experience. It also bugs me to have things pop up unexpectedly, especially when it blocks something I'm reading. I don't like that at all. But if it were something like this, on the side, there's a little area where something pops up, that would be okay. (Participant 12)

The findings indicate that the participants particularly favored the linking components when judging online annotation for its usefulness for reading online. It must take advantage of the hypertext capabilities to link related information and provide some descriptive information about the link relationship.

#### 7. “**Learning to operate online annotation** would be easy for me”

Table 4.26 “Value” and “Difficulty” reasons related to the learning of annotating online would be easy for the readers

Value Reasons	Total Value Episodes	Difficulty Reasons	Total Difficulty Episodes
Tool-tips help	1	Learning curve of using annotation tool system	7

Annotation is a common activity in the print environment; however, annotating online requires resources and additional skills. In this study, the participants expressed favorable views on the ease with which the annotation prototype works. It is easy to use the mouse to highlight the text and click on the yellow bar to start creating annotations. As Participant 14 pointed out, once one learns the annotation method, it becomes easy to highlight and make notes. In the main study, participants showed that they had some ease-of-use issues in using the linking components of the actual implementation as previously discussed. However, participants also commented that readers needed to practice enough to become efficient at annotating online. Unless annotating online is often practiced, occasional or casual users may not be able to instantly remember everything about operating the annotation features.

Several participants had some difficulty in creating online annotations. Some participants were able to quickly figure out how it worked -- and if it did not work as they wanted, they usually got around the difficulty with their own way of creating annotations -- but there was still a learning curve. Other participants did not easily operate the annotation features, and they wished to have an online help function to reduce the difficulty in annotating online. For example, Participant 4 suggested a tool-tip function or a pop-up window to explain how linking works. Upon failing to create an annotation once or twice, Participant 5 also suggested that a help information bubble, similar to the Microsoft Agent, should appear with the correct steps. The findings show that it may be easy to pick up how to operate annotation online immediately after some training; however, sufficient practice is required to “learn” the operation and become efficient.



8. “I would find it easy to get online annotation tool to **do what I want it to do**”

Table 4.27 “Value” and “Difficulty” reasons related to online annotation tool can do what the readers want it to do

Value Reasons	Total Value Episodes	Difficulty Reasons	Total Difficulty Episodes
Easy to edit annotations	5	System limitation on undo	1
Easy to differentiate public annotations from private	4	-	0
Easy to share annotations selectively with different audiences	2	-	0

With regard to getting the online annotation tool to do what the user wants it to do, perhaps the ease of editing annotations of the prototype is the most favored feature of annotating online. Protocol evidence found in the “value” episodes shows that participants value how easy it is to use backspace instead of scratching things out, which is what they would have done if they were doing annotations on paper. If an annotation is no longer needed the reader would be able to easily delete it, which is often impossible to do on paper. They also like the ability to go back and change or even refine the notes to make full sentences out of dangling phrases, which would often be impossible on paper as well. However, without an Undo button, the tool is not satisfactory for editing, in case of deleting an annotation accidentally.

In a shared environment, participants anticipate the ability to differentiate public annotations from personal annotations, as well as the ability to share annotations selectively with different audiences. These are some features online annotation tools might support, whereas paper could not. In this regard, for example, the participants expressed the desire for the ability to save two versions of online annotations, one with their personal annotations and another for sharing, or to use different colors of highlighting to differentiate personal, group(s), and public annotation. The findings indicate that online annotation systems have some superior functionalities when compared to its paper counterpart. Functionalities such as the easy editing

of annotations, the ease of separating the ownership of annotations, and the ability to share annotations selectively with different audiences are seen as useful.

9. “I would find online annotation to be flexible **to interact** with”

Table 4.28 “Value” and “Difficulty” reasons related to the interaction flexibility of online annotation

Value Reasons	Total Value Episodes	Difficulty Reasons	Total Difficulty Episodes
Graphical tools will provide the flexibility to draw	5	System limitation of annotating graphics	1
-	0	System limitation of highlighting length	5
-	0	System limitation of note-making	5
-	0	Ability to write longer notes	1
-	0	System limitation of adding new linktype	1
-	0	System limitation of linking	3
-	0	Can't draw arrows to connect topics	7

The participants expressed the view that online annotation had functionalities that could do what they wanted it to do, as previously discussed, but this did not mean that they found online annotation to be flexible enough to interact with. In this section, protocol evidence is found in the “difficulty” episodes indicating that the flexibility of interaction in annotating online is limited by system features. These limitations cannot be changed easily and adapted to different conditions and circumstances as they occur. They require additional programming to make the interaction possible. For example, Participant 8 felt that limiting the length of highlighting was a bad idea, since she tended to highlight a lot early on, when much information seemed relevant. The limitation on highlighting length appeared to her quite arbitrary.

Although readers may find online annotations easier to edit than paper, they may also wish to have more flexibility in editing longer notes. Rather than having the content of a long

note all in one long paragraph, they want to be able to press carriage return within the note, or at least be able to separate out multiple points. If an annotation becomes too long, they do not want the note area covering the text, and there ought to be a maximum window size with a scroll bar to make reading and writing online easier. For example, Participant 5 complained that she could not use the Enter key or the Tab key in the note-writing space; Participant 15 also complained about long notes being limited to one large paragraph -- if an annotation contained more than one idea, he would like to be able to at least separate out the points, rather than having them all in “one big blob”.

Annotating an image is no different from annotating text on paper, but the ability to annotate images is limited by the system features available when annotating online. This feature is not widely supported in existing annotation tools, and only some image-based digital libraries (Agosti et al., 2006; Bradley, 2008) implement spatial hypertext programming to implement annotation of images.

Furthermore, some participants expressed a desire for the flexibility of one-to-many linking when annotating online. For example, Participant 9 commented that when she read from the screen, relying on the software, she would anticipate the ability to choose all linked paragraphs from all the articles that link to a particular point and put them in the margin, so that the readers could read only the linked paragraphs related to the point. In addition, Participant 11 suggested that the ability to go from one to many would have an additive value where readers could link different passages in other documents and acquire a stronger sense for a particular term or concept.

Linking or creating one-to-many linking without the ability of bi-directional linking also limits the flexibility of interaction. In the way linking is set up in the ANNOLINK prototype, one has to identify a primary article, which will have the asterisk on it. The only way one can get around this is by making two different links, one going one way and the other returning. Readers do not have the ability to make a two-way path. For example, Participant 15 wanted to make a connection between the mention of Theodore Nelson in the Landow article and the mention of Nelson in the Vora article, but he could not make a double-legged link -- an active link that could be pressed on from both articles, taking one to the other. In addition, despite appearing to support the creation of a within-document link, the ANNOLINK prototype could not create a working link of this kind. Participant 4 recalled making a within-document link, but there was no response when she clicked the linking icon later. Then she had trouble remembering where and what she made the link to.

In addition, when creating a link between texts, the reader may want to establish a new linktype to annotate the link rather than to select an existing one from the drop-down list. As Participant 15 pointed out, new linktypes are meant to be functional depending on the purpose of reading each time. The reader might register totally different linktypes depending on what his/her purpose for reading the article is. Having a limited selection of linktypes is seen as another factor affecting the flexibility of interaction.

Perhaps graphical tools are something carried from the paper environment, and this expressed need is found in both value and difficulty episodes. Sometimes an annotation may not necessarily be text; it may be abstract ideas best represented by free-drawn arrows, brackets, or charts using a pen-like feature. For example, Participant 6 pointed out that a lot of her annotations in her studies of linguistics involved charts showing the location in the mouth where

the sound is made. It would be useful if she had a “paint” option for drawing things freely, choosing different colors, and linking drawings with base texts. Another participant found it annoying not being able to draw an arrow between words with the ANNOLINK prototype, because drawing a bracket and an arrow towards a paragraph may explain things in a much different way than hypertext allows.

Graphical tools support would also make it easier to express perspective opinion. For example, Participant 7 commented that “Instead of highlight, I want to put a circle and a check.... But eventually, a purely graphic ability to draw on the screen might be helpful. If I can draw bubbles diagram on the page, which I do, actually, in the printed text, I can manipulate the page from a graphical point of view.” These findings indicate that it takes additional programming to support the flexibility in interaction with online annotation, i.e., it cannot be changed easily.

#### 10. “It would be easy for me to become **skillful** at using online annotation”

Table 4.29 “Value” reasons related to becoming skillfulness at using online annotation

Value Reasons	Total Value Episodes	Difficulty Reasons	Total Difficulty Episodes
Familiarity makes easier to use	6	-	0

To become skillful at using ANNOLINK, the users must have with computer skills, have the knowledge of using ANNOLINK features, be clear in changing task from note-making to linktyping or vice versa, and be able to maintain the mental model when creating linking and continuing with the reading. Participants said that once they had figured out how to use ANNOLINK to create annotations, things began to work better. Sometimes they could not make a feature work, and they would come up with ways to get around that.

For example, the highlighting feature has been designed in a manner that would be familiar to most computer users, i.e., the mouse button is held down and the cursor drawn across the segment to be highlighted. As implemented, the highlighting feature maps well onto what people are already familiar with in paper environments. In addition to the constrained workspace inherent in locating text notes in the margin of the document, participants also bring their skills learned from word-processing and look for greater functionality in the processing of the notes. Participants expressed the desire to edit their notes beyond the rudimentary capability offered by the prototype system including the ability to add bulleted items, the ability to visually differentiate between original notes and additions or emendations (e.g., by color coding), and the ability to search their annotations. More capability in the editing of text annotations is interpreted as a desire to further a more active reading strategy where users can more easily integrate the reading and writing functions.

Participants were keen to “try out” the linking and linktyping capability in early stages, but increasingly relied on the more familiar components (e.g., highlighting and note-making) as the session progressed. For example, Participant 7 experienced trouble in switching from note-making to linktyping in the use of ANNOLINK, and felt that with more practice he would be able to become more proficient in that function. Furthermore, the heavier cognitive load required to create these relationships may have resulted in a certain attenuation in motivation. Perhaps Participant 14 best summarized the efficacy of the linking and linktyping components:

[1:18:26] Yeah, I like that there's only a few tasks. The key ones like highlighting and annotating, by far, are the ones that I would be most frequently doing. And the linking, that's nice, but I wouldn't be doing it as much. And the link typing, I don't know. I don't know if I would do that, to be honest. I really am intrigued by the concept, but I don't know if I would actually do it on a regular basis. But it's worth a whirl, just as something that's there to ... I would find that intriguing as a user to see that that was there, and may eventually, once I gained comfort with the environment, and got the annotating that was part of my regular practice, then eventually I might add on the link typing. But I wouldn't be doing it the first day. Whereas the

highlighting and annotating, absolutely. That would be right in there. That would totally be something I'd be doing. I can see that there's a bit of addictive quality to it, and it helps with on-screen reading because provides some kind of interactive engagement that helps draw me into the text. And that's a good thing. (Participant 14)

Participant 11 said that she could quickly figure out how to use ANNOLINK, but she felt that there was still a learning curve. She did not expect to be able to pick it up a week later and still remember everything. She felt that if she had practiced a few more times, she would probably become more efficient and comfortable with it. The findings show that annotating online is a skill that requires knowledge and practice to learn how to use all the annotation features.

#### 11. "I would find the online annotation tool **easy to use**"

Table 4.30 "Difficulty" reasons related to the readers find the online annotation tool easy to use

Value Reasons	Total Value Episodes	Difficulty Reasons	Total Difficulty Episodes
-	0	Features not visible to users	17
-	0	Tedious system use	1

The survey analysis shows that, in general, participants find the online annotation prototype easy to use, but some improvements are required in the interface design. The findings of the difficulty episodes indicate that the invisibility of some annotation features causes difficulty, and it is one of the major reasons the ease of use needs to be improved. For example, if the participants were not told to click the bar to start annotating, they would look for buttons or try to right click. They anticipate the ability to click and highlight, and then right click to have a list of options familiar to most users of online text, just as readers can do in Word and many other applications. They also would like to minimize the amount of movement back and forth between the bar and the marginal annotations when creating annotations. In addition, participants have perceptual difficulties in distinguishing between highlights that overlap, and in

the inability of the tool to clearly associate marginal notes with corresponding overlapping highlights.

The lack of obvious indication of the completion of the use of a feature is another factor affecting the ease of use. “Click elsewhere in the annotation margin” is an action to end each annotation task of ANNOLINK, and some participants often forget to click elsewhere in the annotation margin to end the note-making task. For example, Participant 5 commented that she always forgot to click elsewhere, and consequently lost some notes. The participants did not get a system message when a note-making action was completed. Ease of use, in a manner, is how easy it is to find the right way to annotate. As Participant 14 said, “it seems like a shame that I would have not realized that, because once you realize it's there, it's really easy.” The invisibility of switching features is also a problem. By design, participants could switch between the note-making and linktyping functions by clicking and changing a minus sign to a plus sign, or vice versa; however, participants sometimes had trouble remembering how to do this.

The invisibility of some linking features also hinders the ease of use of the prototype. Linking relationships described by the linktyping components are sometimes not obvious to the reader. For example, the causation relationship between two passages cannot be clearly presented by a linktype, but is better presented graphically. As on paper, readers may wish to draw an arrow and point to the target passage indicating the relationship is “this causes that,” but the prototype does not have that feature available.

Some participants complained that the activation of some annotation features was tedious. For example, Participant 6 suggested that it would be easier if the amount of movement back and forth on the screen could be minimized. Instead of clicking the yellow bar, she felt that it would



be easier to simply click, highlight, and then make a right click, calling up a list of options to choose from. The findings show that to make a tool easy, efficient and comfortable to use, system features must be made visible, and on-screen movement should be minimized.

#### **4.2.6.6 Summary of Research Question 6**

The results of questionnaires show that the overall opinions of the participants about annotation online are that it is very useful. The participants think positively that online annotation would “improve my performance in reading online,” “enhance my effectiveness on reading online,” “be useful for reading online,” and “allow me to become skillful at using it with practices.” However, in order for them to use online annotations in the future, a number of improvements would be required.

Although “using online annotation in my online reading would enable me accomplish tasks more quickly” received less favorable scores from the participants in the Perceived Values questionnaires, episode evidence shows that, in fact, the participants think that the improvements in the ability to annotate online, to search annotations, and support *in situ* discussions would be useful to accomplish their active reading task more quickly.

In terms of “using online annotations in my reading online would increase my productivity” the participants would like to use the linktypes to consistently label the annotation. On the other hand, their difficulty in choosing the appropriate linktype slowed down their reading and annotating.

Many improvements need to be made to satisfy participants that “using online annotations would make it easier to do my reading online.” For example, annotated texts should

not distract the reading flow, and the disorientation and cognitive load caused by linking should be minimized. In addition to the system limitations on annotating graphics, highlighting length, note-making and note length, linking, and adding new linktypes, the lack of graphical tools (for drawing arrows, for example) is among the major issues affecting the flexibility of annotating online.

There is a learning curve in using the annotation tool system, and tool-tips and a help function should be provided to make learning to annotate online easier. The participants perceive the ease of use in being able to edit annotations whenever they want to, but they demand the Undo feature. In a shared environment, they think that it should be easy to get the online annotation tool to share annotations selectively with different audiences and to differentiate public annotations from private ones. Finally, to make the online annotation tool easy to use, the features must be visible to users to minimize system misuse caused by unfamiliarity, and must avoid tedious movements in using a system tool.

### **4.3 Summary of Chapter 4**

This chapter reports the findings from the main study (user protocol and interview transcripts) and supplementary information (post-session questionnaire and perceived value questionnaire), and analyzes the data according to the six research questions. In Research Question 1, Marshall's form-function mapping is applied as a framework to analyze the annotations remaining on the screen, and to reconstruct online annotation forms to Marshall's functions mapping. The mapping results show some variations from Marshall's studies. It is conjectured that annotation content and annotative circumstances need to be examined to reconstruct the functions in the digital environment.

In Research Question 2, annotation content and protocol transcripts are examined to reconstruct the functions in annotation online. The results show that similar forms are sometimes used to implement different functions, and different forms are sometimes used to implement similar functions. It is conjectured that the forms may not truly represent their functions. In addition, forms are associated with the location of the text passages they cue, from which they may manifest different functions.

In Research Question 3, “Linking” as a marking of text structure allowing certain types of text entities to be linked, and the intended functions are investigated. The results show that links signal the connection of different text patterns that reflect specific kinds of relationship. “Linking Only” and “Linktyping Only” were found to have individual sub-functions in addition to the proposed “Linking Ideas Meaningfully.” When used with a linktype or a note, Linking components may reflect multiple functions describing the relationship between text items.

In Research Question 4, other forms that online annotation might support are explored in the main study. The findings show that the participants’ “wished-for forms” closely resemble their counterparts in print. The findings indicate that to explore more innovative forms by taking the advantage of computer and network capabilities, it requires information other than the main study can support.

Research Question 5 explores whether function and form vary by role, using data from the main study. The findings show that participant preferences in the usefulness of the forms and functions vary by roles, and there are different characteristics in sharing annotation with group or public. In addition, those social forms mentioned in the “wished-for forms” may

manifest additional functions. It is conjectured that, in a share-enabled environment such as online environment, some annotation forms and function may vary by role.

Lastly, Research Question 6 attempts to investigate the perceived values of annotation online. The Perceived Values of Online Annotation questionnaire analysis shows that the overall opinions of the participants think online annotation is very useful. The more opinionated participants favor the usefulness of online annotation in their reading online and with practice it would become easier for them to use online annotation. In order for them to use online annotations in the future, a number of improvements are required. The episode analysis uses the Perceived Values questions to assess various reasons that account for the acceptance of annotating online.

## 5 DISCUSSION

### 5.1 Introduction

This chapter provides a discussion of the main study findings by utilizing the results of a review of existing annotation tools, and a review of the larger annotation literature for comparing and contrasting the findings of the main study. The discussions are arranged according to the six research questions. Each recapitulation (shown in bold) describes the major observations (results) in the main study, where the recapitulations are also supplemented with evidence found in existing research or applications that show or exemplify the finding results. Taken together, these findings improve understanding of multiple phenomena of annotation in the digital environment (the form-, function-, role-, and value-dimensions of online annotation).

The discussions presented in this chapter provide an explanation from three different perspectives. First, the findings of forms as “Manifest” content (annotations remaining on the screen) are grounded in the theory of signaling. Second, in this study an Annotation Functions Typology is applied to articulate annotation functions in a structural way. This Annotation Functions Typology describes the relationships among the annotation functions and divides the annotation functions into different concepts. When applying this typology in interpreting the coding findings, it is noted that at the concept level of the typology the annotation functions differ in different reading tasks. That is, the annotation functions in the general reading task indicate “To Remember” and “To Clarify” concepts, and in the directed reading tasks also indicate more instances of the “To Think” concept in addition to those instances of the “To Remember” and “To Clarify” concepts. Furthermore, this typology also represents forms and functions in terms of how they reflect the computer network capability in annotation online.

Lastly, when annotating online the annotation writers must use a system tool. The author and reader roles converge, where the reader becomes an author writing annotations and the author becomes a reader using the annotations at the same time. Overall, ease of use is constantly an issue to annotation writers when annotating online, and usefulness of annotation is also a major concern to readers. Hence, the perceived values of online annotation are also discussed from the author-reader perspective.

## **5.2 Discussion of Research Questions**

### **5.2.1 Research Question 1**

**Do the same annotation functions in the print environment also exist in a digital environment?**

This section discusses the results found in Chapter 4 to set up the research context for the rest of the research questions. There is no new evidence introduced in this section. Statements of major observations (results) based on the main study are presented in bold as a recapitulation. The approach in the following section presents discussions of the findings of the examination of “online annotations remaining on the screen” to verify whether the same annotation forms Marshall defined (1997) exist in the digital environment.

#### **5.2.1.1 Discussion of Online Annotation Forms**

**Not all forms mapped directly onto the form typology of Marshall. Similar forms in the electronic system may actually manifest different functions. Furthermore, there were forms in the electronic annotation system that had no equivalent in the paper-based annotations studied by Marshall.**

The results found in Section 4.2.1 show that there are mapping differences of forms from Marshall's categories due to the ANNOLINK prototype's lack of support of certain forms mentioned by Marshall (1997). For example, forms such as free drawing forms (cross-outs, circles, drawings, and doodlings) found by Marshall are not supported by the ANNOLINK prototype. Other differences point to the limitations of the system features of annotation tools, e.g., the length of characters or words that can be highlighted or entered into a note. In addition, online annotation forms such as Links and Linktypes should not be categorized as static telegraphic marginal symbols and appropriate notations in margin as in the paper world (Marshall, 1997), which do not reflect the capability of hyperlinking. In general, online annotation forms are the features supported by systems. Online annotation forms such as mouse highlighting, linking, and linktyping have no similar mechanism available in the paper world. It is conjectured that other online annotation forms may exist due to the design features available in an electronic environment.

The annotations created by the participants as pieces of "evidence on the screen" were the results of applying the online annotation form-function mapping (see Table 4.2, p. 77). Based on only the evidence from the screen captures and logs, 492 separate annotation instances were observed. The investigator of this study compared these forms with Marshall's forms by "naked-eye" examination and interpreted these forms in terms of the forms closest to Marshall's definition. It was clear from analysis of the observations that not all forms could map directly onto the form typology of Marshall. In fact, similar forms in the electronic system may actually manifest different functions. Furthermore, there were forms in the electronic annotation system that had no equivalent in the paper-based annotations studied by Marshall. The mapping of online annotation forms directly onto Marshall's form-function mapping is not sufficient due to

the changeable electronic environment. Some forms, depending on system features supported, may not accurately manifest the functions (Marshall, 1997) they were mapped onto. For example:

- Short notes require looking into the content to differentiate “Recording Interpretation” from “Incidental Reflection”; short notes to remind the reader to return should be categorized as “Procedural Signaling”;
- Long notes in the margins may not just represent “Recording Interpretation”.
- Short highlighting may be an alternative way of extended highlighting as “Tracing Progress through Difficult Narrative” due to the change to an electronic environment. For example, due to the system limitation on the number of consecutive highlighted characters supported by the ANNOLINK prototype, participants used short highlighting instead.
- Extended highlighting may not represent “Tracing Progress through Difficult Narrative.” Extended highlighting on whole paragraphs or citations may represent “Place-marking” or “Procedural Signaling” instead.
- Linking, as a form, may manifest other functions. Linking and Linktyping may represent other functions because the capability of hyperlinking and the semantic description of the linking relationship are not manifested. The functions of Linking and Linking will be discussed in Research Question 3.



### **5.2.1.2 Discussion of Online Annotation Functions**

**To reconstruct the functions from online annotation, annotation content and annotative circumstances need to be examined.**

The results found in Section 4.2.1 show that some online annotation forms do manifest the same functions as Marshall defined in a digital environment. The findings also show different functions may be manifested from similar annotation forms, and the same function may be manifested through different forms. Furthermore, other functions may exist. The findings indicate that to reconstruct the functions from online annotation, annotation content and annotative circumstances need to be examined. For example, short notes of “need to return” are signaling “procedural Signaling”. When reading online, mouse highlighting may be a way to trace progress through difficult narratives, and is not captured by the system, only observable in the screen recordings. Mouse highlighting (i.e., holding down the mouse button and drawing the cursor across the segment to be highlighted) is often used to trace progress through passages manifesting the “Tracing Progress through Difficult Narrative” function. However, mouse highlighting is a transient form in a digital environment, when the mouse pressing is released.

### **5.2.1.3 Summary of Research Question 1**

This section discusses the results found in Chapter 4 to set up the research context for the rest of the research questions. The results show that there is no exact mapping because the functionality available in a digital environment is not exactly the same. Online annotation forms vary due to the change of electronic environment. For example, differences of online annotation forms are due to the available system features, the limitation of a form, as well as the way users employing the limited resources of ANNOLINK to do things that would have been done

differently if the proper tool were available. Functions manifested through online annotation forms may vary. It is not sufficient to reconstruct functions by simply looking at the online forms, because some forms may not accurately manifest the functions they were mapped onto due to the change to electronic environment. To reconstruct the functions in online annotation, annotation content and annotative circumstances need to be examined.

## 5.2.2 Research Question 2

**Are the functions manifested through similar forms? If not, how were different forms used to implement functions?**

Research Question 2 is based upon an analysis of the “manifest” content of annotations as well as on the “latent” content of the protocol transcripts. The goal of the analysis is to determine whether the form/function relationship differed between the paper-based annotations in Marshall’s study and the annotations created by users with ANNOLINK. The approach is to conduct a text-based analysis based on the theory of text signaling to discuss the findings in the “manifest” content (annotation forms and content). The “manifest” content is what appears to the annotation reader while reading the annotation, and it is intended to guide the annotation reader’s text processing. From this perspective, it is closely related to signaled information affecting text processing<sup>16</sup> (Lemarie et al. 2008). Some annotation forms (e.g., annotation notes using content keywords, i.e., recapitulation) function similarly to signaling devices (e.g., headings, enumeration, etc.) as proposed in previous research (Lorch & Chen, 1986; Lorch, 1989). These forms manifest the information functions as defined in theory of signaling (Lemarie et al., 2008) to communicate the text structure to readers.

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<sup>16</sup> In the education psychology field, “text processing” is related to how readers construct a coherent representation of a text as they read and how that representation influences what they recall from a text (Lorch & Lorch (1995) and Meyer (1975) (cited in Ritchy, Schuster, & Allen, 2008, p.859)).

Furthermore, to differentiate the original forms from variations of these forms, an examination was conducted of: (1) the particular instantiation of form: highlighting, notemaking, linking, and linktyping; (2) the relative location of the cued content (highlighting on heading, in paragraph, etc.); (3) kinds of text entities (heading, name, year, keyword, etc.); and (4) the annotation content were investigated. When the “manifest” content of annotations did not sufficiently support the analysis and discussion, the screen recordings and verbal protocols were examined to determine the “latent” meaning arising from the participants’ intention in creating such annotations.

#### **5.2.2.1 Discussion of Whether Functions Are Manifested through Similar Forms**

**“Incidental Reflection”, as a function, cannot be solely identified from its manifestation as a particular form without considering the content of the annotation itself. The content may be personal reflections inspired by the texts. But, the potential of sharing annotations in a digital environment may cause the user to reflect not on the text but on the use of the text, e.g., sharing with a collaborator.**

In Chapter 4 it was observed that “Incidental Reflection” might manifest itself in forms other than those noted by Marshall. Appendix 10 shows that notes implementing the “Incidental Reflection” function include notes that were evoked by the content but largely unrelated to it, or notes that referred to studies similar to the one at hand for the purpose of synthesizing and connecting ideas. Blair (2004) pointed out that annotations in early modern books often included doodles or miscellaneous extraneous material (recipes, poems, family genealogies). Perhaps such annotations signaled associative thinking prompted by the text; alternately, they could have been a pragmatic result of a scarcity of technologies for writing. (When paper is not

available, the margins of the book one is reading must suffice for recording miscellaneous information.)

Furthermore, content may be explicit enough for any reader, but it also can be personal to the degree that only the author understands its relevance or meaning. For personal annotations, these notes may be of a more personal nature. Blair (2004) pointed out while reading along readers engage in a kind of personal dialogue with the text. They often cite lived experience as evidence to relate that described in the text. Hence, the content may be personal reflections inspired by the texts.

However, the results in Chapter 4 also indicate that the potential of sharing annotations in a digital environment may cause the user to reflect not on the text but on the use of the text, e.g., sharing with a collaborator. For example, participants made incidental reflections about applying the materials read to a class project they were working on, notes about inviting other's input regarding thoughts expressed in the notes or about the passage from the text commented upon in the annotation, and notes for reminding the participant to share the text with a friend. The potential of online annotation is to arouse people's attention in noting in order to communicate some additional context to readers, indicating the "To Communicate" concept as identified from previous research (Ames & Naaman, 2007). People are aware that in an online environment, with appropriate devices, it is possible to communicate with an audience via annotation. Thus, "Incidental Reflection" can be expanded to include contextual information such as a collaboration task indicating the role dimension of online annotation. Alternatively, a new function could be created to reflect a new higher order concept of "communication" as identified by Ames and Naaman. (2007).

**The “Place-marking” function is manifested through other forms in addition to short highlightings on main points in texts, including markings representing importance and numerical numberings of main points. These forms are used to distinguish levels of importance in text and also to aid in the recollection of main ideas.**

As discussed in Chapter 4, the “Place-marking” function is manifested in short highlightings, markings, and numerical numberings. Short highlightings are found in a random mix of the trivial and the significant, e.g., on names, years, and diagrams captions, keywords, phrases. Some words or passages are more important, more striking, or more relevant than others are, depending on the goals and expectations that one brings to the text. Highlighting keywords and phrases tends to signal relatively local scope in contrast to highlighting headings that have a more global scope (Lemarie et al., 2008). Johnson (1998) found out that highlighting helped students to distinguish between levels of importance in text and to remember main ideas. Nist and Hogrebe (1987) also found that the use of properly highlighted text aided recall.

Highlighted words or phrases, as typographical cues, distinguish the words visually from the rest of the text. As such, they represent or “signal” only an awareness of the words or sentences they distinguish. Short highlightings of names, years, keywords, or phrases are simple enough for the reader to readily record (and later to aid in remembering) the relationship between the cues and the text content (Lorch, 1989). Porter-O’Donnell (2004) indicated annotating is a writing-to-learn strategy for use while reading or rereading. In her study, during the reading process, students were taught to mark instances of who (character), when (setting), where (setting), as well as vocabulary items, and other important information. Furthermore, readers were able to develop a personalized marking system unique to their individual reading habits.

Furthermore, if highlighted words or phrases signal text topics or important arguments or ideas about these topics, the reader may process the gist of the text more efficiently and effectively. Highlighted words or phrases, in a sense, serve as place-marking devices. In turn, it would aid subsequent recall of the signaled information and direct a reader's attention to one potential interpretation of an ambiguous text (Lorch, 1989).

In this study it was found that multiple markings are used to signal an important expression about the texts. Marginal symbols such as stars usually stand for important arguments and question marks for passages that are unclear to this person to help oneself to evaluate the author's techniques and ideas. Previous studies showed that, for example, the asterisk is common to denote importance or key point (Engler & Berger, 2001) to draw attention to a piece of information; exclamation mark to denote excitement, surprise, or shock; and question mark to denote uncertainty or doubt. Other markings, without an established common understanding of the meanings they represent, may gesture toward a meaning but rarely articulate it fully to other readers.

Numerically numbering main points are found in the results. Numerical numberings suggest aiding memory for signaled content both by indicating the relevance of the associated content and by providing an explicit statement of the organization of the content. This kind of typographical cue may be used to indirectly signal the structure of a text by careful selection of phrases or sentences to be cued (Lorch, 1989). Numerically numbered main points are called "enumeration devices" as one of the text signaling devices in expository text. Signaling influences readers' text processing strategies (Sanchez, Lorch, & Lorch, 2002). Signaling devices are typically used by the author of an expository text to help readers identify and remember the text's main points (Lorch, 1989). Education psychologists have examined some of

the effects of different signaling devices on reading and memory process, and research findings (Lorch & Chen, 1986; Lorch, 1989) suggest “enumeration devices” cause readers to attend more to the organization of signaled information, with the result that readers have an effective plan for retrieving the signaled information at recall.

The findings show that markings and numerical numberings, the same as short highlightings manifesting the “Place-marking” function, are used to distinguish between levels of importance in text and to remember main ideas, as well as the use of properly highlighted text aided recall.

**“Procedural Signaling” function is not only manifested from highlighting texts at a higher level and telegraphic marginal symbols, but also other forms are found in this study such as notes explicitly expressed to signal attraction for future reading and short notes denoting the meaning of cross-outs.**

The results of the “manifest” content analysis in this study show the “Procedural Signaling” function is manifested from: (1) highlighting texts at a higher level; (2) telegraphic marginal symbols like an asterisk (the Linking icon); (3) short notes and long notes that were used explicitly to signal attraction for future reading (e.g., Need to return); and short notes denoting the meaning of cross-outs.

Highlighting at the higher level such as headings, as signaling to attract attention for reading more closely later, has its root in how signals affect text processing. The difference in the visual appearance of the text reflects the use of a class of writing devices called “signals” (Meyer, 1975). Authors use signaling devices to aid readers in their attempts to follow a text’s organization and to identify important text content. Headings represent main concepts or

indicate some special aspect of the passage below. Headings are spatially closely associated with the text they signal and are often visually distinctive, and these attributes may be more effective in providing access to subordinate content and inducing the readers to attend carefully to the topic structure as they read (Lorch & Lorch, 1995). Headings, as one type of the organizational signals (Lorch & Lorch, 1995), are generally known to signal textual content and thus aid access and search tasks and help readers to find relevant information on the local or “micro” level (Kools, Ruiter, van de Wiel, & Kok, 2008, p.2). Therefore, highlighting at the higher level such as headings is signaling to attract attention for reading more closely later. The findings conformed to Marshall’s definition.

The linking components seek to increase the level of coherence between fragments of journal articles being read and annotated within the system. Participant 15 mentioned that a week later when he revisits the text, after he has forgotten what the text was, the Linking component (i.e., the asterisk icon in ANNOLINK) is signaling a click that would bring him to that other area related to the text. Although the asterisk mark, or any other type of visual cue, is not just a telegraphic marginal symbol, it is conceptually and structurally hypertextual, producing a navigable hypertext link to the target text. Creating a link demands, at least conceptually, a certain understanding of the content items at both ends of the link. Linking requires memory ( Craik & Tulving, 1975) and movement through the articles within the system demands that readers remember where the target information is to create a link to and to recall where the source document is to continue with the reading task. Subsequently, readers become authors by creating functionally meaningful relationships between these fragments.

Furthermore, it would require some consideration of the nature of the relationship between the content items before attributing a linktype. Linktyping enables the identification of



related information (from the perspective of the reader), and the ability to type the relationship (e.g., “illustrates,” “defines,” “generalizes,” “exemplifies,” etc.). Linking and Linktyping together give emphasis to certain aspects of the semantic content or point out aspects of the structure of the content. As a result, Linking and Linktyping help annotation writers organize the information so that they can see links between the main points and supporting details (Nist & Holschuh, 2000). In fact, treating the Linking and Linktyping forms as static annotations and treating them separately may not sufficiently interpret the functions the linking components manifest.

**“Recording Interpretation” function is manifested not only from different forms of notes but also suggests the content has to be examined for identifying the function. In addition, there are more fine-grained sub-functions within the “Recording Interpretation” function.**

Annotating text may include the following components: (1) writing brief summaries, (2) enumerating multiple ideas (e.g., cause-effect relations, characteristics), (3) noting examples, (4) putting information on graphs and charts if appropriate, (5) marking possible test questions, (6) noting confusing ideas, and (7) selectively underlining or highlighting keywords or phrase (Simpson & Nist, 1990, p.123). Porter-O'Donnell (2004) indicated that annotating is a writing-to-learn strategy for use while reading or rereading. In her study, students were taught to mark text passages during the reading, as well as to write in the margins to summarize, make predictions, formulate opinions, make connections, ask questions, analyze the author's craft, write reflections/reactions/comments/, and look for patterns/repetitions (Porter-O'Donnell, 2004). Writing long notes helps readers think about the text they are reading and work out their ideas (Brown, 2007).

Notes made to recapitulate the text are mainly found with respect to the location in the topic sentence in a paragraph in an interesting observation. Recapitulation of the text is a kind of “repetition of content,” such as the exact repetition of a statement for emphasis, and is another text signaling device (Lorch, 1989). In text processing, certain types of preview or summary can help readers consolidate their understanding of difficult textual material. Similarly, in this study, many participants use this strategy to emphasize specific content to attract their attention to the relevance of a text to their needs or the main ideas of the text. For example:

[15:18] And, I did the same thing, I just put a note “constructivist theory of learning” using the exact same language that used in the text. Sometimes I wonder why, write the exact same thing in the margin of the text, but I highlight in the body of the text. But I think when you do that it lets you make a stronger connection to the text, and it’s kind of just a method of reinforcing the idea. (Participant 3)

The results show that different forms manifest the “Recording Interpretation” function and also suggest that content has to be examined to identify the function. In addition, based on Marshall’s definition and the findings in the “Incidental Reflection” section and “Recording Interpretation” section in Chapter 4, there are more fine-grained sub-functions that exist in the “Recording Interpretation” function.

**The “Tracing Progress through Difficult Narrative” function may not be easily identified from extended highlightings in online annotation. The system features of annotation tools and readers’ highlighting habit may restrict the length of extended highlighting. In addition, mouse highlighting may be used for tracing progress through a difficult narrative while reading, which makes the mouse highlighting a transient form that has no similar form in its print counterpart.**

Findings in Chapter 4 show that not all extended highlightings can be categorized as implementing the “Tracing Progress through Difficult Narrative” function. Furthermore, the system features of annotation tools restrict online annotation forms. From the verbal protocols

and screen recordings, it is found that highlighting on the first word of a paragraph is an adapted form of highlighting people use to signal as highlighting the whole paragraph.

It is also observed that the highlighting habits among participants allow them to be categorized as “meager markers” and “happy highlighters” (Golovchinsky & Marshall, 2000). For example, Participant 8, a “happy highlighter,” said she would highlight several paragraphs as her conventional reading behavior. On the other hand, Participant 14, a “meager marker,” mentioned that he seldom used highlighting, and when necessary he would use pencil to underline.

Some annotation functions may be manifested through online annotation forms different from Marshall’s (1997) form-function mapping findings. For example, mouse highlighting (i.e., the mouse button is held down and the cursor drawn across the segment to be highlighted) is often used to trace progress through passages manifesting the “Tracing Progress through Difficult Narrative” function. However, mouse highlighting is a transient form and disappears when the mouse button is released.

**The “Work on Problems” function is manifested from the forms of notes and linktypes. The results show that the content of notes is associated with works from Internet searching or urls, and the linktypes manifest multiple functions depending on how they are used.**

The “Work on Problems” function is manifested not only through making appropriate notations in the margins or near links, but also through working on word definitions, pronunciation, URLs created from the TinyURL site, or any information found by searching on the Internet. This function is also found where the linktypes, used directly with the highlighted texts, were applied to tag definitions, examples, etc. for categorizing the text passages.

The necessity to select an appropriate linktype to describe the relationship forces annotation writers to pay attention to different ways the text affects them. The selected linktypes, whether they describe links or tag highlighted passages, help annotation writers to reconstruct the purpose of the passages when re-reading them, and as a result, making it easy for quickly reviewing material. In the analysis of the verbal protocols, it became evident that participants were using marginal notes during the General Reading task to collocate content for future reference. In other words, Linktypes were used as notes to tag content that could be reviewed thematically later. For example, Participant 8 mentioned:

[52:10] I want to go back and revisit ... and be able to find all the annotations that, while I was reading them, they came up. I think what's very handy about this as I'm going through it now is ... the collocation function you can perform afterwards in terms of all the times you put context, context, context, to a background, right? It's like subject headings ... but you're not linking it outside the document yet, you're just within the document you're trying to find patterns. (Participant 8)

The purpose of isolating key information is to reduce the amount of information that a student must remember. Although underlining and highlighting are popular methods of isolating information, they do not support the organization, transformation, or elaboration on the material (Nist & Holschuh, 2000). Linktypes used as labels/tags can be treated as purpose to direct attention to important content in a text. For example, “definition,” “example,” etc. may serve as linguistic pointer devices. Educational psychologists found that pointer devices induce better memory for signaled content (Lorch & Lorch, 1986). In this regard, Linktypes used to label/tag ideas help annotation writers to actively engage the text and to process the relative significance of different elements of the text. Thus, while highlighting is used to help improve concentration (Engler & Berger, 2001), Linktyping is used to improve recall (i.e., “Place-marking” function).

It is conjectured that the forms manifesting the “Problem-working” function may also manifest multiple functions.

#### **5.2.2.2 Discussion of How Different Forms Are Used to Implement Different Functions**

This section discusses the findings as they apply to the question of whether similar forms implement different functions. Highlightings manifest different functions in the “manifested” content. For example, Highlightings of headings and subheadings label the dominant topic or theme of the subsequent text, signal for returning to read closely, and thus conform to Marshall’s definition of the “Procedural Signaling” function. However, highlighting a whole paragraph or citation seems to signal for reading closely or further reading, and is identified as “Procedural Signaling”.

Highlightings cause the content of the words or sentences they signal to be visually distinct from the rest of the text, and allow readers to readily grasp (remember) the relationship between the cues and the text content (Lorch, 1989). Visual foraging of highlighted text in an eye-tracking study (Chi, Gumbrecht, & Hong, 2007) showed that a highlighted item isolated against a homogenous background is more likely to be attended to and remembered. Previous studies showed highlightings helped students to distinguish between levels of importance in text and to remember main ideas (Johnson, 1988), and the use of properly highlighted text aids recall (Nist & Hoglebe, 1987). Thus, highlighting keywords and phrases manifest the “Place-marking” function. In this perspective, highlighted texts function like signaling devices. Lorch (1989) pointed out that all devices share the goal of directing the reader’s attention during reading. For example, typographical cues include the use of underlining, boldface, and color to tag very specific content as important. Sanchez et al. (2002, p.419) pointed out that “signaling main ideas

also generally improves recall of topics and their organization within a text.” Their findings (Sanchez et al., 2002) showed that there were larger effects of signaling in the cued recall condition than in the free recall condition, which were consistent with the Lorch and Lorch (1995) study.

However, it is only through verbal protocols and screen recordings (the latent content) that it is discovered that the highlightings on the first word of a paragraph were adapted forms of representing an extended highlighting of the whole paragraph. The highlighted text at the beginning of a paragraph functions as paragraph headings, which also functions as signaling devices. Headings and sub-headings are signaling devices that often used by authors to highlight the topic structure of a text to help reader’s processing of the topic structure of an expository text, which facilitate recall of unfamiliar topics (Lorch & Lorch, 1995). Participants consistently applied this adapted form for reflecting those paragraphs that need to return for successive reading. Its visual characteristics cause people to detect and reproduce the pattern more easily (Amitay, 2001). Thus, highlighting the first word of a paragraph is used to signal the “Procedural Signaling” function.

Extended highlightings, for example, highlighting on a whole paragraph or on a citation, may not always mean “Tracing Progress through Difficult Narrative.” Mouse highlighting while reading online replaced the behavioral form of “Tracing Progress through Difficult Narrative.” This online reading form is reported by Kurniawan and Zaphiris (2001), who found that some users used their mouse pointers to guide them in keeping track of their reading location. Furthermore, Nielsen (1997) pointed out that reading material online is causing a major shift in everyday reading activities. Therefore, it requires the examination of annotations created in

different reading tasks, i.e., general reading task (as skimming) and directed reading task (reading in depth), to understand whether the annotation functions manifest differently.

Annotation content affects the implementation of functions as identified in the findings of Note-making (both short notes and long notes); e.g., “Incidental Reflection” cannot simply be manifested through forms. Notes require looking into the content to differentiate “Recording Interpretation” from “Incidental Reflection,” and notes for reminding to return should be categorized as “Procedural Signaling”.

Long notes in the margins may not just represent “Recording Interpretation.” The findings in the main study show that some participants put TinyURL links into the notes for linking to another piece of information, which indicated people adopted the Note-making form to serve the same function as the Linking component. Long notes may also signal “Procedural Signaling,” “Place-marking,” or other functions. Brown (2007) showed writing long notes helps readers think about the text they are reading and to work out their own ideas including summarization, making predictions, formulating opinions, making connections, asking questions, and analyzing the author’s craft, writing reflections/reactions/comments, and looking for patterns/repetitions. Note-making, whether short notes or long notes, requires the reader to pay more attention to the content and manifests other functions than “Recording Interpretation” based on the “latent” content.

Treating links simply as asterisk (\*) markings and Linktypes as short notes is not sufficient to identify the functions manifested through them. Linking components contain several forms (Linking alone, Linking with Linktyping, and Linking with Note-making) which may manifest multiple functions. The functions of Linking and Linktyping remain unclear if

they are treated as static markings and notes by ignoring their hypertextual capabilities. In this study, analysis of Research Question 3 further investigates the functions manifested through linking components.

Linktyping is designed to type the linking relationship (e.g., “illustrates,” “defines,” “generalizes,” “exemplifies,” etc.), and, thus manifests “Linking Ideas Meaningfully.” However, in this study the participants used linktypes to collocate content for future reference. In other words, Linktype was adapted to “tag” content that could be reviewed thematically later. On this view, Linktyping is used to improve recall, while highlighting is used to help improve concentration (Engler & Berger, 2001). Linktypes used as labels/tags can be treated as the purpose to direct attention to important content in a text. For example, “definition” may serve as linguistic pointer devices. Educational psychologists found that pointer devices induce better memory for signaled content (Lorch & Lorch, 1986). The findings show that Linktyping manifests multiple functions depending on the way it is used.

An interesting finding from the discussions in this section is the similarity of the annotation form-function relationship to signaling devices and their functions. A text-based and reader-based theory of signaling was proposed by Lemarie et al. (2008) to explain how signals affect text processing. This study makes use of their theory to explain the finding. The theory of signaling states that there are two components to the way people cognitively process signaling devices. The first component specifies text-based signaling devices made available to the reader. If a signal carries information that is relevant to the reader’s text-processing and is easily grasped by the reader, the device also emerges as a reader-based signaling device, the second component, which depends jointly on the reader’s goals and the ease with which that information can be used. Similarly, some annotation forms, for example, typographical cues such as highlighted text,



numberings, recapitulations, and headings are created for annotation readers (including the annotation writers themselves who later become readers). Subsequently, a number of “functions” emerge from these forms during reading, such as “Placemarking,” “Procedural Signaling,” focusing attention, easy remembering, easy differentiating, etc.

### **5.2.2.3 Summary of Research Question 2**

In general, functions are not always manifested through “similar forms” (see 4.2.1.1). People adapt forms in various ways to implement function. For example, “Incidental Reflection” is manifested from forms and the content, and may also signal the collaboration task. “Place-marking” is manifested through short highlightings on main points, markings representing importance. “Procedural Signaling” is also manifested through notes denoting future reading and cross-outs. “Recording Interpretation” is closely related to the content and needs more fine-grained sub-functions. The “Tracing Progress through Difficult Narrative” function may not be easily identified in online annotation because mouse highlighting is often used to implement this function. Lastly, “Problem-working” is manifested through notes and linktyping; however, the notes and linktypes sometimes may manifest multiple functions.

The original forms and adapted forms are discussed on the granularity of forms. The visual appearance of the annotation is closely related to how signals affect text processing. For example, some annotation forms (e.g., highlighted text) are visually distinct from the rest of the text, and other annotation forms (e.g. notes recapitulating or enumeration of main ideas) are functioning similar to signaling devices (e.g. headings, enumeration, etc.). In general, relative location of the cued content (highlighting on heading, in paragraph, etc.) and annotation on text entities (heading, name, year, keyword, etc.) communicates the text structure to readers, which affect the implementation of functions.

### **5.2.3 Research Question 3**

#### **What is the function of linking as a form?**

In Chapter 4, the findings show that Linking requires some consideration of the nature of the relationship between text items before attributing a linktype or a note. Without linktypes (or notes) describing the link relationship, the function manifested from “Linking Only” relies on the textual signals. This section presents a discussion from the findings of the examination of Linking and Linktyping in relation to text structure and text patterns. The approach is, first, to identify the intended functions of “Linking Only” emerging from the data grounded in the information functions of signal devices. Secondly, to identify the intended functions of Linking with Linktyping or Note-making to discuss the functions reflected.

#### **5.2.3.1 Discussion of the Functions Reflect through “Linking Only” Form**

##### **Linking as a marking of text structure with hypertextuality capture information functions of signaling devices such as Demarcation and Organization**

Linking icons, such as the asterisk (“\*”) used in the ANNOLINK prototype, are a visual cue indicating that a click on the asterisk navigates away from this segment of the current page to the target segments via hyperlinking. Without notes or linktypes describing the link relationship, Linking relies on the text patterns (e.g., heading-to-heading, heading-to-paragraph, and sentence-to-sentence) to signal information functions. For example, linking at heading level connects the main ideas. Topic headings were observed to be powerful signaling devices that facilitate online comprehension processes and improve memory for text topics (Hyona & Lorch, 2004). Linking

heading to heading connects concepts at a high level. Linking heading to paragraph indicates that the target paragraph contains supporting information to the heading in the source node.

The connection between text patterns and the manifested information function is best exemplified by the hypertext writing guidelines. Morkes and Nielsen (1997, cited in Amitay, 2001, p.39) have written guidelines for writing online texts on the Web based on extensive user studies. Their guidelines confirm that writing conventions have not changed much over time. Based on their findings that some users read only the first sentence of each paragraph, they suggest a number of patterns to the authors: (1) use topic sentences; (2) place topic sentence at the beginning of the first paragraph; (3) limit each paragraph to one main idea; (4) present the main points in a concise form as users like summaries; (5) use simple and informal writing; and (6) keep sentences short. This study finds that these patterns are also relevant to the way people annotate in hypertext. The text patterns (heading-to-heading or heading to sentence) are visible to the user as a distinct entity (highlighted). These visual cues are meant to show the exact place of the link, but they also guide the reading of the paragraph. When the readers link texts they employ not only their experience as online readers, but also their knowledge about the medium and its audience as authors.

Linking establishes boundaries or limits separating two text entities. A click on the Linking component enables users (whether annotation writers or annotation readers) to navigate away to another area. Linking, as a specific hypertextual object for departure point, where the readers must capture the rhetorical styles to help in their structuring of the information in an effective manner. The function of Linking, like some signaling devices, helps communicate text structure by signaling junctures in the text structure. In the theory of signaling, this information

function is called Demarcation: the establishment of boundaries or limits separating two areas, groups, or things (Lemarie et al., 2008).

Linking also imposes certain syntax on the text structure. The linking components may signal organization relationships between segments of a text (or texts). Examples are linking a heading to a paragraph, with the target paragraph as the supporting information to which the heading links, or linking sentence to sentence, to connect two associated definitions. The hierarchical relationships of topics may be signaled by linking from source-anchored heading to target-paragraph, or from source-anchored sentence to target-sentence. A click on the linking icon navigates away from this segment of the current page. Order relationships of topics in the original text are changed because the linking components signal the change of logical structure of a text. In the theory of signaling, this information function is called Organization: the establishment of the logical structure of the text (Lemarie et al., 2008).

#### **5.2.3.2 Discussion of the Functions of Linking with Linktyping (or Note-Making)**

**Linking and Linktyping together reflect the proposed “Linking Ideas Meaningfully” function, and Linktyping may reflect different information functions of signaling devices separately. Note-making used with Linking may have effects on the functions of Linking.**

The proposed “Linking Ideas Meaningfully” function is actually manifested from two form components; one is Linking, i.e., the hyperlinking of segments and the other is Linktyping, i.e., the link relationship has a purpose described by the linktype. In other words, Linking Only is not giving any “Meaningful” information in an explicit way, and Linktyping Only (i.e., without attributing to a link) is not technically “Linking Ideas” of any two text segments.

“Linking Only” establishes the concept of (1) navigating away to another area, and (2) signaling organizational relationships between different text patterns. Linking with Linktyping establishes the concept of (1) navigating away to another area, (2) signaling organizational relationships between different text patterns (e.g., heading to heading) (3) labeling relevant topics or ideas in a text, and (4) typed links identify the role of the target section. Linking with Linktyping is a pattern in the way annotation writers describe the link in relation to the other text segment in an external resource. Thus, the “Linking Ideas Meaningfully” function is best practiced in typed links, which capture multiple information functions. These findings seem to confirm that “Linking Ideas Meaningfully” is more evident now that there are more fine-grained sub-functions manifested from Linking and Linktyping. The next section provides evidence for the grounded results in the information function of signal devices from the findings of Linking and Linktyping.

The Linktyping component used alone is an interesting phenomenon, since the large majority (44%) of the linktypes used did not reference an actual link (see Table 4.8). Participants used the linktyping component as a collocation device, essentially applying a form of subject heading to the content to be used to identify and gather similar themes within the article. Participants continued this strategy by using linktypes to describe text content rather than a link relationship.

This study has found that participants select certain linktypes and apply them to label/tag the highlighted texts or links as they see fit. There were six instances found where the linktypes used directly with the highlighted texts were applied to tag definitions, examples, etc. for categorizing the text passages about relevance. The process of selecting an appropriate linktype to describe the relationship forced the annotation writers to pay attention to the different ways

that a text affected them. Readers reconstruct the purpose of the passages from the selected linktypes, whether to describe the link or to tag the highlighted passages. It helps to save time spent on re-reading, as a result making it easy to quickly review material. In the analysis of the verbal protocols, it became evident that participants were using marginal notes during the General Reading task to collocate content for future reference. In other words, Linktype was used as notes to “tag” content that could be reviewed thematically later -- for example, Participant 8 described it as “looking for patterns”.

The purpose of isolating key information is to reduce the amount of information that a reader must remember. Although underlining and highlighting are popular methods of isolating information, they do not support the ability to organize, transform, or elaborate on the material (Nist & Holschuh, 2000). Linktypes used as labels/tags can be treated as function and relevance indicators to direct attention to important content in a text. For example, “definition,” “example,” etc. may serve as linguistic pointer devices. Educational psychologists found that pointer devices induce better memory for signaled content (Lorch & Lorch, 1986). In this regard, Linktypes used to tag ideas help annotation writers to actively engage the text and to process the relative significance of different elements of the text. Thus, while highlighting is used to help improve concentration (Engler & Berger, 2001), Linktyping is used to improve recall. It is conjectured that the forms manifesting the “Problem-working” function may also manifest multiple functions.

Linktype as a label/tag with hypertextuality captures information functions of signaling devices such as Labeling and Identification. Labeling (Lemarie et al., 2008) refers to a concise way of indexing a text object and aids the process of making connections between relevant topics or ideas in a text, and thus helps the reader in constructing a mental representation during reading.

From that perspective, Linktyping has the labeling function to signal a link relationship between text segments before traversing a link to the signaled text segment (the target segment). A typed link enables the reader to “process” the text in a particular reading, and helps the reader realize a particular meaning as he/she selects what might be a unique assemble.

Lemarie et al. (2008) defined Identification as indicating the role of the section (e.g., Introduction, Background, Discussion, etc.). If the function of a section is identified before its content is processed, the reader is in a better position to understand the content and its relationship to other parts of the text. The Linktyping component fulfills the Identification function because the target segment is identified before its content is processed. A typed link may indicate the function of the target segment as background information, definition, or example, etc. Linktyping serves to tag the annotated text to categorize patterns or repetitions. Other studies also showed this sort of clustering of ways to respond to the text made the invisible, mental reading process visible to the reader (Porter-O'Donnell, 2004). The reader is then in a better position to understand the content and its relationship to the source segment. In the situation of Linking without Linktyping, perhaps the unforeseen conjunctions between two text segments are not created at the time of annotating, but it provides a sense of significance.

The results in Chapter 4 also show that Linking is used in combination with Note-making. For example, Participant 8 entered “Definition” in her notes instead of selecting the “Definition” linktype from the list. Hence, Linking with a note is similar to Linking with a linktype, except that the vocabulary of notes is unconstrained. Linking used in combination with Note-making, where the note gives an explicit form of annotation is more like the “Recording Interpretation” function. In general, when Note-making is used together with Linking, it gives a clear description of the linking relationship. It is conjectured that Linking with Note-making manifest

more of the “Recording Interpretation” in addition to the “Linking Ideas Meaningfully” function. Similar findings are also observed in the combination of Linking with Linktyping and Note-making components. Hence, these combined forms probably manifest both “Recording Interpretation” and “Linking Ideas Meaningfully” as well.

### **5.2.3.3 Summary of Research Question 3**

Research Question 3 presents a discussion from the findings of the examination of Linking and Linktyping in relation to text structure and text patterns. The concepts established from Linking Only, Linking with Linktyping, and Linking with Note-making are examined.

The functions emerging from the data are grounded in the information functions of signal devices. Linking establishes boundaries or limits separating two text entities and captures the information functions of signaling devices such as Demarcation and Organization. Linktyping establishes labeling and identifying the role the target segment captures the information functions of signaling devices such as Labeling and Identification. These findings seem to confirm that there are more fine-grained sub-functions manifested from the Linking and Linktyping, and the proposed “Linking Ideas Meaningfully” function is actually manifested from two form components (Linking with Linktyping or Linking with Note-making).

When Note-making is used with Linking, it gives clear description of the linking relationship. It is conjectured that Linking with Note-making manifests the “Recording Interpretation” function in addition to the “Linking Ideas Meaningfully” function.



## **5.2.4 Research Question 4**

### **What other forms and functions might online annotation support?**

In Chapter 4, a number of “wished-for forms” were noted, as well as a list of annotation functions mentioned in the main study that online annotation might help facilitate in active reading online. The approach of this section is to supplement the findings in the main study with a review of existing annotation tools as well as related tools discussed in the research literature for exploring other forms online annotation might support. When forms are found to support individual use and social/shared use, individual use is discussed first followed by social/shared use.

Categories of annotation functions which emerged from the main study, the review of existing tools, and the research literature are integrated into the coding scheme. An Annotation Functions Typology is developed from the coding scheme to gain a holistic view of functions from coding protocol scripts. This Annotation Functions Typology is used to articulate annotation functions in a structural way to describe the relationships among those annotation functions, and to observe the shift of annotation functions manifested in different reading tasks.

#### **5.2.4.1 Discussion of Other Forms Found in the “Wished-for Forms”**

In the main study, the participants mentioned a number of annotation forms they wish to have to facilitate active reading online. From the pre-test questionnaire, it is noted that no participants have experience of using any online annotation tools. This section presents the discussions of other forms that participants (as first time users) have in mind in creating and using online annotations beyond the provided forms.

**Markings and typographical signals are found as one of the “wished-for forms,” as well as in the existing annotation tools and research literature. The functions might be “Procedural Signaling” or “Place-marking”.**

The results show markings and typographic signals are found in the wished-for forms.

For example, Participant 3 commented:

[16:40] Then, the sum of benefits of ... hypertext of the last paragraph ... So, I think that I need to return to this paragraph, and I’m just gonna read it quickly. Ahm.. I guess for this summary paragraph, I’m going to highlight the word “benefit” here, I suppose. If I had a paper text, what I would do is to put those sort of big brackets [emphasis added] at the one side of the ... at the margin of the paragraph, and put a note there says the summary of the benefits, so since I cannot do that bracket thing, I just highlight it and then putting a note saying that “summary of benefits” in the margin there. (Participant 3)

In existing tools some evidence showed markings are supported as a kind of online annotation form. For example, Notate<sup>17</sup> and Zoho Notebook<sup>17</sup> have a toolbox feature for drawing lines, free-hand lines, rectangles, circles, and shapes. Some annotation tools provide various typographic signals such as capitalization, italics, boldface, and color variation for writing annotations. HyLighter<sup>17</sup>, for example, enables the reader to apply standard text editing features to the notes including the addition of bolding, italics, centering or justifying text, controlling font and font size, and so on.

Online annotation forms such as free-draw markings and typographical signals found in the review are closely resemble their counterparts in print. The annotation function for these kinds of typographic signals serve purposes [functions] such as introducing technical terms, emphasizing important information, and calling attention to key concepts (Lorch & Lorch, 1995).

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<sup>17</sup> See Appendix 11

These findings conform to those of Qayyum (2008) who showed that there is not much difference in the types of markings that users make on paper and electronic documents for private use. Markings and typographical signals support the function of “Procedural Signaling” for future attention and “Place-marking” for aiding memory, and perhaps “Incidental Reflection” of the material circumstances of reading because of the free-draw capability.

**Overlap highlighting is implemented in ANNOLINK and in existing tools. Overlap highlighting is shown in variant tone densities from aggregating frequencies of highlights. Overlapping highlight might signal the “To Differentiate” function as it signals different purposes in the personal view; and it signals different group highlightings in the public view.**

This form is provided in ANNOLINK, and also found in four other existing online annotation tools reviewed. The ANNOLINK prototype supports only one highlight color (yellow), the overlapping highlights appear with increasing tone darkening where the darker area indicates the overlap area, which is also the case in ShiftSpace<sup>18</sup> and Sidenote<sup>18</sup>. HyLighter allows overlaps, but gives no visual indication: There is no distinction between the highlights in terms of color or shade change, i.e., it looks like one continuous highlight. Notate also support this form, but overlapping area is only associated with one of the highlights, possibly the one that is made first; however, there is no strong visual indication of the overlapping areas in Notate. Notate also allows overlapping highlights, but it does not show as a highlight once the note is submitted.

In the personal view, overlapping highlights enable the reader to highlight fragments that have elements in common. It may be, for example, that a reader returns to a text and highlights a passage that overlaps with another, previous highlight, for a different purpose. This will allow

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<sup>18</sup> See Appendix 11

him/her to directly compare comments made at two different points in time. Alternatively, the reader could highlight a word or phrase for the purpose of noting a definition, and then return to highlight a longer text phrase that overlaps the original highlight, and associate a note that elaborates on the relevance and/or importance of the context to a more fine-grained interpretation of the definition.

Overlapping highlights may simply be a consequence of providing a visual indication of different highlighting on the passage, such as was found for ANNOLINK, and HyLighter in the review. The ANNOLINK prototype supports the condition where overlapping highlights (and associated) notes of others may be shown in the document (i.e., the individual reader can turn on the public view of the article), or they can be the visual concentration of community highlightings, such as is found in the Open Annotation and Tagging System (OATS).

**Multiple-color highlighting is found in the “wished-for forms” and in the reviews.**

**Multiple-color highlighting might support the “To Differentiate” function as it signals different themes for personal use; and it signals different roles in public view.**

This form is found in the “wished-for forms” (mentioned by Participant 2, 5, 7, 8, 13) of her/his habit of using three color highlighters for certain themes, the color codes is only opaque to her/him. Participant 7 also mentioned the use of color to capture concepts for comparison.

Diigo<sup>19</sup>, for example, enables three highlighting styles for the personal view. The first style allows the more traditional change of background color, but the reader can also choose to use a dotted underline, or a dotted underline accompanied by a change in font color across the fragment. Notate, another example, enables readers to change the color of the highlight via the

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<sup>19</sup> See Appendix 11

associated sticky note. The highlight itself will only show this color when the associated note is hidden. When the associated note is showing, the highlight color reverts to yellow.

The review also shows that some tools support color highlighting to differentiate group highlightings (representing the roles) in public view, i.e., multiple colors for separating annotations created by different groups. For example, HyLighter “maps” the accumulating input of a group using color coding to reveal “hotspots” within a document, i.e., Yellow is mine, Blue is theirs, and Green is ours.

**Labeling (or Tagging) annotation is applied in the main study. Labeling facilitates the quick recall and discovery of the annotated content, and helps the reader improve recollection.**

This form is found in the “wish list,” when participants (Participant 3 and Participant 8) used some of the linktypes to “tag” their annotations. Labeling (or Tagging) annotation facilitates the quick recall and discovery of more finely grained content—the annotated content, and also serves as reminders that are used later to improve recollection. As previously discussed in 5.2.3.2, labeling helps the reader in constructing a mental representation during reading.

From the review of existing tools, seven annotation tools are found to support this form, e.g., Diigo, Notate, Notefish<sup>20</sup>, Stickis<sup>20</sup>, Stikkit<sup>20</sup>, Yahoo! NotePad<sup>20</sup>, and Zoho Notebook provide the “label or tag a note” feature. For example, Notate allows the reader add subject terms (tagging) to the note, either by choosing from among existing terms, or by creating a new term.

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<sup>20</sup> See Appendix 11

In the literature, Brockman, Neumann, Palmer, and Tidline (2001) claimed that the researchers they interviewed reported that after reading and annotation and/or notetaking, one of the steps in developing an interpretation is the naming of a concept that one has discovered in the texts, and to relate it to other concepts the researchers were then organizing notes to find relationships, and then be organized, collated, identified, and related together into some sort of unified structure. For example, the Open Annotation and Tagging System (OATS) allows users to add tags by first clicking on a piece of text they have already highlighted. Amaya (Kahan, Koivunen, Hommeaux, & Swick, 2002) provides a comprehensive set of types (Advice, Change, Comment, Example, Explanation, Question, and SeeAlso) providing annotation types that enable annotation writers to give further readers an overview of the annotation contents.

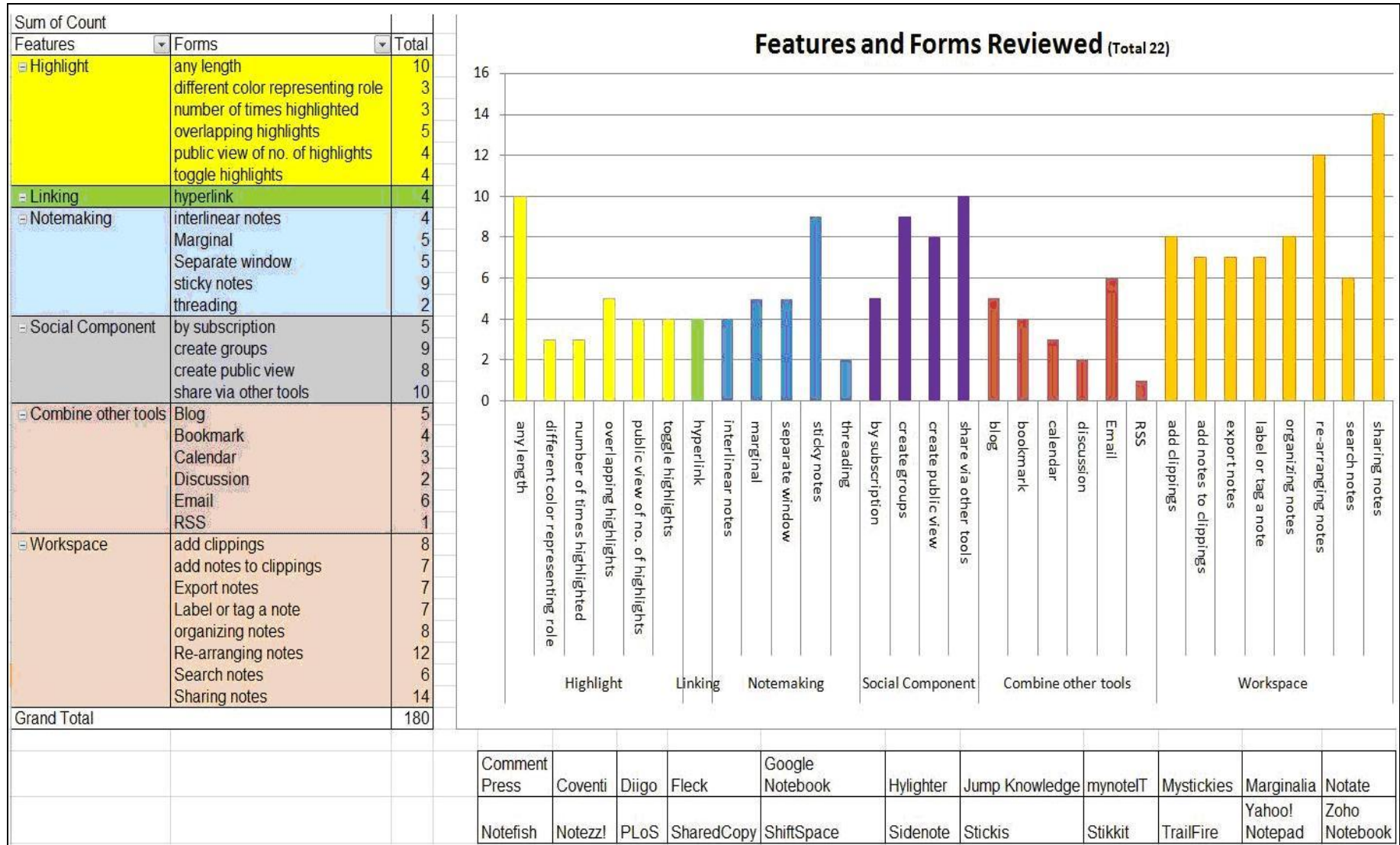
#### **5.2.4.2 Discussion of Other Forms Found in the Review of Annotation Tools and Research Literature**

A review of twenty-two annotation tools was conducted to identify the forms that current annotation tools support (Kopak & Chiang, 2009). The features and forms are grouped for examining their popularity among those annotation tools (see Figure 5.1 and Appendix 11<sup>21</sup>). The findings show that Highlight with any length is popular among these tools (10 out of 22), followed by overlapping highlight (5 out of 22). Some tools aggregate times of highlighting and display the number in private view or in public view. Some tools allow the readers to toggle on and off highlightings for better support of online reading flow. A sticky notes format is found to be more popular than other note formats (9 out of 22), and threaded annotations are the least-supported format among the existing tools. Linking is found in four tools. Seven tools support a labeling/tagging note form used with a separate workspace.

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<sup>21</sup> See Appendix 11 for a list of the annotation tools reviewed in this study

Figure 5.1 Features and forms of 22 existing annotation tools reviewed (Kopak & Chiang, 2009)



It is noticed that creation of a workspace is a widely supported feature in the existing annotation tools. A number of tasks can be realized within a workspace, such as sharing notes with others, re-arranging notes, adding clippings from online resources, organizing notes for editing work, adding notes to clippings, exporting notes, and searching notes. Social components are implemented in network community through subscription, creation of individuals' groups (9), and publishing to a public view. The most interesting finding is that ten annotation tools facilitate sharing of annotations via other online tools such as email, blogs, bookmarking, and discussion. These features and forms shed some light on the existing online annotation forms supported in the digital environment. The next section discusses the analysis of forms found in the review of annotation tools and the literature other than those supported by the ANNOLINK prototype.

**Predefined icons or symbols are found in the research literature. Predefined icons or symbols, as a kind of annotation forms, might signal perspective opinions in personal view; and differentiate opinions and roles in public view.**

Predefined icons and symbols as a form was not mentioned in the “wished-for forms” or in the existing tools reviewed. However, pre-defined symbols or icons supported by online annotation tools were identified in the literature. Bottoni et al. (2003) used icons for signaling a point to be remembered. Another example is found in AnnotatED, in which a thumbs-up icon represents positive notes and a question mark icon represents problem type notes (Farzan & Brusilovsky, 2008a).

When annotations are made in print documents, the telegraphic markings are usually a personal opaque coding; however, in shared annotation systems a set of pre-defined symbols acting as typographical signals is important. In ICDL (International Children's Digital Library),



used with highlighting, “rubber stamp icons” were supported for use with highlighting. For example, a question mark stamp indicates that student does not understand a section of text, an exclamation stamp indicates importance of text selections, a light bulb stamp indicates annotations containing general ideas, and a large eye stamp indicates annotations having to do with more careful or close reading (Kaplan, Chisik, Knudtson, Kulkarni, Moulthrop, Summers, & Weeks, 2004; Kaplan & Chisik, 2005b).

However, in ICDL teachers have a stamp to alert readers that a passage might be challenging and that readers might want to read more slowly through those parts. Children have a notation tool for registering surprise (exclamation point). These “rubber stamp icons” carry a color-coded icon representing the meaning, but the nature of the stamps available depends on the role of the user. The color associated with the question mark for teachers differs from the one for children to distinguish between the meaning of a teacher-generated question and a student-generated one (Kaplan et al., 2004). The predefined icons not only differentiate opinions, but also roles in a shared environment.

Studies have noted the usefulness of marginal notations for learning (Nist & Hoglebe, 1987; Nist & Simpson, 1988). Marginal symbols are especially effective for drawing out formal and logical characteristics of the text (Engler & Berger, 2001). Icons are similar to [marginal] symbols, and they are only useful when the meaning of icons or symbols were set forth beforehand to be readily understandable by users. Some characters would serve this purpose such as “\*” for a key point, “V” for a distinction, “>” for a summation or conclusion, “>>” for an anticipation or preview, “/” for an argument or premise, and “:” for a counter-argument (Engler & Berger, 2001). In the literature, it is found that in the Domain Help System (DHS), using digital plain text, a set of conventional symbols ( , , ~ , \* , \*= for adding, deleting, suggesting, and

changing were proposed for students to make interlinear (or inline) corrective annotations (Rodriguez & Brunsberg, 2004).

**Role-attached forms emerge from the review of existing annotation tools and research literature. Those role-attached annotation forms presented either as user-generated social forms and/or as aggregated information generated by the system to show the concentration of use.**

In the confirmatory task, some participants mentioned that they wanted to separate their annotations from those of others, when in public view. This means some annotation creators have a strong sense about having control of private and public forms. For example, ANNOLINK allows the readers to choose individual annotation (Highlighting, Note-making, Linktyping, and Linking) to be shown in the public view.

In the review, two tools, HyLighter and PLoS<sup>22</sup>, were found which provide a public view of the number of highlights created by different users. Seven tools allow the users to create a public view to share their notes with the public (Fleck<sup>22</sup>, Marginalia<sup>22</sup>, mynoteIT<sup>22</sup>, Notate, SharedCopy<sup>22</sup>, Stickis, and Yahoo!Notepad). Nine tools allow the users to further create groups they would like to share their annotation with (Diigo, HyLighter, Google Notebook<sup>22</sup>, mynoteIT, Notate, Stickis, Stikkit, Zoho Notebook, and Coventi<sup>22</sup>). Some evidence found in the review showed that there is a role attached to annotation forms, either implemented as user-generated social forms and/or as aggregated information generated by the system to show the concentration of use.

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<sup>22</sup> See Appendix 11

**User-generated social forms are found in the existing annotation tools. In a shared environment, threaded annotation is a kind of social form manually created by the users. Threaded annotations signal the “To Communicate” function.**

The review shows some tools allow the users to further create groups, with which they would like to share their annotations. These tools have implemented some forms that are associated with roles, depending on the creators’ role previously registered as a group member or merely as the general public. For example, HyLighter supports multiple-color highlighting for different roles (Yellow is Mine, Green is Ours, and Blue is Theirs). In ICDL color-coded stamps are implemented to differentiate teachers’ stamps from children’s ones in addition to the opinions the stamps represent.

In Note-making, for example, some tools, four tools found in the review and one in the literature, provide threaded annotations (e.g., HyLighter, Diigo, Notate, CommentPress<sup>22</sup>, and EDUCOSM). Threaded annotation in a shared environment is a kind of social form manually created by the users. Threaded annotation design has been implemented to support a follow-on comment additional to the original comment (a reply) for shared annotation. Threaded annotations contain a link back to the original article being commented on, the full text of an annotation (consisting of poster’s username, date and time), responses, the capability to flag a post, and the capability to respond to the post.

**System-generated social forms are found in the existing research literature. System-generated social forms are aggregated from making use of many users’ past interaction with the system and guide new users of the system through signaling this social navigation information.**

In addition to manually creating groups or public view, the ability of the annotation tools to be used in a form of social navigation (Munro, Höök, & Benyon, 1999) as found in the

literature, e.g., AnnotatEd, OATS, and OurWeb, is of great potential. Social Navigation Support techniques make use of many users' past interaction with the system to guide new users of the system, relying on the collective knowledge of a large community of users (Farzan & Brusilovsky, 2008a). Annotation-based social navigation support (Farzan & Brusilovsky, 2008a; 2008b; Kim et al., 2008) is based on the annotation activities of the users, thus offering more reliable evidence of page importance than simple visitor count. The availability of aggregation information and community support (user-controlled or system-controlled social forms) suggests there are role-oriented forms in online annotation.

AnnotatEd uses these techniques to identify pages with higher numbers of annotations or positive annotation. In AnnotatEd, a thumb-up or thumb-down icon represents the overall attitude of the community about the relevance of the paper. The thermometer icon represents the “temperature” of the annotations as well as signals annotation popularity (Freyne, Farzan, Brusilovsky, Smyth, & Coyle, 2007; Farzan & Brusilovsky, 2008a). OATS (The Open Annotation and Tagging System), borrowing from the Social Navigation Support from AnnotatED and using the community influence on a given HTML page, uses 4 levels to visualize the concentration of highlights: (1) none (0 highlights), low (1-3 highlights), medium (4-8 highlights), or high (9 or more highlights). These translate into different shading of highlights within the text, i.e., the more people make highlight the darker the tone density. OurWeb (Miettinen et al., 2006) uses a footprint icon with bar display to show the relative amount of reading, highlighting, commenting, and threaded discussion activity associated with the document. Various factors, including the relative length of the document are taken into account when calculating the heights of the bars.

#### **5.2.4.3 Discussion of the Functions of Other Forms Found in the Main Study, Existing Annotation Tools, and Research Literature**

**Overlap highlighting for personal use captures the concepts “To Differentiate” or “To Compare”.**

At its most basic level, the tone difference in the overlapped area will remind the reader that the highlights (regardless of any associated notes) were created at two different points in time, and may indicate a difference in engagement function, e.g., the earlier highlight may simply have indicated place-marking. The more intense the tonality of the background means the more important, or frequently highlighted, the text (Villaroel, de la Fuente, Pedrero, & Adiego, 2006). Villaroel et al. (2006) concluded that the strategy of varying color tonality has been demonstrated to be useful. According to their observations the key point of tone variation was in the contrast of colors produced for the variation of tones.

**Multiple-color highlighting for personal use or for sharing captures concepts “To Differentiate” or “To Compare”.**

Color highlighting is a kind of marking system useful to distinguish topics, subtopics, common categories, and details (Kiewra & DuBois, 1998). Multiple-color highlighting is found in the “wish list” (Participant 2 mentioned her habit of using three color highlighters for certain themes, the color codes is only opaque to her). Participant 7 also mentioned the use of color to capture concepts for comparison. For facilitating personal use, highlighting in color is often used to differentiate textual passages.

Some annotation tools support multiple-color highlighting but have not adopted the conventions for reflecting pre-defined themes. Some tools such as Notate and Zoho Notebook provide a color tool box for changing highlight color, but there is no pre-defined color scheme

for different themes. For personal use, multiple-color highlightings do not add any content on the base document and manifest functions close to text signaling devices, and hence support the function of “Procedural Signaling.” However, community support of multiple-color and overlap highlighting manifests the function involving role dimension. For sharing annotations with others, HyLighter uses three colors to differentiate different role (mine, ours, and theirs).

Other evidence found in the literature showed that it is a common training in religious studies to use color schemes for highlighting different themes (Engler & Berger, 2001). Multicolor highlighting is a useful study technique for religious studies student to draw on a wide variety of interdisciplinary sources, methods, and theoretical perspectives. Monochrome highlighting works only if readers select text through a discriminating reading process (Engler & Berger, 2001). In religious studies, Engler and Berger (2001) indicated that a pre-set schema may be set out for the process of active reading. For example, color highlights implement functions such as

- (1) to specify types of text and information,
- (2) to facilitate retention and review,
- (3) to emphasize discipline-specific categories and concepts, and
- (4) to prompt greater awareness of students personal responses as they relate actively to texts.
- (5) To identify ideas, themes or issues, learning types of information,
- (6) To apply theoretical concepts and descriptive typologies, or
- (7) To pay attention to personal dimensions of responses.

**Labeling/Tagging text passage captures the concept “To Label Segment,” serving the purpose of looking for patterns in the text. In a community support environment, labels/tags need to be pre-defined for sharing without ambiguity in meaning.**

Labeling/Tagging a particular concept or theme of a section is as “looking for patterns” in the texts, as Participant 8 described. Labeling/Tagging in the margin is functioning like headings signaling effects on text-processing to enumerate multiple ideas in an organized fashion

(Simpson & Nist, 1990). Labels and tags can later be used to serve the purpose for reformatting of text.

For terms used for labeling or tagging or annotation in a shared environment, the same as pre-defined symbols or icons, the meaning of the label/tag must be pre-defined or have consensus upon the meaning for readers to be clear about the concept they represent. A tag cloud is a visual depiction of content from aggregating the frequency of labels/tags used on a website, found in Notefish. Selecting a single label/tag within a tag cloud will generally lead to a collection of items that are associated with that tag aggregated by the system. In a community support environment, social tagging can manifest the function involving role dimension. That is, labels/tags can be aggregated as a system-generated form manifesting the “Place-marking” function, which is to recognize an important passage or identify an argument in the text, and is probably signaled whatever information is relevant to their learning goals.

### **Predefined symbols and icons for personal use or for sharing capture concepts “To Differentiate” or “To Compare”**

Evidence from the literature suggests that symbols and icons implemented in the systems should be pre-defined for better understanding of the meaning to apply. The function may be “Procedural Signaling” for future attention or “Place-marking” for aiding memory, but certainly not “Incidental Reflection” of the unrelated material circumstances of reading. For personal and internal use, a set of conventional symbols were proposed by Rodriguez and Brunsberg (2004) in accordance with the active reading in print documents. For sharing annotations, some evidence suggests that in online annotation the icons/symbols implemented are pre-defined such as ICDL and AnnotatED. In AnnotatED, a thermometer is implemented to indicate the aggregated reflections of icons from shared annotations.

**Threaded annotations are user-generated social forms and signal the intention for communicating ideas within a registered community, and the comments need to be the focus of attention.**

Threaded annotations are user-generated social forms and they are intended to communicate or exchange comments of the base text passage within a registered community. Online discussion systems, such as threaded annotations, face a tradeoff between focusing attention on threaded comments or on the document being discussed. Brush et al. (2002) pointed out that the comments might better be the focus, when reviewing others' comments and replying.

**System-generated social forms may be presented in colors, tone density, and rating icons that capture the concept “To Differentiate”.**

System-generated social forms make use of many users' past interaction with the system to guide new users of the system, relying on the collective knowledge of a large community of users. These forms may be presented in different colors, tone density, and rating icons that signal a more reliable evidence of importance of online annotations than simple forms. Thus, system-generated social forms capture the concept “to differentiate.” The next section describes the analysis of suggested functions explored in the main study, the review of tools and literature. Categories of annotation functions emerged from the data are integrated into the coding scheme. The results shed some light on what other functions online annotation might support.

#### **5.2.4.4 An Annotation Functions Typology Emerged**

The aim of this section is to identify occurrences of annotation functions in the main study, and the suggested functions explored in the review and the literature, to find out what other functions online annotation might support. The initial concepts were collected from



previous research (Marshall, 1997; Ovsiannikov et al., 1999; Wolfe, 2002; Bringay et al., 2006; Ames & Naaman, 2007). The highest level includes five concepts: (1) To Remember, (2) To Clarify, (3) To Think, (4) To Record incidental reflection, and (5) To Communicate<sup>23</sup>. These concepts have guided the coding of annotation functions as a process of identification and categorization of online annotations. They provided an initial framework for qualitative data analysis by suggesting important leads to identify empirical indicators and to develop their relationship to concepts and role grounded in and emerging from the data.

**Themes of concepts, functions, and sub-functions emerged from reconstructing functions of the annotation forms identified in the main study.**

After completing the analysis of the annotations as “evidences on the screen” to answer the previous research questions, the process confirmed only Marshall’s six functions plus the proposed Linking Ideas Meaningfully function. To understand what other functions online annotation might support, the think-aloud protocol approach was taken to elicit what people have in mind when creating annotations online, i.e., mapping the annotation forms into functions. Analysis began by identifying and categorizing annotation forms and functions in the general reading and directed reading task; and analyzing of the confirmatory task focused on coding the relationship of role (share or private) and function. The analyses include verbal protocol analysis, open and axial coding<sup>24</sup> (Creswell, 1998, p. 239), categorization of concepts and relationships found in the data.

A protocol analysis was applied to investigate functions in the participants’ mind at the time of creating annotation online, as well as forms they wished to have. Open coding allows

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<sup>23</sup> “To Communicate” concept, introduced by Bringay et al. (2006) in their research in annotations on clinic records, is the role for observing the relationships between function and form.

<sup>24</sup> Axial coding: "Axial coding is a process that follows open coding. It consists primarily of “relating categories of information to the central phenomenon category” (Creswell, 1998, p. 239).

identifying events with common themes within the data, i.e., “issue-relevant meaning” (Creswell, 1998, p.154). As the analysis progressed, many “issue-relevant meaning” terms were identified, based on the literature and categories and themes that emerged while conducting the analysis, an analytic framework from which to organize the data was created.

The approach allowed for a gradual refinement of the coding as new, relevant topics appeared during the analysis and was added to the list of codes as the original seven functions were tested against new evidence (Miles & Huberman, 1994). Coding continued until recurring themes and the patterns of their relationships became evident. The progressive refinement of the codes resulted in the creation of the final coding scheme in Appendix 12.

**The coding of annotation forms with their functions/concepts presents differences in relation to different reading tasks.**

During the coding process of general reading and directed reading sessions themes emerges from the verbal protocol transcriptions. In addition, in some segments multiple functions<sup>25</sup> were identified and multiple codes were applied. In the confirmatory task, the participants were asked to revisit their annotations and express whether or not they would like to share their annotations with others, which gives evidence of the relationship of role and function.

The analyses first examined the extent to which each of the seven annotation functions were elicited across all of the verbal protocols. The second round of coding was an open coding to find out what other functions might online annotation support. An important aspect of this coding is that the coding categories were developed to describe the level of annotating processes,

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<sup>25</sup> Marshall (1997) mentioned that sometimes multitude of functions existed.

rather than the content of thought processes, that was captured by the coding scheme used in this study.

Another important aspect of this coding scheme is that it does not take into consideration the appropriateness or accuracy of the participants' thinking. The intent of the coding framework was simply to describe annotating processes. Participants may engage in constructive thinking process (e.g., connect ideas) that lead them to create notes or links that may not seem appropriate. Nevertheless, in order to examine and compare the types of annotating processes elicited by the annotation functions, it is important to document when the annotation forms were created, whether or not they result in a distinctive type of annotation functions.

It should also be noted that the coding categories were not considered mutually exclusive. For example, it would be possible for a participant to initially engage in the process, "Procedural Signaling," to flag a need for revisiting the annotation. The participant may then find an idea and consider it in her thinking about the topic. The participant's verbal report for this topic would then receive both the "Procedural Signaling" code and the "Connecting ideas" code. If the participant then goes on to develop an interpretation about the text, her verbal report for the topic would also be coded for "Recording interpretation".

### **Highlighting -- Functions and Concepts in Relation to Tasks**

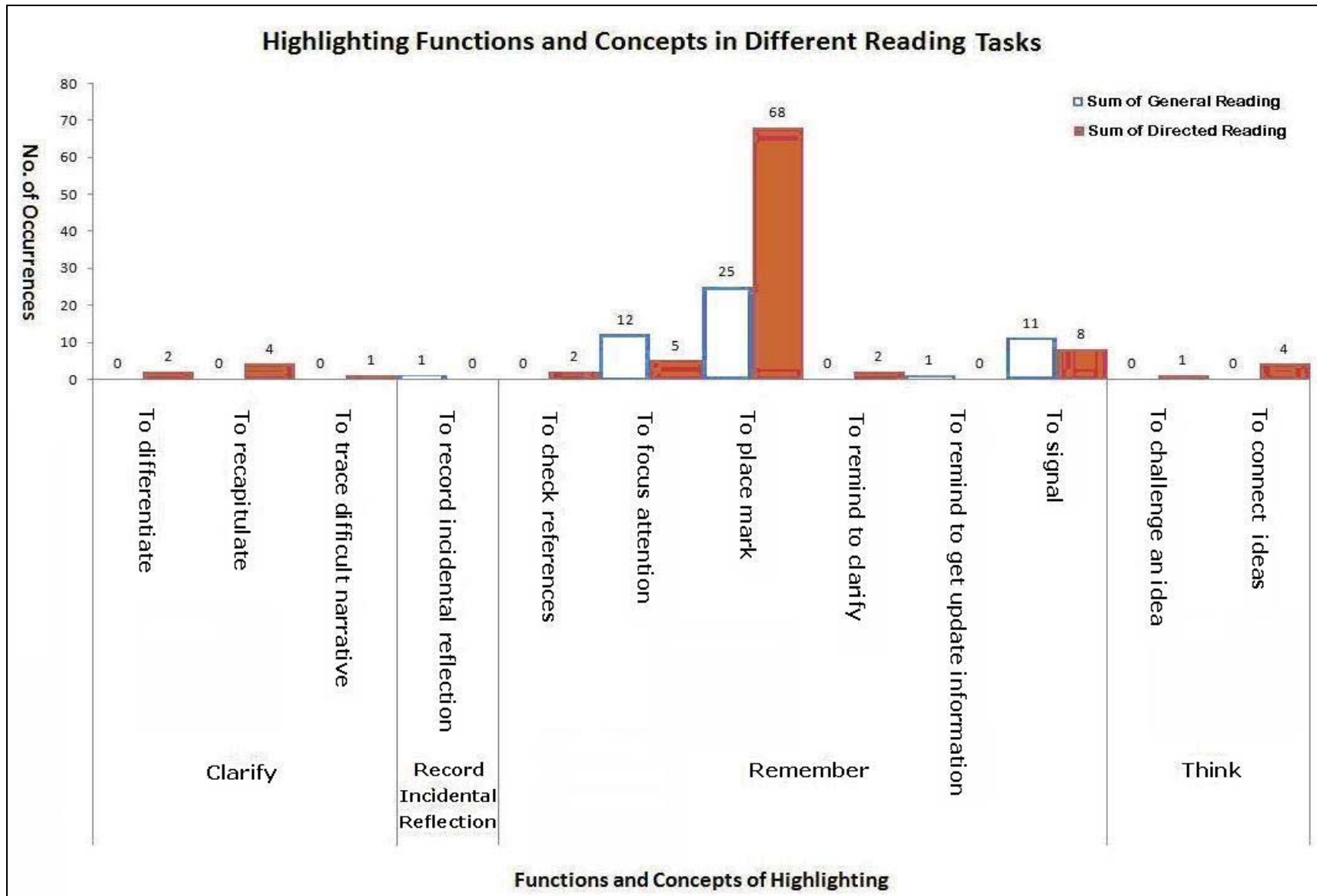
The following specific research sub-questions guided the initial examination of highlighting functions by task and their relationships with concepts during open coding. What other functions might people be making highlights? Do the functions and corresponding concepts differ in general reading from those in directed reading, as well as their corresponding concepts? Are there multiple functions existing via highlighting?

Table 5.1 indicates that whether in general reading or directed reading, people are highlighting also to focus the attention (Bringay et al., 2006) in addition to place marks and to signal procedures. Figure 5.2 shows that the functions mapping from people creating highlightings in general reading were mainly “To Remember”; as people dived into directed reading, the concepts emerged from the annotation functions showed they were not only “To Remember,” but also “To Clarify” and “To Think”.

Table 5.1 Annotation functions and concepts reflected in highlighting by task

Form	Function	Concept	General Reading	Directed Reading
Highlighting	To place mark	Remember	25	68
	To focus attention	Remember	12	5
	To signal	Remember	11	8
	To remind to get update information	Remember	1	0
	To record incidental reflection	Record Incidental Reflection	1	0
	To identify connecting ideas	Think	0	4
	To recapitulate	Clarify	0	4
	To differentiate	Clarify	0	2
	To remind	Remember	0	2
	To check references	Remember	0	2
	To challenge an idea	Think	0	1
	To trace difficult narrative	Clarify	0	1

Figure 5.2 Annotation functions and concepts reflected in highlighting by task



## Multiple Functions of Highlighting

Table 5.2 shows a further examination into whether online highlightings support multiple functions. Highlighting a passage can be interpreted as “To Place Mark” for the purpose of connecting similar ideas so as to remember the highlighted texts are related. As pointed out by Participant 6:

[38:46] Anyway. One way of supporting navigation in unfamiliar hypertext and overcoming disorientation is to provide preauthored linear paths through the document. Right. I remember all these paths. There was - OK, sequential path, ordered sequence of nodes, um. I guess I'll highlight those. (Participant 6)

Table 5.2 Multiple functions identified through open coding

Form	Function		General Reading	Directed Reading
Highlighting	To place mark (Remember)	To place mark (Remember)	25	64
		To identify connecting ideas (Think)	0	2
		To recapitulate (Clarify)	0	1
		To focus the attention (Remember)	0	1
	To focus the attention (Remember)	To focus the attention (Remember)	12	3
		To differentiate (Clarify)	0	2
	To signal (Remember)	To signal (Remember)	11	2
		To focus the attention (Remember)	0	2
		To remind (Remember)	0	2
		To check references (Remember)	0	2

Highlighting a passage as “To Place Mark” and as “To Recapitulate” the main points of a passage was found as pointed out by Participant 13:

[40:32] So I would highlight that, not as a definition or anything, just because I think it best explains what that paragraph is about. (Participant 13)

Highlighting “To Focus the Attention” and “To Differentiate,” as pointed out by Participant 8:

[43:49] When you're highlighting it, ..., it draws your attention to the way in which the author is kind of re-iterating the same things. So it can, it helps you to kind of, you could almost compare the different iterations of the same idea in the section then just choose the one that seems the pithiest. (Participant 8)

Highlighting “To Signal” and “To Remind” as Participant 4 pointed out:

[47:30] Seimic. Again I'm just going to highlight seismic because I don't know what it means, um. And then once I find out what it means I can return to the instances in the text that used it and re-read those sentences now that I know what it means so this is just a way of flagging it for me. ... And this way I can make sure I come back and that I will understand. (Participant 4)

## Note-Making -- Functions and Concepts in Relation to Tasks

Table 5.3 shows more annotation functions reflected in note-making, which may mean writing involves a certain complexity. In general reading, the annotation functions revealed from writing notes are mostly for tagging the segments (To label segment consistently) and signaling certain key points along the reading (To signal) as a way to quickly recollect the main ideas in the second or future reading. The annotation functions found in directed reading were different from the findings in general reading. For writing notes, participants mostly tended to give an opinion of remark or critical observation (To comment), to restate thematic ideas or recite briefly of the major points in their notes (To recapitulate), and to signal main points for recollect the main ideas (To signal). These functions indicate that people writing notes are motivated more by the concepts “To Think” and “To Clarify,” than “To Remember” (see Figure 5.3).

Table 5.3 Annotation functions and concepts reflected in note-making by task

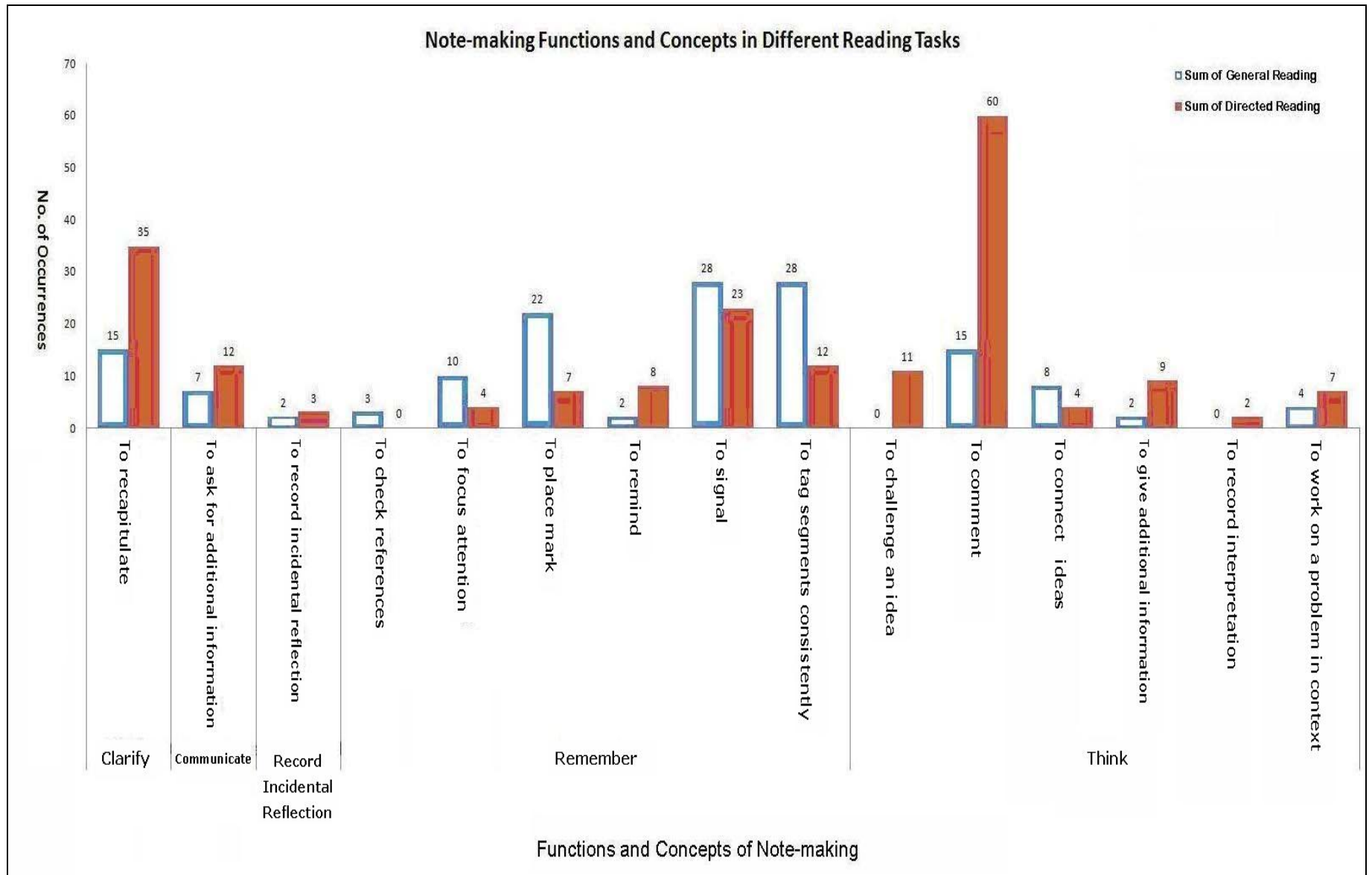
Form	Function	Concept	General Reading	Directed Reading
note-making	To label segments consistently	Remember	28	12
	To signal	Remember	28	23
	To place mark	Remember	22	7
	To comment	Think	15	60
	To recapitulate	Clarify	15	35
	To focus the attention	Remember	10	4
	To identify connecting ideas	Think	8	4
	To ask for additional information	Communicate	7	12
	To work on a problem in context	Think	4	7
	To check references	Remember	3	0
	To remind	Remember	2	8
	To record incidental reflection	Record Incidental Reflection	2	3
	To give additional information	Think	2	9
	To challenge an ideas	Think	0	11
	To record interpretation	Think	0	2

In addition, before the think-aloud session started, participants were told about the networking potential of online annotation. Therefore, whether in general reading or directed reading, they expressed their intentions of writing notes to get feedback from others (To ask for additional information). Given the potential of communication via an explicit online annotation form, i.e., note-making, the “To Communicate” concept emerged through annotation functions.

Table 5.3 also shows the concepts that emerged from note-making functions in different reading tasks. The note-making functions manifested in the process of directed reading indicated that people came up with his/her own new ideas, critical marks, questions, and notes reflecting his/her opinion on the subject, which revealed the “To Think” concept in writing notes, as well as “To Remember.” The annotation functions manifested through Note-making form in different reading tasks showed that: in general reading annotation functions are mainly for “To Remember,” and in deep reading people focused more on functions of “To Think” concept than “To Remember.”



Figure 5.3 Annotation functions and concepts reflected in note-making by task



## Multiple Functions of Note-Making

Table 5.4 shows that from the analysis of the verbal protocols, it became evident that participants were using marginal notes during the General Reading task to collocate content for reference. In other words, notes were written to “tag” content that could be reviewed thematically later in the Directed Reading task. For example, all instances of “metaphor” or “disorientation” were recapitulated as such in the marginal note, and these instances were for placing marks during the reading tasks when the participant would focus on that particular concept or theme. Participant 8 described this as looking for “patterns”:

[07:04] I want to go back and revisit ... and be able to find all the annotations that, while I was reading them, they came up. I think what’s very handy about this as I’m going through it now is ... the collocation function you can perform afterwards in terms of all the times you put context, context, context, to a background, right? It’s like subject headings ... but you’re not linking it outside the document yet, you’re just within the document you’re trying to find patterns. (Participant 8)

Table 5.4 Multiple functions of note-making identified through open coding at Code Level 2 and (concept)

Form	Multiple Functions		General Reading	Directed Reading
Note-making	To label segments consistently (Remember)	To place mark (Remember)	20	7
		To recapitulate (Clarify)		
		To signal (Remember)	7	-
		To work on a problem in context (Think)	1	2
		To place mark (Remember)	0	2
		To recapitulate (Clarify)	0	1
	To comment (Think)	To comment (Think)	11	24
		To place mark (Remember)	3	13
		To give additional information (Think)	0	5
		To differentiate (Clarify)	1	3
		To capitulate (Clarify)	0	3
		To ask for information (Communicate)	0	2
		To record incidental reflection (Record Incidental Reflection)	0	1

This particular explanation only accounts for the unexpected higher frequency of text notes in the General Reading condition. What can be interpreted from the analysis is that the

creation of text notes for this purpose resulted in the use of individual words or short phrases to describe the content rather than longer phrases and sentences. The use of the text notes to describe content, and to use this capability as a form of advance organizer, though, seems a potentially useful one. In the section on link typing to follow there will be an elaboration on the value of this feature, and provide further indication of its efficacy.

Perhaps Participant 8's comment best interprets to enter notes or choose linktypes such as Definition, Example, etc. to label segments consistently as a strategy of placing marks for remembering:

[06:40] Yeah, 'cause this is a paragraph where they're talking about the early school of thought. So this would be... Oh, actually I could almost, no I don't do linktypes here, what I was going to say was this would be... if it were a linktype and I was connecting it to something, it would be context. (...) I think what's very handy about this is as I'm going through it now is being able to... the collocation function you can perform afterwards in terms of all the times you put context, context, context, to a background, right? So it's now... [So in a way you're doing subject heading almost to the...] It's like subject headings and it's not because you're using vocabulary similar to what you would be using in link typing, but you're not linking it outside the document yet, you're just, it's within the document you're trying to find patterns. (Participant 8)

The purpose of tagging segments consistently is to find patterns through the examination of concepts. Those linktypes were used as subject headings are Alternate View, Application, Background, Definition, Example, and Explanation. Among these Definition is the most used type for tagging a piece of information. Different perspectives also provide frameworks for structuring knowledge (Newell, 1984). The organization of concepts, meanings, analogies to other concepts, and explicit links among concepts are most critical to the reading and writing process (Langer, 1984). In this study, the combination of not-writing with labeling/tagging is observed to be used together for the purpose of selecting and structuring the information.

## Linking -- Functions and Concepts in Relation to Tasks

Table 5.5 and Figure 5.4 show that Linking requires a lot of thinking. During the think-aloud protocol sessions, an underlying challenge of linking is that of maintaining coherence in meaning when creating links between two pieces of information. Van Dijk and Kintsch (1983) regarded coherence as one of the “fundamental properties” of discourse and essential in efficient comprehension of textbases. Key to the semantic navigation (navigation based on pursuit of understanding and meaning relationships) of textbases is the role of “global” coherence. Global coherence is achieved when the gist or theme of a larger text fragment (i.e., beyond the sentence level) is carried forward to meaningfully relate to the gist or theme of subsequent text fragments.

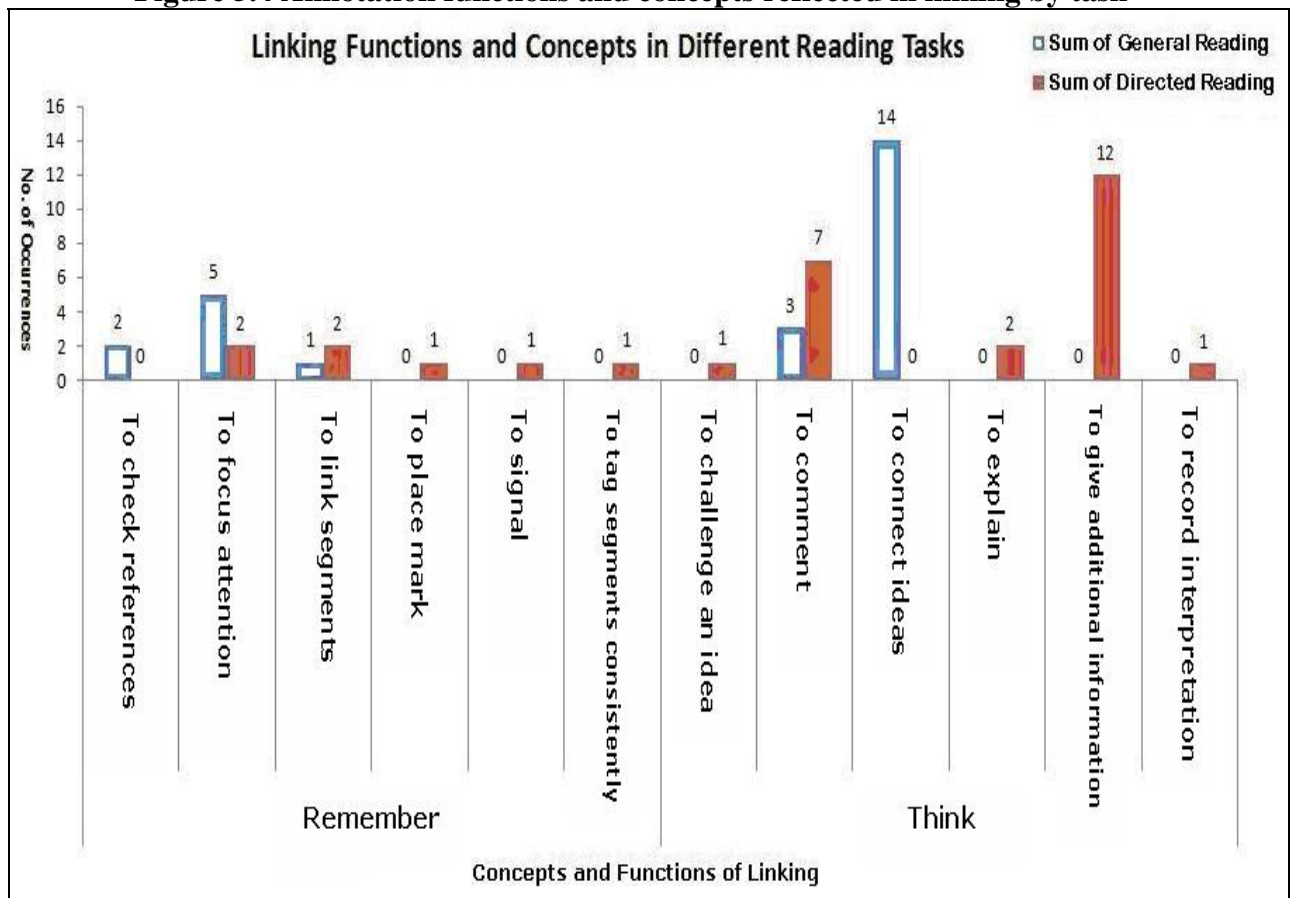
Table 5.5 Annotation functions and concepts reflected in linking by task

Form	Function	Concept	General Reading	Directed Reading
Linking	To identify connecting ideas	Think	14	0
	To focus the attention	Remember	5	2
	To comment	Think	3	7
	To check references	Remember	2	0
	To demarcate the segment for linking	Remember	1	2
	To give additional information	Think	0	12
	To explain	Think	0	2
	To place mark	Remember	0	1
	To challenge an idea	Think	0	1
	To record interpretation	Think	0	1
	To signal	Remember	0	1
	To label segments consistently	Remember	0	1

The results showed that readers become authors by creating functionally meaningful relationships between these fragments and varied by different reading tasks. “To identify connecting ideas” is mainly reflected in the general reading task, which indicates the readers generated connections between pieces of information and connected fragments of semiotic productions using various narrative strategies such as linking, linktyping, and note-making. While in directed reading, readers became more familiar with the themes of the text fragments

and tended to find support information for enhancing their comprehension of the basetexts; “To give additional information” indicated that the readers took the advantage of network environment and applied the linking components to add updated information as the extension of the textbases.

**Figure 5.4 Annotation functions and concepts reflected in linking by task**



### Multiple Functions of Linking

Table 5.6 shows that the participants in the main study created few links. Most of them are created in general reading task. Among those “To identify connecting ideas” (To Think), multiple functions are more for the purpose of “To check references” (To Remember). That is, the Linking is for the convenience of remembering to check references.

Table 5.6 Multiple functions of linking identified through open coding at Code Level 2 and (concept)

Form	Multiple Functions		General Reading	Directed Reading
Linking	To identify connecting ideas (Think)	To focus the attention (Remember)	4	0
		To check references (Remember)	7	0
		To place mark (Remember)	1	1
		To give additional information (Think)	1	1
	To demarcate the segment for linking (Remember)	To focus the attention	0	1
	To place mark (Remember)	To differentiate (Clarify)	0	1
	To give additional information (Think)	To label segments (Remember)	0	1

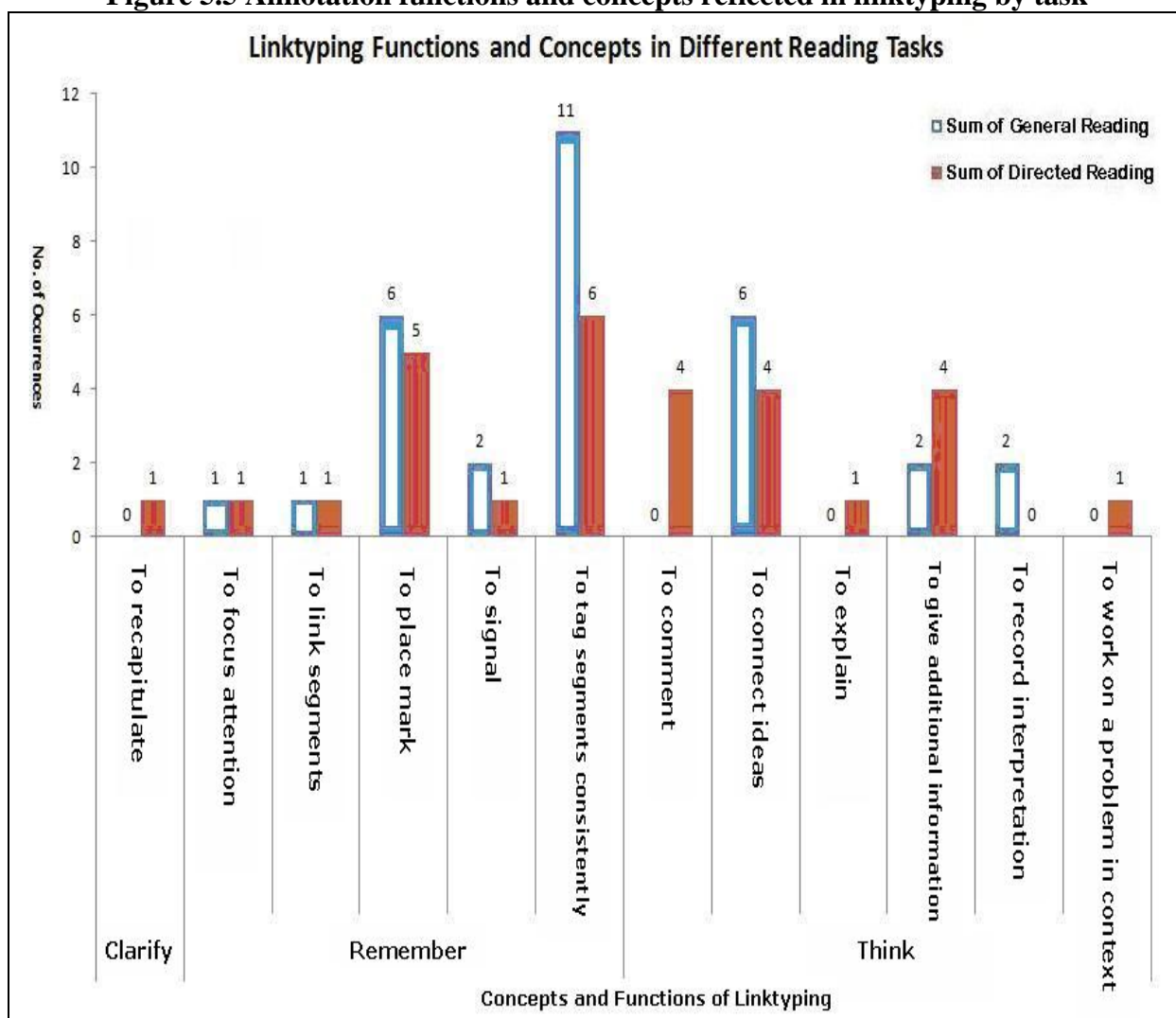
### Linktyping -- Functions and Concepts in Relation to Tasks

As discussed in Research Question 3, linktyping was used mostly to flag text passages because its convenience of application, Table 5.7 and Figure 5.5 show the coding results mainly reflected “To label segments consistently” and followed by “To place mark,” and mostly were observed in the general reading task to serve a higher purpose of “Remember.” Little evidences was found to manifest “To identify connecting ideas” and “To give additional information” to fulfill its initial purpose -- semantic navigation. The coding results showed no significant multiple functions manifested through linktyping.

Table 5.7 Annotation functions and concepts reflected in linktyping by task

Form	Function	Concept	General Reading	Directed Reading
Linktyping	To label segments consistently	Remember	11	6
	To identify connecting ideas	Think	6	4
	To place mark	Remember	6	5
	To signal	Remember	2	1
	To give additional information	Think	2	4
	To record interpretation	Think	2	0
	To focus the attention	Remember	1	1
	To demarcate the segment for linking	Remember	1	1
	To comment	Think	0	4
	To recapitulate	Clarify	0	1
	To work on a problem in context	Think	0	1
	To explain	Think	0	1

**Figure 5.5 Annotation functions and concepts reflected in linktyping by task**



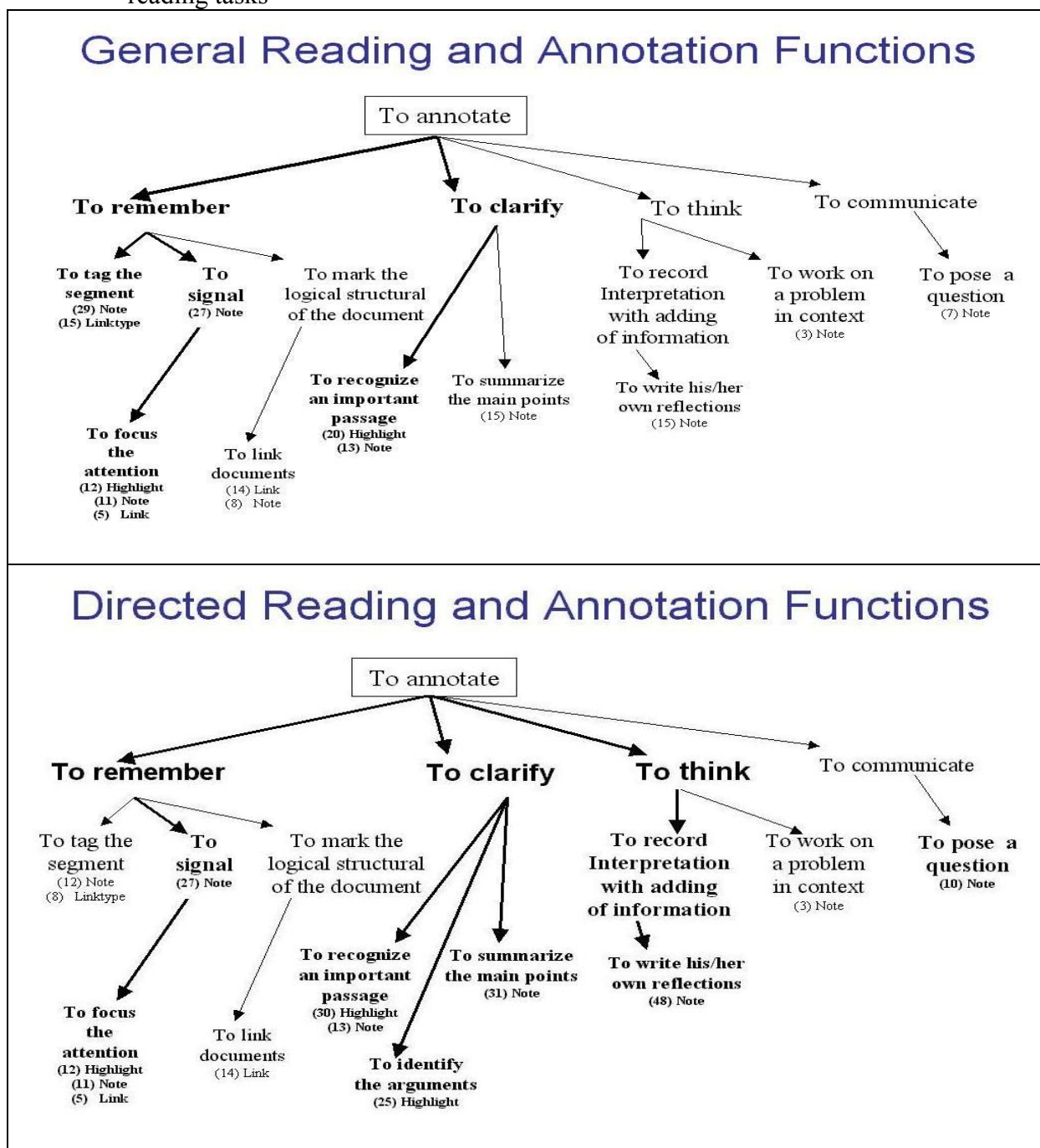
**An Annotation Functions Typology emerged from the coding results of main study. By applying this typology, it is observed that annotation functions/concepts differ in relation to different reading tasks.**

The Annotation Functions Typology is developed from the coding scheme to gain a holistic view of functions from coding protocol scripts. This Annotation Functions Typology is used to articulate annotation functions in a structural way to describe the relationships among those annotation functions. Applying the coding results (i.e., the frequencies of functions with respect to their forms) into this typology, the shift of annotation functions manifested in different reading tasks is noticed.

Figure 5.6 shows the Annotation Functions Typology indicating the relation of annotation function to the reading tasks. In general reading, the results show that functions mainly served the “To Remember” and “To Clarify” concepts. Under these concepts more notes and linktypes implement the “To Signal” and “To Tag the Segment” functions, and “To Focus the Attention” through highlights, notes, and links. Under the “To Clarify” concept, more highlights and notes are implemented for “To recognize an important passage.” Some notes are implemented to summarize the main points. But, even in the early stage of reading an article, as for general reading, the participants made some notes of their own reflections to serve the “To Think” concept.



Figure 5.6 Annotation Functions Typology indicates the relation of annotation functions and reading tasks



In the directed reading task, the annotations functions are intended more to serve the “To Think” and “To Clarify” concepts. Most notes are written as the individuals’ own reflections, and thus serve the “To Think” concept, followed by “To Clarify” concept including the notes manifesting “To Summarize the Main Points” and “To Recognize an Important Passage,” as well

as highlights manifesting “To Identify the Arguments.” “To Remember” has less instances compared to the general reading task, and has more notes manifesting “To Signal” and less for tagging the segment. In both reading tasks, it is found that some notes are addressed to pose questions toward the network community as “To Communicate.” It is conjectured that sharing annotations has less to do with the reading task and is perhaps more related to the content with respect to the possibility of seeking others’ comments.

**Applying the codes to reconstructing functions from the review of existing annotation tools, it is observed that no new function and/or concept emerged.**

In this section, it is intended to reconstruct function from the evidence of online annotation forms identified from the “wish-list” and the annotation tools review. The variant characteristics of these annotation tools it is impossible in this study to create a testing environment like the OJS ANNOLINK and conduct a user study on each of them to construct the functions. Nonetheless, an attempt is made to identify the functions mapped from the other forms found in the participants’ “wish-list” and the annotation tools review.

Table 5.8 shows that most of the functions are mapped under the concept of “To Remember.” Markings usually are personal and opaque, and suggest the function of “To Signal” (under the concept of “To Remember”). However, pre-defined markings such as thumb-up and thumb-down icons express either positive or negative opinion for distinguishing or comparing differences between base texts, and manifest the function of “To Differentiate” (under the concept of “To Clarify”). Role-oriented forms, in addition to the “To Communicate” concept (see Table 5.8), tend to remind readers of certain key points or to attract their attention when reading annotations made by others. Therefore, role-oriented forms also manifest the “To Differentiate” function for distinguishing or comparing differences between annotations.

Table 5.8 Annotation forms mapping into function in the “wish-list” and the annotation tools review (Code Level 2)

<b>Form</b>		<b>Function (code level 2)</b>	<b>Concept</b>
<b>Marking</b>	Markings and typographical signals	To signal; To place mark	Remember
	Predefined icons or symbols	To signal (e.g., question mark)	Remember
		To differentiate (e.g., thumb-up, thumb-down)	Clarify
<b>Highlighting</b>	Overlap Highlighting	To place mark; To signal	Remember
		To differentiate	Clarify
	Multiple-color highlighting	To place mark; To signal;	Remember
		To identify connecting ideas	Think
		To differentiate	Clarify
<b>Label/Tag annotation</b>	Label/Tag annotation	To signal	Remember
		To identify connecting ideas	Think
<b>Role-oriented forms</b>	User-controlled social form	To signal	Remember
		To differentiate	Clarify
		To share	Communicate
	System-generated social form	To signal	Remember
		To differentiate	Clarify

There is also the condition where overlapping or multiple-color highlights of others may be shown in the document (see Table 5.9), i.e., the individual reader can turn on the public view of the article. Overlapping highlights show how two or more users share consensus on relevance of various text passages (Shipman et al., 2003; Bradshaw & Light, 2007), and thus indicate a level of social agreement on the important (or problematic, interesting, etc.) components within the overall corpus. The visualization of highlighting studied by Villaroel et al. (2006) indicates there are two common activities in the visualization of shared highlights: comparing annotations

from different users and observing relevance levels calculated from the number of coincidences of highlighted fragments.

Table 5.9 Functions and concepts manifested through overlapping or multiple-color highlights

Form	Function (Concept)	Description of Function
Overlapping or Multiple-Color Highlights	To place mark (Remember)	show how two or more users share consensus on relevance of various text passages
	To differentiate (Clarify)	indicate a level of social agreement on the important (or problematic, interesting, etc.)
	To identify connecting ideas (Think)	use color schemes to connect similar themes
	To focus the attention (Remember)	show the calculated relevance levels from the number of coincidences of highlighted fragments

#### 5.2.4.5 Discussion of What Functions Might Online Annotation Support

The Annotation Functions Typology derived from the coding scheme provides a structural view to examine functions from a higher-level purpose: to remember, to think; to clarify; to record incidental reflection; and to communicate. This section describes other functions explored in the main study and from the review.

##### **From the Main Study**

1. There is some evidence that Marshall's six functions might have more elaborated categories matched when reading and annotating scholarly papers online:
  - "Procedural Signaling," in addition to being to remind of certain key points or to attract attention in further reading (Marshall, 1997), is also "To Remind" to revisit, and

“To Check Bibliographic Citation” for further reading, which all serve a higher concept as “Remember”.

- “Place-marking” found in this study is to recognize an important passage or identify an argument in the text when reading and annotating scholarly articles. This function probably signals whatever information that is relevant to people’s learning goals. Ovsianikov et al. (1999) pointed out that people tend to forget the contents of the paper and there must be a way to quickly recollect the main ideas. This function may serve a higher concept as “Remember.”
- Annotations as a record of interpretative activity. Marshall (1997) pointed out that our stereotype of writings in texts usually turns out to be interpretive annotations. Some researchers interviewed by Brockman et al. (2001) mention annotation and note-taking as key activities that go on during reading for research and researcher who wrote in the margins of materials that one needed to absorb and that one almost never underlined without writing in the margin because otherwise one found oneself "simply underlining, rather than absorbing" (Brockman et al., 2001, p.7).
- In this study, some evidence showed that “Recording Interpretation” is not only to explain, to comment, and to challenge an idea, but also to add additional information found from Internet searches while reading online and thus the coding reflects more elaborated functions than other annotation forms. Ovsianikov et al. (1999) pointed out that in the process of reading a paper, the reader can also come up with his or her own new ideas, critical marks, questions, and notes reflecting his opinion on the subject, which serves a higher concept as “To Think.”
- “Problem-working” is manifested through people interrupted the current reading task and performed an online search to resolve unfamiliar terms, to settle questions or arguments they have about the texts. The approach includes looking up definitions for

a term, finding an online copy of a bibliographic citation, or finding answer to a question the reader has when reading scholarly articles online. This function is found closely related to the “Recording Interpretation” function, because the results of “Problem-working” such as URL, text, or picture may be added in the annotation. In the process, people would utilize online search tools to facilitate annotating, research (Marshall, 1997; Ovsiannikov et al., 1999, Wolfe 2002; Bringay et al., 2006) indicated that to work on a problem in context serves a higher concept as “To Think”.

- The “Incidental Reflection” function is also found in this study that the reader reflected thought occurring by chance or without intention when reading journal online, which serves a higher concept as “To Record Incidental Reflection” (Ovsiannikov et al., 1999; Bringay et al., 2006).

2. Some evidence points to other functions that were not included in Marshall’s six original functions; for example:

- “To Mark the Logical Structure” of the document for reorganizing thoughts from the reader’s perspective (Bringay et al., 2006). This function is manifested through providing a link to related information or tagging segments consistently. In the review of existing tools, re-arranging notes is found in a number of annotation tools. In the process, annotations facilitate the purpose of classification (Abiodun, 2007), restructuring (Abiodun & Amos, 2006), or enumerating multiple ideas in an organized fashion (Simpson & Nist, 1990). Bringay et al. (2006) pointed out that to mark the logical structure of the document serves a higher concept as “To Remember”.
- “To Identify Connecting Ideas” is manifested for linking or associating something with another text through annotations. This function is related to text comprehension strategy (Moreland, Dansereau, & Chmielewski, 1997; Landow, 1996). The research

by Bringay et al. (2006) pointed out that “To Identify Connecting Ideas” serves a higher concept as “To Think”.

- For difficult narratives, this study found that the functions manifested are “To Recapitulate” (to restate thematic ideas or to recite briefly of the major points in a narrative) and “To Differentiate” (to distinguish or compare differences between things) as indicated by Abiodun and Amos (2006), which is found to serve a higher concept as “To Clarify”.

### **From the Review of Existing Tools**

From the review of existing annotation tools, multiple-color highlighting for different themes or different roles also serves the function of “To Differentiate,” as well as the dynamic display of sticky notes to place notes adjacent for comparison serves the function of “To Differentiate”.

This study found that underlining and highlighting longer passages is replaced by cursor tracing action and thus identified as a function manifested through a transient form, i.e., cursor tracing action does not leave a visible trace. Once the mouse highlighting is released the recall may quickly fade; however, it is argued here that other online annotation functions manifesting “Tracing Progress through Difficult Narrative,” such as to recapitulate and to differentiate, have the tendency to clarify and may manifest through different forms.

People create annotations online for communication (annotation role). Because of the potential of sharing annotations with others, the reasons people consider annotations for personal use include personal interest, don’t want to confuse people, uncertain about the interpretation, and need to update notes before sharing. For sharing annotations with others, people consider

the annotations should be an appropriate interpretation, helpful to others, they would like to know other's reflection, annotations are useful to a task, or there is a designated audience to share with. The dilemma is, on the one hand people want to see others' annotations, especially annotations from those considered as "experts" (e.g., teachers, famous authors, etc.); on the other hand, people tend not to share annotations that are not clear or not helpful to others. With a social annotation support mechanism, shared annotations might help communities locate points of consensus or controversy (Wolfe & Neuwirth, 2001). The role of annotation will be discussed in Research Question 5.

In all, some online annotation may take a style similar to scholarly text, in some sense this means that it mimics the static annotation process. Some online annotation forms need to be pre-defined or used with common awareness, and these forms signaling effects on text-processing. Some online annotation forms take the dynamic and flexible annotation formats and have no analogue in the print. Some online annotation forms bear role-oriented forms and functions, and some demand separation of private from public. The dynamic nature of computer use determines the forms provided and the functions supported, as well as the role of annotation supported.

#### **5.2.4.6 Summary of Research Question 4**

The question of what other forms online annotation might support is explored through the "wished-for forms" mentioned in the main study and the review of existing annotation tools and literature. The analysis results show features and forms found in annotation tools and the literature in addition to those supported by the ANNOLINK prototype. These features and forms shed some light on the existing online annotation forms supported in the digital environment.



The findings of other forms are summarized as follows. (1) Markings and typographical signals are found in the main study, existing tools, and literature. There is not much difference in the types of markings and typographical signals that users make on paper and electronic documents. (2) Predefined icons or symbols are found in the literature. Predefined icons or symbols signal opinions in personal view, and can be implemented to differentiate opinions and roles in the public view. (3) Overlapping highlights shown in variant tone densities signal aggregate frequencies. Overlap highlighting is used to differentiate different purposes in the personal view, and is also used to differentiate group highlighting in the public view. (4) Multiple-color highlighting is used for different themes for personal use, and multiple-color highlighting is also used to differentiate group highlightings in public view. (5) Label/Tag annotation for improving recollection is found in the reviews of tools and literature. (6) Role-attached forms emerge from online annotation. Some evidence found in the review shows that there is a role attached to annotation forms, either implemented as user-generated social forms (e.g., threaded annotations) or as system-generated social forms. System-generated social forms make use of many users' past interaction with the system to guide new users of the system, relying on the collective knowledge of a large community of users.

Suggested functions explored from other forms in the main study and the reviews are summarized as follows. (1) Overlap highlighting for personal use captures the concept "To Differentiate" or "To Compare." (2) Multiple-color highlighting for personal use or for sharing captures the concept "To Differentiate" or "To Compare." (3) Predefined symbols and icons for personal use or for sharing capture the concept "To Differentiate" or "To Compare." (4) Labeling/Tagging text passages captures the concept "To Label Segment," serving the purpose of looking for patterns in the text. In a community support environment, labels/tags need to be

pre-defined for sharing without ambiguity in meaning. (5) Threaded annotations are user-generated social forms and capture the concept “To Communicate,” and the comments need to be the focus of attention. (6) System-generated social forms may be presented in colors, tone density, and rating icons that capture the concept “To Differentiate.”

An Annotation Functions Typology was developed from the coding scheme to gain a holistic view of functions from coding protocol script. The initial list included five broad concepts collected from previous research, and these concepts have guided the coding of annotation functions. This typology is used to articulate annotation functions in a structural way to describe the relationships among those annotation functions. Marshall’s functions are found to have more elaborated categories, and other annotation functions exist because of the ability provided by computer features and a network environment. In addition, there is a communication dimension existing in annotation online. Applying the coding results (i.e., the frequencies of functions with respect to their forms) into this typology, it is discovered that the annotation functions manifested shift in different reading tasks.

### **5.2.5 Research Question 5**

#### **Do function and form vary by role?**

From the results of Chapter 4, this study finds, for sharing annotations with others, whether to a group or the public, people think the annotations should be appropriate interpretations, helpful to others, useful to a task; or the content is addressed to the intended audience to share with; or the annotations are aiming to invite other’s reflection. Hence, there is a communication dimension of online annotation functions.

Previous studies showed the practice of sharing marginalia is hardly new. Medieval manuscripts allow readers to write comments in any of the four margins of the page as well as between the lines of the primary text. Genette (1997) pointed out that medieval readers used annotations to bridge the explanatory gap between the meaning of the text and the reader's interpretation, and writing annotations became a strategy to influence other readers. The annotations served for a better comprehension of the text and a more precise reading. As Wolfe (2008) pointed out, early manuscripts were expensive and the number of copies was limited, so many readers made use of a single copy, and any annotations to that copy were automatically public to all. Marshall (1998) found that some people seek the "dirtiest," i.e., most annotated copy available, because they consider previous readers' annotations valuable. Marshall (1998) also indicated that most annotations are initially created for personal use, and not for the public. In printed documents, annotations are shared through changing ownership of the physical copy. To the annotation readers, the annotation writers are anonymous.

From the findings, evidence shows that personal annotations and shared annotations may have different characteristics reflecting the annotation writers' various reasons for sharing or purposes of creating them. Most annotations are created for personal use, and for those annotations intended for sharing with others, whether a workgroup or the public, the forms must be evident or self-explanatory in some way to be either useful or helpful to others. The results of this study determine that annotation functions and forms not only vary by role, but also have different characteristics in sharing.

#### **5.2.5.1 Functions Vary When Sharing**

**Overall, most functions are considered more useful for personal use, and for sharing with a workgroup, but less useful when sharing with the public (see Table 4.11 in Chapter 4).**

In addition, the findings in 4.2.5.2 Investigation on Functions Varying by Role indicate that the same annotation function may vary by role, and individual comments from the verbal protocols show that annotation functions vary by different reasons to share (see Appendix 13). A further discussion about the reasons of sharing or not sharing in relation to annotation functions is discussed in the following.

Table 5.10 shows the reasons for “sharing” annotations with others fall within three categories. Shared annotation should be: first, made to indicate related resources; second, made to ask questions, ask for comments, or to spark debate; and third, annotations made to share personal insight on associated text (see Appendix 13). The rationale for “not sharing” annotations is two-fold. First, the annotations are either created out of personal interests or for personal use, and hence those annotations are most likely not shared. Second, the annotations are considered unclear (it is perceived that may confuse other people, have typos, or that others won’t understand them), be counterproductive (they may distract or impose the annotator’s ideas), or are not perceived as useful to others (see Appendix 14).

Table 5.10 Functions in relation to share and not share in the verbal protocols  
(√ means evidence is found; - means no)

Function	Share			Not Share	
	Share personal insight on associated text	Ask questions; Ask for comments, Spark debate	Indicate related resources	Personal interest or Personal use	Unclear; Not helpful or useful to others
Procedural signaling	√	-	-	√	-
Interpretation	√	√	-	√	√
Place-marking	√	√	-	√	√
Incidental reflection	√	√	√	-	√
Problem-working	-	-	√	√	-
Connecting ideas meaningfully	-	-	√	-	√
Tracing progress through difficult narratives	-	-	-	-	-

There are multiple reasons to share or not to share in relation to the annotation functions such as “Incidental Reflection,” “Recording Interpretation,” and “Place-marking.” The annotations manifesting the “Procedural Signaling” function are viewed as for personal use, and viewed as providing personal insight on associated text if shared with others. Annotations of the “Problem-working” function may indicate some work with related resources; however, they are also viewed as for personal use. The annotations manifested the “Linking Ideas Meaningfully” function may indicate external related resources; however, if this supplementary information is unclear or not useful then they are not intended to be shared. The “Tracing Progress through Difficult Narratives” function is manifested through mouse highlighting and could not be identified in the verbal protocols, but only through the observations and Morae recordings, and thus there is no evidence of sharing.

This study finds that usually there is a specific purpose for sharing annotations with a group, and the annotation writers hope the annotation readers can benefit from their annotations. Annotated books were commonly shared by circulating within specific communities of users before books have been produced in large-scale printing (Jackson, 2001, cited in Wolfe, 2008, p.146). Sharing with a workgroup suggests some purpose is involved; for example, some participants anticipate using annotations to work on a project together with a work group. Neuwirth, Kaufer, Chandhok, and Morris (1990) suggested that the most important purpose of shared annotations is the fine-grained exchanges among co-authors creating a document. Wolfe (2008) argued that annotations were also pedagogical in that they were crucial in teaching students how to read by inducting them into the thoughts and habits of a particular community of readers. Chen and Chao (2008) observed that shared annotations mainly include identified key points, asked questions, and supplementary information suggested by others. Marshall and Brush (2002) found that the intended use changes the actual content of the annotations. They

also noted that personal annotations usually reflect unselfconscious reactions to reading material, while public or shared annotations on a document reflect specific communicative intent (Marshall & Brush, 2004).

#### **5.2.5.2 Forms Vary When Sharing**

The findings in 4.2.5.3 indicate that forms vary by role in terms of sharing or not sharing. It is observed that the forms shared with a group or the public have different reasons. The discussions of the characteristics of sharing reasons in terms of each annotation form are in the following.

#### **Highlighting needs to be made on main points or keywords when sharing.**

Findings in Chapter 4 (Table 4.14) indicate 42 percent of highlights are not intended to be shared with others. The reasons for keeping highlights for private use include: highlights are idiosyncratic and are not helpful to others because their purpose is not immediately evident to other people, and therefore, some participants feel it is not worthwhile to share highlights with others.

Table 5.11 sheds some light on the characteristics of sharing highlights. An interesting observation is the difference in the text patterns highlighted when sharing. Most participants would share highlighted keywords with the public, and one participant commented that she would only share with anonymity and the shared highlights must be counter arguments, examples, or elaboration, etc. Highlights on important names and main points are judged appropriate to share with a work group; however, some participants think the highlightings may distract people, or that further interpretation is needed before sharing.

Table 5.11 Characteristics of sharing and not sharing highlights

Share				Not Share
Unconditional Sharing		Conditional sharing		
Group	Public	Group	Public	All Conditions
<ul style="list-style-type: none"> <li>• Highlighting names and main points is important or may be helpful to other group members (17 of 38)</li> <li>• Open to group discussion (1 of 38)</li> </ul>	<ul style="list-style-type: none"> <li>• Highlighting keywords (9 of 21)</li> </ul>	<ul style="list-style-type: none"> <li>• Share, but need to add interpretation (4 of 38)</li> <li>• Share, but may distract people (4 of 38)</li> </ul>	<ul style="list-style-type: none"> <li>• Share (the highlights must be counter argument, example, or elaboration), but with anonymity (7 of 21)</li> </ul>	<ul style="list-style-type: none"> <li>• Something of my own, not worth to share with others (18 of 73)</li> <li>• Not immediate evident to people (16 of 73)</li> <li>• Not helpful to others (9 of 73)</li> </ul>

**Notes content needs to reflect its intended use when sharing.**

Findings in Chapter 4 (Table 4.15) indicate 55 percent of notes would be shared with others. Sharing notes is viewed as appropriate across all roles with 93 percent of participants' ratings viewed as useful in the personal role, 77 percent in the workgroup, and 77 percent for the general public (See Table 4.12 in Chapter 4). Very similar to highlights, the content of notes needs to be evident and explicit to the intended audience when sharing.

Table 5.12 Characteristics of sharing and not sharing notes

Share				Not Share
Unconditional		Conditional		
Group	Public	Group	Public	All Conditions
<ul style="list-style-type: none"> <li>• Open to discussion (24 of 64)</li> <li>• It's important [for group members] to know this comment (5 of 64)</li> <li>• It's an indication for further exploration (5 of 64)</li> <li>• This [note] points out main point (5 of 64)</li> </ul>	<ul style="list-style-type: none"> <li>• Updated information for people (2 of 66)</li> <li>• People might be interested (1 of 66)</li> <li>• [That's] my little comment; share as it is; that's me saying wow! (1 of 66)</li> <li>• Let people comment about that (1 of 66)</li> </ul>	<ul style="list-style-type: none"> <li>• Share, but need to revise my notes (15 of 64)</li> </ul>	<ul style="list-style-type: none"> <li>• Share, but need to revise my notes; write more in them, add a little more context to them (29 of 66)</li> <li>• For people who doesn't know much about the article is helpful (14 of 66)</li> <li>• Share, but with anonymity (11 of 66)</li> <li>• I need to do a little bit research on that, if I can't find extra, I will take that out (5 of 66)</li> <li>• It's just a general question [I have], may be the community could clarify or contribute to this note; otherwise I don't know I want to share with others (2 of 66)</li> </ul>	<ul style="list-style-type: none"> <li>• A comment of my own opinion or my own speculating, [that I want to] keep it to my self (31 of 103)</li> <li>• No one but myself would understand; my own system to follow up (23 of 103)</li> <li>• Not helpful to others; might distract or confuse people; not sure people would be interested to see [my notes]; not immediate evident to people (11 of 103)</li> <li>• That's a personal note (8 of 103)</li> <li>• There's a typo, so I don't want to let others see it before I proofread my annotations (7 of 103).</li> <li>• For my own use: a definition, a conversation with the author (2 of 103)</li> </ul>

Table 5.12 shows, in general, notes need to be revised before sharing, whether with a workgroup or the public, although some participants commented that if notes are shared with the public it is helpful to add a little more context for those who do not know much about the content. On the other hand, notes intended for open discussions with a group may be shared without context information. The reasons given for not sharing notes included a sense that the notes



were the annotation writers' own speculations and idiosyncratic comments. Some participants think others may not be interested because their notes may not be helpful to them, suffer from a lack of clarity, distract or confuse people, or may contain typos.

### **Linking needs a description of the linking relationship when sharing.**

Linking is judged appropriate across all groups, although viewed as slightly more applicable for workgroups and the public (Table 5.2). Furthermore, linking alone does not give a clear indication about the relationship of linked ideas. Linking needs a description of the linking relationship when sharing.

Table 5.13 Characteristics of sharing and not sharing links

<b>Share</b>				<b>Not Share</b>
Unconditional		Conditional		
Group	Public	Group	Public	All Conditions
<ul style="list-style-type: none"> <li>• [I want to] create more links for sharing (5 of 8)</li> </ul>	<ul style="list-style-type: none"> <li>• Wouldn't mind to share my links; let others know about the linking to the supplement information (1 of 13)</li> </ul>	<ul style="list-style-type: none"> <li>• Need to write more in notes [explaining the linking relationship] (3 of 8)</li> </ul>	<ul style="list-style-type: none"> <li>• Need to write more in notes [explaining the linking relationship] (7 of 13)</li> <li>• Links may be quite useful, they are like people's path of thinking. (5 of 13)</li> </ul>	<ul style="list-style-type: none"> <li>• [The linking] is my own noting system or my own speculating (8 of 11)</li> </ul>

Findings from Table 5.13 show some participants commented that they would create more links for sharing with a workgroup just for pointing out related Web information. For sharing with the public, most participants wouldn't mind sharing their links to let others know about related resources. Some participants think that links may be quite useful because they reflect people's trains of thought. Although linktypes are useful indications of what kind of relationships exist between two text segments, it is necessary to supplement the Linking components with clear descriptions explaining the linking relationship.

**Linktyping as a form of tagging needs shared understanding of its meaning within a group when sharing.**

Linktyping is seen as useful when sharing with others (see Table 4.12 in Chapter 4).

Whether Linktyping is used to describe the linking relationship or as a form of making a note about the base text, it is viewed as a form of tagging. The meaning of a linktype needs to have shared understanding to make it a useful label.

Table 5.14 Characteristics of sharing and not sharing linktypes

Share				Not Share
Unconditional		Conditional		
Group	Public	Group	Public	All Conditions
<ul style="list-style-type: none"> <li>• [Linktype] doesn't impose anything (8 of 39)</li> <li>• Useful labels [linktype-Alternate View; linktype-Application] (4 of 39)</li> <li>• It's helpful for group members just scanning through examples [linktype-Example] (1 of 39)</li> <li>• This [linktype-Explanation] indicates this sentence is a main idea (1 of 39)</li> </ul>	N/A	<ul style="list-style-type: none"> <li>• Share, but delete Alternate View (8 of 39)</li> </ul>	N/A	<ul style="list-style-type: none"> <li>• [It's like] a form of tagging system (5 of 7)</li> <li>• Not sure that's helpful to others (1 of 7)</li> <li>• Not sure about the meaning of Alternate View (1 of 7)</li> </ul>

Table 5.14 indicates Linktyping is viewed as not suitable to share with the public.

Participants think that linktypes don't impose the annotator's ideas on others, and some linktypes, such as Example and Explanation, are considered as useful labels and are helpful for group members scanning the article for examples or indications of the main idea. It is also observed

that if a user is not sure about the meaning of a linktype, is not sure it is helpful to others, or considers the linktype as a form of labeling/tagging, the linktype (for example, Alternate View) would be deleted when sharing with others.

### **5.2.5.3 Discussion of Role-Attached Social Forms Found in the Existing Annotation Tools and Research Literature**

It is noted that the nature of the online environment encourages a perspective of sharing annotations with others. In Research Question 4, the review of existing annotation tools shows some online annotation forms can be exploited to exhibit social annotation support forms, which helps communities locate points of consensus or controversy.

#### **Role-attached forms carry a purpose of communication when creating annotations online.**

In Research Question 4, the main study shows people do carry a purpose of communication when creating annotations online. The content may be addressed to the intended audience, or the annotations may aim to invite others' reflection. The review of annotation tools shows some annotation tools support private and public annotations and some tools allow the users to create groups with whom they would like to share their annotations. Hence there are roles – private or public; or “mine” as personal; “our” as group, and “their” as public – attached to the annotation forms created. Role-attached forms such as multi-color highlighting, threaded annotations, and role-attached icons are discussed in the following.

**Multi-color highlighting needs pre-defined roles reflecting the “To Differentiate” function when sharing.**

Multi-color highlighting, for example, as a form of annotation, may indicate different themes in a personal annotation tool environment and/or “community highlights” in a shared environment, where it serves to distinguish or compare differences between things (Abiodun & Amos, 2006; Villaroel et al., 2006), i.e., the function of “To Differentiate.” Some tools such as Notate and Zoho Notebook support a color tool-box for changing highlight color, but there is no pre-defined color scheme for different themes. With this type of annotation form, people can carry their habit from print to online environment. As with linktypes, unless there is a consensus on the meaning of color schemes, this form exists more as a personal annotation form. However, some annotation tools use multi-color highlighting indicating “community highlights” in a shared environment. For example, HyLighter uses colors to distinguish the annotation role representation (theirs, ours, and mine highlights). Community highlights allow a user to quickly survey a page and spot the most frequently highlighted parts of the text as validated through the community, and this technique may also lead users to create consensus on which parts of a page are important as viewed by a group and/or the public.

**Threaded annotations need a mechanism to focus the attention on the comments when reviewing others’ comments and replying.**

Threaded annotations contain a link back to the original article being commented on, the full text of an annotation (consisting of poster’s username, date and time), responses, the capability to flag a post, and the capability to respond to the post. The highlighted or numbered passages in the document serve as “anchors” for specific threads, and form links between discussion and content. Threaded annotation in a shared environment is a kind of social form created by the users. Threaded annotation design has been implemented to support a follow-on

comment additional to the original comment (a reply) for shared annotation. In the review of existing online annotation tools, it was found that HyLighter, Diigo, Notate, CommentPress, and EDUCOSM support this form of annotation.

Online discussion systems face a tradeoff between focusing attention on threaded comments or on the document being discussed. Brush et al. (2002) concluded that the comments might better be the focus, when reviewing others' comments and replying. Evidence suggests that the toggle on/off annotations to have the control of display, identified from the "wish list," manifests the function of "Focus of Attention," and enables users to choose whether to focus on the text or the comments.

### **Iconic stamp representing private use needs to identify its ownership when sharing.**

Another example of role-attached social form has been implemented to support icons to mark the ownership of notes. In ICDL (Kaplan & Chisik, 2005b), after selecting an icon, the reader clicks on a spot on a page – either within the text or in a margin – where he/she wants to leave a mark or a note. A virtual sticky note appears beside the icon, inviting an annotation. The user can, however, choose to leave the mark without adding any commentary. A "lock" icon in the upper left corner of the virtual sticky shows that the annotation and its iconic stamp are private. A private note can be edited or elaborated upon, its icon can be moved to another location, or it can be deleted. Once it becomes public, however, a stamp and its accompanying note can no longer be edited, deleted or moved. To make an annotation public, the participant clicks on the lock, opening it to signify that it will become public once the author closes the note by clicking the X in the upper right corner (Kaplan & Chisik, 2005b).

**System-generated social forms are a form of social validation through the aggregate information, as well as social navigation where the actions of others guide activity of others.**

When sharing annotations with others, people believe the annotations should be appropriate interpretations of the text, helpful to others, or useful to a specific task, which gives a form of validation. On the other hand, people want to see others' annotations that are useful to their task, especially annotations from those considered as the "experts," which also help to validate others' annotations. Based on the annotation activities of the users, system-generated social forms offer more reliable evidence of annotation importance than simple visitor count. System-generated social forms have been implemented through the availability of aggregation information in online annotation.

The main study shows that some people are quite hesitant to share their annotations with others. The review of existing annotation tools shows some aggregation implementations have been implemented in highlighting, note-making, labeling/tagging, and linking. System aggregated information occurs as an effortless side effect of just using the system and can be aggregated into a concept of "traffic on a page." This information scales well and avoids privacy issues because it aggregates contributions from many people (Dieberger & Lonnqvist, 2000). System-generated social forms, in a way, are a form of social navigation (Munro et al., 1999; Dieberger, 1999), where the actions of others guide the activity of others. Borrowing from the Social Navigation theory (Dourish & Chalmers, 1994), Bateman, Farzan, Brusilovsky, and McCalla (2006) called it Social Annotation Support.

#### **5.2.5.4 Discussion of New Functions Manifested through Role-Attached and System-Generated Social Forms**

The aggregate information of annotation forms provides a previously-unanticipated benefit in the future-- getting attention, i.e., the “Social Signaling” function (Ames & Naaman, 2007), as a way of exploiting the socially- and locally-situated annotation sharing. Furthermore, the overall attitude of the community to the annotated text and annotations can be computed as a social validation of the annotation content; as a result, the “Social Validation” function is proposed by Cabanac, Chevalier, Chrisment, and Julien (2005; 2007) to filter useless annotations. These social forms of annotation have been implemented out of original annotation forms and manifest the “Social Signaling” function as well as the “Social Validation” function.

#### **Pre-defined icon or symbol needs to bear rating for aggregating to signal importance when sharing**

Icons are similar to [marginal] symbols, which are used for signaling a point to be remembered (Bottoni et al., 2003). They are only useful when the meaning of icons or symbols were set forth beforehand to be readily understandable by users. The telegraphic markings made in print documents usually are a personal opaque coding scheme; however, in shared annotation systems a set of pre-defined symbols acting as typographical signals is important.

For sharing annotations, some evidence suggests that in online annotation the icons or symbols implemented are pre-defined such as in ICDL and AnnotatED. These icons or symbols bear rating of the text selections and can be aggregated to signal the “community view” of positive or negative ratings. For example, in AnnotatED, a thermometer has been implemented to indicate the aggregated reflections of icons from shared annotations, the higher the temperature the more positive ratings the text selection receives.

**Highlight aggregation needs visual affordance to signal importance when sharing.**

In some systems overlapping highlights (and associated notes) of others may be shown in the document (i.e., the individual reader can turn on the public view of the article). Overlapping highlights show how two or more users share consensus on relevance of various text passages (Shipman et al., 2003; Bradshaw & Light, 2007), and thus indicate a level of social agreement on the important (or problematic, interesting, etc.) components within the overall corpus.

Highlights in public view allow the readers to visualize the concentration of community highlights, either by calculating the overlap of highlights in the text or by the number of users other than the current user.

Highlight density is a tone variation strategy in the same way as it is described above for overlapping highlights in the personal (private) view. Villaroel et al. (2006) showed the more intense the tonality of the background the more important or frequently highlighted the text is, and concluded that the strategy of varying color tonality has been demonstrated to be useful. Instead of using tone density, ANNOLINK flags the consensus in number. By clicking on the number displayed in the left margin it shows others' annotations created within the same paragraph. The community highlights allow a user to quickly survey a page and spot the most frequently highlighted parts of the text, and studies showed that this technique may also lead users to create consensus on which parts of a page are important.

The Open Annotation and Tagging System (OATS) (Bateman et al., 2006) and CoREAD (Chiarella & Lajoie, 2006) support the “community highlights.” OATS (The Open Annotation and Tagging System) uses four levels to visualize the concentration of highlights: (1) none (no highlights), low (1 to 3 highlights), medium (4 to 8 highlights), or high (9 or more highlights).



In Bateman et al.'s (2006) research, OATS translates the concentration into different shading of highlights (tone density) within the text, where light is the lowest and dark is the highest concentration of highlighting. Such social information could relate to the social view of importance of the content. The visualization of highlighting studied by Villaroel et al. (2006) indicates there are two common activities in the visualization of shared highlights: (1) comparing annotations from different users and (2) observing relevance levels calculated from the number of coincidences of highlighted fragments.

**Note aggregation needs to give social validation on the content of notes when sharing.**

The ANNOLINK prototype used in the main study displays “the number of notes published to the public” in the left column once an annotation writer toggles the annotation to share with others. Clicking on the number allows the reader to see those shared notes in the right column. However, the number of notes does not manifest a social validation function. The review shows a number of annotation tools have the ability to aggregate notes written by others with validation information. AnnotatEd (Farzan & Brusilovsky, 2008a) is able to make public and private annotations with an “Annotation Icon” (praise, problem, or general note) attached. Furthermore, in order to motivate students to share feedback with their classmates, students can choose to sign notes or to keep them anonymous. In shared notes, the background color (three color levels) of the Annotation Icon represents the magnitude of group annotation activity and the color of the foreground icons (two color levels) represented the density of individual notes (Farzan & Brusilovsky, 2008a, p.16). A thermometer icon was added to present the “overall temperature” of the annotations made by the group of students; the temperature grew warmer when a page attracted more positive annotations and colder when it attracted more problem-type annotations (Farzan & Brusilovsky, 2008a, p.18).

**Label/Tag aggregation needs visual affordance to signal a heated topic when sharing.**

Labeling/Tagging represents an action of reflection, where the tagger sums up a series of words into one or more summary tags, each of which stands on its own to describe some aspect of the resource based on the tagger's experiences and beliefs (Brooks et al., 2006). Collaborative tagging makes use of a community's public annotation of resources using keywords that describe those resources (called tags). Each tag is both an annotation to describe the resource and a vote for the annotation being suggested to others. A tag cloud is often used as a stylized way of visually representing occurrences of words used to the described tags.

**Link Aggregation needs social navigation support to encourage link traverse to higher-activity annotations when sharing.**

Social navigation support (SNS) techniques are based on the social navigation theory (Dourish & Chalmers, 1994), which defines social navigation in information space as "moving towards cluster of people" or "selecting subjects because others have been examining them." SNS technique makes use of past users' interactions with the system to guide new users of the system and relies on the collective knowledge of a large community of users.

AnnotatEd system provides two types of SNS: traffic-based and annotation-based. Traffic-based SNS relies on the traditional footprints concept in social navigation (Wexelblat & Mayes, 1999). It generally provides information about the number of visits users have made to each link. Traffic-based SNS promotes links that have a higher number of visits. For example, Dieberger and Lonnqvist (2000) modified the collaborative web known as the CoWeb to visualize traffic-based social navigation. The system tracks how often a page is accessed or modified. It visualizes the density of the aggregated access for the past 24 hours by applying three levels of color intensity to the footprint symbol. Annotation-based SNS provides stronger

support by employing the annotation activities of the users instead of the number of visitors. These systems promote links to pages annotated by users, especially pages with higher number of annotations or positive annotations. For example, Educo (Kurhila, Miettinen, Nokelainen, & Tirri, 2002) provides an annotation tool that allows learners to associate comments with a document. It provides simple annotation-based SNS by keeping track of when comments are modified and visually demarcates new comments.

#### **5.2.5.5 Summary of Research Question 5**

There appears to be evidence that annotation functions and forms not only vary by role, but also have different characteristics in sharing. The results show that functions vary when sharing, and reasons to share or not to share are discussed.

Forms are used for different reasons when sharing. Highlighting needs to be made on main points or keywords when sharing. The content of notes must reflect its intended use when sharing. Linking needs a description of the linking relationship when sharing. Linktyping as a form of tagging requires shared understanding of its meaning within a group when sharing. There are two types of role-attached forms: user-controlled and system-generated. User-controlled social forms are used for the following reasons: (1) Multi-color highlighting needs pre-defined roles reflecting the “To Differentiate” function when sharing; (2) Threaded annotations require a mechanism to focus the attention on the comments when reviewing others’ comments and replying; and (3) Iconic stamp representing private use must identify its ownership when sharing. System-generated social forms have been implemented out of original annotation forms and manifest the “Social Signaling” function as well as the “Social Validation” function. System aggregated information occurs as an effortless side-effect of just using the

system and can be aggregated into a concept of “traffic on a page,” where the actions of annotation writers guide the activity of readers.

New functions are manifested through role-attached and system-generated social forms. For example, a pre-defined icon or symbol needs to bear a rating for aggregating to signal importance when sharing. Highlight aggregation needs visual affordance to signal importance when sharing. Note aggregation gives social validation on the content of notes when sharing. Tag aggregation requires visual affordance to signal a heated topic when sharing. Lastly, link aggregation needs social navigation support to encourage link traverse to higher-activity annotations when sharing.

### **5.2.6 Research Question 6**

#### **What are the perceived values of the use of online annotation?**

In Chapter 4, findings of the post-session questionnaire show that overall, online annotation is very useful to users. The Perceived Values Questionnaire analysis indicates positive acceptance of annotation online. However, the findings also reveal that some improvements need to be made for users to accept annotation online. The episode analysis identifies reasons of “value” and “difficulty” that account for the acceptance of annotation online. The Perceived Values results in conjunction with reasons of “value” and “difficulty” suggest that the acceptance of online annotation involves both perspectives as annotation-writers and as annotation-readers. This section discusses the findings and the annotation author-reader relationship.

### 5.2.6.1 Discussion of Perceived Values Revealed from the Questionnaire

**The results from the Perceived Values questionnaire indicate some improvements are required to increase the acceptance of annotation online.**

In Chapter 4, upon close examination of the more critical participants' responses, some perceived values ("Increase annotation productivity," "Make reading online easier," "Make annotation online easier," "Make online annotation flexible to interact with," and "Find the annotation tool is easy to use") show lower likelihood to be accepted by users, and may require further improvement to increase its technology acceptance. These perceived factors suggest that people want to produce more annotations while reading without blocking the reading flow. They also want the features to be visible and the work of editing annotations to be easier. From the annotation writers' perspective, they would find an annotation tool easier to use if these perceived factors were supported.

The participants are likely to use online annotations in the future. The findings show that for future use they think positively that online annotation would "Improve my performance in reading online," "Enhance my effectiveness on reading online," "Be useful for reading online," and that they would "Become skillful at using it" that accounts for the likeliness of use online annotations. These perceived factors suggest that participants think positively about the future use more from their perspective as annotation readers. On the other hand, for future use the participants have more concerns from the perspective as annotation writers. They would be more likely to use annotation tools, if improvements are made in the following seven perceived values: "Accomplish my tasks more quickly," "Increase my productivity," "Make reading online easier," "Operate online annotation would be easy," "Find online annotation flexible to interact with," and "Find online annotation easy to use." The next section discusses the findings of each

perceived value (except perceived future use) identified in the transcript data.

#### **5.2.6.2 Discussion of Perceived Values Revealed from the Transcript Data**

**The results from the episode analysis verify the perceived values, and provide the reasons for accepting annotation online.**

In Chapter 4, to explore the perceived “usefulness” and “ease of use” values from the participants’ experience in using the ANNOLINK prototype, each of the twelve perceived values, except perceived future use, was used as the baseline criteria for identifying episodes of reasons in the transcribed protocols. Episodes were then grouped into sub-categories under the “value” and “difficulty” aspects. In terms of whether online annotations would “improve my performance in reading online,” some evidence suggests that, for personal use, marginal notes provide the context and summarized notes help to focus the attention in future reading, as long as annotated texts do not distract the reader. The close proximity to the annotated texts and the format of presentation without blocking the reading flow may improve readers’ performance in reading online. In a shared environment, the ability to turn annotations selectively on/off or share selectively with different audiences also suggests the relation to the reading flow.

In terms of whether online annotations would “enhance my effectiveness on reading online,” some evidence suggests that the content of annotations must be evident to readers. This applies to annotations for both personal use and sharing with others. “Insightful comments” is favored the most; however, the credibility or trustworthiness of annotations is also considered important. In addition, annotations should “Support online reading engagement” and “Support multi-colors for different topic schemes” for effective reading online.

In terms of whether the participants find online annotations “useful for reading online,” the results suggest that most of them favor the capabilities of the linking component. Participants not only favor linking passages between two papers, but also linking within a paper, as well as to supporting two-way links. The linking component inherits the disadvantages of hypertext -- disorientation and cognitive load. The ability to preview the target’s citation information and to direct the linking pinpointing at the highlighted target passage must be evidence to the readers; otherwise, the linking causes difficulty for the readers. Again, the fact that the linking component’s tool-tip window blocks the reading flow is noted.

This research question asks: what are the perceived values of the use of online annotation? The participants think positively that online annotation would “improve my performance in reading online,” “enhance my effectiveness on reading online,” “be useful for reading online,” and “allow me to become skillful at using it with practices” which accounts for the likelihood of use of online annotations. Although there are learning curves in using the ANNOLINK prototype, some evidence suggests that with more practice users would “become skillful at using online annotation”.

Although the Perceived Values questionnaire analysis shows that “using online annotation in my online reading would enable me accomplish tasks more quickly” is less highly favored, episode evidence shows that the participants think that the improvements in the ability to annotate online, to search annotations, and support *in situ* discussions would be useful to accomplish their active reading task more quickly. In terms of “using online annotations in my reading online would increase my productivity,” the participants like to use the linktype to consistently label the annotation. However, the difficulty in choosing the appropriate linktype slowed down their reading and annotating.

A lot of improvements need to be made to improve the perception that “using online annotations would make it easier to do my reading online.” For example, annotated texts should not distract the reading flow, and the disorientation and cognitive load caused by linking should be minimized. In addition to the evident system limitations on annotating graphics, highlighting length, note-making and note length, linking, and adding new linktypes, the lack of graphical tools to draw arrows, for example, is among the major issues affecting online annotation to be flexible to interact with.

There is a learning curve in using the annotation tool system, and tool-tips and a help function should be provided to make learning to annotate online easier. The participants perceive the ease of use in the editing of annotations whenever they want to, but they demand the Undo feature. In a shared environment, they think that it should be easy to get the online annotation tool to share annotations selectively with different audiences and to differentiate public annotations from private ones.

Finally, to make an online annotation tool easy to use, the features must be visible to users to minimize system malfunction caused by unfamiliarity, and must avoid tedious movements in using a system tool.

#### **5.2.6.3 Perceived Values in Relation to the Design for Annotation Online**

**The perceived values of annotation online reclaim the design goal for online reading-writing activities of engaging people in active reading.**

The findings of this study show that annotation while reading, different reading tasks, and using annotations are intertwined. In different reading tasks, readers choose to make annotations according to something that they have read, linking it to other texts, and they may



change their texts in deep reading. “Annotation as Writing vs. Annotation as Reading” (as a continuum) was identified in Marshall’s research (1998) as one dimension of annotation functions. Bizzell (1982, cited in Amitay, 2001, p.38) found that when people write, they employ not only their knowledge about the medium and its audience, but also their experience as online reader. While reading a document, the reader is scribbling some comments or highlighting a group of words, which helps the reader to build his document perception, his mental representation of its content. Bringay, Barry, and Charlet (2004) discussed how the annotations facilitate annotation writers’ reading, and carry further interpretations of documents. Annotation writers use the annotations to incorporate their knowledge as they process the information contained in the document. According to Bringay et al., annotations used to facilitate reading allow the addition of information relative to the annotation writer’s original point of view on the document. The reader becomes the writer. They also pointed out that the important thing about annotation online is how easy it is to write something out of the base text and how little it interrupts reading.

This study also shows that annotation online is closely related to textual cue and structure with respect to reading tasks. The findings suggest that different reading tasks and the material characteristics of physical documents affect how people perform the physical act of reading-writing online. Bringay et al. (2004) pointed out that the reader uses annotation to appropriate the document, and to rewrite it according to the wished use while reading along the text. From this perspective, the reader becomes the author of his reading. Goldman, Saul, and Cote (1995) suggested that while readers could use the conventional paragraph structure to facilitate the reading process, interpretation of the content requires the interaction between the information in the text and the readers’ prior knowledge. These findings suggested that people look for familiar

patterns in the writing to increase the effectiveness of looking for the important bits of information in the text.

Overall, this study shows ease of use is constantly an issue to authors when annotating online, and usefulness of annotation is also a major concern to readers. When designing for reading technology, Marshall (1997) suggested annotation should interrupt reading as little as possible. The findings of the perceived values of online annotation show that when annotating online the reader and author roles are converged, where the reader becomes an author writing annotations and the author becomes a reader using the annotations at the same time. When the reader-author reads electronic documents, he/she suffers from many difficulties. The reader is often disorientated by too many requests (e.g., buttons, links), which overload his memory. Bringay et al. (2004) reported that after an interruption, critical text information must be reconstructed in order to successfully continue the development of the memory of where the readers are in the text. On the other hand, the reader-author must be able to add knowledge resulting from his inspiration of the moment. The possibility of writing during the reading determines the type of the reading. Collecting, combining, and rewriting modify the strategies used during the reading of the documents.

In addition, the previous findings show that some annotations are created for an intended audience and for sparking discussion. Findings of this research question also show that it is the usefulness or value that justifies the sharing of annotation. Annotations created during the reading can be consulted later by the annotation writer or another reader. These annotations may assist a fast second reading of the annotated document. However, when the acts of annotation and reading are distant in time, as Participant 14 mentioned, the annotation writer might even have difficulty to understand what he had written. In addition, if the reading objective is

different, the reader would interpret the document differently and may have a different context in which the annotations could be interpreted. For annotations to be useful or of value to share with others, personal annotations need to go through the process of writing: plan the activity, translating the ideas into text, and edit the content to be clear to the readers. As Marshall (2002) pointed out, personal annotations need to go through substantial re-writing to share with others. The desired functionality must accommodate the reader-author to gradually rewrite the results of active reading later in time.

The findings for this research question suggest that ease of use is a determining factor of the acceptance of the online annotation tools. For example, the participants showed cognitive load in creating links, and some participants showed difficulty in using the annotation tool. The features should always be visible to the readers and should not weigh users down with a steep learning curve and overly technical process before users can make annotations. In online annotation, as a means of active reading, the content should be evident to the readers, the form should support engagement in reading online without blocking the reading flow. Online annotation takes the form of hypertext and inherits the disadvantage of disorientation and cognitive load. The use of online annotations may be preferred by readers, and may be viewed as useful and even easy to use; however, the likeliness to use online annotations in the future requires a number of improvements. The perceived values of annotation online reclaim the design goal for online reading-writing activities of engaging people in active reading.

#### **5.2.6.4 Summary of Research Question 6**

The overall opinions of the participants about annotation online from the Perceived Values questionnaire analysis indicate that they think online annotation is very useful. However,

some improvements are required to increase the acceptance of annotation online. The perceived factor analysis suggests that people think more positively about the future use from their perspective as annotation readers, but they express more concerns from their perspective as annotation writers.

The results from the episode analysis verify the perceived values, and provide the reasons of accepting annotation online. The findings of the “value” and “difficulty” episodes in the transcript data confirm that these perceived values are the factors of concern in the annotation reader-author experience. To promote the use of online annotations, the annotation reader-author perspectives need to be considered, and the acceptance of an annotation tool is also affected by the satisfaction of the reading-writing technology supported. The findings of this study show that annotation while reading is intertwined with different reading tasks and using annotations. Most importantly, the perceived values of annotation online have implications for the design for online reading writing activities of engaging people in active reading.

### **5.3 Summary of Chapter 5**

This chapter presents a discussion of the findings of the main study, and compares and contrasts them with the results of a review of existing annotation tools and literature. The discussions are arranged according to the six research questions. In Research Question 1, the naked-eye examination of “online annotations remaining on the screen” is discussed. There is no exact mapping as Marshall defined (1997), because of the functionality available and the changeability of forms and features in a digital environment.

Research Question 2 discusses how people adapt forms in various ways to implement function. Some forms may manifest multiple functions, and other functions and sub-functions

may exist. In addition, forms represent the visual appearance of annotations and they function similar to signal devices as discussed in the literature.

Research Question 3 discusses the findings of the examination of Linking and Linktyping in relation to text structure and text patterns. The intended functions of “Linking Only” and “Linktyping Only” are grounded in the information functions of signal devices. Linking and Linktyping manifesting the proposed “Linking Ideas Meaningfully” capture the concepts in accordance with the intended functions. In addition, Linking with a note may manifest more of “Recording Interpretation” beyond the “Linking Ideas Meaningfully” function.

In Research Question 4, from a discussion of the “wished-for forms” and the review of annotation tools and literature, other forms that online annotation might support emerge. These features and forms shed some light on the existing online annotation forms supported in the digital environment. An Annotation Functions Typology is developed through coding Marshall’s functions, the suggested functions and sub-functions found in the main study, and the results of review of annotation tools and the literature. This Annotation Functions Typology provides a holistic view of annotation functions. When applying this typology in interpreting the coding findings, it is noted that annotation functions differ in different reading tasks.

Research Question 5 discusses the preferences and characteristics in annotation forms and functions in relation to different audiences. The results of a review of annotation tools and literature are also discussed. It is noted that new functions are manifested through role-attached and system generated social forms.

Research Question 6 discusses the annotation author-reader relationship. Annotation readers and annotation writers are the same people, but may hold different opinions from their perspective as annotation writers and as annotation readers. This reader-author relationship in the process of reading and writing has been confirmed by prior research. It is also noted that annotation while reading is closely related to reading tasks and using annotations. For future use, participants think more positively from their perspective as annotation readers, but express their concerns from their perspective as annotation writers. The perceived values of annotation online suggest a key design issue is that writing annotation must not obstruct reading.

## **6 CONCLUSION**

### **6.1 Introduction**

The goal of this study is to empirically explore a broader understanding of what forms and functions facilitate the creation of an individual's online annotation while reading. It investigates how the forms and functions of online annotation differ from print, and the correlation of the form, function and role of annotation when reading actively online. Furthermore, the preference of the use of online annotations and the perceived values of online reading and writing which constitute the acceptance of annotation online are analyzed.

In this concluding chapter, the major outcomes of the study are summarized. First, these outcomes in terms of the overall research goal are highlighted. Second, a short reflection on the research procedures and techniques used in this study is given, and their adequacy assessed. Third, in light of the outcomes, a number of design heuristics that have implications for online annotation design and functionality are presented. Last, a number of recommendations are made for future research.

### **6.2 Highlights of the Study**

The purpose of this dissertation is to provide context for multi-dimensional research in digital annotation. By creating a digital annotation environment, this study addresses the research questions related to investigating the relative values (combining frequency of use and user rating) of combinations of form, function, and role. Furthermore, the study seeks to elicit from participants the perceived values of online annotation. The analysis of the data collected

from the participants in the study, along with the review of digital annotation tools and literature, reveals the following noteworthy outcomes in relation to these goals.

### **6.2.1 Summarization of Forms**

Annotation form represents the behavior associated with completing an annotation. Annotation forms can manifest themselves in various ways. In this study, it was speculated that online annotation tools that work best in a new reading environment are (a) those that do exactly what was done in the old environment, and (b) tools that can be exploited by using the network environment of the community. To understand what constitutes online annotation forms, this study sets out to gain a wider understanding of state-of-the-art annotation functionalities.

The understanding of online annotation forms is first based on the forms supported by one annotation tool (i.e., the ANNOLINK prototype) as shown in Chapter 4. A mapping of online annotation forms supported by the ANNOLINK prototype to forms presented in Marshall's original research provides a framework with which to begin the study. The annotation instances created in the main study (492 annotations in total) are analyzed by applying the mapping. The annotations are analyzed as the "manifest" content, i.e., as artifacts remaining on the screen. A wider understanding of existing online annotation forms is achieved by collecting the "wished-for forms" mentioned by the participants and by reviewing twenty-two existing annotation tools to identify functionalities other than ANNOLINK. Furthermore, it seeks out existing research literature to gain an insight into innovative annotation functionalities (e.g., social navigation support annotations) as discussed in Chapter 5. These findings constitute the understanding of online annotation forms that might be supported.



Based on the mapping, it becomes obvious that some of the forms are difficult to duplicate/represent in the other environment. The mapping framework reveals that some differences of annotation forms provided in an online environment are due to the availability of system features. Some online annotation forms resemble their counterparts in print environment. For example, markings and telegraphic symbols are found as the “wished-for forms” in the main study, and the literature review shows pre-defined perspective-taking markings and symbols are implemented by some tools. Multiple-color highlighting, as another example, is supported by some tools and can be applied idiosyncratically for different themes for personal use. Tag/label annotation for facilitating quick recall and organizing notes is found in the main study, and the reviews show that some tools call this pre-defined set of perspective-taking terms “annotation types” (e.g., Advice, Change, Comment, etc.). Some tools allow the reader to add subject terms to the note by choosing from existing terms or creating a new term.

It is also noted through review of existing annotation tools that some online annotation forms take advantage of the system’s ability to visually represent forms in different ways, which has no print counterpart. For example, highlighting can be customized to change the background color, to change from highlighting to dotted underline, or to a dotted underline accompanied by a change in font color across the fragment. Notes can be customized to have changing highlighting color when the mouse rolls over the associated based text, or the format of the original notes (e.g., marginal notes) can be changed to sticky notes or to inline notes.

Some online annotation forms are exploited by using the network capabilities of the user community. These online annotation forms may also take advantage of the change capability in visual styles of interface design. For example, multiple-color highlighting is also utilized to differentiate group highlightings (e.g., mine, ours, and theirs) in public view, which is not a

function in print. Furthermore, role attached forms are either implemented as user-generated social forms and/or as aggregated information generated by the system to show the concentration of use. Threaded annotations, as another example, are implemented as a user-controlled social form to allow communication between readers via annotations. Perhaps of great potential is the ability of system-generated social forms to be used in a form of social navigation found in the literature. The design of system-generated social forms takes various factors into account to calculate the collective knowledge of community intelligence for guiding new users of the system. Various factors might include the users' past interactions (e.g., relative amount of reading, highlighting, commenting, and threaded discussion activity associated with the document), the relative length of the document; and the number of perspective-taking annotations can be aggregated and calculated.

While comparing the mapping and examining the “manifest” content (annotations remaining on the screen), it is found that annotation forms are closely related to visual foraging of information and the theory of signaling. For example, visual foraging of highlighted text using eye-tracking (Chi et al., 2007) showed that a highlighted item isolated against a homogeneous background would be more likely to be attended to and remembered. Similar to an author's use of signaling devices (e.g., section headings, font style, etc) to aid readers in their attempts to follow a text's organization and to identify important text content, differences in the visual appearance of the annotation forms can be used as “signals” (Meyer, 1975) in processing the text (e.g., to attract future attention). Annotation forms in combination with annotating text types (e.g., headings) and text structures (e.g., topic sentence) are found, in some cases, to represent functions other than those represented by the form on its own. Furthermore, role-attached social forms also are seen as functioning as “signals” for sharing and communication.

### 6.2.2 Summarization of Functions

Annotation functions are the purposes for which people use annotations, and which drives the use of specific annotation forms. In this study, there are five research questions addressing the issues surrounding annotation functions. Annotation functions are reconstructed from the “manifest” content (i.e., annotations remaining on the screen) by applying the form-to-function mapping framework, and supplemented with the purpose of annotating from the protocol transcripts to verify the intention of annotating.

The findings show that the relationship of form and function is not always manifested through the form-to-function mapping framework. Interestingly, people try to adapt forms in various ways to increase efficiency when limited by system features. The adapted forms oftentimes reveal the intentions and functions. For example, in ANNOLINK, extended highlighting is limited to 1000 characters, so participants highlighted the first word of a paragraph instead. This limitation is not a concern in print. It is not sufficient to reconstruct functions by simply looking at the forms; annotation content and annotative circumstances need to be examined as well. “Procedural Signaling,” as an example of the same function that may be manifested through different forms, is not only manifested through highlighting higher level structure (like section headings), but also through notes expressing future reading or cross-out intentions. Notes, as an example of different functions that may be manifested through the same form, not only manifest the “Recording Interpretation” function, but also may manifest the “Incidental Reflection” function or “Procedural Signaling” depending on the content.

In addition, it is also found that annotation on text types (e.g., heading, key term, name, year, and citation) and the relative location of the cued content (topic sentence, within a paragraph, and concluding sentence) in relation to different reading tasks also affects the

implementation of functions. For example, “Procedural Signaling” is found more frequently in the general reading task through highlighting higher level structure (like section headings), and “Place-marking” is found more frequently in the directed reading task through highlighting sentences in paragraph (like main arguments). Another example such as Note-making is found more in the directed reading tasks, and frequently manifests the “Recording Interpretation” function. An examination of the relative locations shows that note-making on topic sentences is found more “to recapitulate” ideas, and note-making on sentences in paragraph is found more “to comment” on ideas.

It is interesting to find that the behavioral form of the “Tracing Difficulty Narratives” function is manifested through Windows mouse tracing, which is a transient digital form that leaves no trace once the mouse pressing is released. Urniawan and Zaphiris (2001) reported that some users use their mouse pointers to guide them in keeping track of their reading location. Hence, in online reading the “Tracing Difficult Narratives” function may exist, but it may be impossible to reconstruct from online annotation forms. Extended highlights, this study shows, are applied mostly on highlighting main points or arguments. In this respect, extended highlights manifest the “Place-marking” function instead.

This study finds that the relationship of annotation form and function is closely related to the theory of signaling devices. For example, in relation to the theory of signaling, highlightings of section headings label the dominant topic or theme of the subsequent text, which Lorch (1989) found to be signals for returning to read closely. Furthermore, tags or labels can direct attention to important content in text. For example, the participants use “definition” or enumeration to label main arguments that the collocation later helps organization. In this perspective, tags or labels may serve as linguistic pointer devices, which Loch and Lorch (1986) found to induce

better memory for signaled content. Similarly, marginal symbols are especially effective for singling out text characteristics, and drawing the readers' attention to a piece of information. Marginal symbols used in a standardized format can draw out the logical orders of the underlying documents (Raban, 2004). Hence, in addition to forms and content, annotation on structure (like highlighting on topic sentence) and the relative location of the cued content (like section headings) have affects on the implementation of functions.

The findings of linking and linktyping show that each component and their combination reflect multiple functions. The combination of linking and linktyping manifests the proposed "Linking Ideas Meaningfully" function, and each component applied individually manifests sub-functions that are grounded in the information function of signal devices. Linking, as a marking of text structure with hypertextuality, reflects Demarcation and Organization of the information functions of signaling devices; Linktyping, as a tag/label with hypertextuality, reflects Labeling and Identification of the information functions of signaling. The results from the coding protocol transcripts also confirm these sub-functions manifested from the protocol analysis.

One of the main contributions of this study is the Annotation Function Coding Scheme, which provides a richer view to annotation functions. The resulting grounded theory provides the theoretical basis for the annotation function typology. The typology provides a richer view of functions involved in online annotation. Applying this model on analyzing annotation functions, it is observed that annotation functions shift in different reading tasks. In the general reading task, the annotation functions mainly reflect "To Remember," and the functions identified in the directed reading task reflect "To Think." Furthermore, because of the potential of sharing online annotations with others, the findings show that people do carry a purpose of communication when creating annotation online. Wolfe and Neuwirth (2001) reported that

shared annotations allow readers to provide feedback to writers or promote communication with collaborators as well as to address remarks directed to future readers while authoring, and thus in a shared environment, some functions reflect “To Communicate” in the conceptual model.

The research carries forward the important work of other scholars on the subject of annotation dimension. Several mappings and concept groupings are relied upon in accumulating the working set of coding schemes in the course of this research. Table 6.1 outlines the contributions made by these scholars, and the additional contribution made in this research.

Table 6.1 Contributions made by various studies on annotation dimensions  
(√ means contribution is found)

	Form-Function Mapping	Concept Grouping of Annotation Functions	Empirical Validation of Annotation Forms, Functions, and Roles	Empirical Validation of Values of Annotations	Development of An Annotation Typology in Relation to Reading Tasks
Marshall (1997)	√		√		
Ovsiannikov et al. (1999)		√			
Bringay et al. (2006)		√	√		
Chiang (2010)	√	√	√	√	√

### 6.2.3 Summarization of Roles

Findings in Research Question 4 show that there are some role-attached forms from the review of existing tools and literature. In addition, in the main study, the coding scheme presents that some annotations are created for an intended audience and some are for communication or collaboration purposes, and hence there is a communication dimension of online annotation functions. These findings suggest some annotation forms and functions may vary by role.

Findings in Research Question 5 show that the form/function relationship varies when annotations are shared with others. First, in the main study, seven participants were asked their

opinions about sharing their annotations with others, and the other eight participants were asked their opinions about viewing others' shared annotations. The results were analyzed and coded in relation to share or not share, and whether there are conditions for sharing. Second, after the sessions, the post-session questionnaire was administered, asking participants to rate their opinions of the usefulness of the forms and functions in terms of varying roles.

The findings indicate that annotation functions are often personal and idiosyncratic, and individuals are not willing to share their annotations when they judge them to be unclear or not helpful to others. The individuals are willing to share when they contain useful insights or interpretations, indicate related resources, or have the potential to spark discussion. The “Tracing Progress through Difficult Narratives” function is manifested through mouse highlighting and thus show no evidence of sharing. In addition, for sharing with a group there is a specific purpose, which may have effects on the function at the time of creating the shared annotations.

The findings also show that forms vary when sharing. The analysis in the main study indicates that Highlighting made on main points or keywords, Notes reflecting intended use, and Linking with a description of the linking relationship are most likely to be shared; in addition, a Tag/Label is likely to be shared if there is a shared understanding of its meaning.

The results from the review of tools and literature indicate that Multiple-color highlighting varies through pre-defined roles and manifests “To Differentiate” when sharing, Threaded annotations vary by role through the focus the attention, and Iconic stamps vary by role through the ownership. System-generated social forms emerge through the aggregation of annotation forms created by various roles including: aggregated rating (e.g., positive or negative),

visual affordance (e.g., tone density), social validation (like the thermometer icon), and annotation-based social navigation support (by calculating annotation activities of the users).

The findings show that annotation functions and forms varying by role must be subject to conditions, such as whether the content is insightful, whether the intended audience is specified, or whether the meaning is clearly represented. The social forms of annotation have been implemented out of original annotation forms because the forms are manifested through the aggregation of original forms via roles representing the “Social Signaling” and the “Social Validation” function.

#### **6.2.4 Summarization of Values**

Like pencil and pen used in the print environment, online annotation requires the use of a system tool to perform active reading online. As Laitenberger and Dreyer (1998) pointed out, users tend to use or not use a tool according to the extent to which they believe it will help them to perform their job better. Borrowing from the Technology Acceptance Model (TAM), Research Question 6 investigates the overall preference and perceived values (ease of use and usefulness) of the use of tool and online annotations, as well as the likeliness to use them in the future. The Perceived Values of Online Annotation Questionnaire is used in this study to assess the participants’ opinions, and the results are supported with evidence found in the protocol transcripts.

The post-session questionnaire is analyzed to investigate the overall preference of the forms and functions, as well as the overall rating of using the annotation tool (i.e., ANNOLINK). The Perceived Values Questionnaire is analyzed to explore the participants’ acceptance of perceived values and future use. Lastly, the participants’ experience in the main study is used as



supporting evidence to the perceived values; hence, the transcribed protocols are coded into value episodes and difficulty episodes, and the resulted episodes are analyzed in accordance with the twelve questions in the Perceived Values Questionnaire.

The results of the post-session questionnaire show that, overall, the participants consider online annotation to be very useful. The average scores of the Perceived Values Questionnaire also show that each of the twelve perceived values shows positive acceptance. However, a further analysis shows that some improvements in the ease of use of the tool may be needed. The participants commented that the ANNOLINK interface is quite straightforward to use. However, the data analysis show that “I find the annotation tools is easy to use” receives a lower likeliness score, as do “Make annotation online easier,” “Make online annotation flexible to interact with,” “Make reading online easier,” and “Increase annotation productivity”; these require further improvements in order to increase the technology acceptance level of the tool.

The findings show that in online environments annotating is closely associated with reading. In terms of “improving performance in reading online,” episode analysis shows that online annotation must keep close proximity to the annotated text, and the format of presentation must not block the reading flow. Summarized notes help to focus the attention in future reading, as long as annotated texts do not distract the reader. It is conjectured that the ability to turn annotations selectively on/off or share selectively with different audiences would increase the acceptance of annotating online.

The participants think positively that online annotation would “improve my performance in reading online,” “enhance my effectiveness on reading online,” and “be useful for reading online.” The episode analysis shows that the content of annotations must be evident to readers.

In addition, the episode analysis shows that “Insightful comments” is favored the most; however, the credibility or trustworthiness of annotations is also important, followed by “annotations should support reading engagement” and “multi-colors highlight different topical themes.” Although there is a learning curve in using the ANNOLINK prototype, especially the use of linking requiring cognitive load, the episode analysis shows that with more practice users would “become skillful at using online annotation.”

From the Perceived Values questionnaire and episode analyses it is observed that people think online annotation would improve their performance in reading online, enhance their effectiveness of reading, be useful for reading online, and allow them to become skillful at it with practice. These reasons account for the likeliness of them using online annotation.

### **6.3 Methodological Contribution**

The research presented in this dissertation makes several contributions to the study of annotation online. The general information model in Chapter 2 facilitates the research design of studying annotation online in different reading tasks, and studying the relations of annotation forms, functions, and roles. The user protocol is successful in eliciting the participants’ comments on their own behaviors. The general and directed reading tasks prove very useful for the analysis of the different annotation functions. Participants’ annotation processes are limited by the functions of the prototype system; and to confront the limitation of ANNOLINK prototype, the combination of the Confirmatory Task with a revised sense-making interview proves useful in eliciting the participants’ comments on their thoughts and decisions of sharing annotation online, as well as their difficulties, helps needed, and functionalities desired.

The post-session questionnaire provides a means for the analysis of the overall preferences in terms of annotation forms and functions. The perceived values questionnaire provides a framework for exploring the perceived values of the use of tools, and the value factors are useful for eliciting the usefulness and difficulty episodes. This combination of techniques affords the rigor of an objective approach, while at the same time supplementing it with qualitative analysis to avoid outcomes that lack substantive validity.

Using the review of existing annotation tools and literature in this study provides insight into other forms and social forms online annotation might support. The review results and literature also provide a means to compare and contrast findings of the main study. The review and literature become an aide once patterns or categories have been identified in the main study (Creswell, 2002, p.31).

## **6.4 Implications for Online Annotation Design and Functionality**

A major purpose of this dissertation study is to look for what variations of forms and features occur and to review the functions these forms and features might support. From this study, a number of important features for future design emerge from the discussions. The following is a list of implications for online annotation design and functionality.

### **6.4.1 Pre-Defined Perspective-Taking Markings**

In Chapter 5, markings and typographical signals are found as one of the “wished-for forms,” as well as in the existing annotation tools and research literature. The functions might be “Procedural Signaling” or “Place-marking.” Predefined icons or symbols, as a kind of

annotation forms, might signal perspective opinions in personal view; and differentiate opinions and roles in public view.

The findings in Chapter 5 show that predefined symbols and icons for personal use or for sharing capture concepts “To Differentiate” or “To Compare.” Wolfe (2008) found that perspective-taking annotations provoke students to work harder to understand the text and reason through their own stance on the primary text; for example, words such as “however,” “but,” “I disagree” and “no!” are usually clear indicators of disagreement while phrases such as “Good point,” “Yes,” “agreed,” and “exactly” indicate agreement. Wolfe (2008) reported that many of the annotations produced by instructors began with such position words; therefore, it may be possible to develop a set of common words and their variations that can be used to identify an annotation’s stance. Wolfe (2008) suggested developing text-mining tools that can identify the stance of the annotation.

The results of this study also show that iconic stamp representing private use needs to identify its ownership when sharing. Furthermore, pre-defined icon or symbol needs to bear rating for aggregating to signal importance when sharing. Similar implementations include the AnnotatED’s (Farzan & Brusilovsky, 2008a) design of pre-defined markings (thumb-up and thumb-down icons) and tags allowing readers to identify the stance of their annotations at the time of create them. Those AnnotatED markings or stances are signaling devices and reflect the Procedural Signaling function. Research showed that this type of annotations could be aggregate form using social navigation mechanisms, e.g., thermometer or tag cloud features. Future research may want to examine the hypothesis that system-aggregate social forms may best be utilized in general reading task, since they manifest the “Procedural Signaling” with social validation.

### **6.4.2 Focus Attention on “Best” Annotations**

In addition to pre-defined markings, in Chapter 5 the results also show that there are other forms reflecting the “Place-marking” function. These forms are used to distinguish levels of importance in text and also to aid in the recollection of main ideas, which could be “best” annotations for readers to gain an advantage from them. For example, numbering of main points, short highlightings on main points or keywords in text, and labeling annotations facilitate the quick recall and discovery of the annotated content, and helps the reader for improving recollection. Numbering of main points and Labeling/Tagging text passage serve the purpose of looking for patterns in the text. In a shared environment, these forms need to be pre-defined and without ambiguity in meaning, because the content must be evident to the reader. Developers should focus on designing annotation systems that present the best, most productive annotations rather than attempting to display all annotations made (Wolfe, 2008).

Visual affordance is an important design heuristic for focusing on “best” annotations in a shared environment. The findings indicate that system-generated social forms are aggregated from making use of many users’ past interaction with the system. Thus, visual affordance indicating the aggregation signals the concentration of use and guides new users of the system. For example, highlights aggregation needs visual affordance to signal importance when sharing. Label/Tag aggregation also needs visual affordance to signal a heated topic when sharing.

### **6.4.3 Design for Social Purpose**

This study finds that while almost half of the private annotations people created could be willingly shared with others, people share their annotations selectively. Annotation functions are

the purposes for which people use annotations, and which drive the use of specific annotation form. Annotation content may be personal reflections inspired by the texts. But, the potential of sharing annotations in a digital environment may cause the user to reflect not on the text but on the use of the text, e.g., sharing with a collaborator. Marshall and Brush (2004) pointed out that there are different purposes when sharing with a workgroup and when sharing with the public, and annotations are subject to go through revisions before being shared.

Designing annotation systems to accommodate social purposes offers new ways to respond to materials, but also new ways to read and to have our readings shaped by the thoughts of others. Findings of this study show that role-attached forms carry a purpose of communication. However, in the case of threaded annotations, it needs a mechanism to focus the attention on the comments when reviewing others' comments and replying.

The “To Differentiate” or “To Compare” concepts attest to both personal and a shared environment. For example, multi-color highlighting is commonly applied to different topical schemes for personal annotation. System-generated social forms are also found in multiple colors to differentiate the ownership (or roles) when sharing. However, colors may be limited for representing annotation owners beyond certain number. The reader should have the control of choosing the owner and a visual cue (e.g., color, number, etc.) when comparing annotations.

#### **6.4.4 “Toggle On/Off” Annotation**

Participants expressed the view that it is absolutely critical that readers could turn the annotations off very quickly and easily, perhaps in one single click. It would also be important to have the annotations turned off by default, because annotated texts distract the readers, especially the first-time readers. Findings of this study suggest that annotation writers should be

in control of the layout format and the sharing of annotations. When the purpose is to read and discuss a published, primary text, interlinear or “sticky note” interfaces do not seem to be useful layouts. In their study of annotation layouts, Zellweger, Regli, Mackinlay, and Chang (2000) found that many readers objected to annotations that interrupted the flow of the primary text. Cabanac et al. (2005; 2007) moreover noted that interlinear annotations may potentially be confused with the primary text.

Findings of this study also show that too much information also makes it hard to read from the screen. As the number of annotations on any given text grows, one would imagine that such interruptions would become increasingly annoying; thus, readers who might tolerate the occasional annotation interrupting the primary text might quickly become intolerant when the quantity of annotation begins to rival the amount of primary text, as could become the case with highly controversial or particularly salient texts.

Furthermore, the findings indicate that some functionality in online annotation systems is better at doing what readers want than their paper counterpart, such as easy editing of annotations, the ease of separating ownership of annotations, and the ability of easily sharing annotations selectively with different audiences. In this regard, for example, participants express the desire to be able to save two versions of online annotations, one version with their personal annotations and another for sharing, or to use different colors to differentiate personal, group(s), and public annotations. These are seen to be useful online annotation features.

#### **6.4.5 “A Separate Space” for Editing Notes and Linking Articles**

In Chapter 4, some participants commented that an online annotation tool for *in situ* annotating, without having to look for other utilities, would accomplish the reading and

annotating task more quickly. Some commented that marginal notes provided context. However, more participants expressed the need to have a workspace for editing notes and linking articles. Specifically, they suggested that the ease of editing annotations made annotating online very useful.

Limited screen real estate is perhaps the central obstacle in the development of marginal note interfaces, and designers have yet to propose a fully satisfactory solution to this problem. ANNOLINK (Marginalia) places all readers' comment in a single margin. However, once again the interface becomes cluttered once a large number of annotations are present; moreover, readers cannot directly comment on one another's comments (Glass, 2005).

Studies of collaborative editing have shown that placing commentary near its referent improves the ability of reviewers to add comments and of later editors to process the comments (Wojahn, Neuwirth, & Bullock, 1998), and also speeds reader performance (Zellweger, Mangen, & Newman, 2002). Pop-up tooltip windows may occlude materials on the original page. Whatever the format may be – interlinear, sticky note, marginal note, etc. – as more and more annotations are added, more cognitive effort is required from users to reconcile annotation with the primary text.

It seems unlikely that any one layout would be a satisfactory solution to this real-estate problem. In order to continue to reap the benefits of an annotation system as it grows in popularity, designers need to take advantage of the interchangeability of interfaces to allow users (1) to change annotation format – for example, the marginal note format is easy to relate with the base text, the sticky note format is easy for moving the annotation to any screen place, e.g., for comparison purpose, and the interlinear format also has the advantage of proximity; and (2) to



adapt the limit of annotation space by extending it into a separate document, similar to using an “infinite expanding space” interface that allows the commentary to expand beyond the confines of a single page. This is well attested by one participant’s speculation that scholarly annotations might eventually turn into an entire essay.

In Chapter 5, the review of annotation tools show that a number of existing tools provide a central and contextualized place to store annotations, and also to allow users to export annotations together with the base passages onto their desktops, version synchronization and checksum is an important function. The whole process should be seamless and require no changes to the work practice of readers.

#### **6.4.6 Annotation Systems Should Support Online Active Reading Practices**

Findings in Chapter 5 show that the use of online annotations needs to consider the reader-author perspectives, and the acceptance of an annotation tool is also affected by the satisfaction of the reading-writing technology supported. The shift of reading strategies from reading the primary text to reading the annotations, which provokes readers to take a position, has been reported useful for scaffolding critical thinking practices in educational settings where instructors often want students to wrestle with complicated and controversial issues (Wolfe, 2008). Hence, annotation systems should be designed with reading practices in mind.

Findings of this study show that in general reading, readers create annotations signaling effects on their text-processing and minimize the interruption of their reading flow. A lightweight annotation interface may be desirable to match the effort required with a generally passive reading style. In successive readings or more directed readings, readers reflect more thinking in their annotations, and a full mode annotation interface may be designed to support

complicated editing work with the ability of changing annotation formats. A robust mechanism that allows positioning annotations in various formats is desirable.

Findings in Chapter 5 show that the participants, in general, think online annotation is very useful. The perceived values suggest that people want to produce more annotations during their reading while not blocking the reading flow. They also want the features to be visible and the work of editing annotations to be easier. When these perceived factors are supported, they would think a tool is easy to use. For perceived future use, this study finds that people think positively about future use more from the readers' perspective.

## **6.5 Future Research**

One obvious course for future research will be to conduct a user study in a digital environment within a social setting. If sharing with a group has a specific intention that is different from sharing with the public, then it is essential that the sharing of annotations be observed in a real environment. Though stated as a research sub-goal, the outcomes for the role were investigated by asking the participants for what they would do in sharing. The “To Communicate” concept is conjectured from the findings in the verbal protocol analysis of the participants' intentions in sharing, as well as the review of tools and literature. The findings shed some light on the social forms and functions, but have not been empirically confirmed. Any future study should seek to confirm both social forms and their functions, and more importantly, the roles of annotation in a real sharing environment.

Further specification of the relationships between annotation forms and the theory of signaling is also an important issue requiring further study. It is clear from an examination of the annotation forms and functions that there are location cue differences. Annotations on relative

locations and text entities affect readers' text processing. It is interesting to find out that the form-function relationship is similar to the text-based and reader-based theory of signaling. That is, the availability of the text signals is relevant to the reader's purpose to grasp the meaning. Annotation while reading is a proven technique to assist learning by engaging people in active reading in the paper environment, but how to incorporate annotations on different text structures – such as headings, topic sentences, and paragraphs in reading – into reading and comprehension could be investigated. Evidence in this study shows annotations on the screen taking the effect of signaling devices. One possible alternative in a future study would be to have two groups of participants creating annotations: one group creating annotations on headings and topic sentences, and the other group creating annotations on paragraphs. The reading comprehension results can be measured to investigate the effects of annotating on different text structures as reading strategies. The task activity must take place over a period of time that is adequate for participants to be learning reading strategies in their use.

Attention might also be given to investigating the relationship between annotation functions and the previous knowledge and profiles of participants, as proposed in the general information model of annotation relationship. None of the participants in this study have previous knowledge of using an online annotation tool. The advantage of this is that it provides a good understanding about the behavior of novice users. One possible alternative in a future study would be to have two groups of participants (i.e., novices and experienced online annotation users) to compare the differences between groups.

Exciting possibilities for future research lie in applying a large-scale survey using the Technology Acceptance Model questionnaire for the use of a popular annotation tool. In this study, the initial findings of the perceived values of annotation online show that the design of

online reading-writing activities must not block the reading flow. The application of TAM survey in this study sheds some light on the perceived values of reader-writer relationship. It is also the only way to truly assess the acceptance of an existing online annotation tool in reading-writing environment. It is clear that this method is best used to assess the perceived values from a large data set. Evidence of this is given in the review of TAM studies. This could be accomplished by sending TAM surveys to the users of a real world annotation tool.

Lastly, and perhaps most importantly, an investigation into the additional functions identified in this study should be carried out, to thoroughly examine the use of these functions and the reasons behind them. This is especially cogent to the development of annotation features and forms in the digital environment. Annotation functions, as presently identified, reflect why people annotate. Currently, the new developments in annotation technologies tend to vary in input device, interface, base text, anchors, storage, and searching and filtering mechanisms (Agosti & Melucci, 2000; Wolfe, 2002; Agosti & Ferro, 2005a; Reeve & Han, 2005). Semi-automatic and automatic creation of annotations is another new technology that researchers are starting to develop (Reeve & Han, 2005). Yet, the use of annotation online is still in its infancy and not widely accepted by users. Only by studying what new forms and functions people would accept or not accept could researchers and designers construct features and techniques of annotating to engage people in active reading online.

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# APPENDICES

## Appendix 1 Certificate of Approval



The University of British Columbia  
Office of Research Services and Administration  
**Behavioural Research Ethics Board**

### ***Certificate of Approval***

PRINCIPAL INVESTIGATOR <b>Kopak, R.</b>	DEPARTMENT <b>Library Archival &amp; Information</b>	NUMBER <b>B06-0824</b>
INSTITUTION(S) WHERE RESEARCH WILL BE CARRIED OUT <b>UBC Campus ,</b>		
CO-INVESTIGATORS: <b>Chiang, Chia-Ning, Library Archival &amp; Information</b>		
SPONSORING AGENCIES <b>Social Sciences &amp; Humanities Research Council</b>		
TITLE: <b>Navigating Information Spaces: Link Types as Semantic Signposts in Hypermedia</b>		
APPROVAL DATE <b>NOV 09 2006</b>	TERM (YEARS) <b>1</b>	DOCUMENTS INCLUDED IN THIS APPROVAL: <b>Oct. 25, 2006, Consent form / Questionnaires / Poster</b>
CERTIFICATION:  <p>The application for ethical review of the above-named project has been reviewed and the procedures were found to be acceptable on ethical grounds for research involving human subjects.</p>  <p><i>Approved on behalf of the Behavioural Research Ethics Board</i> <i>by one of the following:</i> <b>Dr. Peter Suedfeld, Chair,</b> <b>Dr. Jim Rupert, Associate Chair</b> <b>Dr. Arminee Kazanjian, Associate Chair</b> <b>Dr. M. Judith Lynam, Associate Chair</b></p> <p>This Certificate of Approval is valid for the above term provided there is no change in the experimental procedures</p>		

## Appendix 2 Call for Participation Email

Hello,

My name is Chia-Ning Chiang. I am a PhD candidate at the School of Library, Archival and Information Studies, UBC. I am conducting a study to fulfill the research component of my degree, and I am sending this note to ask for volunteers. In my research, I am interested in the use of an online annotation system and looking for participants to use the system and who will share their experiences of the annotating process.

If you agree to participate in this study, we would ask you to do the following things:

1. Complete a Demographic Questionnaire.
2. Be given instruction on the use of the annotation feature of the Open Journal System.
3. Perform think-aloud protocol on the annotation exercise. You will be asked to perform an annotation exercise while verbalizing your thoughts. The session will include reading six short articles and writing annotations using the annotation feature, creating hypertext links between article segments using the linking feature, and choosing a link type from a drop down box that describes the nature of the relationship between the two segments. The annotation sessions will be recorded via Morae software (including recording of the screen, user, and keystrokes).
4. Review a replay of the annotation session via the Morae software and to reflect on your experiences in performing the annotations and linking and express your thoughts in your own words when the scenario is replayed. You will also be asked to complete a short questionnaire asking you to rate quantitatively features of the annotation and linking component. It is estimated no longer than two hours to complete the annotation sessions (step 3 to 4).

Participation in this research is voluntary, and participants are ensured confidentiality. The sessions may also be videotaped. Videotapes will be used for analysis only. You have the option not to be videotaped. Please consider participating. If you would like to participate, for the good of the research, or because you would like to help out a colleague; else please respond to me by [DATE]. If you do not wish to participate, but can recommend someone who can participate, please forward that person's contact information to me.

If you decide to participate, we can discuss arrangements for the test and interview: date, time, and location (if appropriate). At that time, I will give you a packet of information that includes a copy of the interview questions, and my contact information. Please note that I have listed my UBC e-mail account and my home phone number below.

Thank you very much.

Chia-Ning Chiang  
PhD Student  
Dr. Richard Kopak  
Principal Investigator  
School of Library, Archival and Information Studies  
University of British Columbia

## **Appendix 3 UBC BREB Consent Form**

### **Consent Form (no videotaping) A Multi-dimensional Approach to the Study of Online Annotation UBC Ethics Approval B03-0490**

#### **Principal Investigator**

Dr. Richard Kopak, Assistant Professor, School of Library, Archival and Information Studies, UBC

#### **Co-Investigator**

Chia-Ning Chiang, PhD student, School of Library, Archival and Information Studies, UBC

#### **Project Purpose and Procedures**

The purpose of this study is to gather information that can help improve the design of interactive technology of online annotation. You will be asked to use a prototype annotation system to perform a number of tasks. Your participation will help us assess the usability of this prototype application. An online annotation tool will be presented on a computer display and you will be asked to manipulate as many as functions through the use of an input device. We will record your performance and analyze how the application is used.

Audio and video recordings may be made of your performance. We will observe you performing those tasks and analyze how the technology is used. You may also be asked to complete a questionnaire and we may ask to interview you to find out your impressions of the technology that will help us assess your experience with computer technology and your impressions of the prototype application. By consenting to participate in this study, you also consent to participation in the audio and video recordings, and the completion of the questionnaire form. Your total participation time will be no longer than about two hours. In exchange for your participation, you will be provided with access to research computing applications and tools to assist you while you are being observed.

We will ensure that all recorded data are accessible only by project investigators and are kept secure in a locked faculty office. All data from individual participants will be coded so that your anonymity will be protected in any publicly available reports, papers, and presentations that result from this work.

We intend for your experience in this study to be pleasant and stress-free. If you are uncomfortable, or are unhappy participating in this study, you are free to withdraw at any time, without any repercussions to you whatsoever. We would be pleased to explain to you the purpose and methods used in this study in academic detail after your participation has concluded, and to furnish you with our results when they become available. We are very grateful for your participation. However, you will not receive compensation of any kind for participating in this project.

This research study is funded by the operating and strategic grant programs of the Social Sciences and Humanities Research Council of Canada (SSHRC). Portions of this research will



be used for graduate theses. If you have any questions or desire further information with respect to this study, you may contact Dr. Richard Kopak or his student Chia-Ning Chiang. If you have any concerns about your rights or treatment in this or any other UBC experiment, you may contact the Research Subject Information Line in the UBC Office of Research Services at (604)822-8598. You have been given a copy of this consent form for your records. You do not waive any legal rights by signing this consent form.

I, \_\_\_\_\_, agree to participate in the project as outlined above.  
My participation in this project is voluntary and I understand that I may withdraw at any time.

\_\_\_\_\_  
Participant's Signature Date

\_\_\_\_\_  
Co-Investigator's Signature Date

## Appendix 4 Pre-Test Demographic Questionnaire

### A Multi-dimensional Approach to the Study of Online Annotation

Participant Number: \_\_\_\_\_

#### Please Check the Appropriate Space to Answer These Questions

1. Your current status is:

Staff \_\_\_\_\_  
Faculty \_\_\_\_\_  
Undergrad \_\_\_\_\_  
Graduate \_\_\_\_\_

2. You are: Female \_\_\_\_\_ Male \_\_\_\_\_

3. Major field of study: \_\_\_\_\_

4. Have you used a Webpage annotation system before?

Yes \_\_\_\_\_  
No \_\_\_\_\_ (if No stop here)

5. If yes, what is the name of the annotation system?

Specify \_\_\_\_\_  
e.g., ADOBE ACROBAT, ANNOTATOR, DEL.ICIO.US, WALDEN'S PATHS, etc.

6. How frequently do you use the online annotation system?

2-3 times a week \_\_\_\_\_  
once a week \_\_\_\_\_  
2-3 time a month \_\_\_\_\_  
once a month \_\_\_\_\_  
Less than once a month \_\_\_\_\_

7. Have you shared your annotation with others?

Yes \_\_\_\_\_  
No \_\_\_\_\_  
Why/Why Not? \_\_\_\_\_

8. Do you check others' annotations?

Yes \_\_\_\_\_  
No \_\_\_\_\_  
Why/Why Not? \_\_\_\_\_

## Appendix 5 Think-Aloud Verbal Protocol Instrument

### THE THINK-ALLOUD VERBAL PROTOCOL INSTRUMENT

(Page 1 of 2)

#### Introduction

The purpose of the think-aloud protocol is to gather information about reading, annotating, and linking processes in which readers are reading while annotating text during the test task situation. The annotation tools of the Open Journal System Demo Site shall be used as a test instrument for the think-aloud protocols. The think-aloud activity will take place individually after the test taker completes a pre-test survey, which will take approximately 10 minutes.

There are articles on this test site, each participant will be asked to read six short articles, write annotations, create hyper links between article segments using the linking feature, and choose a linktype from a drop down box that describes the nature of the relationship between the two segments. Each think-aloud activity will last for 1 1/2 to 2 hours at a quiet and secure place. You will first make annotations only for your private use, and in the returning sessions to edit them for sharing with others. I will ask you to think aloud what you thought while annotating the article. You can take a break after completing one article, or choose to continue to another article. All think-aloud activities will be video-audio recorded by the software called Morae installed on the designated machine.

I want to emphasize that I am not interested in how well you write the annotations, but I am interested in what you thought while completing the annotation process. Therefore, I will ask you to talk aloud CONSTANTLY, to say as much as you can about what you are thinking and doing as you read and make annotations. You don't have to explain what you are reading. Just act as if you are alone in the room and talking to yourself out loud. Whatever you say is good.

What is very important is that you keep talking, and talk clearly and loudly enough into the microphone. The interaction between the interviewer and the participant shall be kept minimal. I will sit quietly while you read and annotate. Questions shall be asked minimally when the participant does not verbalize thoughts sufficiently. In case you forget to say what you are thinking and doing, I will remind you to think out loud. Thinking out loud while you read might seem strange at first, but you will get the hang of it quickly, and we will practice together for a few minutes.

Thanks for your help with this project.

#### Set Up

(To be filled by an interviewer prior to a think-aloud session)

Participant # \_\_\_\_\_

Date:

Starting time:

Ending time:

Place:

Equipment

Reading material used for a session:

Comments on the setting: (i.e., interruption, delaying, etc.)

### Instructions for Thinking Aloud

- Attach your microphone as close to your mouth as possible. Make sure to speak into the microphone, not the voice recorder.
- Speak at a normal volume – don't try to talk more quietly or quickly than you normally would. When you're typing, speak especially loudly.
- Try to enunciate as much as possible.
- Please say aloud **everything** you're thinking as you select, read, think about, react, and compose responses to the reading/annotating/linking process.
- If you notice you have stopped talking, start again by noting which section heading you are currently reading or writing and describing your thoughts about that message.
- Refer to each section you **read** by indicating the name of the author and by reading at least some of the content.
- Refer to each section you **write** by indicating that you are composing a message and by reading at least some of the content as you type.
- When you **read**, focus on describing:
  - (1) Your initial judgments/reactions to the section you read and
  - (2) Your reasons for greater interest in liking over others
- When you **write/compose**, focus on describing:
  - (1) Your intentions in composing the annotation
  - (2) Your reasons for choosing certain words over others or a certain linktype over another
- Don't worry about stray remarks or irrelevant comments – The important thing to remember is to continue talking as much as possible about your cognitive processes and judgments of reading while writing in the annotation process.

## Appendix 6 Revised Sense-Making Interview Questions

(Page 1 of 2)

Before the Interview: (Introduction to study—to be read with participants on the day of the interview at the time they sign the Consent Form.)

Script: You are being asked to participate in an interview that will last approximately 1-1 1/2 hours. Your voluntary participation is appreciated. Should you identify yourself on the tape, that portion will be erased and excised when the tape is transcribed. Feel free to ask any questions about the interview process before the interview begins, or after it has ended. However, during the actual interview, I will not be able to answer questions of that nature. Thank you for holding questions/suggestions that arise concerning the interviewing process until the interview has ended. After the interview, I will gladly answer your questions.

The interview will consist of a series of questions relating to your experience as a reader /annotator of information technologies. I will ask you to recount your experiences, prompting you using a set of open-ended questions. Prompts are designed to jog your memory, and get you started in your responses. I have structured the interview questions in such a way as to allow you to explore your answer as thoroughly as possible. Therefore, some questions may sound repetitive, but each question aims toward exploring a different, though related, facet of your experience. This cyclical recurrence in questioning, is called redundancy. However, if you think you have answered a question as thoroughly as you would like; just inform me, and I will move on to the next question. Remember that the goal of the interview is to let you respond as fully to a question as you would like, so at times, there will be periods of silence—as in normal conversation—to allow you to collect your thoughts and to continue with a train of thought or to indicate that you have finished with that response.

**Upon completion of this research, results may be mailed or otherwise distributed to you, at your request. Simply contact me at the address listed in your information packet.**

### **Situation 1 -- General Reading Task**

(Page 2 of 2)

1. What reading strategy you were using? Did it help you to make annotations? How? Did it hinder? How?
2. What annotation functions do you think they have matched here? For each used, did it help in the later reading tasks? How? Did it hinder? How?

### **Situation 2 -- Directed Reading Task**

3. At this stage, what reading strategy you were using? Did it help you to make annotations? How? Did it hinder? How?
4. What annotation functions do you think they have matched here? For each used, did it help in the later reading tasks? How? Did it hinder? How?
5. Did you have any thoughts/ ideas/memories at this stage in the annotation process? If yes, what were they?
6. Do you think at this stage you would like to share your annotation with others? If yes, to a work group or to the larger public? What leads you to think of your audience in this way?
7. If you have help at this stage in making annotations, what would have helped?
8. Did you have any emotional reactions about making highlighting, annotating, linking, or linktyping at this point? If yes, what were they?

### **Situation 3 -- Confirmatory task**

9. At this stage, if these annotations were made by another user, what would have helped for you to use other's annotations in any way?
10. If you are going to share your annotations with others, what let up to your decision in sharing of the annotations?
11. Is there anything about your shared annotation as it is now that you would want to change? If yes, what leads you to want to make this change?
12. What annotation functions do you think they have matched here?
13. Did you have any thoughts/ ideas/memories at this stage in the annotation process? If yes, what were they?
14. If you have help at this stage in making annotations, what would have helped?
15. Did you have any emotional reactions about making highlighting, annotating, linking, or linktyping at this point? If yes, what were they?

Suppose this system is not a prototype and can do thins that you want to make annotations online, what features do you think would be helpful?

## Appendix 7 Post-Session Questionnaire

(Page 1 of 3)

### POST THINK-ALoud PROTOCOL QUESTIONNAIRE

1. Did you find any new features in this system?
2. What feature(s) do you like most when annotating online for your own annotations?

Feature	Please <b>circle</b> your rating					
	Most	1--2--3--4--5	Least	Don't know 0		
Underlining/highlighting	1	2	3	4	5	0
Note-writing	1	2	3	4	5	0
Marking (e.g., asterisk)	1	2	3	4	5	0
Linking	1	2	3	4	5	0

3. What feature(s) do you like least about annotating online for your own annotations?

Feature	Please <b>circle</b> your rating					
	Most	1--2--3--4--5	Least	Don't know 0		
Underlining/highlighting	1	2	3	4	5	0
Note-writing	1	2	3	4	5	0
Marking (e.g., asterisk)	1	2	3	4	5	0
Linking	1	2	3	4	5	0

4. What kind of annotation function do you use most for your own annotations?

Function	Please <b>circle</b> your rating					
	Most	1--2--3--4--5	Least	Don't know 0		
Procedural signaling to attract attention in future readings	1	2	3	4	5	0
Place marks to aid memory	1	2	3	4	5	0
Work on problems	1	2	3	4	5	0
Record interpretations	1	2	3	4	5	0
Trace progress through difficult narrative	1	2	3	4	5	0
Incidental reflection of the material circumstances of reading	1	2	3	4	5	0
Follow annotation type link to look for information more like this	1	2	3	4	5	0

5. What kind of annotation function do you use most for sharing your annotations with your work group, for example your project partners in your class?

Function	Please <b>circle</b> your rating					
	Most	1--2--3--4--5	Least	Don't know 0		
Procedural signaling to attract attention in future readings	1	2	3	4	5	0
Place marks to aid memory	1	2	3	4	5	0
Work on problems	1	2	3	4	5	0
Record interpretations	1	2	3	4	5	0
Trace progress through difficult narrative	1	2	3	4	5	0
Incidental reflection of the material circumstances of reading	1	2	3	4	5	0
Follow annotation type link to look for information more like this	1	2	3	4	5	0

6. What kind of annotation function do you use most for sharing your annotations with the larger public, for example, the whole class?

Function	Please <b>circle</b> your rating					
	Most	1--2--3--4--5	Least	Don't know 0		
Procedural signaling to attract attention in future readings	1	2	3	4	5	0
Place marks to aid memory	1	2	3	4	5	0
Work on problems	1	2	3	4	5	0
Record interpretations	1	2	3	4	5	0
Trace progress through difficult narrative	1	2	3	4	5	0
Incidental reflection of the material circumstances of reading	1	2	3	4	5	0
Follow annotation type link to look for information more like this	1	2	3	4	5	0

7. When you shared your annotations with the others, did you stick with your initial annotation or did you change your content?

Stick with initial \_\_\_\_\_

Change \_\_\_\_\_ Please explain why you make changes?



8. How do you feel about annotating online?

Strongly like 1---2---3---4---5 Strongly dislike Don't know 0

1 2 3 4 5 0

9. Were there any problems or concerns about this think-aloud activity?

10. While you were thinking aloud, you said XX. Could you tell me a little more about what you thought?

## Appendix 8 Perceived Values of Online Annotation Questionnaire

### Perceived Values of Online Annotation

The OJS annotation tool is a prove-of-concept prototype to demonstrate the highlighting, note-making, linking, and linktyping capabilities of online annotation. Say you had the OJS annotation tool to help with your reading journal articles online. Please give your reaction to the following statements about online annotation.

Perceived Usefulness (Select ONLY ONE rating per row)	
Perceived Usefulness Questions	Please <b>circle</b> your rating
	Extremely Likely 1-2-3-4-5-6-7 Strongly Unlikely
1. Using online annotation in my online reading would enable me to accomplish tasks more quickly	1    2    3    4    5    6    7
2. Using online annotation would improve my performance in reading online	1    2    3    4    5    6    7
3. Using online annotations in my reading online would increase my productivity	1    2    3    4    5    6    7
4. Using online annotations would enhance my effectiveness on reading online	1    2    3    4    5    6    7
5. Using online annotations would make it easier to do my reading online	1    2    3    4    5    6    7
6. I would find online annotations useful for reading online	1    2    3    4    5    6    7
Perceived Ease of Use Questions	Please <b>circle</b> your rating
	Extremely Likely 1-2-3-4-5-6-7 Strongly Unlikely
7. Learning to operate online annotation would be easy for me	1    2    3    4    5    6    7
8. I would find it easy to get online annotation tool to do what I want it to do	1    2    3    4    5    6    7
9. I would find online annotation to be flexible to interact with	1    2    3    4    5    6    7
10. It would be easy for me to become skillful at using online annotation	1    2    3    4    5    6    7
11. I would find the online annotation tool easy to use	1    2    3    4    5    6    7
Self-Predicted Future Use	Please <b>circle</b> your rating
	Extremely Likely 1-2-3-4-5-6-7 Strongly Unlikely
12. Assuming an online annotation tool would be available as I read online. I predict that I will use it on a regular basis in the future.	1    2    3    4    5    6    7

Comments and suggestions about the value of online annotations are welcome

---

## Appendix 9 User Session Procedure Sheet

### Procedures outline

1. Sign BREB consent form
2. Ask participants to read Vora's article and bring the copy to us (Vora's article)
3. Fill out the Pre-test Questionnaire
4. Take Training
5. Start think-aloud: read, annotate, link, linktype for three tasks
  - 15 minutes - General Reading
  - 30 minutes - In-depth Reading
  - 15 minutes - Revisit your annotations (2nd group needs to comment on others' annotations)
6. Fill out the Post-test Questionnaire
7. Use annotations remaining on the screen and interview the participants
8. Sign honorarium Receipt
9. Copy the participants' printed Vora article

### Instruments

1. Consent Form
2. Pre-test Questionnaire
3. Training Kit
4. Think-aloud Script
5. Post-test Questionnaire
6. Time-line Interview

### Equipments

1. Microphone
2. Tape recorders
3. Tapes

### The Procedures of recording the use of OJS Annotation Tools

1. Go to <http://pkp.sfu.ca/ojs/checkout>
2. Under Open Journal Systems Demonstration Journal, click REGISTER to register yourself as reader.
3. Start Morae recording
4. Log in the Open Journal Systems Demonstration Journal with your ID and PW
5. Click Open Journal Systems Demonstration Journal
6. Click CURRENT to get the Table of Contents of the test issues
7. Click HTML article format to begin your annotation tasks, first the General Reading Task, stop the Morae recording when finished. Then follow the Morae Procedure in the followings to save the recording file. The same procedure applies to the Directed Reading Task and the Confirmation Task.

### Morae Procedure Sheet

1. Start Morae
2. Choose "Start a new project by recording the screen" and click OK
3. Select Entire Screen (Record the entire screen), and click Next on the New Recording Wizard window
4. Select Next on the Recording Options message

5. Click Finish
6. Press F9 to start the recording process or click the Record button on Morae Recorder
7. Click Yes to confirm the recording dimensions
8. During the recording there is green light blinking at the bottom right corner of the screen.
9. Press F10 to stop the recording process or double click the Morae button (red ball icon at the bottom right corner of the screen) to call out the Morae Recorder, click Capture and select Stop
10. Morae will automatically play the whole recording
11. Click Save button
12. Give a file name following this convention: start with a K to represent this study, your participant number with an underscore, the task code (G, D, R), and the no. of times of your recording (if failed to record at the first time, just simply make a new project and continue to record). For example: K007\_G\_2.mrcfg (means K study, Participant number 7, General Reading Task, and the second recording; the mrcfg is the file attribute of the Morae Recording File)
13. Select “Produce my video in a shareable format” on the Post-Save Options window.
14. Select Custom production settings, and click Next
15. Select AVI video (Audio Video Interleave)
16. Click Next on AVI Encoding Options window
17. Click Next on Video Size window
18. Click Next of Video Options
19. Click Next on Marker Options
20. Type in the same file name (for example K\_007\_G\_2) in the Production name, and click Finish button.
21. Click Finish on the Production Results window.
22. Morae will render the project, and the Morae Player will automatically display the recording.

## Appendix 10 RQ2.1 Table

Total numbers of episodes found from the content analysis with examples by using the mapping online annotation forms to functions **(Page 1 of 3)**

Function	Form (ANNOLINK)	Forms Used (Examples from user sessions)	Total
Procedural signaling to attract attention in future readings (Procedural Signaling)	<ul style="list-style-type: none"> <li>Highlighting higher level structure (like section headings)</li> </ul>	<ul style="list-style-type: none"> <li>Highlightings on headings</li> </ul>	<b>29</b>
	<ul style="list-style-type: none"> <li>Telegraphic marginal symbols like asterisks (the Linking icon *)</li> </ul>	Links (where the signals are located) and their target text patterns include: <ul style="list-style-type: none"> <li>Name to heading</li> <li>Name to name</li> <li>Name to sentence</li> <li>Heading to heading</li> <li>Heading to paragraph</li> <li>Phrase to paragraph</li> <li>Sentence to sentence</li> </ul>	<b>9</b>
	<ul style="list-style-type: none"> <li>Short Notes</li> </ul>	Short notes signaling future revisit: <ul style="list-style-type: none"> <li>See Conklin, See below re: Nelson - inventor of hypertext; see also Vora and Helander for comparison</li> <li>Check it later</li> <li>I would like to read this article</li> <li>Look up and link for theory</li> <li>Need to return; need to revisit</li> <li>Not clear, needs further understanding</li> <li>Read more about this</li> <li>Reminder: read Bush's paper later</li> </ul>	<b>28</b>
	<ul style="list-style-type: none"> <li>Long Notes</li> </ul>	Long notes signaling future revisit: <ul style="list-style-type: none"> <li>Update? Look for newer editions or works by the same editor/author</li> <li>Has this happened? What research is being done?</li> <li>I wish I could link to a definition in another article to that I could refer to it later</li> </ul>	<b>3</b>
	<ul style="list-style-type: none"> <li>Short notes similar to Cross-outs</li> </ul>	Short notes denote disagree or similar to cross-outs: <ul style="list-style-type: none"> <li>Disagree with this ideas</li> <li>Not a current term</li> <li>I don't buy this - weak point</li> </ul>	<b>3</b>

**Appendix 10** RQ2.1 Table - Total numbers of episodes found from the content analysis with examples by using the mapping online annotation forms to functions **(Page 2 of 3)**

Function	Form (ANNOLINK)	Forms Used (Examples from user sessions)	Total
Place marks to aid memory (Place-marking)	• Short highlightings	Short highlightings signal the importance of texts: • Name • Year • Diagram caption	6
	• Highlighted words or phrases	Highlighted texts where the signal is located: • 29 instances (10+19) appeared in the first sentence of a paragraph • 19 instances (7+12) appeared within the passage • 4 instances (1+3) appeared at the end	52
	• Marginal markings like asterisks (**), exclamations (!!!), and question marks (???)	Markings signaling the impression of reading the texts	6
Trace progress through difficult narrative (Tracing Progress through Difficult Narrative)	• Extended highlighting (more than 10 words highlighted)	Extended highlightings where the signal is located • Whole citation (3) • Whole paragraph (5) • Highlighting keyword such as First and Second in a paragraph instead of the whole sentence (adapted form).(2) • Phrases (7) and sentences (38) • Extend highlightings of the sentence at the beginning of a paragraph means the topic sentence. A topic sentence states the essential idea of its paragraph or larger section (12 out of 38). • Concluding sentences (4 out of 38) summarizes the main ideas of the paragraph.	53
	• Short highlightings	Highlights from mouse tracing • (transient, only captured by screen recordings)	3
Work on problems (Problem-working)	• Appropriate notation in margins (e.g., Linktype used as labeling the highlighted texts) or near links	• Linktypes selected or the links • Linktypes selected to describe the links	108

**Appendix 10** RQ2.1 Table - Total numbers of episodes found from the content analysis with examples by using the mapping online annotation forms to functions **(Page 3 of 3)**

Function	Form (ANNOLINK)	Forms Used (Examples from user sessions)	Total
Work on problems (Problem-working)	<ul style="list-style-type: none"> <li>• Short notes of word definitions, pronunciation, and url created from TinyURL site</li> </ul>	<p>Short notes created as a result of Internet searching or url translation work</p> <ul style="list-style-type: none"> <li>• Definition checking via the OJS Reading Tools</li> <li>• Update: Coiro, 2006. <a href="http://tinyurl.com/23o6ta">http://tinyurl.com/23o6ta</a></li> <li>• Definition: <a href="http://tinyurl.com/yrtpec">http://tinyurl.com/yrtpec</a></li> <li>• Homeopathic fallacies - an assumption that hypertexts resembles memory or the structure of the brain</li> <li>• Pronunciation: "ka-t-'krE-ss</li> </ul>	8
Record interpretation (Interpretation)	<ul style="list-style-type: none"> <li>• Short notes in the margins (less than 10 words)</li> </ul>	<p>Short notes, e.g.,</p> <ul style="list-style-type: none"> <li>• A further elaboration of linking</li> <li>• I'm still not sure that people really get this.</li> </ul>	109
	<ul style="list-style-type: none"> <li>• Long notes in the margins (greater than 10 words)</li> </ul>	<p>Long notes, e.g.,</p> <ul style="list-style-type: none"> <li>• Technique for organizing computer databases or documents to facilitate the non-sequential retrieval of information.</li> <li>• It is interesting that Barthes refers to this specifically as "computer hypertext" which implies that there is a non-computer form of hypertext. This indicates somehow that the idea of hypertext is not limited to the technology used.</li> </ul>	65
Incidental Reflection of the material circumstances of reading (Incidental Reflection)	<ul style="list-style-type: none"> <li>• Notes unrelated to the materials themselves</li> </ul>	<p>Long or short notes, e.g.,</p> <ul style="list-style-type: none"> <li>• These dimensions are useful for evaluating our project of course assignment</li> <li>• If any one who have more sources regarding the distinctions between the two, it's welcome</li> <li>• Suggestion to my friend majoring in education</li> <li>• Lisa</li> <li>• Refers to a similar study by Kevin Lynch called the Image of the city wherein links , nodes and how they capture the image of a city</li> </ul>	14
<b>Total</b>			<b>492</b>

## **Appendix 11 A List of 22 Online Annotation Tools Reviewed in This Study**

Based on the recommendations from faculty, researchers, system developers, and [www.digg.com](http://www.digg.com), 22 annotation tools were selected for review in this study.

1. CommentPress -- [www.futureofthebook.org/commentpress/](http://www.futureofthebook.org/commentpress/)
2. Coventi Pages -- [coventi.com](http://coventi.com)
3. Diigo -- [www.diigo.com](http://www.diigo.com)
4. Fleck -- [www.fleck.com](http://www.fleck.com)
5. Hylighter -- [www.hylighter.com](http://www.hylighter.com)
6. Google Notebook -- [www.google.com/notebook](http://www.google.com/notebook)
7. Jump Knowledge -- [www.jkn.com](http://www.jkn.com)
8. Marginalia -- [www.geof.net/code/annotation/download](http://www.geof.net/code/annotation/download)
9. mynoteIT -- [www.mynoteit.com](http://www.mynoteit.com)
10. Mystickies -- [www.mystickies.com](http://www.mystickies.com)
11. Notate -- [beta.textensor.com/](http://beta.textensor.com/)
12. Notefish -- [www.notefish.com](http://www.notefish.com)
13. Notezz! -- [www.notezz.com](http://www.notezz.com)
14. PLoS --  
[www.plosone.org/article/feedArticle.action?articleURI=info:doi/10.1371/journal.pone.0000000](http://www.plosone.org/article/feedArticle.action?articleURI=info:doi/10.1371/journal.pone.0000000)
15. SharedCopy -- [sharedcopy.com](http://sharedcopy.com)
16. ShiftSpace -- [www.shiftspace.org](http://www.shiftspace.org)
17. Sidenote -- [www.macupdate.com/info.php/id/17654](http://www.macupdate.com/info.php/id/17654)
18. Stickis -- [stickis.com](http://stickis.com)
19. Stikkit -- [www.stikkit.com](http://www.stikkit.com)
20. TrailFire -- [trailfire.com](http://trailfire.com)
21. Yahoo! Notepad -- [widgets.yahoo.com/widgets/yahoo-notepad](http://widgets.yahoo.com/widgets/yahoo-notepad)
22. Zoho Notebook -- [notebook.zoho.com](http://notebook.zoho.com)



## Appendix 12 RQ4.1 Annotation Function Coding Scheme

Code name:

Level:

Definition:

Source:

Synonym:

Example:

### Annotation functions

Code name: **To remember**

Level: 1

Definition: People tend to forget the contents of the paper and there must be a way to quickly recollect the main ideas.

Source: Ovsiannikov et al. (1999)

Synonym: keep in mind, retain information, memorize, consider, take into account, recollect  
(Thesaurus: English (U.S.))

Example:

Code name: **To signal**

Level: 2

Definition: People tend to remind themselves or readers about certain key points or to attract attention in the second or future reading.

Source: Marshall (1997)

Synonym: to incite to action, to indicate something has happened or is about to happen  
(Encarta Dictionary: English (North America))

Example: annotations or verbal protocols such as “need to return,” “revisit,” “read more detail,” etc.

Code name: **To remind**

Level: 3

Definition: remind to revisit the previous annotations

Source: Bringay et al. (2006)

Synonym: cause to think of something,

Example: remind to clarify; remind to get update information

Code name: **To focus the attention**

Level: 3

Definition: bring to attention

Source: Bringay et al. (2006)

Synonym: reminiscent, resonant (serving to bring to mind)

Example:

Code name: **To check references**

Level: 3

Definition: check bibliographic citation for further reading

Source:

Synonym: Reference (Abiodun, 2007); Chiang's findings

Example:

Code name: **To place mark**

Level: 2

Definition: Hold the quotes that are being reserved for the paper that the student will write at the end of the term, the chemical reactions and term definitions the student must memorize for the final, the theorem that is key to the proof in the homework assignment (Marshall, 1997).

When reading scholarly articles, this function is to recognize an important passage or identify an argument in the text, and is probably signaled whatever information is relevant to their learning goals (Chiang, 2010).

Source: Marshall (1997)

Synonym: None

Example: identify an argument; recognize an important passage; make markings (e.g., ?, !, \*, etc.)

Code name: **To mark the logical structure of the document**

Level: 2

Definition: make the annotation serves the purpose for organization of text

Source: Bringay et al. (2006); Lemarie et al. (2008)

Synonym: classification (Abiodun, 2007); structuring (Abiodun & Amos, 2006), tagging to categorize, reorganize, arrange, group, and label (Chiang, 2010)

Example:

Code name: **To demarcate the segment for linking**

Level: 3

Definition: demarcate the link to related information and thus changing the reading order

Source: Landow (1996); Moreland et al. (1997); Lemarie et al.(2008).

Synonym: connect, route, associate, and relate something with another; demarcate

Example:

Code name: **To label segments consistently**

Level: 3

Definition: enumerate multiple ideas in an organized fashion

Source: Simpson & Nist (1990); Lemarie et al. (2008)

Synonym: label, classify

Example:

Code name: **To think**

Level: 1

Definition: In the process of reading a paper, the reader can also come up with his/her own new ideas, critical marks, questions, and notes reflecting one's opinion on the subject.

Source: Ovsiannikov et al. (1999)

Synonym:

Example:

Code name: **To record interpretation**

Level: 2

Definition: To add an explanation or one's new ideas, critical remarks, or questions

Source: Bringay et al. (2006); Marshall (1997)

Synonym: Understanding, explanation, reading, construal, elucidation, analysis  
(Thesaurus: English (U.S.))

Example: an explanation of an unfamiliar language, the remarks refer to a single word or phrase, comments made by the participants, etc.

Code name: **To explain**

Level: 3

Definition: give details about something or give reasons for something to illustrate or make extension of the original text that carries new information

Source: Moreland et al., (1997); (Chiang's findings);

Synonym:

Example:

Code name: **To comment**

Level: 3

Definition: to state a fact or give an opinion of remark or critical observation

Source: (Chiang's findings); evaluation (Abiodun, 2007)

Synonym: To analyze, assess, criticize, evaluate, agree, disagree

Example:

Code name: **To challenge an idea**

Level: 3

Definition: object to something or call something into question by demanding an explanation, justification, or proof

Source: question (Moreland et al., 1997); raise a point (Abiodun, 2007); (Chiang's findings).

Synonym:

Example:

Code name: **To give additional information**

Level: 3

Definition: To add updated information

Source: (Chiang's findings); illustration, extension of document (Abiodun, 2007)

Synonym:

Example:

Code name: **To work on a problem in context**

Level: 2

Definition: resolve unfamiliar term; finding information to answer the questions or arguments the annotation writers have when reading online

Source: Chia-Ning adapted from Marshall (1997)

Synonym:

Example: The approach to lookup definitions for a term, to find an online copy of a bibliographic citation, or to find answer to a question the reader has when reading online.

Code name: **To identify connecting ideas**

Level: 2

Definition: identify connections between pieces of information and connect together fragments of semiotic productions using various narrative strategies such as linking with linktyping and/or notemaking.

Source: adapted from Castaneda, Lopez, and Romero (1987); Zacklad (2005)

Synonym:

Example:

Code name: **To clarify**

Level: 1

Definition: The clarification of certain places in the paper such as personify information in the paper by reshaping the hard-to-grasp ideas in the text into one's own verbal representations, or rephrasing in the person's own conceptual language. This is contrast with To Think, clarifying notes do not carry much new information.

Source: Ovsianikov et al. (1999)

Synonym: To synthesize, classify, organize, structure,

Example:

Code name: **To trace progress through difficult narrative**

Level: 2

Definition: People tend to trace progress through difficult narrative, as a visible trace of the reader's attention.

Source: Marshall (1997)

Synonym:

Example:

Code name: **To recapitulate**

Level: 2

Definition: To restate thematic ideas or to recite briefly of the major points in a narrative; Paraphrasing (definition from Wikidictionary)

Source: Simpson and Nist (1990); Abiodun and Amos (2006);

Synonym: recapitulation; summary;

Example:

Code name: **To differentiate**

Level: 2

Definition: To distinguish or compare differences between things.

Source: Abiodun (2007);

Synonym:

Example:

Code name: **To record incidental reflection**

Level: 1

Definition: People's writing may be repurposed for a different circumstance than supposed. The incidental reflection of the material circumstances of reading may not be related to the reading topic.

Source: Marshall (1997)

Synonym: reflect thoughts occurring by chance or without intention

Example:

Code name: **To communicate**

Level: 1

Definition: To share or exchange information (OED); to reveal by clear signs (Merriam-Webster); to talk about your thoughts and feelings, and help other people to understand them (Cambridge); to impart knowledge of (Wiktionary). For this study, to communicate represent a dimension of communication with others or only keep to him/herself; therefore, to communicate means to share annotations with others or concerning annotations private or personal.

Source: Ames and Naaman (2007)

Synonym: To ask, discuss; to answer to a question (Abiodun, 2007).

Example: "Like to know other's reflection on this" (share annotation), "Pose a question" (share annotation), "Bring to discussion"(share annotation); "Appropriate interpretation" (share annotation); "Personal interests" (private), "For personal use" (private), "Don't want to confuse people" (private), "Uncertain about the interpretation" (private);

Code name: **To write a personal note**

Level: 2

Definition: Private annotation for personal use;

Source: Bringay et al. (2006)

Synonym:

Example: personal interests; don't want to confuse people; uncertain about the interpretation; need to update notes

Code name: **To share annotation with others**

Level: 2

Definition: Shared annotation

Source: (Chiang's findings)

Synonym:

Example: "Appropriate interpretation"; "Helpful to others"; "Like to know other's reflection"; "To share with a designated audience"; "Useful to a task".

Code name: **To ask for information**

Level: 3

Definition:

Source: Bringay et al. (2006)

Synonym: question somebody, pose question, make request, invite somebody to discuss (Thesaurus: English (U.S.); Encarta Dictionary: English (North America))

Example:

Code name: **To share with a designated audience**

Level: 3

Definition: similar to Bringay's definition (to make circulate a piece of information)

Source: adapted from Bringay et al.'s (2006) definition

Synonym:

Example

## Appendix 13 RQ5.1 Reasons of Sharing Annotations with Others

Function	Reasons to Share (Examples)	Category
Incidental Reflection	<ul style="list-style-type: none"> <li>• I don't know what they are, may be someone could explain or spark discussion (P2).</li> <li>• People might be interested (P4).</li> <li>• [That's] my little comment there (P4).</li> <li>• [Web 2.0] that's what people kind of doing these days (P11)</li> <li>• This is for my sister Lisa (P13)</li> </ul>	<ul style="list-style-type: none"> <li>• Spark Discussion</li> <li>• Interesting</li> <li>• Helpful</li> <li>• Additional information</li> <li>• Helpful</li> </ul>
Interpretation	<ul style="list-style-type: none"> <li>• Let people comment about that (P4).</li> <li>• [Share this annotation with others] but need some revision (P4), (P14).</li> <li>• [Share, but need to] revise so a little bit clear to people (P4), (P9).</li> <li>• [Share, but] not sure if it's helpful [to others] (P4).</li> <li>• I think that's interesting for others to know too (P4).</li> <li>• Need to revise, this is related to my background so I would be happy to make it public (P6).</li> <li>• Important [for others] to know this comment (P10)</li> <li>• [Share but need to] write more in them, add a little more context to them (P11)</li> <li>• I like that for any reader (P14)</li> </ul>	<ul style="list-style-type: none"> <li>• Spark Discussion</li> <li>• Clear</li> <li>• Clear</li> <li>• Interesting</li> <li>• Interesting</li> <li>• Helpful</li> <li>• Useful</li> <li>• Clear</li> <li>• Interesting</li> </ul>
Place-marking	<ul style="list-style-type: none"> <li>• Doesn't impose any thing [on others] (P3).</li> <li>• The part that I didn't understand, someone can help me (P3).</li> <li>• Highlight the keyword [for others] (P4).</li> <li>• There is a definition [evident to people] (P4).</li> <li>• That was me saying wow! (P4).</li> <li>• It's helpful for people just scanning through examples [evident to people] (P6)</li> <li>• This is a main point (P6) (P10).</li> <li>• May be this would trigger something meaningful (P6).</li> <li>• I need to do a little bit research on that, if I can't find extra, I will take that out (P12).</li> <li>• Highlighted names may be helpful to people (P13).</li> <li>• This sentence is a main idea and useful for people (P13)</li> <li>• I don't know why I used Alternate View [linktype] there; I should make changes (P13).</li> <li>• Markings are purely for personal use, but the highlighted part is the main point that can be shared (P13).</li> </ul>	<ul style="list-style-type: none"> <li>• Helpful</li> <li>• Ask help</li> <li>• Helpful</li> <li>• Helpful</li> <li>• Interesting</li> <li>• Helpful</li> <li>• Useful</li> <li>• Spark discussion</li> <li>• Clear</li> <li>• Helpful</li> <li>• Useful</li> <li>• Clear</li> <li>• Useful</li> </ul>
Procedural signaling	<ul style="list-style-type: none"> <li>• Indications for exploration (P10)</li> <li>• Share but I want to expand or revise (P12)</li> </ul>	<ul style="list-style-type: none"> <li>• Useful</li> <li>• Clear</li> </ul>
Problem-working	<ul style="list-style-type: none"> <li>• Updated information for people (P12)</li> </ul>	<ul style="list-style-type: none"> <li>• Additional information</li> </ul>
Linking ideas meaningfully	<ul style="list-style-type: none"> <li>• Let others know the linking [to another piece of information (P4).</li> <li>• [Let others know] a link to the footnote in the Burbules [article] (P12)</li> <li>• Links may be quite useful, they are like people's path of thinking. Although linktypes are useful to somebody who can get what kind of relationships between the two articles (P15)</li> </ul>	<ul style="list-style-type: none"> <li>• Additional information</li> <li>• Additional information</li> <li>• Useful</li> </ul>

## Appendix 14 RQ5.2 Reasons of Not Sharing Annotations with Others

(Page 1 of 2)

Function	Reasons of Not Sharing (Examples)	Category
Incidental reflection	<ul style="list-style-type: none"> <li>• I don't really know whether others would understand (P2)</li> <li>• There's a typo so I won't share with others (P2).</li> <li>• This may cause confusion (P2).</li> </ul>	<ul style="list-style-type: none"> <li>• Not clear</li> <li>• Not clear</li> <li>• Not clear</li> </ul>
Interpretation	<ul style="list-style-type: none"> <li>• Just a question comment that I'm interested in (P2).</li> <li>• A comment for myself (P2).</li> <li>• A general question for myself (P2).</li> <li>• Not sure larger public know what it means, probably not [to share with others] (P2).</li> <li>• Need to make sure this has not been defined in this article, I don't want to confuse people (P4) (P6).</li> <li>• Look it up before I am asking people (P4).</li> <li>• Need to make sure before sharing (P4).</li> <li>• Why I put this Alternate view here, I don't think that's what I mean. So I just delete it [if I want to share with others] (P4).</li> <li>• I would read the article through before I share [the annotations with others] (P4).</li> <li>• Not sure people would understand what I mean here (P6)</li> <li>• More help to myself (P6).</li> <li>• My own opinion, and not to share with others (P6).</li> <li>• My little interpretation there (P6)</li> <li>• It's just a summary [Not very helpful] (P6).</li> <li>• It's a conversation with the author, keep it to myself (P12).</li> <li>• Something that I goof around, no [not share with others] (P14).</li> <li>• Not useful [to others], delete (P14)</li> <li>• Not share, unless my annotations are clear and pointed, or a question asking about something (P14)</li> </ul>	<ul style="list-style-type: none"> <li>• Personal Interests</li> <li>• Personal use</li> <li>• Personal use</li> <li>• Personal use</li> <li>• Not clear</li> <li>• Not clear</li> <li>• Not clear</li> <li>• Not clear</li> <li>• Not clear</li> <li>• Not clear</li> <li>• Not clear</li> <li>• Personal use</li> <li>• Personal interests</li> <li>• Personal interests</li> <li>• Not helpful</li> <li>• Personal interests</li> <li>• Not useful</li> <li>• Not useful</li> </ul>
Place-marking	<ul style="list-style-type: none"> <li>• Highlight it, so that I can find it later and put a question there [for myself] (P1).</li> <li>• [Share highlights, but I] need to revise [to share with the group] (P1).</li> <li>• Not immediately evident to people (P4).</li> <li>• Numerical numbering things, not to confuse people (P4).</li> <li>• Delete the repeated highlight, because it will not help people (P4).</li> <li>• That was something for my own (P4).</li> <li>• It's just repeated the words in the text, not helpful to others (P6).</li> <li>• Not sure that's helpful to others (P6).</li> <li>• [The word repeated from the text is] Just the flagging along my reading, not need any more (P6).</li> <li>• I'll take that out [if I want to share with others], not to distract people (P6).</li> <li>• Take Alternate View out [not clear what it means] (P6).</li> <li>• Not comfortable to share highlights with somebody else (P13).</li> <li>• [Look up ... is ] My own system to follow up (P13).</li> <li>• This is something of my own interests, if it's going to be shared I would [revise it and] put "collaboration" for labeling the idea (P13).</li> <li>• If everybody is sharing highlighting, I suppose everything would be highlighted [so not share] (P15).</li> </ul>	<ul style="list-style-type: none"> <li>• Personal use</li> <li>• Not clear</li> <li>• Not clear</li> <li>• Not clear</li> <li>• Not helpful</li> <li>• Personal interests</li> <li>• Not helpful</li> <li>• Not helpful</li> <li>• Not helpful</li> <li>• Not useful</li> <li>• Not clear</li> <li>• Not clear</li> <li>• Personal use</li> <li>• Personal use</li> <li>• Personal interests</li> </ul>



## Appendix 14 RQ5.2 Reasons of Not Sharing Annotations with Others

(Page 2 of 2)

Function	Reasons of Not Sharing (Examples)	Category
Procedural signaling	<ul style="list-style-type: none"> <li>• Need to revisit. That's personal (P2).</li> <li>• A note for myself (P2) (P10) (P12)</li> <li>• General comment, no one but myself would understand (p2)</li> <li>• My own speculating (P11).</li> </ul>	<ul style="list-style-type: none"> <li>•Personal use</li> <li>•Personal interests</li> <li>•Personal interests</li> <li>•Personal interests</li> </ul>
Problem-working	<ul style="list-style-type: none"> <li>• Definitions or pronunciation [notes] are for myself (P12).</li> </ul>	<ul style="list-style-type: none"> <li>•Personal use</li> </ul>
Linking ideas meaningfully	<ul style="list-style-type: none"> <li>• I never follow links, so may be not useful to others (P6)</li> </ul>	<ul style="list-style-type: none"> <li>•Not useful</li> </ul>